Technical Memorandum

April 27, 2022

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From	Tim R Anderson	**Ref. No.**	12559567
Subject	EES referral for the Geelong Hydrogen Hub – Groundwater assessment		

1. Introduction

GHD Pty Ltd (GHD) is engaged by GeelongPort Pty Ltd (GeelongPort) to support the preparation of environmental referral documents in relation to the proposed development of the Geelong Hdyrogen Hub at the Port of Geelong. GeelongPort is seeking to undertake the following referrals to the relevant agencies:

– Environmental Effects Statement (EES) referral to the Victorian Minister for Planning and the Department of Environment, Land, Water and Planning (DELWP) under the *Environmental Effects Act 1978*
– *Environment Biodiversity and Conservation Act 1999* (EPBC) self-assessment, and potentially a referral under the same Act to the Commonwealth Department of Agriculture Water and Environment (DAWE)

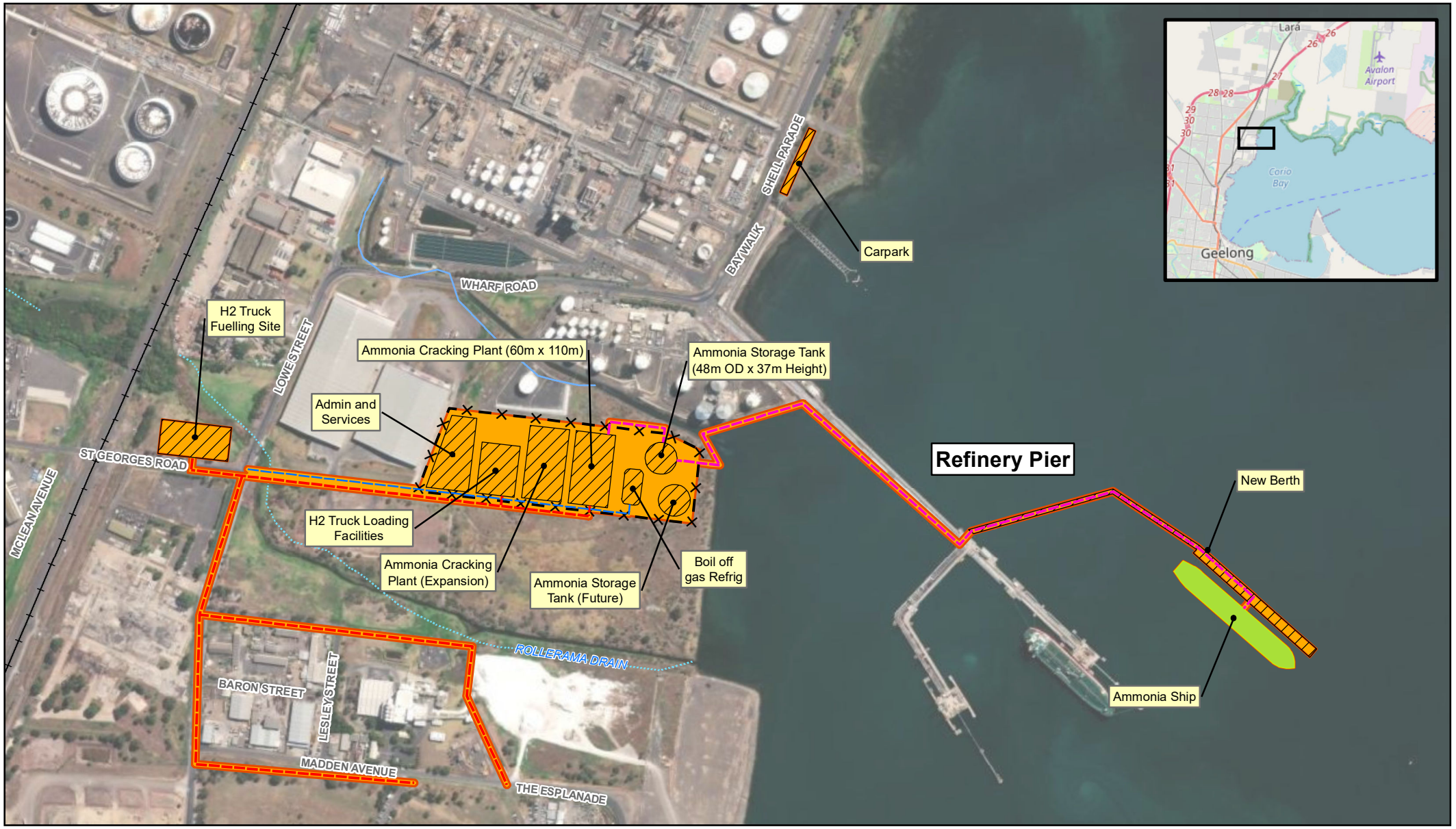
This memorandum has been prepared to support and inform the environmental referral documents and , and presents the findings of a preliminary groundwater assessment (desktop assessment only) for the proposed project and development area.

2. Project overview

GeelongPort propose to develop a facility at Port of Geelong to import liquid ammonia, produce hydrogen and nitrogen by ammonia decomposition (or cracking over a catalyst), and distribute hydrogen to potential offtake users within the Port of Geelong as well as in wider Victoria. Use of hydrogen for these industrial processes will present a strong offset for gas production and consumption needs. The site layout highlights the key process buildings, pipeline routes and structures, and allows for future expansion or alternative applications for the ammonia/hydrogen (Figure 1). The proposed site for the facility comprises approximately 7.5 hectares of land that is wholly owned by GeelongPort. The key project components comprise:

– New ammonia import berth as an extension of Refinery Pier in Corio Bay
– Transfer pipeline to an onshore storage facility
– Onshore storage facility for liquid ammonia (60 m diameter storage tank(s))
– Catalytic cracking plant(s) to decompose ammonia into hydrogen and nitrogen
– Onshore distribution pipelines to potential industrial users either within the Port of Geelong or in adjacent industrial zones
– Vehicle refuelling facility (hydrogen)
– Carpark

An options assessment was undertaken for alternative berth layouts to accommodate future imports of ammonia. The preferred berth layout is located within the existing dredge pocket and therefore no capital dredging is required.



LEGEND

- Hydrogen Off Take Route Options
- Ammonia Import Pipeline
- Road and Power Utilities
- Building/area
- Ammonia Ship
- Fence
- Concept layout footprint

Paper Size ISO A4

0 50 100 150 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

GeelongPort

GeelongPort Hydrogen Facility EES Referral

Conceptual site layout

Project No. **31-12559567**
Revision No. **0**
Date **26 Apr 2022**

FIGURE 1

G:\31\12559567\GIS\Maps\Deliverables\12559567_002_ConceptualSiteLayout_A4L_Rev0.mxd
Print date: 26 Apr 2022 - 15:30

Data source: GHD, 2021;Vicmap; 2021. ESRI, World Imagery, 2021. Created by: fcarve

2.1 Investigation area

The groundwater study area is a parcel of land extending from the eastern extent of St Georges Road, Geelong, to Corio Bay. The main industrial process area is to be located here, with a truck (tanker) fuelling site to be located near the intersection of St Georges Road and Seabeach Parade.

Supply pipelines and services will extend along the Refinery Jetty and border the Terminals Tank Farm located to the north of the site, to the industrial process location.

Apart from Corio Bay, there are two other waterways close to the groundwater study area:

– Rollerama Drain (also referred to as Cuthbertson's Creek)
– Unnamed stormwater outlet (southern boundary of Terminals Pty Ltd) – has been referred to as Oyster Bay Creek or alternatively the Shell Effluent Channel (Woodward Clyde, 1997)

3. Method

This memorandum has been prepared using publicly available information regarding groundwater. This includes:

– Published geological mapping (Victorian Mines Department)
– Environmental Audit reports (released by the EPA)
– DELWP Water Measurement Information System
– DJPR Earth Resources Database
– Review of aerial imagery

No site inspection or intrusive subsurface investigations have been undertaken.

4. Relevant legislation

In terms of the groundwater environment, the legislation summarised in Table 1 is relevant:

Table 1 Legislation, policy and guidelines

Document	Relevance
National Environment Protection Council Act 1994 (NEPC Act) (Commonwealth)	This is considered a relevant guideline where contaminated groundwater (and water, land, air) may be encountered by the project.
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Commonwealth)	This is relevant where there are EPBC Act listed species within the project study area.
Water Act 1989 (State)	This is relevant where works require the use of, or result in the disturbance to the State's water resources
Environment Protection Act 2017 as amended by *Environment Protection Amendment Act 2018* (State) (EP Act)	Has resulted in a number of policies relating to groundwater (and water) being rehoused in new regulations and standards. Former EP Act (1970) has been repealed.

5. Geology

5.1 Regional setting

The geology of the groundwater study area comprises a series of Palaeozoic rocks which have been overlain by Mesozoic and Neogene (Tertiary and Quaternary sediments and volcanics). The geology and physiography of the area is influenced by a series of major structures and tectonism over geological time. A summary stratigraphy has been provided in Table 2.

Table 2 Summary stratigraphy

Epoch		Formation		Lithology
Quaternary	Recent	Undifferentiated alluvials and coastal dunes		Variable mixtures of sands, silts, clays and gravels
	Pleistocene	Undifferentiated alluvium		
		Freshwater limestone	Newer Volcanic Basalt	
Tertiary	Pliocene	Moorabool Viaduct Sand		Calcareous sand, clayey sand
	Miocene to Oligocene	Barwon Group	Fyansford Formation	Limestone, sandy clays, silts, marls
			Maude Limestone	
			Batesford Limestone	
			Curlewis Limestone	
			Waurn Ponds Limestone	
	Eocene	Werribee Formation	Older Volcanics Maude Basalt	Basalt
	Paleocene			
Cretaceous	Lower	Barrarbool Sandstone		Sandstone, shale, mudstone
		Unconformity		
Devonian				Granite
		Unconformity		
Ordovician	Middle	Castlemaine Group equivalents		Slate, shale, sandstone
	Lower			

Notes:
1. Adapted from the Geelong 1:63,360 geological mapsheet.
2. Moorabool Viaduct Sands time equivalents include the Brighton Group (now referred to as the Sandringham Sandstone).

The oldest rocks in the region are indurated Lower to Middle Ordovician marine sediments. These rocks comprise bedded siltstones, shales and sandstones and form the geological basement. There was a period of non-deposition and then intrusion of granites during the Upper Devonian to Carboniferous periods. These older Palaeozoic rocks do not outcrop locally and their existence is inferred from deeper drilling.

Rifting and breakup occurred around the late Jurassic to Cretaceous periods. Volcaniclastic rich sequences of non-marine greywackes, mudstones, coals and sandstones were formed. These rocks were subsequently eroded and buried beneath more recent sedimentation during the Tertiary and Quaternary. The Cretaceous geology is considered too deep to be influenced by the proposed project.

During the Tertiary (Neogene) there were several phases of marine transgression and regression (sea level changes) resulting in the formation of the thick marine sequences over the Palaeozoic rocks. The basal Tertiary sequence is the terrestrial Werribee Formation, however, it is likely to be thin (<20 m thick) and buried at depth (>150 m) beneath the site (if at all present). There were also periods of volcanism resulting in the deposition of the Older and Newer Volcanics.

Limestones (marine) sequences were deposited in the mid-Tertiary and are expected to be upwards of 150 m thick at the site. In the upper Tertiary, the Moorabool Viaduct Sands were deposited, and subsequently covered in part by various lava flows of the Newer Volcanics. These have been in part eroded, or covered by recent (Quaternary) alluvial, beach and swamp deposits.

5.2 Site geology

The Geelong 1:63,360 scale geological mapsheet indicates the site to be situated on Quaternary and Tertiary age sediments (refer Figure 2). Quaternary coastal dune deposits are mapped along the coastal strip. These in turn overlie the Moorabool Viaduct Sand (or time equivalents). Further west of Seabeach Avenue / Lowe Street, lava flows of the Newer Volcanics have been mapped.

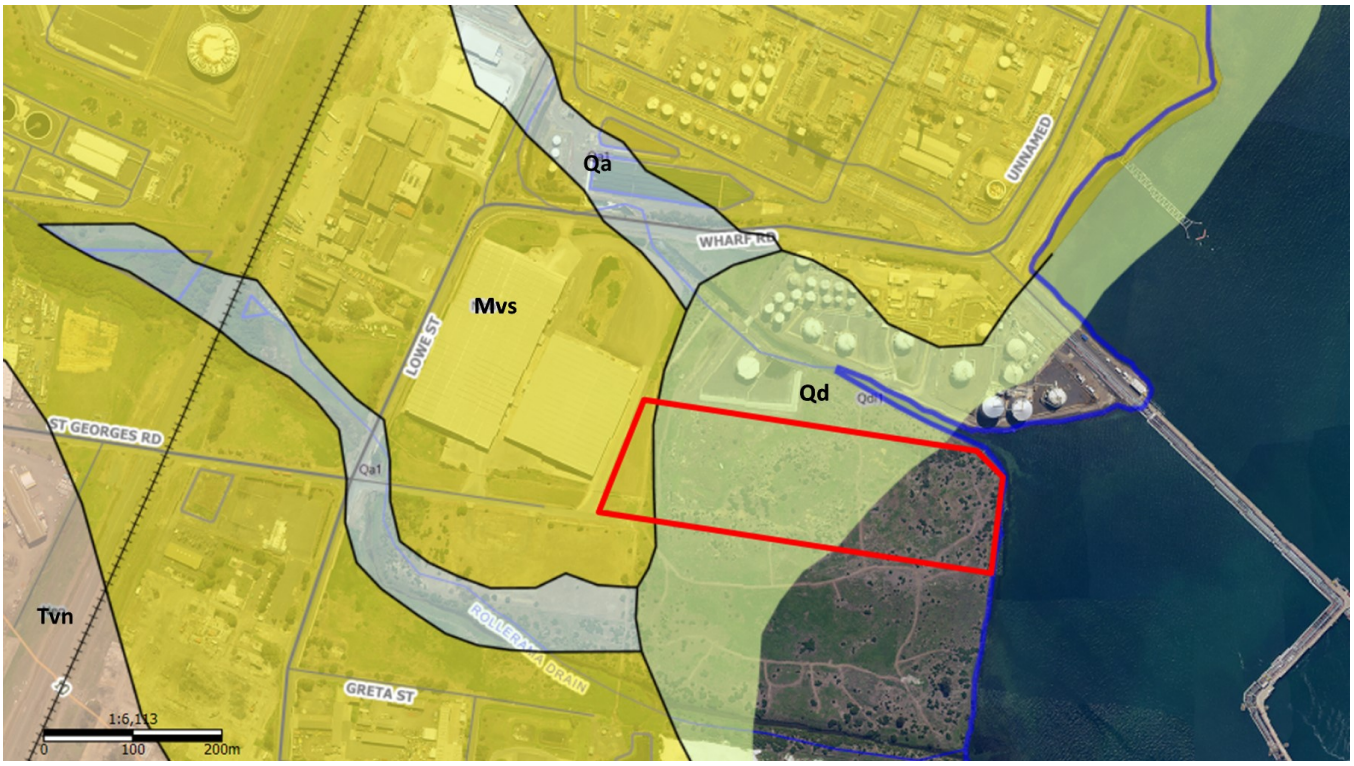


Figure 2 Study area geology

Tvn – Newer Volcanics, Mvs – Moorabool Viaduct Sand, Qd – Quaternary coastal deposits, Qa – Quaternary alluvials

Given the groundwater study area is located within an industrialised precinct of Geelong, it is likely that anthropogenic filling has occurred to level the land and reclaim swamps and low lying depressions adjacent to the coastline. Woodward Clyde (1997) noted that drilling undertaken in the area often encountered approximately 1 m of fill over much of the site. The log of borehole OC18 indicated domestic fill to at least 8 m depth (refer Figure 4 for bore location).

6. Hydrogeology

6.1 Identified aquifers

All of the afore mentioned geologies, where saturated, constitute aquifers. The Moorabool Viaduct Sand is the principal aquifer in the groundwater study area and constitutes a regional water table aquifer. It is interpreted to be hydraulically connected with the coastal dunes aquifer systems, and where present, the overlying Newer Volcanic basalt.

The groundwater study area does not fall within a defined groundwater management area (GMA). This is circumstantial evidence that there are no groundwater resource issues that require closer management by DELWP.

6.2 Conceptualisation

A schematic of the hydrogeological conceptualisation has been shown in Figure 3 which is a stylised cross section through the groundwater study area. On the site the water table resides with the Moorabool Viaduct Sands and the undifferentiated Quaternary deposits. Filling has occurred and there will be areas where deeper fill is saturated (below the water table).

The Newer Volcanic basalts are not mapped on site and occur further to the south and west. They too form a water table aquifer where saturated. The Moorabool Viaduct Sands are estimated to be around 20 m thick, and overlie mid-Tertiary marine sediments (limestones). The Moorabool Viaduct Sands are a bedded sedimentary sequence and therefore horizontal hydraulic conductivities are potentially an order of magnitude greater than vertical hydraulic conductivities.

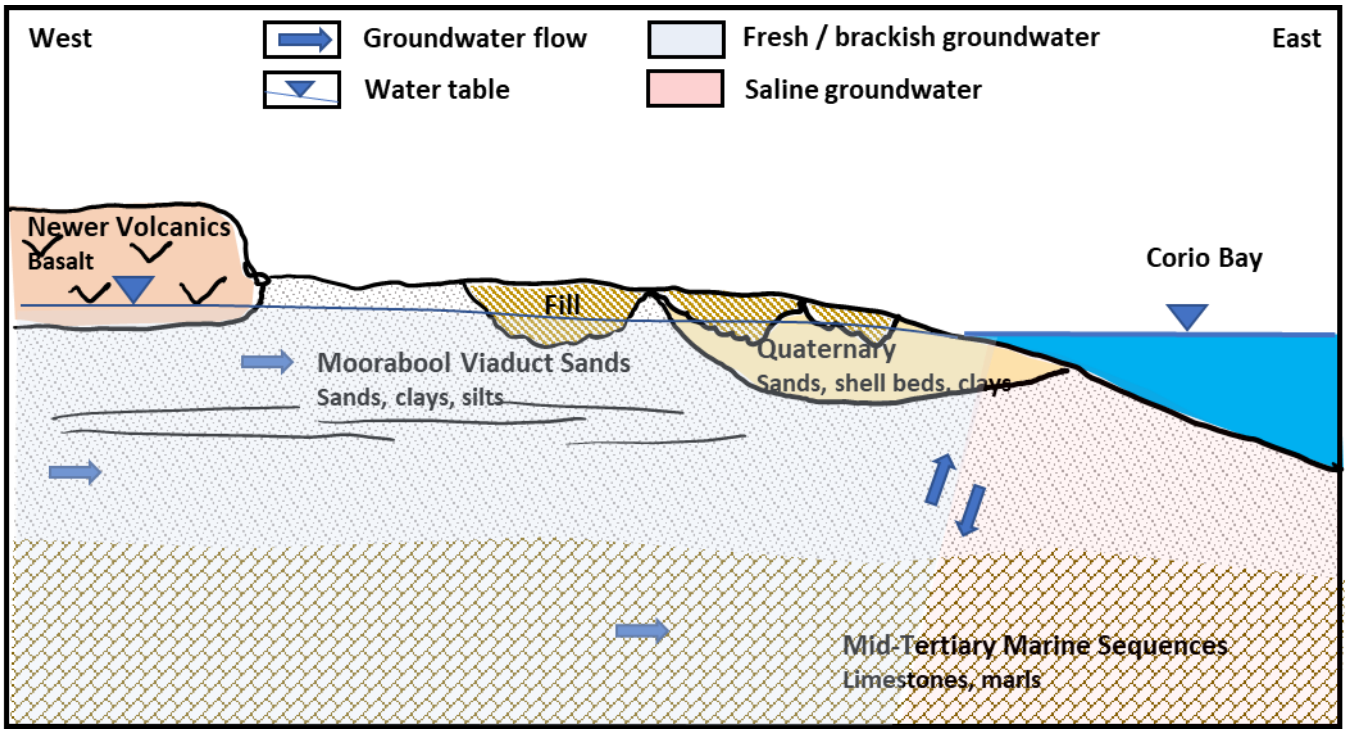


Figure 3 Hydrogeological conceptualisation

Note: Not to scale

The aquifers are recharged by infiltrating rainfall, and potentially from waterway leakage within the greater catchment. Groundwater is fresh to brackish and is interpreted to flow towards the coast and nearby waterways e.g. Rollerama Drain (not shown on the schematic). The schematic shows fresher groundwater migrating towards the coast where is discharges, and this overlies denser saline waters of Corio Bay. A mixing zone (of indeterminate width) would separate the two groundwaters. The Geelong Refinery further north of the groundwater study area is understood to have a groundwater interception trench. The influence of this trench on the regional groundwater flow is not known.

Rainfall infiltration through the shallow fill materials has the potential to leach constituents into the groundwater, affecting the groundwater quality and potentially, down-gradient receptors such as Corio Bay. This was acknowledged by Woodward Clyde (1997). The shallow nature of groundwater occurrence, and potentially high hydraulic conductivity of coastal sediments, suggests that the groundwater is vulnerable to contamination from land use practices (both current and historical).

6.3 Groundwater use

6.3.1 Abstractive use

A review of the DELWP Water Measurement Information System (WMIS) was undertaken to characterise groundwater use in the area. Over 60 bores were identified within an approximate 1 km radius of the site. The majority of these bores were registered as being used for groundwater investigation or groundwater observation purposes. Many of these bores are likely to have been installed as part of contaminated land investigations.

Two bores were registered as having a stock and/or domestic use (WRK973511 and WRK974498) and three (3) State Observation Network bores were identified. The operational status of the two stock / domestic bores is not known. Interestingly, the diameter of the two stock and domestic bores (50 mm) is narrow which cannot accommodate a submersible bore pump. The bores, however, could be equipped with low yielding jet pumps.

6.3.2 Environmental needs

Review of aerial imagery suggests that there are no obvious wetlands or existing groundwater dependent ecosystems (GDE) on the site, however, this is subject to confirmation by site inspection and ground truthing.

Groundwater is conceptualised as likely to discharge to Rollerama Drain, and Corio Bay. Review of the Bureau of Meteorology's GDE Atlas indicates that a temporary freshwater swamp is present in Rollerama Drain in a reach west of the groundwater study area, between Station Street and Lowe Street, which may be a potential GDE.

6.4 Groundwater quality

6.4.1 Classification of groundwater

With the *Environment Protection Amendment Act 2018* coming into effect, the former SEPP (Waters) has been replaced by the Environmental Reference Standard. The ERS aims to maintain and, where possible, improve water quality to protect environmental values. In respect to groundwater, groundwater with higher concentrations of salinity (measured as mg/L TDS) is deemed to have fewer environmental values. It forms the primary guide to determining existing impacts and the risk of impacts to groundwater quality.

The ERS provides that groundwater is categorised into segments based on the groundwater salinity, with each segment having particular identified environmental values. The segments and their environmental values are summarised in Table 3.

Table 3 Environmental values for groundwater

Use	Segment (mg/L TDS)						
	A1	A2	B	C	D	E	F
	0 – 600	601 – 1,200	1,201 – 3,100	3,101 – 5,400	5,401 – 7,100	7,101 – 10,000	>10,001
Water dependent ecosystems and species	✓	✓	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓						
Potable water supply (acceptable)		✓					
Potable mineral water supply	✓	✓	✓	✓			
Agriculture and irrigation (irrigation)	✓	✓	✓				
Agriculture and irrigation (stock watering)	✓	✓	✓	✓	✓	✓	
Industrial and commercial	✓	✓	✓	✓	✓		
Water-based recreation (primary contact recreation)	✓	✓	✓	✓	✓	✓	✓
Traditional Owner cultural values	✓	✓	✓	✓	✓	✓	✓
Cultural and spiritual values	✓	✓	✓	✓	✓	✓	✓
Buildings and structures	✓	✓	✓	✓	✓	✓	✓
Geothermal properties	✓	✓	✓	✓	✓	✓	✓

6.4.2 Study area groundwater salinity

Although there is a high density of groundwater investigation and observation bores, there is limited publicly available groundwater quality data. This is not unexpected given the sensitive nature of the groundwater data collected from potentially contaminated sites.

Groundwater salinity information was available from the three State Observation Network (SON) bores and is summarised as follows:

– Bore 121452: electrical conductivity (EC) of 3,030 µS/cm
– Bores 121456 and 121457: EC of 13,300 µS/cm and 14,020 µS/cm respectively

6.4.3 Review of EPA databases

6.4.3.1 Port of Geelong environmental audit

The Department of Treasury and Finance commissioned statutory environmental audits of the Port of Geelong, which included lands within, and close to the groundwater study area. This included, adopting the Woodward Clyde (1997) terminology:

– Site 2: The Terminals Pty Ltd tankfarm (bounded by Wharf Road and the Shell Effluent Channel)
– Site 3: The land west of the Terminals tankfarm (bounded by Wharf Road and Lowe Street, and currently occupied by Incitec Pivot)
– Site 5: Southern side of the eastern end of St Georges Road
– Site 6: Land encompassing Rollerama Drain (Oyster Cove Drain) to Lowe Street
– Site 7: Encompassing the groundwater study area: land to the west of St Georges Road and extending from the Shell Effluent Outfall to Greta Street

These areas are shown in Figure 4 and the approximate outline of the groundwater study area has been indicated.

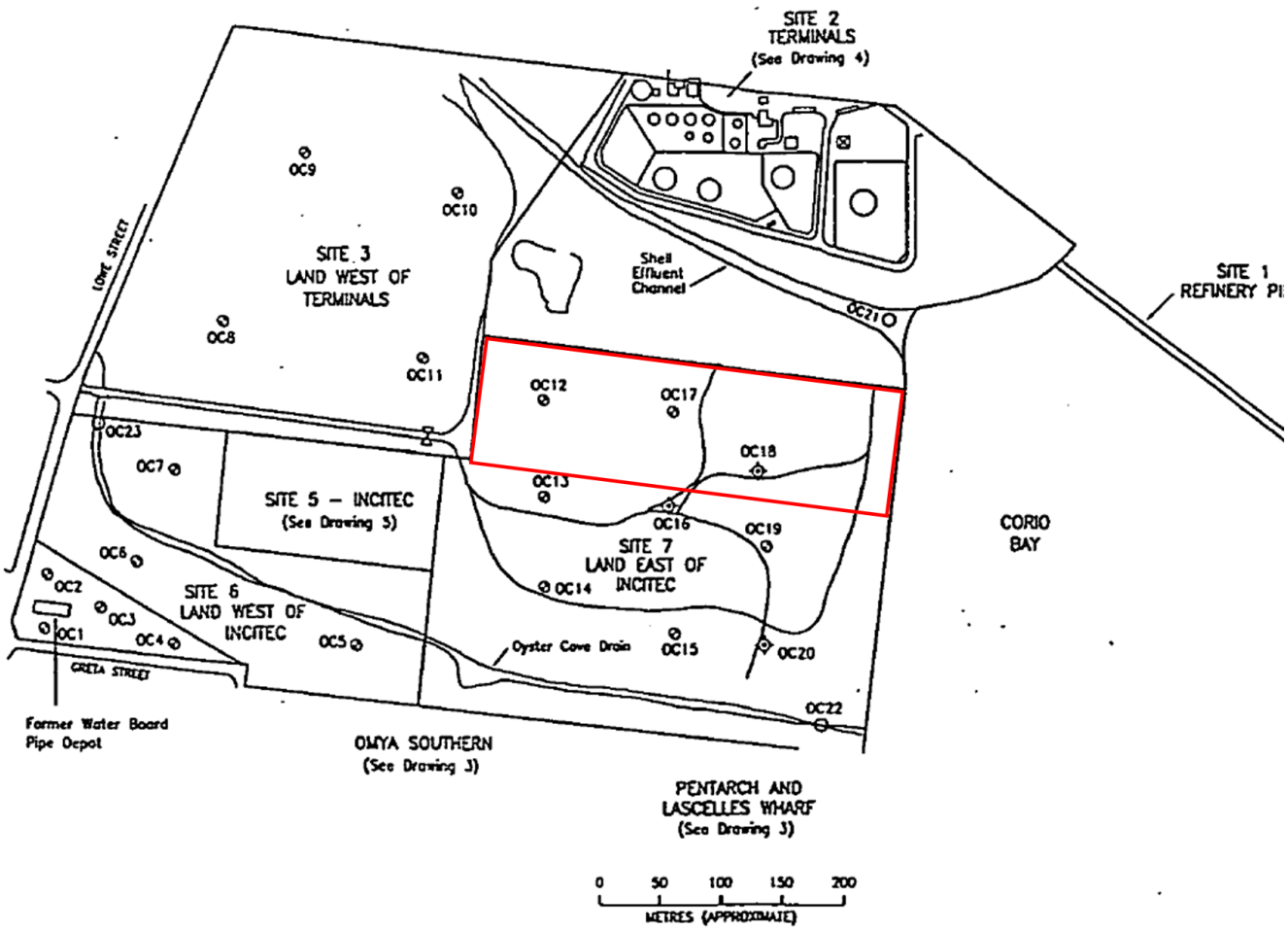


Figure 4 Delineation of Woodward Clyde Environmental Audit areas

Source: Woodward Clyde (1997)

Woodward Clyde (1997) note the following regarding 'Site 7':

- Landfilled with municipal solid waste to reclaim the swampy coastal land
- The landfill is capped with a metre of black to brown silty clay and sand
- At the time of reporting, landfill gas (predominantly methane) was being generated
- Leachate contains some concentrations of petroleum hydrocarbons but no heavy metals
- Leachate generated from the landfill may be seeping into Corio Bay
- No leachate or landfill gas control measures have been constructed at the site
- Bore OC-18 reported a salinity concentration of 7,800 mg/L TDS. It also reported elevated concentrations of organic nitrogen and petroleum hydrocarbons above the limits of laboratory reporting.

6.4.3.2 Other audits

A review of EPA databases indicates that other industrial sites close to the groundwater study area, e.g. Geelong Refinery, have been subject to environmental auditing under the original EP Act (1970). Further information of these technical studies has been provided by the contaminated land specialist.

These sites are hydraulically up-, and cross-gradient from the groundwater study area.

6.4.4 Environmental values of groundwater

The SON bores located west and north of the groundwater study area indicate that the groundwater quality is variable, ranging between 2,000 mg/L TDS and 8,000 mg/L TDS (using an EC to TDS conversion factor of 0.65), and historical sampling from an onsite bore indicated 7,800 mg/L TDS. This would place the groundwater in Segment E, however, this classification is preliminary only (owing to uncertainties regarding the available data from the groundwater study area).

Other drilling documented by Woodward Clyde (1997) on site 6 identified fresher groundwater at 1,300 mg/L TDS (bore OC23), and for site 2 (Terminals tankfarm) groundwater salinities ranged between 4,700 mg/L and 17,000 mg/L TDS.

It is uncertain whether the onsite groundwater is naturally saline, or whether the salinity has been influenced by historical landfilling activities. Regional beneficial use mapping completed by DELWP suggests a segment B classification.

The industrialised setting of the groundwater study area would suggest that many of the environmental values of a segment B groundwater, specifically those associated with an abstractive benefit, are not likely to be realised in the region, i.e. irrigation and stock use are unlikely. It is further suspected that low aquifer yields, the risk of groundwater quality degradation (through saline intrusion), and the availability of reticulated potable water may result in low rates of groundwater development.

Groundwater quality, however, needs to be maintained to protect the aquatic environments, e.g. Corio Bay, immediately down-gradient of the site.

6.5 Depth to groundwater

Most of the bores identified on the WMIS were constructed to depths less than 12 m, and many had depths less than 6 m. This would imply that the depth to groundwater below the ground surface is small. Site groundwater levels are not known, however, it is expected that water levels would be marginally above mean sea level i.e. 1 m to 2 m AHD.

Three SON bores were identified at two locations to the north, and west of the site. Bores 121456 and 121457 constitute a nested monitoring site on Shell Parade, approximately 200 m north of the Refinery Jetty. Bore 121452 is on Greta Street, southwest of the site. A hydrograph showing the water level behaviour over time has been presented in Figure 5. The depth to water in all three sites has mostly been within 2 m of the surface, although bore 121452 has had water levels between 2 m and 3 m of the ground surface between 2001 and 2016. The SON hydrographs confirm the presence of a shallow groundwater table, lying approximately between 1 m AHD and 2 m AHD.

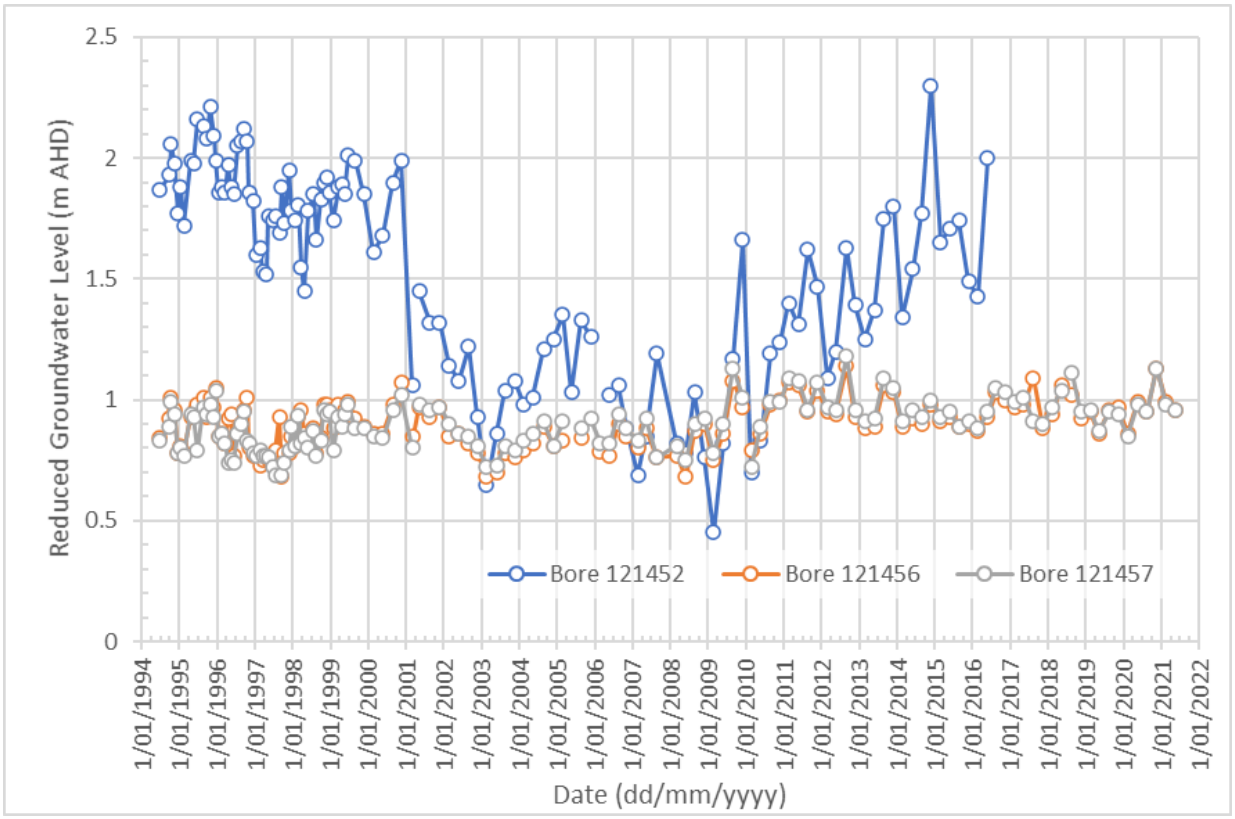


Figure 5 *State Observation Network bore hydrographs*

6.6 Groundwater flow

The groundwater flow direction of the groundwater study area is interpreted to be eastwards or coastwards. The formation is recharged by infiltrating rainfall (in areas of outcrop), or leakage from overlying units (including younger alluvium and Newer Volcanics).

7. Proposal

7.1 Overview

GeelongPort seeks to construct the Geelong Hydrogen Hub, an ammonia import and hydrogen supply facility. This would involve the construction of an industrial facility (including up to two 60 m diameter storage tanks), high pressure transfer pipelines, catalytic cracking plant(s), onshore distribution pipes, vehicle refuelling station and upgrades to the Refinery Jetty (new berth). The preferred berth layout is located within the existing dredge pocket and therefore no capital dredging is required.

It is acknowledged the dredging has been historically undertaken for the Refinery Jetty and berthing areas, and dredge areas are periodically maintained.

7.2 Groundwater resource development

This assessment has assumed that groundwater will not be developed as a water supply to service either the construction of the project, or its on-going operation. This is considered a reasonable assumption based upon:

– The brackish nature of groundwater in the area (in most of the shallower aquifers)
– The historical land uses of the groundwater study area would predispose it to being potentially contaminated
– The availability of reticulated potable water, i.e. Barwon Water mains supply

If groundwater were to be developed as an alternative to mains water, there is a licensing process, under the *Water Act* (1989) which mandates an assessment of the impact of groundwater take on existing users and the environment.

7.3 Assumptions

The groundwater study area has focussed on the main parcel of land that will be developed into the industrial facility. It is acknowledged that there will be pipes extending from this land parcel to potential vehicle fuelling facilities located further afield.

This assessment has assumed that these sites and the connecting services would be shallow and unlikely to directly interact with the groundwater environment. Therefore the risk of disturbance, albeit uncertain, is considered to be low. It is acknowledged that further geotechnical and contaminated land investigations may be required to assess whether contaminated soils (and the water table) are intersected during construction of these other facilities remote from the main cracking and storage site.

8. Addressing EES referral requirements

8.1 Significant effects

Based upon the high level project description, the project is not expected to have significant interaction with the groundwater environment as most of the structures will be constructed on the ground surface, or offshore. Therefore, it is not likely to directly create significant environmental effects to groundwater.

However, historical land use activities (both onsite and neighbouring) have potentially created legacy environmental issues such as soil and groundwater contamination that will need to be addressed by the proponent. These are discussed in the sections below.

8.2 Discussion of potential effect of project on regional groundwater resources

The site setting and available information suggests that the groundwater levels are shallow and likely to be within 1 m to 2 m of the ground surface. With shallow groundwater, there is an increased likelihood that excavations to construct foundations, or underground services, may intersect groundwater.

Construction dewatering may be required to enable safe and stable excavations below the water table, however, such activities are temporary, and recovery of the groundwater table is reasonable at the cessation of dewatering activities. Under these circumstances impact to groundwater from dewatering could be reasonably managed through design, and construction environmental management processes.

As the groundwater study area is not within a recognised groundwater management area, and there is limited abstractive groundwater use nearby, the project is expected to have minimal effect on the groundwater resource in terms of quantity (volume taken from the aquifer).

Nevertheless, construction dewatering can create a number of issues that will require management during the design and construction of the project:

– Oxidation of acid sulfate soils. It is noted that the published mapping indicates a low probability of occurrence at the groundwater study area.
– Managing volumes of groundwater recovered during dewatering activities, i.e. how is groundwater disposed, and the groundwater may be contaminated.
– Increased risk of the generation of vapours (and methane release) as the water table is lowered and saturated subsurface materials become unsaturated and exposed to air.
– Disturbance of contaminated groundwater

There are a range of options to minimise the disturbance of the groundwater environment and dewatering activities. This could include:

– Design of foundation / structure elevations (to minimise or avoid deep excavations and water table intersection)
– Flow cut-offs / barriers, e.g. sheet piling, secant / contiguous piles, diaphragm walls
– Reinjection of the seepage water recovered from excavations back into the aquifer system.

On the assumption that there will be no increase in the dredging area, offshore works are not expected to influence the groundwater environment.

8.3 Discussion of potential effect of project on groundwater on environmental values

There is some uncertainty regarding the current condition of the groundwater in the study area, however, historical landfilling and industrial activities are likely to have degraded the groundwater quality. Under these conditions the following is noted:

– Excavations to construct the onsite infrastructure, and various utility pipelines have a high likelihood of disturbing fill materials which could include contaminated soils, and groundwater

- Excavations may remove contaminated material, however, contaminated soils and fills may remain and continue to generate leachate and contamination of the groundwater and the down-gradient receiving environment
- Some areas containing fill may not be disturbed by the project, but could continue to act as a source of leachate, groundwater contamination and contaminated discharge to the marine environment
- Construction of the infrastructure has the potential to sterilise access to parts of the landfilled areas and prevent or complicate future clean-up. Therefore an understanding of the status of groundwater contamination and whether it poses an on-going risk to the groundwater environment is required.
- Operation of the project is not likely to result in further degradation of the environment. The main constituents of the industrial process, ammonia and hydrogen are gases and therefore spills and industrial accidents are not likely to impact on groundwater.
- Some clean-up of soil and groundwater may be required, however, such would be assessed as part of the Contaminated Land scope of work
- Environmental investigations were completed over 20 years ago (Woodward Clyde 1997) and therefore emerging contaminants such as Per- and polyfluoroalkyl substances (PFAS) and their presence in the groundwater study area may not have been assessed

Under the new EP Act (2017), and irrespective that the contamination may have been a responsibility of legacy land users and managers, the proponent (GeelongPort) has a general environmental duty to understand and meet their environmental protection duties. Specifically, whether construction of the project and its on-going operation would result in greater fluxes of contaminated groundwater discharging from the site and resulting in unacceptable adverse impacts to the aquatic ecosystems of the Rollerama Drain or Corio Bay.

9. Investigation program

Uncertainties exist over the current condition of the site and the previous environment investigations. These investigations:

– Had limited groundwater assessment
– Occurred over 20 years ago and may not reflect current conditions
– Did not consider emerging contaminants such as PFAS
– Had limited development of a hydrogeological conceptualisation and ground contamination model.

Intrusive environmental investigations will be required to determine whether the groundwater study area soils and groundwater are contaminated and pose an unacceptable risk to human health (both construction workers, and site operators), and down-gradient receiving environments.

Such a program may include:

– Delineation of filling extents
– Characterisation of
    - Capping and fill materials
    - Groundwater flow directions
    - Background groundwater quality (noting that there are current and historical land uses which pose a groundwater contamination risk)
    - Fluxes of constituents in groundwater discharging at the coast (down-gradient quality)
    - Interactions of groundwater with Rollerama Drain
– Assessment of aquifer permeability to determine construction dewatering requirements for deep foundations or service pipeline trenches

The project site investigation program would be designed in consultation with the contaminated land specialist, and any geotechnical assessment of the site.

Regards

Tim R Anderson
Hydrogeologist

10. References

GHD 2021: Ammonia Import Terminal Concept Layout Option B. GHD Ref 12537431-SKETCH_02

Woodward Clyde, 1997: Addendum Report Environmental Audit of Sea-bed area, Port of Geelong. Prepared for the Department of Treasury and Finance. Woodward Clyde Ref A3100570

Woodward Clyde, 1997: Environmental Audit Report Port of Geelong. Prepared for the Department of Treasury and Finance. Woodward Clyde Ref A3100570