Appendix H – Detailed Site Investigation

Detailed Site Investigation

Pieces 501 and 502 Gillman
208 Eastern Parade, Gillman
North Arm Road, Dry Creek
South Australia

Prepared for:	Department for Infrastructure and Transport
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Written	**Approved**
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Rev No	Status	Date	Author	Reviewer
01	DRAFT	8/04/2024	JDL	DP
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ACRONYMS

Acronym	Description
AASS	Actual Acid Sulfate Soils
ACM	Asbestos Containing Materials
AEA	Australian Environmental Auditors
AHD	Australian Height Datum
ANZECC	Australia and New Zealand Environment and Conservation Council
ASC	Assessment of Site Contamination
ASLP	Australian Standard Leaching Procedure
ASS	Acid Sulfate Soils
B(a)p	Benzo(a)pyrene
BGL	Below Ground Level
BTEXN	Benzene Toluene Ethylbenzene Xylene Naphthalene
CBD	Central Business District
CEMP	Construction Environmental Management Plan
CEnvP	Certified Environmental Practitioner
CPB	Coast Protection Board
CSIRO	Commonwealth Scientific Industrial Research Organisation
CSM	Conceptual Site Model
CT	Certificate of Title
DIT	Department for Infrastructure and Transport
DO	Dissolved Oxygen
DQO	Data Quality Objective
DSI	Detailed Site Investigation
EHIA	Environment and Heritage Assessment Guideline
EIL	Ecological Investigation Levels
ESL	Ecological Screening Levels
EP Act	Environment Protection Act (SA) 1993
EPP	Environmental Protection Policy
EPBC	Environmental Protection and Biodiversity Conservation
ERA	Environmental Risk Assessment
EV	Environmental Value
GAR	Guideline for the Assessment and Remediation of site contamination
GME	Groundwater Monitoring Event
GPA	Groundwater Prohibition Area
HILs	Health Investigation Limits
HSLs	Health Screening Limits
IWS	Integrated Waste Services
LLCW	Low-Level Contaminated Waste
MEP	Multiple Extraction Procedure
MFP	Multi-Function Polis

Acronym	Description
NAPP	Net Acid Producing Potential
NEMP	National Environmental Management Plan
NEPM	National Environmental Protection Measures
NSC	North South Corridor
PAEC	Port Adelaide Enfield Council
PAH	Polycyclic Aromatic Hydrocarbons
PASS	Potential Acid Sulfate Soils
PCAs	Potentially Contaminating Activities
PDS	Preliminary Desktop Studies
PFAS	Per- and Poly Fluoroalkyl Substances
PID	Photoionisation Detector
PSI	Preliminary Site Investigation
SAPPA	South Australian Property and Planning Atlas
SA EPA	South Australian Environment Protection Authority
SAILIS	South Australian Integrated Land Information System
SARA	South Australian Rifle Association
SARIG	South Australian Resource Information Geoserver
SAQP	Sampling Analysis and Quality Plan
SMF	Strategic Management Framework
SMP	Site Management Plan
SWL	Standing Water Level
SMP	Site Management Plan
SRF	Spoil Receival Facility
T2D	Torrens to Darlington
TBM	Tunnel Boring Machine
TDS	Total Dissolved Solids
TOP	Transition Out Plan
TOPA	Total Oxidisable Precursor Assay (laboratory analysis for PFAS compounds)
TPH	Total Petroleum Hydrocarbons
UCL	Upper Confidence Limits
US EPA	United States Environment Protection Agency
UoA	University of Adelaide
UXO	Unexploded Ordinance
W2R EPP	The Environment Protection (Waste to Resources) Policy 2010 (under the Environmental Protection Act 1993)
WDF	Waste Derived Fill

EXECUTIVE SUMMARY

Background

Agon Environmental (Pty Ltd) ('Agon') was engaged by the Department for Infrastructure and Transport (DIT) to undertake a detailed site investigation (DSI) to assess soil, groundwater and surface water conditions on a site comprising a portion of the following land parcels across a total area of 145.19 ha:

- Piece 501, 208 Eastern Parade, Gillman, SA 5013
- Piece 502, 208 Eastern Parade, Dry Creek SA 5093

The site is owned by the Urban Renewal Authority trading as Renewal SA and has been ear-marked for future commercial/industrial development, which would require site levels to be raised to at least 3.7 m AHD to meet Coast Protection Board Requirements. To fill the entire site would require well over 10 million tonnes of allotment fill.

Around 7 million tonnes of fill material is expected to be generated from the DIT Torrens to Darlington (T2D) project which is a component of the overarching North-South Corridor. DIT proposes to reuse the surplus spoil as allotment fill on the Renewal SA site. The T2D spoil will include excavated spoil from some parts of the project and tunnel boring spoil from other areas (which will contain soil, rock, water, and conditioning agents/tunnelling additives).

To reuse the T2D spoil as allotment fill, a waste derived fill audit is required by the SA EPA. This DSI is required to assess the baseline environmental condition of the site as part of the waste derived fill audit. The document map provided as Figure 1 identifies where this report fits into the broader scope of works for the waste derived fill audit.

Before T2D spoil can be taken to the site, a Spoil Receival Facility (SRF) will be constructed at the site following a detailed design process. The SRF is expected to operate for around 10 years allowing for drying out of the tunnel boring spoil, placement and geotechnical treatment. The SRF will be managed during this time under a site management plan (SMP), with oversight from the Environmental Consultant and Auditor.

Key Issues

The large scale of the proposed site filling means that there is the potential for significant:

- Compression and settlement of the existing soils under and adjacent to the area filled.
- Changes to groundwater levels and flow rate, both on and offsite.
- Changes to surface water drainage patterns, both on and offsite.

These changes could disturb acid sulfate soils and cause contaminants to move via groundwater and surface water, where they could affect the environment on and offsite, both during and after the project.

Past investigations identified several potential onsite and offsite sources of contamination at the site:

- Operation of part of Lot 501 for Defence Works leading to the potential for UXO, explosive organics and nitroglycerine residues and metals onsite.
- Offsite properties including landfills and waste depots, service stations, and auto wreckers. Potential contaminants of concern include landfill gases, nutrients, solvents, petroleum hydrocarbons, heavy metals and PFAS. Past investigations of surrounding sites have indicated that groundwater has been

contaminated by inorganics and nutrients (metals, fluoride, TDS, sodium, chloride, sulfate, phosphorous, total N, TOC and BOD) as well as organic compounds (BTEX, TRH, TCE, PCE, PAH, PFAS).

- Imported fill materials brought onto Pieces 501 and 502 including the presence of ACM and elevated levels of heavy metals, PAH and TRH in the subsurface. While these areas of filling have been excised from the site, it is still possible that imported fill materials may be present from uncontrolled waste burial and illegal dumping on other parts of the site.
- Acid generation from disturbance of Acid Sulfate Soil (ASS) materials.

This DSI provides a baseline understanding of the current contamination status of soil, groundwater and surface water. Any changes to site conditions during and after the project can be compared to the baseline data.

Further environmental investigations are likely to be required at key stages of the project and may include the following

- The design of the SRF - particularly any excavations for site infrastructure.
- Geotechnical investigation - and how the geotechnical condition of the site may impact site establishment, filling and settlement properties, PASS/ASS affected soil and groundwater movement.
- If any unexpected results are picked up during SMP compliance monitoring (e.g. surface water, groundwater).
- Verification sampling of imported fill upon arrival on site, prior to use as lot fill.
- Validation investigation at completion of all site filling and settlement.

Objectives

The objectives of the DSI were to:

- Compare soil and water results to adopted criteria.
- Complete a determination of site contamination of soils and groundwater.
- Update the conceptual site model, identify potential risks to human health and the environment associated with feasible source-pathway-receptor linkages including groundwater movements, tidal influences, salinity variations and groundwater recharge/discharge mechanisms.
- Identify data gaps.
- Identify contamination risks associated with fill importation, in the context of the baseline site condition.
- Assess baseline soil and groundwater conditions at the site, including the presence of any site contamination.

Scope

An intrusive site investigation was undertaken to assess the baseline condition of soil, groundwater and surface water as follows:

- Soil investigation comprising 136 grid-based soil boreholes.

- Groundwater investigation, comprising installation of 15 new groundwater wells and sampling of 22 wells (15 on site; 3 offsite adjacent to the north; 4 offsite in the Magazine and Range Wetlands).
- Surface water preliminary assessment comprising 9 electronic data loggers installed.
    - Barometric pressure – one logger.
    - Groundwater level and temperature in onsite wells – 6 loggers.
    - Surface water level and temperature in creek channels – one onsite and one offsite.

Surface water sampling in 9 locations.

A robust quality assurance and quality control program was undertaken, the results of which were overwhelmingly supportive of the data being reliable and suitable to form the basis for the conclusions of this report, in accordance with the DQOs.

Determination of site contamination

The existence of site contamination is determined with reference to the SA EPA *Environment Protection Act 1993* which defines site contamination exists if:

a) "Chemical substances are present on or below the surface of the site in concentrations above the background concentrations (if any); and
b) The chemical substances have, at least in part, come to be present there as a result of an activity at the site or elsewhere; and
c) The presence of the chemical substances in those concentrations has resulted in—
    i. actual or potential harm to the health or safety of human beings that is not trivial, taking into account current or proposed land uses; or
    ii. actual or potential harm to water that is not trivial; or
    iii. other actual or potential environmental harm that is not trivial taking into account current or proposed land uses."

Based on the results obtained during the soil and groundwater investigations Agon has made the initial determination that site contamination of soil exists at the site with respect to a land use as an area of ecological significance, with surface soils containing arsenic, copper, lead and zinc above the criteria for areas of ecological significance, after statistical assessment. Agon does not consider that the arsenic or zinc identified in soil across the site is site contamination; however, copper and lead may be attributable to past Defence activities.

Site contamination does not exist with respect to a potential future land use of commercial/industrial, as no exceedances of the commercial/industrial criteria have been observed.

Groundwater results indicate that site contamination of groundwater exists, based on concentrations of chemicals above the adopted criteria. A preliminary assessment of background concentrations was undertaken with the finding that groundwater concentration exceedances may be attributable to offsite sources (with the exception of fluoride). This preliminary assessment requires additional sampling rounds to be undertaken to allow a more reliable determination of background to be completed.

Notifications (Section 83A)

When site investigations identify the presence of site contamination that affects or threatens underground water, a notification to the SA EPA must be made; this is known as a Section 83A Notification.

A Section 83A notification was prepared by Agon and submitted to DIT on 19 March 2024 on the understanding that DIT would share the Section 83A with Renewal SA and submit it to the SA EPA. Upon DIT's request, Agon also submitted the Section 83A directly to the SA EPA on 9 April 2024. The Section 83A included the full groundwater table and specified that the Section 83A was in relation to metals & metalloids, petroleum hydrocarbons, non-metallic inorganics, PFAS and nutrients (Appendix L, DSI).

A Section 83A notification relating to the surface water results was prepared by Agon and submitted to the SA EPA on 10 May 2024. The Section 83A included the full surface water table and specified that the Section 83A was in relation to metals & metalloids and PFAS (Appendix L, DSI).

Risk to human health and/or environment

The baseline soil impacts at the site include arsenic, copper and lead above the ecological assessment criteria. This indicates that a risk to offsite ecological receptors may exist, and this will need to be considered as the project moves forward. It is not considered that onsite ecological receptors are relevant for further investigation as it is understood that vegetation clearance will be undertaken prior to spoil receival.

Groundwater contamination is present at the site with metals, ammonia and PFOS above the ecological criteria; in addition, groundwater at the site is hypersaline. As a result, there may be some baseline risk to the flora and fauna in the terrestrial, surface water and estuarine environment both at and down gradient from the site. Fluoride is also present above the recreational criteria which may preset a human health risk for users of the site and of the environment down gradient from the site.

The baseline soil condition meets the criteria for a commercial/industrial land use; it is not envisaged that any remediation would be required as part of site preparation works ahead of spoil receival. The baseline soil condition should allow successful completion of the waste derived fill audit for a commercial/industrial land use, so long as the imported spoil meets auditor requirements.

The site in its baseline condition is not considered to pose a risk to intrusive maintenance workers, as compliance with commercial/industrial criteria is protective of intrusive maintenance workers. Therefore, it not envisaged that any remediation would be required to make the site safe for workers involved in establishing or operating the SRF. The exception to this is the presence of ASS materials, where there is a clear need to develop an ASS management plan to cover any intrusive work on site.

Summary of conclusions and recommendations

ASS materials are widespread across the site and the placement of fill material on site is likely to cause subsidence and groundwater changes which could disturb these materials, causing metals and acidity to move through groundwater and surface water and affect receptors. ASS materials will require more detailed assessment in certain areas that are likely to be disturbed, once known through SRF design or indicated by hydrogeological modelling. An acid sulfate soils management plan will be required for the project to carefully manage any high risk areas.

Overall chemical concentrations in site soil are within the same waste soil classification (Intermediate Waste Soil) as the T2D tunnel boring spoil. However the maximum arsenic concentration in the tunnel boring spoil was 3 times higher than in the natural site soil, which will require further assessment of the environmental risk (known as Tier 2). Barium, copper, manganese and nickel concentrations are generally higher in the tunnel spoil than at the Gillman site, and this may also require further consideration in a Tier 2 environmental risk assessment.

Surface water contamination is present on and offsite with metals, ammonia and PFOS above the ecological criteria. Based on the distribution and concentration patterns, PFAS chemicals may enter onsite groundwater through surface water discharges from the wetlands. It is thought that PFAS chemicals may be present in stormwater discharges entering the wetlands from wider offsite catchments.

A comparison of groundwater and surface water hydrochemistry as well as concentrations of chemicals of concern confirms some level of interaction and potential ‘exchange’ of chemicals. The elevations of surface water and groundwater are very similar, and seasonal surface water release and flooding in some parts of the site may result in infiltration and recharging groundwater, i.e. impacting groundwater. On the other hand, during seasonal groundwater level rise groundwater may be exposed at the surface, causing some water logging and mixing with surface water causing surface water impacts.

The CSM for the site in its current form as well as post-construction upon site filling, indicates that numerous pathways for exposure of environmental and human receptors to hypersulfidic and sulfuric soils exist, for example through excavations, subsidence, dewatering and/or changes to the groundwater levels and flows.

Several data gaps remain at this stage of the project, with further work to be undertaken once more details of the contractor’s activities on site are known.

Overall, the site is considered suitable for receipt of the T2D spoil subject to completion of the following additional work, with outcomes that support suitability of the site for receipt of the T2D spoil:

- Geotechnical assessment.
- Ecological risk assessment.
- Additional groundwater monitoring to assess seasonal variations and verify outlier results.
- Surface water monitoring.
- Hydrogeological modelling, including levee bank condition assessment.
- Waste classification report for excavated spoil.
- Site management plan.
- Construction and environmental management plan.
- Acid sulfate soils management plan.
- Prioritisation, scoping and addressing of data gaps.

In conclusion, this DSI provides an initial assessment of the current condition of the site with respect to site contamination, to inform the assessment of the risks associated with importing a large volume of spoil, and to form a baseline against which to monitor any changes to site conditions during and after large-scale site filling.

1.0 INTRODUCTION

Agon Environmental (Pty Ltd) ('Agon') was engaged by the Department for Infrastructure and Transport (DIT) to undertake a Detailed Site Investigation (DSI) to assess soil, groundwater and surface water conditions on a site comprising a portion of the following land parcels across a total area of 145.19 ha:

- Piece 501, 208 Eastern Parade, Gillman, SA 5013
- Piece 502, 208 Eastern Parade, Dry Creek, SA 5093

The site is owned by the Urban Renewal Authority trading as Renewal SA (Renewal SA) and has been earmarked for future commercial/industrial development. However, it is low lying and cannot be developed without raising the site levels to at least a minimum of 3.7 m AHD to meet Coast Protection Board requirements. DIT proposes to contribute to the site's fill requirements by using the site as a Spoil Receival Facility (SRF), which would involve the deposition of spoil from the River Torrens to Darlington (T2D) component of the North South Corridor (NSC) project on the site.

The total volume of spoil expected to be placed at Gillman is approximately 3.88 million m^3, including excavated spoil from the lowered motorway as well as tunnel boring spoil. The tunnel boring spoil is expected to make up approximately 2.06 million m^3 of the total spoil volume and will include a mixture of soil, rock, water and conditioning agents/tunnelling additives. Geotechnical analysis commissioned by DIT indicates that the overall bulk density of all spoil may be 1.8 tonnes/m^3, for a total spoil weight of 7 million tonnes. The large scale of the proposed filling associated with the establishment of an Spoil Receival Facility (SRF) at the site means that there is the potential for significant:

- Compression and settlement of the existing soils under and adjacent to the area filled.
- Changes to groundwater levels and seepage patterns, both on and offsite.
- Changes to surface water drainage patterns, both on and offsite.

These changes could disturb acid sulfate and hypersaline soil types and cause mobilisation and transport of contaminants via groundwater and surface water pathways to impact the environment on and offsite, both during and after the project.

This DSI provides an initial assessment of the current condition of the site with respect to site contamination, to inform the assessment of the risk associated with importing a large volume of spoil from the T2D to the site, and to form a baseline against which to monitor any changes to site conditions during and after large-scale site filling. This is summarised in a Conceptual Site Model (CSM) for the site.

This DSI is envisaged to be the first iteration of site contamination assessment for the site and, as such, provide a baseline summary of conditions at the site prior to operation of the site as an SRF for tunnel spoil. Revisions to the DSI, CSM and potentially additional data collection will be required in several stages at keys stages of the project, including but not limited to:

- Following provision of site establishment and construction details, including the extent of any excavations for site infrastructure.
- Following review of geotechnical investigations and how the geotechnical condition of the site may impact site establishment, filling and settlement properties, PASS/ASS affected soil and groundwater and surface water dynamics.
- Monitoring of any changes in site conditions (e.g. Acid Sulfate Soils (ASS), groundwater flow) during filling.
- Assessment of verification sampling results for fill upon arrival on site, prior to use as allotment fill.

- Assessment of validation/verification investigation results at completion of all site filling and settlement.

1.1 Objectives

The objectives of this DSI report are to:

- Assess baseline soil and groundwater conditions at the site, including the presence of any site contamination.
- Identify baseline potential risks to human health and the environment associated with feasible source-pathway-receptor linkages.
- Develop an understanding of the baseline groundwater conditions at and near the site, to inform the Waste Derived Fill (WDF) Audit and future commercial/industrial land use and development.
- Develop a robust CSM including groundwater movements, tidal influences, salinity variations and groundwater recharge/discharge mechanisms.
- Provide a basis for the development of WDF acceptability criteria for all fill to be imported.
- Outline the rationale and methods for the sampling, analysis and data interpretation.
- Demonstrate the reliability, accuracy, reproducibility, and representativeness of the data collected.
- Deliver a concise report based on current site knowledge regarding the current conditions at the site prior to operation of the site as an SRF.

1.2 Scope of Works

The DSI included assessment of soil, groundwater and surface water as follows:

- Detailed review of the environmental setting including ASS and adjacent wetlands.
- Detailed review of previous investigations on the site and surrounds.
- Soil investigation comprising 136 grid-based soil boreholes.
- Groundwater investigation, comprising installation of 15 new groundwater wells and sampling of 22 wells (15 on site; 3 offsite adjacent to the north; 4 offsite in the Magazine and Range Wetlands).
- Surface water sampling from offsite wetland ponds and onsite water dam.
- Surface water/groundwater preliminary assessment comprising 9 electronic data loggers installed:
    - Barometric pressure – one logger.
    - Groundwater level and temperature in onsite wells – 6 loggers.
    - Surface water level and temperature in creek channels – one onsite and one offsite.
- Reporting of all works inclusive of:
    - Comparison of soil and water results to adopted criteria.
    - Assessment of data quality.
    - Determination of site contamination of soils and groundwater.
    - Refinement of the preliminary baseline CSM.
    - Identification of data gaps.
    - Identification of contamination risks associated with fill importation, in the context of the baseline site condition.

1.3 Document Map

This DSI is the second deliverable for the site assessments that are required for the WDF audit, to allow the deposition of spoil from the T2D. The document map provided as Figure **1** identifies where this report fits into the broader scope of works for the WDF audit.

1.4 Proposed Development and Activity

There is currently no infrastructure on the site, and site preparation will be required prior to any future filling activities, including:

- Connection of utilities and services including electricity, telecommunication, water, sewerage, and stormwater services.
- Minor filling to make the site trafficable.
- Construction of facilities for the receipt and processing of the spoil including dewatering of spoil and water management/treatment.

The finished filled level of the site is yet to be determined and is likely to be in excess of 3.7 m AHD based on the Coast Protection Board (CPD) requirements, with even higher fill heights on the order of 5 to 7 m AHD required as preload over several months.

Agon understands that all site preparation works and management of the environmental risks associated with the project (e.g. disturbance of potential or actual ASS) will be the responsibility of the future contractor Alliance (See Section 2.2.2).

1.5 Regulatory Requirements

The key Acts relating to site contamination and the WDF audit are summarised in this section. Other legislation is likely to apply to the overall project, a review of which is beyond the scope of this DSI.

1.5.1 Environment Protection Act

The South Australia Environment Protection Act 1993 (the EP Act) specifies that certain activities must only be carried out under licence or other form of environmental authorisation granted by the South Australian Environment Protection Authority (SA EPA). These activities include the receipt, storage, treatment, or disposal of waste.

Part 1 Section 4 (1) provides a definition of “waste” under the Act as:

> *“(a) any discarded, dumped, rejected, abandoned, unwanted or surplus matter, whether or not intended for sale or for purification or resource recovery by a separate operation from that which produced the matter; or*
>
> *(b) any matter declared by regulation to be waste for the purposes of this Act (following consultation by the Minister on the regulation with prescribed bodies in accordance with the regulations); or*
>
> *(c) any matter declared by an environment protection policy to be waste for the purposes of this Act, whether or not of value.”*

The EP Act also provides for the development of environment protection policies (EPPs) which can set out detailed requirements for protecting aspects of the environment or protecting the environment from particular activities.

The EP Act and Environment Protection (Waste to Resources) Policy 2010 (W2R EPP) sets out the regulatory requirements for waste management activities. To support the beneficial reuse, recycling, and recovery of wastes, the W2R EPP provides a mechanism by which a waste that meets specifications or standards published or approved in writing by the SA EPA will be considered a product instead of a waste.

Reuse of spoil either within the project corridor or external to the project corridor may occur where spoil is not considered to be a waste. The T2D project team has agreed with the SA EPA to prioritise and progress consideration of all appropriate regulatory pathways to provide certainty to the Project. The most likely outcome being re-use onsite as part of T2D works and the application of the "Auditor Protocol" provided in the *SA EPA (2013) Standard for the production and use of waste derived fill (WDF Standard)* to allow for re-use of spoil for land reclamation and rehabilitation purposes.

The site is undergoing a WDF Audit in accordance with the Auditor Protocol outlined in the *WDF Standard*. This standard supports the objectives of the EP Act and W2R EPP; and describes the processes required to support the beneficial reuse of waste materials.

DIT has advised that disposal of spoil may be required where there are no reuse opportunities within the project corridor or identified reuse options external to the project corridor, or simply for logistical reasons such as the classification of the spoil exceeds the site specific criteria. In these circumstances the spoil is considered to be a waste.

1.5.2 Planning Development and Infrastructure Act

Under the Planning Development and Infrastructure Regulations (2017) Schedule 3 Clause 5 site filling meets the definition of development in a coastal area and will require development authorisation before site establishment and fill importation can occur.

It is understood that the development application will be made by DIT and the application may be referred to state, local or federal government bodies including but not limited to the local council, the SA EPA, the Department for Environment and Water, the CPB, Safework SA and SA Water.

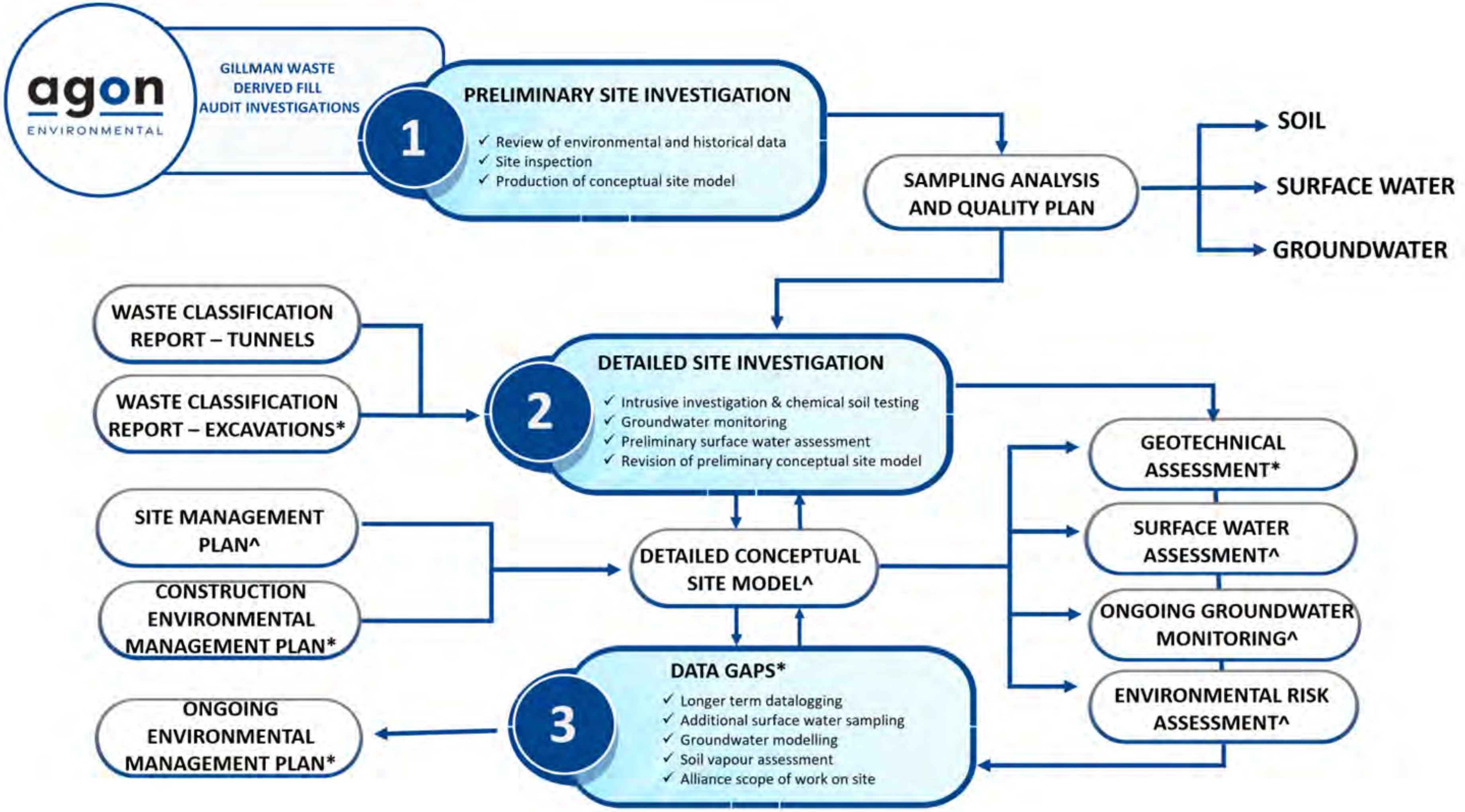


Figure 1: Document Map

**Yet to be addressed*

^Work in progress

2.0 T2D PROJECT OVERVIEW

2.1 T2D Project Background

The T2D project forms the missing link of the NSC program, being a 78 km non-stop motorway from Gawler in the north to Old Noarlunga in the south. The T2D component is a 10.5 km segment between the River Torrens and Darlington (refer Figure 2), which is the only portion of the corridor not yet upgraded to motorway standards.

The T2D project involves the construction of two separate tunnel sections, the Southern Tunnels and the Northern Tunnels, which will be connected by an open motorway. Lowered motorways will also connect the Southern and Northern tunnels to the existing road corridor. Major construction works are expected to commence in 2025, with the first Tunnel Boring Machine (TBM) scheduled to start in 2026. This report relates specifically to spoil to be generated from the Northern and Southern Tunnels. The locations of the Southern and Northern Tunnels are presented in Figure 2.

2.2 Relevant Parties

2.2.1 DIT

DIT is responsible for delivering the T2D Project on behalf of the State.

2.2.2 Construction and Operation Partner

DIT has determined that an alliance contracting framework is the most appropriate model for delivery of the T2D project. The non-owner participant in the T2D design and construction is yet to be awarded, with (at the time of issuing this report) procurement process is under way (for Contracts 22C233 and 22C321).

Upon tender award, the successful non-owner participant and DIT will enter into an Alliance contract and will deliver the project as “the Alliance”.

2.2.3 Agon Environmental

Agon has been engaged by DIT under Contract No. 22C336 to deliver the WDF Assessment Services for the T2D project. Agon is pre-qualified under the Professional Services/Site Contamination Auditor Services Panel and employs Certified Environmental Practitioners (CEnvP) Site Contamination Specialists as required by DIT and the SA EPA. The role of Agon is to assist DIT by:

- Providing a baseline assessment at the spoil receiving site (i.e., this report).
- Collating soil physical and chemical data for the T2D alignment.
- Developing WDF acceptability criteria and completion of an in-situ WDF Assessment for spoil to be generated from the T2D project.
- Ensuring delivery of the Site Management Plan (SMP) for the SRF.
- Undertaking quality assurance and reporting on compliance with the SMP during operation of the SRF and post-closure.

Agon’s services will also be novated to the successful Contractor(s) for the management of spoil at the site to ensure continuity with the WDF audit process and suitable placement of the material at the receiving site in accordance with the SMP as part of an Alliance agreement between DIT and the successful Contractor.

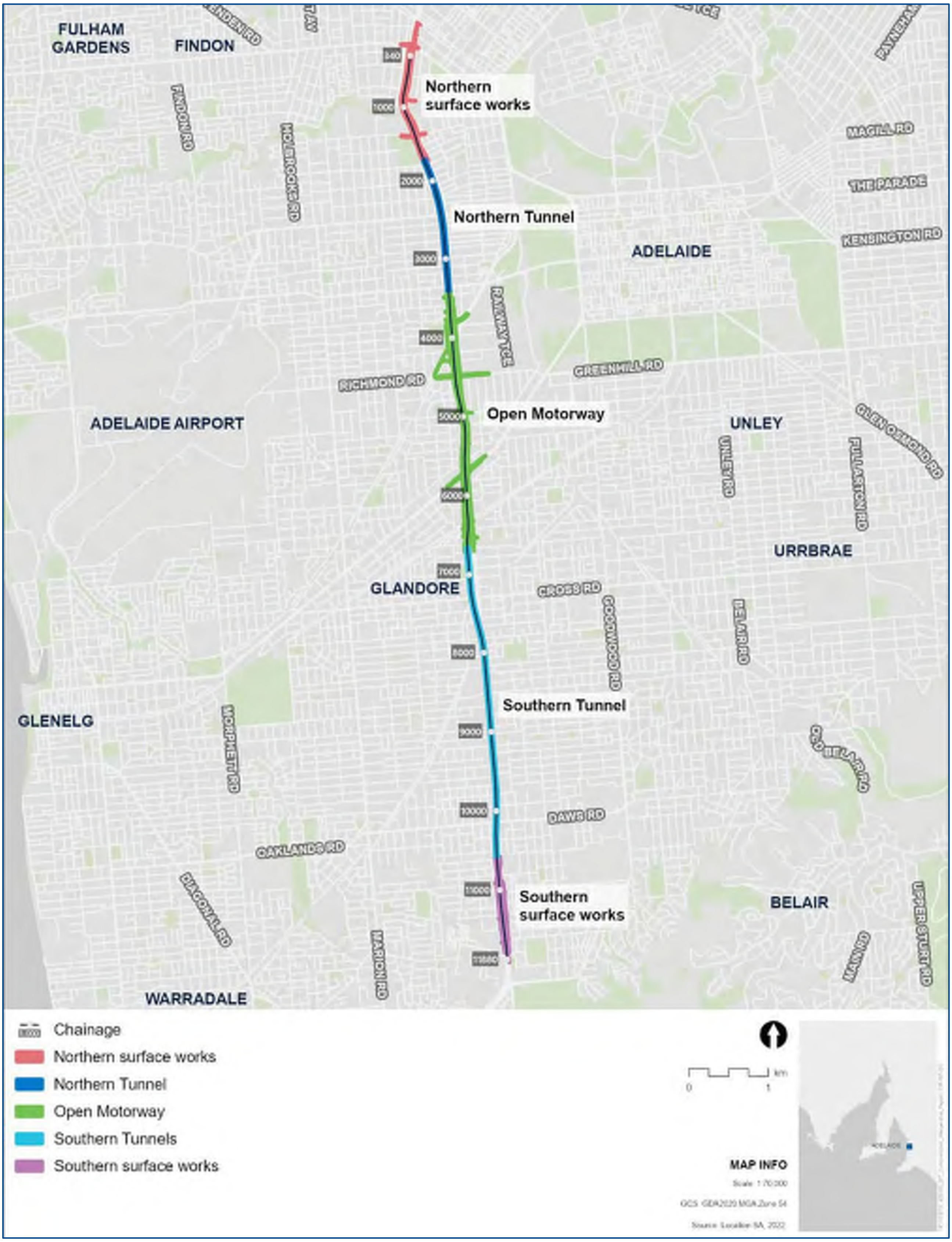


Figure 2: Tunnel Sections

Source: Provided by Client

2.2.4 Other Environmental Consultants

Other environmental consultants have been engaged by DIT to undertake site investigations at the T2D project site and produce factual reports. Agon will undertake technical review of factual reports by other environmental consultants to produce interpretive reports relating to waste classification and the receiving site.

2.2.5 Australian Environmental Auditors

Australian Environmental Auditors (AEA) has been engaged by DIT under Contract No. 22C337 to deliver WDF Audit Services. AEA is pre-qualified under the Professional Services/Site Contamination Auditor Services Panel. Mr. Jean-Paul Pearce is the SA EPA accredited Auditor ("the Auditor") assigned to project. The role of AEA and by extension, the Auditor, is to assist DIT by:

- Initiating and overseeing WDF audits (i.e. for the site) in line with the SA EPA guidelines and the national environment protection measure (assessment of site contamination) requirements.
- Continuously monitoring the activity and reports of the WDF Assessments consultant.
- Reviewing and endorsing the Site Management Plan.
- Undertaking independent verification that the SMP is being followed during the pre and post filling stages and any post filling requirements are being fulfilled.
- Issuing interim audit advice to the SA EPA.
- Issue of Site Contamination Audit Report/Site Contamination Audit Statement for the receiving site under a proposed commercial/industrial land use following all filling and associated activities.
- If required, endorsing a suitable Environmental Management Plan for the ongoing use of the receiving site.

2.2.6 SA EPA

The SA EPA is responsible for accreditation of the Auditor, for reviewing interim audit advice documents and the site contamination audit report and providing any approvals that may be required under the WDF Standard. It is noted that SA EPA acceptance is required prior to placement of any WDF, and SA EPA approval may be required prior to any discharges from the site.

2.2.7 Renewal SA

Renewal SA is the landowner responsible for providing consent to site access and investigations for the WDF audit. It is understood that DIT has involved Renewal SA in the overall site filling strategy for the site and keeps Renewal SA updated on site activities.

2.2.8 Other parties

Other parties will need to be consulted with throughout the project and approvals process such as the local council and community. Agon has not undertaken consultation with other parties and this will be a matter for the DIT or Alliance.

2.3 T2D Spoil Generation and Importation

2.3.1 Waste Soil Classification

Agon has undertaken a waste classification for the tunnel spoil to be generated from the Southern Tunnels and the Northern Tunnels (Agon, 2024). Upon application of statistical analysis (ProUCL), the 95% upper confidence limits (UCL) of all contaminant concentrations in natural soils were less than the SA EPA Waste Fill criteria, with the exception of arsenic for the Southern Tunnels (Section 1 and Section 2) which was reported at an Intermediate Waste Level (Table 1). It is noted that the 95% UCLs for barium, manganese and copper were less than the Waste Fill criteria, however the maximum concentration and standard deviation were not within acceptable limits for classification as Waste Fill, requiring classification as Intermediate Waste.

The elevated arsenic concentrations are noted to be naturally occurring within the Hallett Cove Sandstone formation of the Tertiary age (i.e. several million years old). The waste classifications for the four nominated Tunnel Sections are summarised as follows:

- Southern Tunnel, Section 1 (chainage 6650 m to chainage 9650 m) – **Intermediate Waste.**
- Southern Tunnel, Section 2 (chainage 9650 m to chainage 10585 m) – **Intermediate Waste.**
- Northern Tunnel, Section 3 (chainage 1710 m to chainage 2280 m) – **Waste Fill**; and
- Northern Tunnel, Section 4 (chainage 2280 m to Chainage 3400 m) – **Waste Fill**.

The leachability of arsenic was assessed using a range of ASLP and LEAF leachate analysis. A maximum arsenic leachability of 1.42 mg/L was reported under alkaline conditions, which are not considered generally realistic in natural environments.

The leachability of arsenic also decreases significantly under acidic conditions, which is a more realistic reflection of conditions likely to be encountered in the site environment, noting that leachability does increase again marginally with a pH below 2.0. Regardless of the conditions, the maximum arsenic leachability was noted to be below the SA EPA Criterion for the Intermediate Waste of 5 mg/L.

Table 1: Summary of Waste Fill Exceedances

Analyte	Waste Fill Criteria (mg/kg)	Intermediate Waste Soil Criteria (mg/kg)	No. of Waste Fill Exceedances	No. of Intermediate Waste Exceedances	Max Conc (mg/kg)	Std Deviation (mg/kg)	95% UCL (mg/kg)
	Section 1						
Arsenic	20	200	70	5	550	66.2	43.89
Barium	300	No criteria	4	0	1,200	130	69.59
Manganese	500	6,000	12	0	5,700	627.4	350.2
Copper	60	2,000	3	0	290	28.26	17.55
Nickel	60	600	4	0	96	15.44	19.46
Zinc	200	14,000	1	0	290	25.26	28.82
	Section 2						
Arsenic	20	200	7	0	180	39.62	29.76
Manganese	500	6,000	2	0	720	159.5	212.5
Nickel	60	600	1	0	68	10.55	17.68
	Section 3						
Arsenic	20	200	1	0	23	3.662	5.556
Manganese	500	6,000	3	0	880	189.2	316.8
	Section 4						
Manganese	500	6,000	2	0	1,100	188.1	274.7
Copper	60	2,000	1	0	170	29.73	29.34

NOTE: Shaded cells indicate value exceeds SA EPA Waste Fill Criterion. Std Deviation required to be below 50% of criteria. Maximum concentration to be below 250% of criteria.

The risk to the site in receiving soils containing naturally occurring elevated arsenic is given preliminary consideration through comparison with arsenic concentrations currently at the site in Section 8.2.7, with further consideration to be undertaken in an environmental risk assessment (ERA).

Currently only spoil generated from the tunnel alignments has been classified. All other soil/spoil likely to be generated by construction activities associated with the T2D have not yet been classified.

3.0 SITE DETAILS

3.1 Site Identification

The site comprises a portion of two land parcels identified as Pieces 501 and 502 of Deposited Plan 121878 under Certificate of title (CT) Volume 6239 Folio 959. The site boundary is shown in Figure A1, Appendix A. Further details are provided in Table 2

Table 2: Site Details

Site Address	208 Eastern Parade, Gillman SA 5013 and North Arm Road, Dry Creek SA 5094
CT Volume/Folio	6239/959 (Portion)
Plan/Parcel	D121878Q501 (Portion) D121878Q502 (Portion)
Current Owner	Urban Renewal Authority trading as Renewal SA
Current Zoning	Strategic Employment
Local Government Area	City of Port Adelaide Enfield
Site area (approximate)	145.19 ha
Current site use	Vacant/Wetlands
Proposed future use	Commercial/Industrial
Proposed Activity	Placement of imported fill to achieve desired levels.

3.2 Physical Setting and Current Land Use

The site is split across the two suburbs of Dry Creek and Gillman, and it is located approximately 13 km north-west of the Adelaide Central Business District (CBD). The two allotments are divided by an access track which is an extension of North Arm Road (not a public road), with Piece 501 to the west and Piece 502 to the east.

Piece 502 has been vacant and is now overgrown with grass and low shrubs, while Piece 501 was formerly the Dean Rifle Range (shooting range) from 1887 until June 2003 (SARA, 2023) is also currently vacant.

The estuarine areas of Gillman and Dry Creek comprises tidal flats and salt marshes and a portion of the Gillman and Dry Creek area has been reclaimed, predominantly with material possibly dredged from the Port Adelaide River.

3.2.1 Dredged Material

As inferred in the DSI the fill material is noted to cover the majority of the western portion of the site within Piece 501. The source of fill was inferred to potentially be originated from historical dredging of the shipping channel, wharves and docks of the Port Adelaide River. This assumption was made based on the observed composition of the fill which encountered abundant shell debris with no signs of brick, metal, glass, slug, rubber, concrete or other fragments which are typically found in fill materials at industrial and residential sites across Adelaide.

Based on historical aerial photographs included in the PSI (Agon, 2024c) the filling of Piece 501 and building of levee banks occurred prior to 1935. Based on review of publicly available historical documents, the initial dredging of the Port Adelaide River occurred in 1840-50s when *'The river channel was widened and deepened, with the dredged silt being used for the reclamation of the adjacent swampy land'* (DEWNR, 2024).

'This spoil was used to reclaim swamp land and build up the commercial area of the port. As a result, the ground level was raised by a number of metres behind the wharves. Major reclamation of the coastal

swampland at Glanville in 1892 created the Glanville Reserve. Continued dredging of the Port River to deepen the shipping channel during the 1920s and 1930s was necessary to accommodate larger ships and the spoil from this deepening program was transported to fill swamps on Lefevre Peninsula and to the east (Gillman).' (McDougall & Vines, 2014).

'Embankments were constructed in the 1880s onwards to prevent sea water flowing over large areas of Dry Creek and Wingfield. From 1883 to 1895 government departments acted to prevent the normal tidal flooding of this and adjacent land by building levees, 1.5 metres broad and 0.9 metres above highest tide, and with exit sluices. The water flow was two way. The St. Kilda embankment was intended to hold in the creeks flowing towards the river and allow the Government land to benefit from the fresh water and silt. The embankments suffered from high tide damage, floods and washaways, particularly in 1917 when a 'stupendous tide' came over the Port Adelaide Rifle Range embankment, causing significant damage to the embankment itself. This land was crossed by the sewage pipeline from Islington, as the main drain from the sewage farm discharged surplus water to the North Arm of the Port River. In 1922 the Harbors Board built an embankment against sewage on the Reserve side of the outfall channel into Sewer's Creek (now called North Arm Creek), to (often unsuccessfully) prevent backflow of the often raw sewage discharged. This problem was solved only when the sewerage farm was closed and the treatment works moved in 1935.' (McDougall & Vines, 2014).

The above references suggest that the western part of the site area was filled using dredged material between 1892 and 1930. This implies that dredged fill is unlikely to contain anthropogenically derived chemicals that would impact soil and groundwater.

The site is protected from tidal influence by a levee bank which forms the northern site boundary. A site features map it is provided in Figure A2, Appendix A.

3.3 Proposed Land Use

Once the filling is completed, Agon understands that the site will be redeveloped for a commercial/industrial purpose. Details of the proposed future development have not been provided.

3.4 Surrounding Land Use

The surrounding land uses include Utilities/Industry, Commercial, Reserve and Recreational land, with further detail on the adjacent land uses provided in Table 3. A general overview of land uses within 1 km of the site is presented in Figure A3, Appendix A.

Table 3: Surrounding Land use

Direction	Land Use Description
North	Adjoining Piece 501 to the north-west are the Magazine Creek Wetlands. To the north of Piece 502 are the Magazine Creek and associated low lying land, Club Road and further the North Arm of the Port Adelaide River. To the northwest are industrial properties along Grand Trunkway, including the Renewal SA Soil Bank.
East	Adjoining the site to the east are the Wingfield Waste & Recycling Centre (including Jeffries, Orora Adelaide Resource Recovery and Transpacific Industries), Cleanaway Wingfield Resource, Allied Waste Services, the Wingfield Landfill, the North South Motorway and the Barker Inlet wetlands.
West	Directly to the west is a heavily industrialised area which includes Bevchain Distribution Centre, Geodis Australia, Eddy Wreckers, Rivet Australia, Ampol Gillman Service Station, the southern portion of the Magazine Creek Wetlands, Whicker Road and Eastern Parade.
South	The southern boundary of the site adjoins the Port River Expressway. South of the Expressway, industrial properties include Pickering Transport, Plasdene Glass Pak, Woodville Wreckers and U-Pull It, Gillman Speedway, Bluestar Logistics, Veolia Adelaide, Solo Resource Recovery, the IWS Landfill and Waste transfer and recycling facility and a portion of The Range wetlands.

4.0 ENVIRONMENTAL SETTING

4.1 Topography and Drainage

The site is situated in the north-west of the City of Port Adelaide Enfield (PAEC) area. The site is relatively flat with an approximate elevation between 2 and 4 m AHD in line with the regional topography. The site comprises several tidal creeks/natural drainage channels and is adjacent to the Magazine Creek and Range Wetlands. The next nearest water bodies are the Greenfields Wetlands, Barker Inlet Wetlands and the North Arm of the Port Adelaide River. Surface water on the site is expected to run off into Barker Inlet, the adjacent wetlands and infiltrate into site soils. Agon notes that open drains connect both the Range Wetlands and Magazine Creek Wetlands with the Barker Inlet. Figure A4, Appendix A shows the surrounding elevation contours and topographic features.

4.2 Geology

A review of regional geological information, as presented in the South Australian Resources Information Geoserver (SARIG, 2023), indicates that the natural regional geology is likely to comprise Holocene aged sediments of the Saint Kilda Formation (Qhck) which is described as “Coastal marine sediment: calcareous, fossiliferous sand and mud of intertidal sand flats, beaches, and tidal marshes; organic, gypseous clay of supratidal flats”.

Past investigations have investigated the geology of the broader area, with the site captured between points A” and B” as shown on Figure 3. An indicative cross section shows that the geology of the site comprises Quaternary sediments representative of the St Kilda, Pooraka, Glanville and Hindmarsh formations (Figure 4; Belperio & Rice, 1989). The St Kilda and Glanville formations are similar and comprise silty fine-grained sands with shell debris and decomposed seaweeds. The Pooraka formation comprises sandy clay or clayey to sandy silt, with typically stiff clay. The Hindmarsh formation is predominantly a mottled red brown, yellow brown and grey, stiff to hard clay.

Figure 3: Site Location Relative to Historic Cross Section.

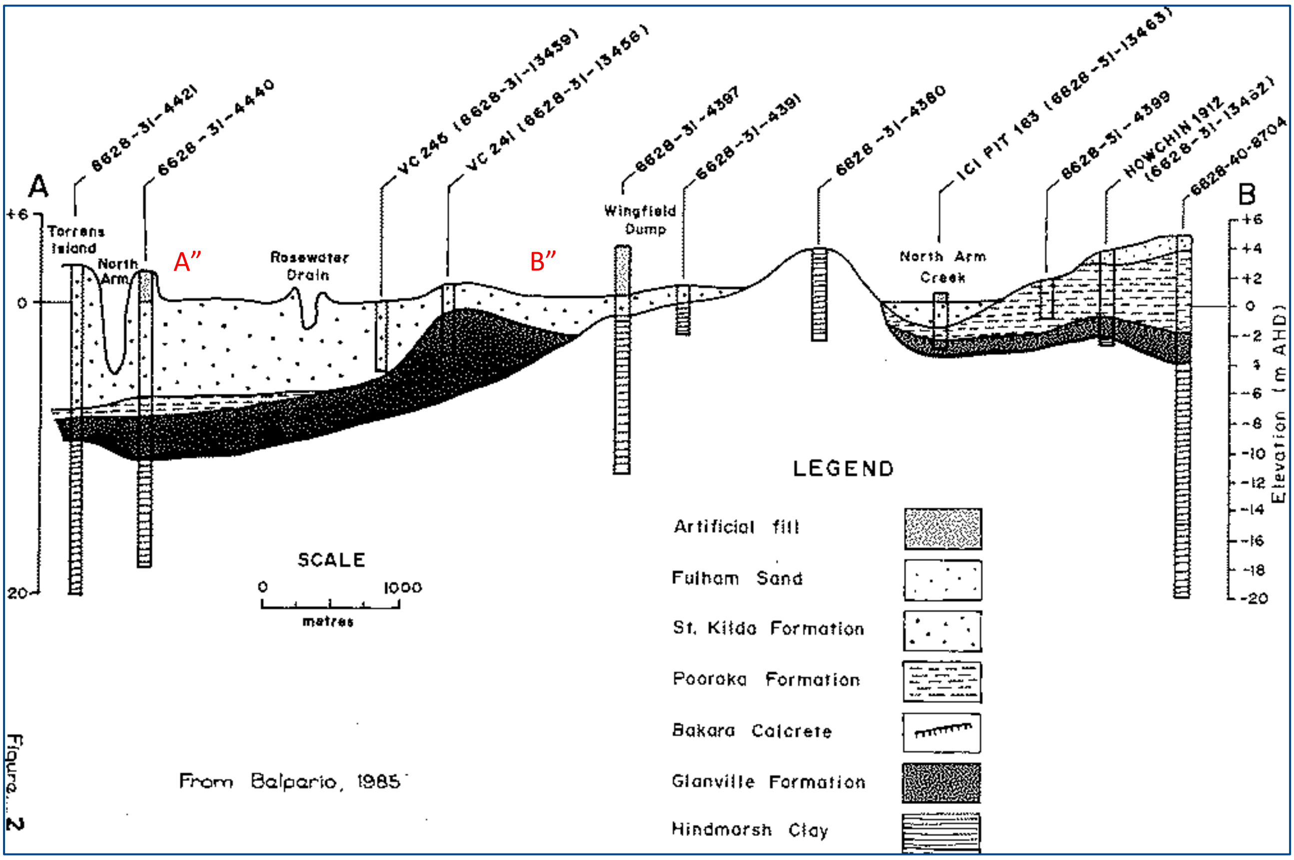


Figure 4: Indicative Cross Section of the site

Source: Belperio & Rice, 1989

4.3 Hydrogeology

4.3.1 Regional Hydrogeology

The Quaternary sediments within the Adelaide Plains include inter-bedded sand and gravel layers within which the water table (uppermost aquifer) generally occurs, and also form other deeper aquifers in the underlying Hindmarsh Clay. These Quaternary aquifers are not highly utilised as the yield and water quality are highly variable. The deeper Tertiary aquifers generally have better quality water and yields and are utilised in some areas within the Adelaide Plains. A generalised cross section through the Adelaide Plains is presented below in Figure 5.

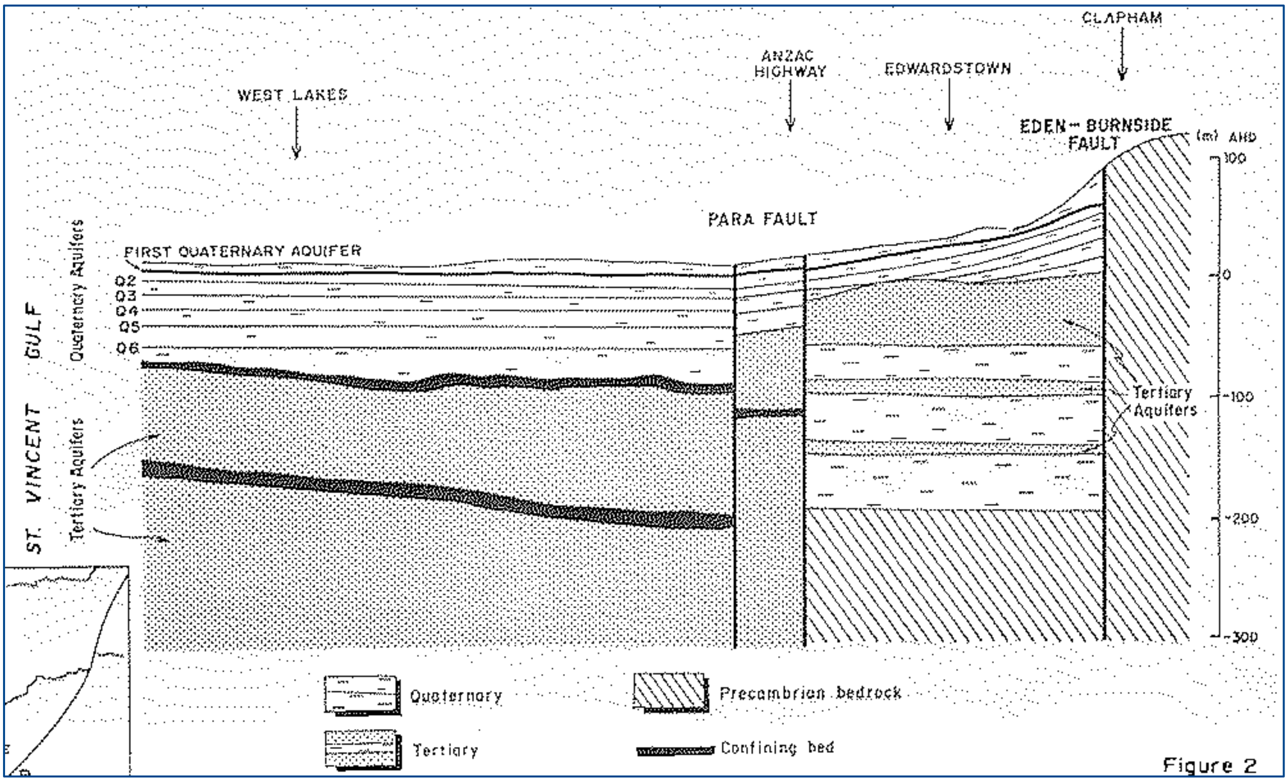


Figure 5: Generalised Cross Section – Adelaide Plains Geology & Aquifers.

Source: Centre for Groundwater Studies Report 'Potential for Storage and Reuse of Adelaide's Stormwater Runoff Using the Upper Quaternary Aquifer System' (CGS report No.40, April 1992).

Generalised groundwater contours for the uppermost aquifer within the Adelaide metropolitan area indicate that the movement of groundwater in the uppermost aquifer at the site is expected to be in a north, north westerly direction towards the Barker Inlet (Figure 6). Groundwater salinity of the uppermost aquifer in the vicinity of the site is expected to be greater than 5,000 mg/L (Figure 7), making groundwater unsuitable for the majority of identified potential uses including drinking and irrigation.

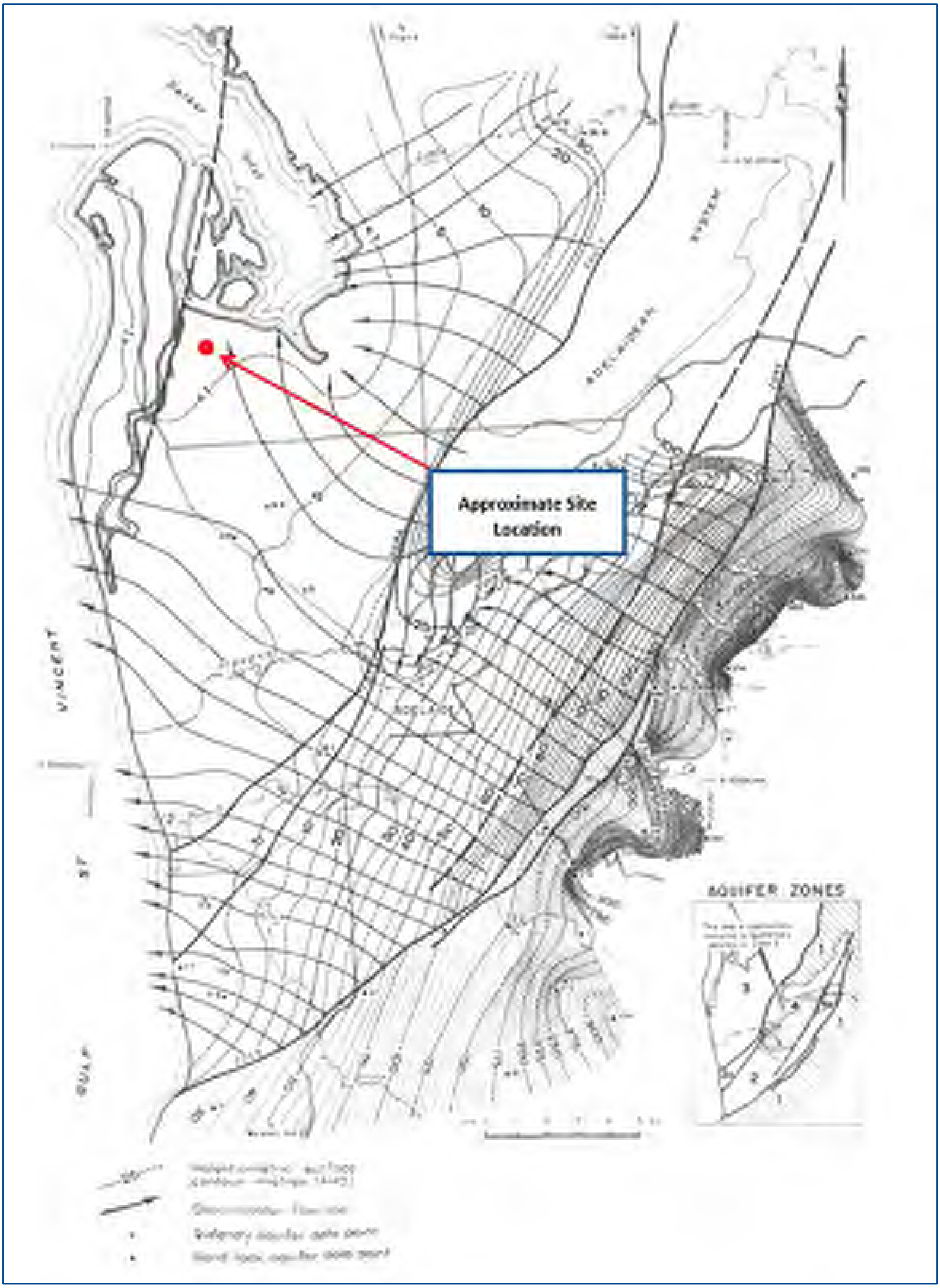


Figure 6: Groundwater Level Contours, Uppermost aquifer.

Source: Gerges 2006

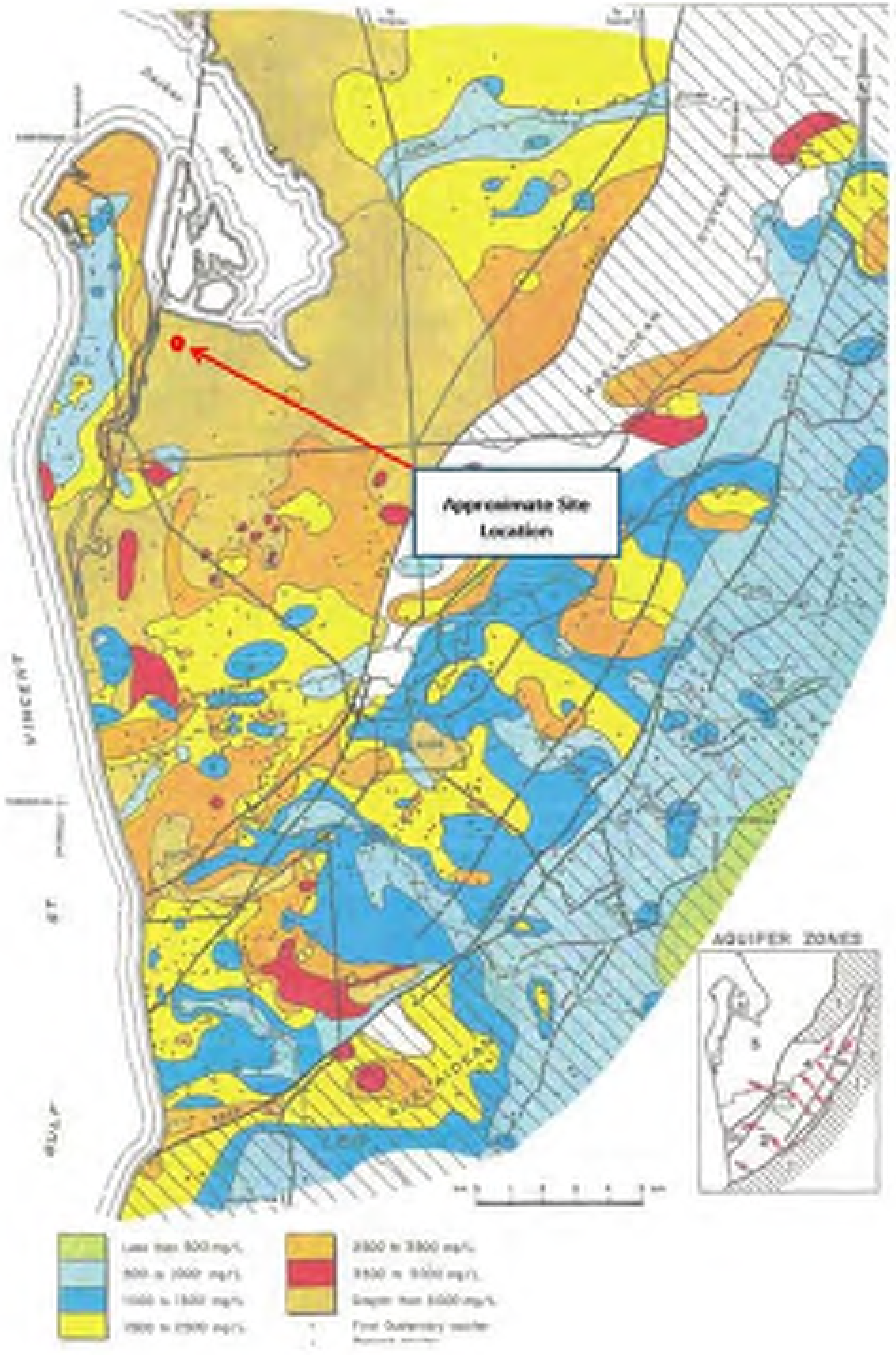


Figure 7: Groundwater Salinity, Uppermost Aquifer

Source: Gerges, 2006

4.3.2 Site Specific Hydrogeology

The saturated portions of the St Kilda and Glanville formations form the uppermost aquifer in the area. These formations are separated by a hard calcrete layer, but this is not continuous, and it is likely that the saturated strata of the St Kilda and Glanville are hydraulically connected. These formations are underlain by the Hindmarsh Clay formation (primarily clay materials) which form the uppermost aquitard (or confining bed).

Soil across the site is generally saturated from shallow depths ranging from 0.5-1.5m below the current ground level (Belperio and Rice, 1989). A review of historical reports indicated that the flow of groundwater at the site is expected to occur to the north/north-west, towards the North Arm Creek and Barker Inlet. This has been confirmed by the results of investigations conducted at the site and discussed in this report.

The groundwater at the site area was found to be hypersaline (2-3 times higher than seawater salinity).

The uppermost aquifer (both St Kilda and Glanville) at the site is unconfined. The recharge to the uppermost aquifer generally occurs as a result of two major mechanisms:

- Rainwater and wetland discharge water (refer Section 4.6) infiltration.
- Groundwater throughflow from up hydraulic gradient locations.

The groundwater discharge would also occur as a result of two major mechanisms:

- Evaporation from the groundwater surface due to shallow groundwater levels.
- Groundwater discharge into marine aquatic systems of the Barker Inlet.

It is also expected that the wetlands and levee banks retaining stormwater create a hydraulic containment limiting/diverting the natural groundwater flow in the area.

4.4 Acid Sulfate Soils

The site is known to contain acid sulfate soil (ASS) types and has been subject to significant ASS investigations including being the subject of a PhD thesis (Thomas, 2011). The broader site area has been isolated from tides since the 1930s when a series of bund walls that prevent tidal inundation were constructed. The location of the bund walls can be seen in historic aerial photography from 1935 as shown in Figure A5 (CPAE, 2024), Appendix A.

The consequent loss of tidal inundation inside the bund walls has resulted in a lowering of the water table which has exposed large areas of hypersulfidic material (or PASS, described in Table 4 below) to the atmosphere. This has allowed sulfide minerals contained in the hypersulfidic material (typically pyrite) to oxidise to produce sulfuric acid, thereby converting the upper 2.0 m of the soil profile inside the bund walls to sulfuric material (AASS) exhibiting very low pH (<4), jarosite mottles, and low acid neutralising capacity (Fitzpatrick, 2023).

It has been observed that seasonal inundation of the site results in water table fluctuations of more than 1 m. This periodic wetting may promote the formation of pyrite near the base of the profile where soil organic matter content can facilitate crystallisation and consumption of acidity under reduced conditions (Fitzpatrick, 2023).

Most of the sulfuric acid that has been produced through the oxidation of sulfide minerals is contained within the soil profile due to the low hydraulic gradient of the area. Past studies have concluded that there is a low risk for discharge of ASS leachate into the North Arm of the Port Adelaide River under the current hydraulic and drainage regime (Jensen, 2009). However, Fitzpatrick (2023) reported that when a drain is excavated, salt efflorescence precipitates on the soil surface along drain walls. These salts dissolve during wetting events, lowering the pH of the drainage waters (and connected water bodies) and increasing dissolved metal concentrations. The risks that ASS materials could pose to water bodies is considered further in the CSM and data gaps in Sections 11 and 12, in the context of future site development and changes to the hydraulic gradient.

Monosulfidic materials have been identified in the sediment underlying low lying creeks/waterlogged areas in the northern part of the site (Fitzpatrick, 2023). Subsequent intrusive investigations have not delineated the occurrence of monosulfidic materials.

ASS materials (refer Figure A6, Appendix A) have been found to be strongly associated with particular landscape units at the site (Thomas, 2011). Seasonally flooded areas comprising former tidal creek depressions, erosion channels, and drains (unit 2) generally contain sulfidic material including hypersulfidic, hyposulfidic, and monosulfidic materials. Higher topographic elevations where former tidal creeks have eroded into sandy soils (units 5, 6 and 7) contain sulfuric material underlain by hypersulfidic and/or hyposulfidic materials (Figure A6, Appendix A). Unit 5 was historically flooded when the site was under natural tidal influence and contains the highest levels of sulfuric and sulfidic material. Lower elevation areas with a higher water table (units 3 and 4) contain less extensive sulfuric material. The majority of the site is composed of landscape units 2, 5, 6 and 7, with Units 1 and 3 having very minor occurrence.

Acid sulfate soil materials identified on site are summarised in Table 4 (Fitzpatrick, 2023; Sullivan, 2018).

Table 4: ASS Materials Present at the site

ASS Material – Technical Name	ASS Material – Conceptual Name	Characteristics	Extent on site
Sulfuric	Actual Acid Sulfate Soil (AASS)	Typically found overlying PASS. Contains reducible inorganic sulfides, such as pyrite, that have undergone oxidation. Field pH (pH f) < 4.0 Soil profile may contain jarosite (yellow) and/or ferric iron oxides (orange to red) mottling. Sulfuric soil material that has undergone oxidation and is highly acidic.	Across the majority of the site.
Hypersulfidic	Potential Acid Sulfate Soil (PASS)	Typically found underlying AASS. pH f > 4 and typically 7-9 Typically saturated with water. Often dark grey in colour. Sulfidic soil material that would become highly acidic upon oxidation.	Across the majority of the site, underlying sulfuric material.
Hyposulfidic	Non ASS	Sulfidic soil materials that would not become highly acidic upon oxidation.	Across the majority of the site, typically underlying sulfuric material.
Monosulfidic	PASS or Non-ASS	Contains waterlogged monosulfide minerals such as iron monosulfide (FeS). >0.01% acid volatile sulfides.	Former tidal creek depressions, erosion channels, and drains.

4.5 Flora and Fauna

As documented in the Preliminary Site Investigation (PSI) (Agon, 2024c), the site and surrounds contain a number of ecosystems and flora and fauna species:

- The site is included within the Nationally important Barker Inlet and St Kilda Wetlands (ref SA0005).
- The site is also within the extent of the Barker Inlet-St Kilda Aquatic Reserve adjacent the Adelaide Dolphin Sanctuary.
- The site contains the Threatened Ecological community of the Subtropical and Temperate Coastal Saltmarsh (vulnerable status).
- The site includes listed State Rated Fauna Sites including for the Little Egret - *Egretta garzetta nigripes* (rare) and the Brown Quail – *Coturnix ypsilophora australis* (vulnerable).
- The site is also a potential habitat for a number of other migratory and threatened species.
- This is an indicative summary of flora and fauna on site, with a more detailed account provided in the Environment and Heritage Impact Assessment report (Mott McDonald, 2024).

4.6 Constructed Wetlands

As mentioned in Section 3.4 there are two wetlands located along the northern western corner of the site (Magazine Creek) and near the south eastern corner of the site (Range). The wetlands were constructed in late 1990s to intercept urban and industrial water runoff and improve its quality prior to discharging into the Barker Inlet and North Arm Creek ecosystem environments. PAEC provided Agon with a number of documents presenting construction and operation details of wetlands. As indicated in the wetland management plans (provided by PAEC) for each wetland prepared by Water Technology (June 2020) the wetland design objectives included:

- Intercept and treat polluted stormwater and runoff to reduce the concentrations and loads of pollutants in order to protect downstream ecosystems.
- Provide a system which supports a diverse aquatic ecosystem and will not be a source of problems including nuisance insects and odours.
- Provide a system which improves the visual amenity of the site and provides recreational opportunities.
- Provide opportunities for the harvesting and reuse of stormwater.
- Provide a means of intercepting chemical spills or accidents within their catchments; protecting downstream systems by presenting an opportunity for isolation and clean up.

The wetland constructions involved excavation of a number of ponds, with the excavated soils placed beside ponds to form earthen mounds separating ponds. The ponds were connected to each other via specifically designed inlets/outlets for stormwater to move between ponds and between wetland entry and exit points.

As the wetland sites are underlain by shallow hypersaline groundwater, a series of subsurface drains were constructed beneath the wetland ponds and connected to 6m deep sumps where groundwater is intersected and discharges under gravity. Each sump was equipped with a windmill that pumps collected groundwater to a dedicated outlet (discharge) pond. This groundwater control system was designed to lower groundwater levels to minimise the potential for hypersaline groundwater to enter wetland ponds (Figure 8).

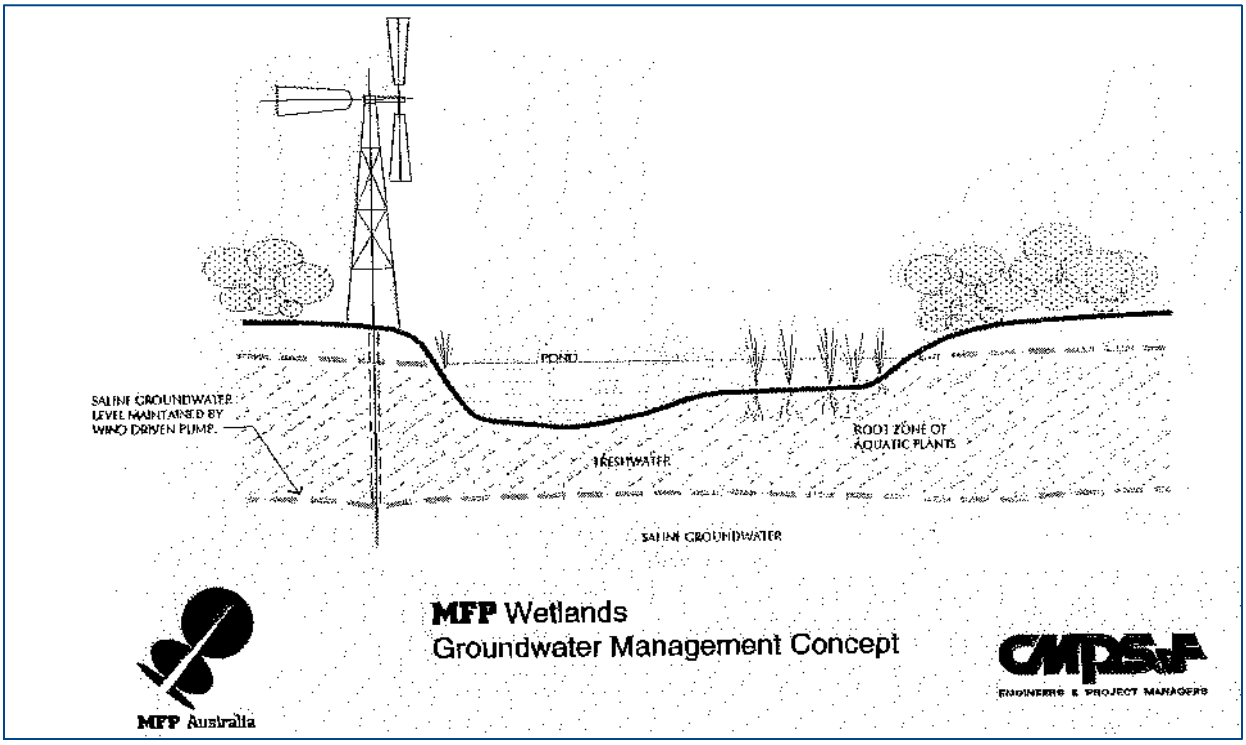


Figure 8: Groundwater Interception Design

Source (provided by PAEC)

The wetlands entries and exits, water flow directions and windmill locations are illustrated on Figure 9 and Figure 10. The water from the outlet (discharge) ponds at each wetland flows through canals towards dedicated discharge areas.

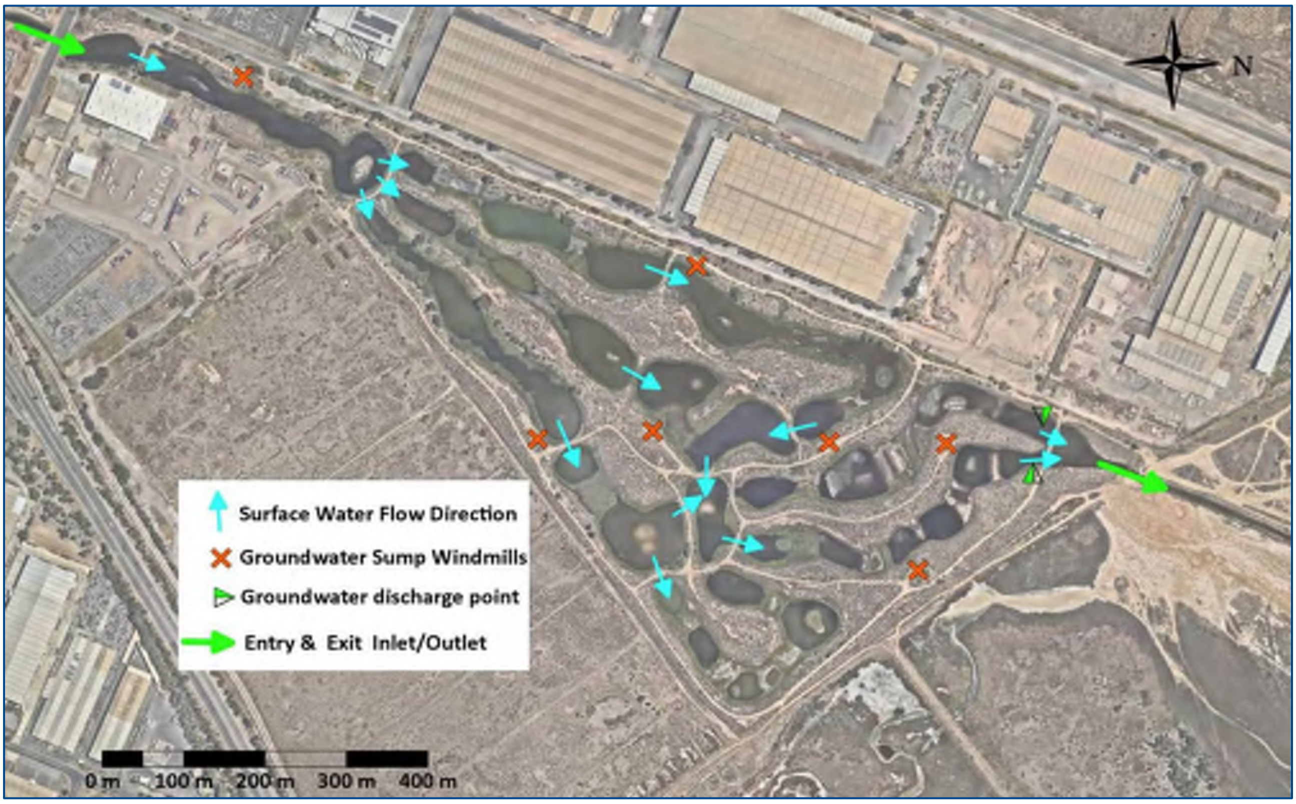


Figure 9: Flow and discharge pattern – Magazine Creek Wetland

Source: reproduced Figure 3-1 from "Magazine Creek Wetland Management Plan" by Water Technology, 12 June 2020

Figure 10: Flow and discharge pattern – Range Wetland

Source: reproduced Figure 3-2 from "Range Wetland Management Plan" by Water Technology, 12 June 2020

The Magazine Creek canal outlet is equipped with a one-directional flap-gate in the levee surrounding the site area to the Port River-Barker Inlet to prevent tidal water inflow. The Range discharge water flows through the canal into an evaporation/soakage basin located south of a tidal levee bank and surface water is supposedly dissipated through evaporation and/or soakage. The wetland discharge areas and water flows are shown on Figure 11.

The released water then accumulates at low lying areas along the northern site boundary levee bank creating surface water pools.

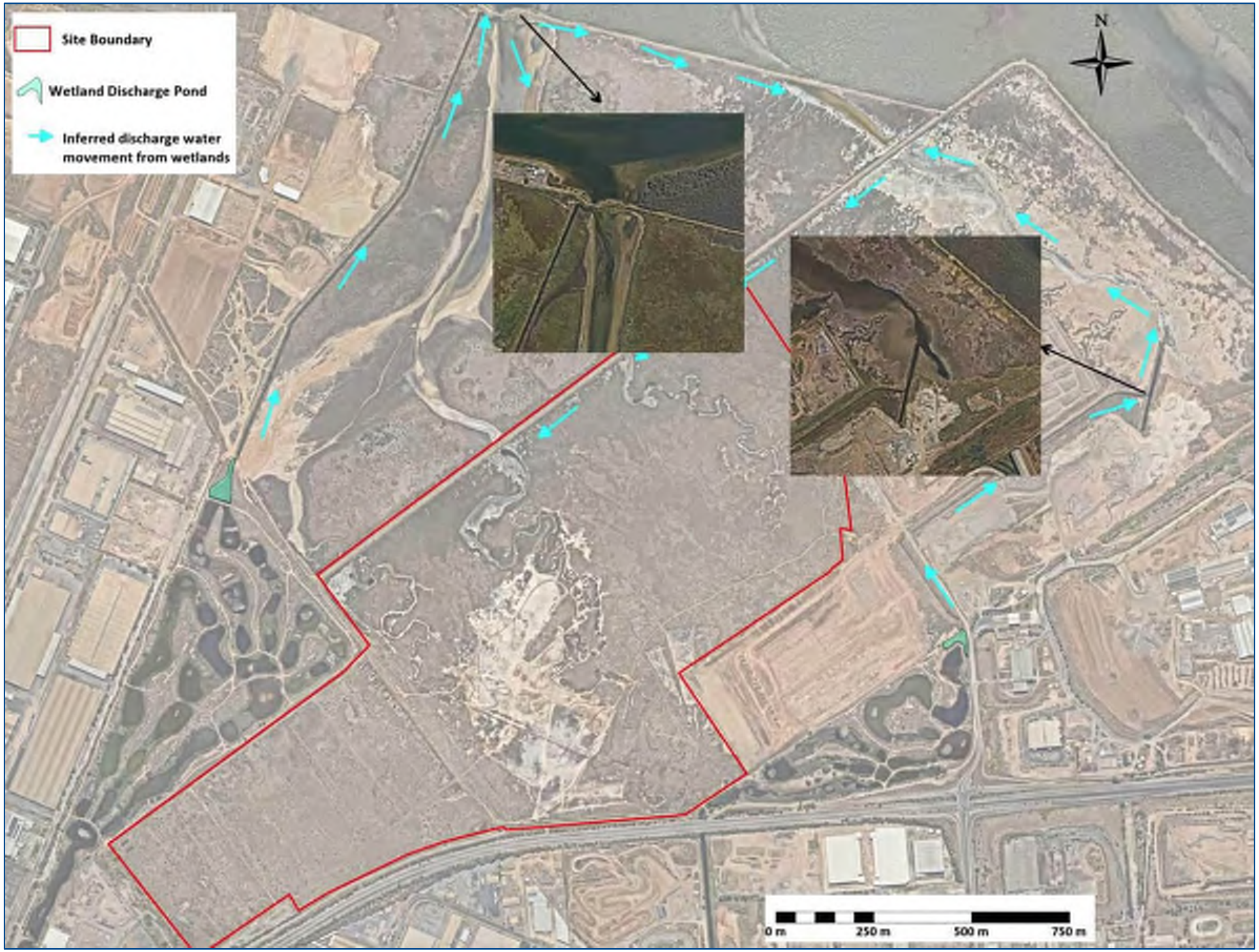


Figure 11: Wetland Discharge Areas

5.0 PREVIOUS INVESTIGATIONS

5.1 Site History Summary

The PSI (Agon, 2024c) identified that the site has been historically owned by The Commonwealth, Renewal SA and several private entities. Piece 501 was operated as the Dean Rifle Range up until 2003. The Rifle Range is understood to have been operated by the Commonwealth from 1887 until being ceded to the State in the 1980s, with information obtained from the Department of Defence suggesting that mortars were used at the site in the 1950s. The historical records indicate that Piece 502 has largely remained undisturbed with the exception of some land clearing.

The site is surrounded by industrial properties which may act as a potential source of offsite contamination including landfills, waste and recycling depots, services stations, vehicle storage, wetlands, transport depots and auto wreckers. Numerous Section 83A notifications have also been recorded for properties near the site.

Onsite and offsite potentially contaminating activities (PCAs) as defined under Schedule 3 of the Environment Protection Regulations 2023, resulting from historical and current land uses at the site were identified as:

- Operation of the site for Defence Works leading to the potential for Unexploded Ordnance (UXO) onsite. Agon notes that the operation of the Dean Rifle Range for private purposes would not constitute a PCA under the Environment Protection Regulations 2023 but is still considered a source of potential contamination in the form of heavy metals.
- Offsite properties including landfills and waste depots, service stations, and auto wreckers. Potential contaminants of concern include landfill gases, nutrients, solvents, petroleum hydrocarbons, heavy metals and PFAS.

Additional sources of contamination were identified that do not meet the definition of PCAs under Regulation 48(2) as the activities have not been undertaken in the course of a business and do not involve the manufacture, production (including as a by-product or waste) or recycling of a listed substance or a product containing a listed substance:

- Imported fill materials brought onto Pieces 501 and 502 including the presence of ACM and elevated levels of heavy metals, polycyclic aromatic hydrocarbons (PAH) and Total Recoverable Hydrocarbons (TRH) in the subsurface. While these areas of filling have been excised from the site, it is still possible that imported fill materials may be present from uncontrolled waste burial and illegal dumping on other parts of the site.
- Acid generation from disturbance of ASS materials.

5.2 Previous Groundwater Investigations

Previous groundwater investigations undertaken at the site and surrounding areas are summarised as follows, with a more detailed account provided in the PSI (Agon, 2024c).

5.2.1 Onsite

Prior to the current site investigations, the following key findings were made regarding groundwater beneath the site:

- Groundwater levels are between 0.2 and 2.7 m BGL with seasonal fluctuation, as interpreted from historic water level data.

- Previous onsite monitoring indicates that groundwater beneath the site is highly saline and contains coliforms and ammonia.
- Groundwater in the area is slightly acidic to neutral.
- A range of metals (aluminium, arsenic, copper, iron, lead and zinc) have previously been reported in groundwater above the SA EPA Water Quality guidelines (fresh and marine).
- A Section 83A notification (61469-01) is in place for the site due to the presence of arsenic and copper in groundwater.

5.2.2 Offsite

Numerous notifications under Section 83A of the Environment Protection Act (Section 83A notifications) exist for the surrounding area, indicating impacts to groundwater above marine guidelines. Information was requested from the SA EPA public register and Section 83A notifications within a 1km radius of the site have been summarised as follows. There are no known exceedances of the direct contact Health Screening Levels HSLs.

ResourceCo, Lot 202 Hanson Road, Dry Creek (adjacent to the East)

A Section 83A notification was submitted by Australian Environmental Auditors for petroleum hydrocarbons. The data tables included indicate that groundwater also contains arsenic, boron, manganese, molybdenum, zinc, ammonia, chloride, sodium and sulfate that exceed the recreation and aesthetics and aquatic ecosystems (marine) criteria. It is noted that additional documentation provided by the SA EPA indicates that these other chemicals (aside from petroleum hydrocarbons) were determined to be background. Groundwater is flowing towards the site from the ResourceCo facility, so these impacts are expected to affect groundwater underlying the site and may be expected to continue to move beneath the site with the direction of groundwater flow.

Adelaide Resource Recovery, Former Wingfield Landfill – Lot 25 and Lot 26 (adjacent to the East)

Jacobs Group was commissioned to install groundwater wells and undertake two groundwater monitoring events (GME) at the former Wingfield landfill (Lots 25 and 26) on 5-6 August 2015 and 2-3 March 2016. The GME included the installation of three nested groundwater wells in the lower and upper aquifer units and the installation of data loggers in the nested wells. Samples were collected from new groundwater wells and a selection of existing wells (2 of the existing nested wells) using low flow purging methods with the following key findings:

- Nutrients (ammonia, phosphorous and total nitrogen) were reported above the PEVs for marine Ecosystem.
- TRH fractions C10-C40 were reported above the laboratory limit of reporting (LOR) but below the relevant PEVs.
- The results from the data logger installation show that the flow direction of groundwater in the upper aquifer is varied, ranging from a general northerly direction in August 2015 to a southerly direction in March 2016. The lower aquifer's groundwater flow direction is mainly westerly to south westerly.
- The data loggers also show tidal, and rainfall impacts on the lower aquifer, with various degrees of connectivity between the upper and lower aquifers.

- A Section 83A notification (dated 18 February 2016) based on the first GME was submitted for the site, reporting the presence of Trichloroethylene (TCE) and Tetrachloroethene (PCE) concentrations in groundwater. The Section 83A was updated following the second GME which confirmed the presence of TCE and PCE.

1-17 Kapara Road, Gillman (~120m South)

A Section 83A notification was submitted to the SA EPA dated 31 October 2014 for TRH, Benzene, Toluene, Ethylbenzene and Xylene (BTEX) and Polycyclic aromatic hydrocarbons (PAH) (AA Scott Pty Ltd, 2014). This site is owned by Scott's Transport Industries Pty Ltd, with the company understood to have transported freight and cargo. Changes to the company name evident on the Australian Business Register indicate that the company may have transitioned to a fleet rental model around 2017. The groundwater contamination is inferred to be related to fuel storage.

30-32 Francis Street, Port Adelaide (~450m South-West)

A Section 83A notification was submitted to the SA EPA dated 5 December 2017 for TRH impacts from a leaking above ground diesel fuel tank.

18 Wilkins Road, Gillman (~450 m South)

Investigations on this site have included soil Investigation, soil remediation, groundwater investigation, groundwater remediation, validation samples and groundwater modelling.

Groundwater contained up to 0.6m of Non-Aqueous Phase Liquid (NAPL) and elevated lead and dissolved hydrocarbons as a result of a leaking above ground diesel fuel tank. The gross soil impacts have been remediated however NAPL remains on site.

The findings of this investigation were as follows:

- In late 2015, the diesel AST, bowser, and fuel supply lines were removed.
- Soil remediation was carried out via excavation between the 11th and 13th of January 2016, removing about 600 tonnes of contaminated soil.
- According to the output logs of the Membrane Interface Probe, the vertical reach of the effects is expected to be restricted to the upper 5 m of the water table aquifer (St Kilda Formation), and is limited by increasing clay content with depth, as indicated by the Electrical Conductivity plot.
- Two validation samples VS01 and VS03 reported TRH >C6-C10 less BTEX (F1 minus BTEX (580 mg/kg and 410 mg/kg) concentration above the criterion of HSL (sand) of 260 mg/kg.
- Ex-situ soils (stockpiles) were bioremediated and were sampled. All samples exceeded the accepted ecological screening standards for terrestrial ecosystem protection (ASC NEPM ESLs for commercial/industrial land use).
- Light Nonaqueous Phase Liquids (LNAPL) was discovered at the site due to diesel contamination in multiple wells around the property.
- Benzene levels at GW02 and GW04 were reported above the drinking water criteria of 1 µg/L.
- Ethylbenzene levels in wells GW02 and GW04 (both 19 µg/L) exceeded the recreational limit of 3 µg/L.
- Naphthalene was detected in wells GW02 and GW04 (22 µg/L and 19 µg/L, respectively), which were slightly higher than the freshwater GIL of 16 µg/L.

- Lead was reported in well GW01 (0.01 mg/L), which was over the drinking water criteria 0.01 mg/L, and in well GW02 (0.006 mg/L), which was above the freshwater GIL of 0.005 mg/L.
- Groundwater remediation was carried out using a skimming system to remove LNAPL, resulting in the recovery of roughly 35 L of LNAPL from the aquifer.
- Following removal of soil sources and residual LNAPL removal accessible in wells, the thickness of LNAPL present in wells was substantially smaller and less recoverable than in 2015. Further LNAPL or dissolved phase petroleum impact remediation of groundwater was not considered possible on this basis.
- According to groundwater modelling, the plume has achieved a stable state and is unlikely to travel further offsite beyond GW07 at the boundary to the next site to the north. It was recommended not to use groundwater for extractive uses in the site.
- All soil vapours were below the adopted criteria HSL D for commercial and industrial for sand 2-4m.

Caltex, Corner of Hanson Road and Wilkins Road, Wingfield (~ 530m South-East)

A groundwater and soil investigation has previously been undertaken to develop the site into a service station.

A Section 83A notification was submitted to the SA EPA for dissolved phase hydrocarbon impacts above the detection limit, and for cobalt, zinc and total organic carbon (TOC) above the adopted investigation levels.

25-91 Bedford Street, Gillman (~665m South-West)

LBW was commissioned to undertake a DSI in 2020 at the Port Adelaide Distribution Centre. The purpose of this investigation was to address data gaps from previous assessments at the site related to elevated concentration of nutrients in soil and groundwater, and trace concentration of polyfluoroalkyl substances (PFAS) identified in groundwater.

The DSI included drilling of 21 onsite and 2 offsite soil bores and the installation of 10 groundwater wells. Surface water samples were also collected from stormwater network (8 locations) and three (3) offsite locations. The key findings were as follows:

- Nutrients (nitrate, ammonia, and phosphorus) were identified in soil samples at the site; however, in some locations, concentrations were below the adopted assessment criteria.
- Ammonia concentrations were detected in almost all groundwater samples at concentrations above the ANZG 2018 Marine Water 95% toxicant guideline values.
- Total Dissolved Solids (TDS) were found in all the groundwater samples above the ANZG 2018 Livestock (ANZECC 2000) criterion.
- Two samples in groundwater samples detected PFAS concentrations above the NEPM 2018 Interim guideline for marine waters (95% protection).
- Twenty four groundwater samples reported fluoride concentrations above the ANZG 2018 Livestock (ANZECC 2000) criterion.
- Four samples from the stormwater network reported ammonia as N exceeding the ANZECC 2000 guideline for marine waters (95% protection).

ResourceCo Wingfield Waste Transfer Station (~ 930 m South-East)

Biannual groundwater monitoring of groundwater quality is a condition of SA EPA licence No. 3 (306-777). The findings from groundwater monitoring events between 2010 and 2020 relating to this site were:

- The biological oxygen demand (BOD) has been consistently above the SA EPA EPP (WQ) for freshwater Aquatic of 10 mg/L in one location.
- Iron concentrations are typically above the SA EPA EPP (WQ) for freshwater Aquatic of 1 mg/L.
- Copper concentrations are typically above the SA EPA EPP (WQ) for freshwater Aquatic of 0.05 mg/L.
- Zinc concentrations are typically above the SA EPA EPP (WQ) for freshwater Aquatic of 0.01 mg/L.
- Elevated nutrient concentrations (ammonia, nitrogen, phosphorus and TOC) were reported above the assessment criteria (0.5 mg/L, 5mg/L, 0.1 mg/L and 15 mg/L respectively) in some locations.
- TPH concentration from different fractions have been detected above the LOR in some locations.
- VOC concentrations have been detected above the LOR in some locations.
- Benzene and Ethylbenzene concentration were above the LOR in one location.

Metal concentrations were noted to be higher adjacent the Port River Expressway; it was concluded that *"this could be the result of run-off from the Port River Expressway and other catchments containing elevated metals concentrations. Reductions in the majority of metals concentrations within the down-hydraulic gradient wells indicates that metals reported in the groundwater may not result from the on-site activities"*.

It was concluded that *"elevated nutrient concentrations (ammonia, nitrogen, phosphorous and TOC) may be the result of decomposition of organic matter at other landfill sites. In addition, nutrient concentrations are generally elevated in wetland areas as a result of run-off, animal activity and decomposition of plant and animal matter, and may be impacting groundwater beneath the site."*

5.2.3 Summary of Findings

Overall, the contaminants of concern known to be present in offsite groundwater above the adopted investigation levels include:

- Inorganics and nutrients:
    - Metals, fluoride, TDS, sodium, chloride, sulfate, phosphorous, total nitrogen, TOC and BOD.
- Organic compounds:
    - BTEX, TRH, TCE, PCE, PAH, PFOS.

A summary of all chemical concentrations in offsite groundwater exceeding criteria is provided in Table 5, noting that some of the Section 83A Notification documentation from the SA EPA did not contain analytical data and therefore could not be included in the summary.

Table 5: Summary of analytes in offsite groundwater exceeding criteria.

83A Notification	Year	Analyte	Max. Concentration	Criteria Exceedance
60049 - Lot 202 Hanson Road Dry Creek	2020	Arsenic	0.07 mg/L	ADWG 2018 Health
		Boron	21 mg/L	ADWG 2018 Health
		Manganese (filtered)	0.46 mg/L	ADWG 2018 Aesthetic
		Molybdenum (filtered)	0.073 mg/L	ADWG 2018 Health
		Zinc (filtered)	0.30 mg/L	ANZG (2018) Marine water 95% toxicant DGVs
		Ammonia as N	42 mg/L	ANZG (2018) Marine water 95% toxicant DGVs
		Chloride	53,000 mg/L	ADWG 2018 Aesthetic
		Sodium	35,000 mg/L	ADWG 2018 Aesthetic
		Sulfate	7,800 mg/L	ADWG 2018 Aesthetic
60883 - Resourceco Wingfield Facility	2020	Ammonia as N	2.18 mg/L	EV -Recreation & aesthetics and Industrial Use Aquatic Ecosystems (fresh waters) 95%
		Chloride	17,000 mg/L	EV -Recreation & aesthetics and Industrial Use
		Boron (filtered)	17.7 mg/L	Aquatic Ecosystems (fresh waters) 95%
		Copper (filtered)	0.013 mg/L	Aquatic Ecosystems (fresh waters) 95%
		Manganese	1.1 mg/L	EV -Recreation & aesthetics and Industrial Use
		Nickel (filtered)	0.017 mg/L	Aquatic Ecosystems (fresh waters) 95%
		Zinc (filtered)	0.029 mg/L)	Aquatic Ecosystems (fresh waters) 95%
		Perfluorooctanesulfonic acid (PFOS)	1.0 µg/L	EV -Recreation & aesthetics and Industrial Use Aquatic Ecosystems (fresh waters) 95%
61130 - 18 Wilkins Road, Wingfield	2022	Lead (filtered)	0.01 mg/L	EPP (Water Quality), 2003 Potable EPP (Water Quality), 2003 Aquatic Fresh
61165 - Caltex NTI Wingfield **Corner Hanson Road and Wilkins** **Road, Wingfield, South Australia**	2013	TOC	22 mg/L	SAEPA (2003) Environment Protection (Water Quality) Policy (EPP) (Marine)
		Copper (filtered)	0.014 mg/L	NEPM 2013 (Groundwater Investigation Levels - Marine Waters)
		Zinc (filtered)	0.08 mg/L	NEPM 2013 (Groundwater Investigation Levels - Marine Waters)
62056 - Lot 6 Hanson Road Wingfield 5013	2018	Boron (filtered)	7.9 mg/L	EPP (2003) Potable Water Guidelines
		Copper	0.011 mg/L	EPP (2003) Aquatic Ecosystem - Fresh Water Guidelines
		Manganese (filtered)	0.87 mg/L	EPP (2003) Potable Water Guidelines
		Zinc	0.25 mg/L	EPP (2003) Aquatic Ecosystem - Fresh Water Guidelines
62176 - 25-91 Bedford Street, Gillman SA	2021	Ammonia as N	28.4 mg/L	ANZG 2018 Marine water 95% toxicant DGVs
		Fluoride	3.6 mg/L	ANZG 2018 Livestock (ANZECC 2000)

83A Notification	Year	Analyte	Max. Concentration	Criteria Exceedance
61615 - Wingfield Landfill	2015-2016	Copper	0.0235 mg/L	SA EPA Environmental Protection Water Quality Policy (Marine)
		Nickel	0.0571 mg/L	
		Zinc	0.133 mg/L	
		TOC	82 mg/L	
		Ammonia as N	13.1 mg/L	

6.0 ASSESSMENT CRITERIA

Based on the desktop research findings, a soil, surface water and groundwater investigation was designed, as detailed in Agon, 2023 and Agon 2024b. The assessment criteria that results would be compared with ARE clearly defined as outlined in the following sections.

6.1 Soils

The current land use is vacant, with a potential future land use of the site as an SRF categorised as commercial/industrial use. As such, commercial/industrial human health and ecological soil criteria are considered most relevant. As the site is undergoing a WDF audit, the SA EPA waste criteria are also relevant.

6.1.1 Human Health Screening Criteria

Soil analytical results have been compared to the National Environment Protection (Assessment of Site Contamination) Measure (NEPC 2013) (ASC NEPM) Health Investigation Levels (HILs) for a Commercial/Industrial land use (HIL D).

Results have also been compared to the ASC NEPM HSLs for vapour intrusion derived from CRC CARE HSLs (CRC CARE, 2011) for further evaluation of potential risks to human health resulting from intrusion of hydrocarbon vapours emanating from soil impacts at the site. HSLs have been adopted based on the potential receptors, subsurface lithology, and depth of any impacts in the soil.

In addition, for potential risks associated with dermal contact with petroleum hydrocarbons and vapour intrusion for maintenance workers, the CRC CARE (2011) direct contact and vapour intrusion HSLs have been adopted. It is considered possible that future site workers could be exposed to soils through the installation or maintenance of structures such as underground utilities, associated trenches and footings.

For potential effects of petroleum hydrocarbons, the ASC NEPM (2013) Management Limits for TRH have also been adopted.

Concentrations of PFAS have been compared to the human health investigation levels (HIL-D) for soil from Table 2 of the PFAS National Environmental Management Plan version 2.0 – January 2020 (PFAS NEMP) published by the Heads of EPAs Australia and New Zealand (HEPA, 2020).

Asbestos has been assessed against the criteria outlined in the ASC NEPM and WA Asbestos-Contaminated Sites Guidelines of no visible asbestos on the site surface. According to the Sampling Analysis and Quality plan (SAQP) – soils, analysis for bonded or friable asbestos is triggered when significant asbestos containing material (ACM) is encountered, which did not occur during the investigations to date. Should this need to be undertaken in future, the adopted criteria are the Health screening levels for bonded ACM and AF/FA in soil for commercial/industrial sites.

Results for explosives residues have been compared to the criteria for nitrobenzene found in the NSW EPA guidance document Waste Classification Guidelines Part 1: Classifying Waste (criteria for nitrobenzene – explosive residue chemical).

6.1.2 Ecological Assessment Criteria

In order to evaluate the potential impact of identified PCAs in soil with respect to ecological receptors, the ASC NEPM approach has been followed to establish site-specific EILs.

The ASC NEPM (NEPC 2013) requires consideration of Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs) on sites (relevant to soils that will be within 2 m of the surface). Soil data from the top 2 m was compared to these EILs and ESLs for areas of ecological significance (ESL/EILs). Site-specific data collected has been used to determine site specific EILs, with the EIL calculations presented in Appendix B and summarised below.

EIL calculations have assumed aged contamination (most representative based on the likely age of the fill). To allow calculation of site specific EILs, 12 soil samples (1 from fill and 11 from natural) were analysed for EIL parameters including CEC, pH, % iron, % total organic carbon (TOC) and % clay content. It is noted that the EIL parameters were analysed in sandy soil types; the site also contains clay soils, however it is considered that using parameters for clay soils would generally result in less conservative EILs due to higher CEC concentrations.

Adopted parameter variables are provided in Table 5 and are based on the average parameters reported, using half the detection limit for non-detects.

Table 6: Averaged EIL Parameters

Soil Domain	Iron %	Clay %	pH	CEC (meq/100g)	TOC %
0 to 2 m depth	1.05	5.00	5.81	23.24	1.20

Based on these parameters, EILs were calculated using the NEPM EIL worksheet, the results of which have been provided in Table 6.

Table 7: Calculated EIL Screening Criteria (mg/kg)

Soil Domain	As	Cu	Cr 3+	Pb	Ni	Zn	DDT	Naphthalene
0 to 2 m depth	40	70	120	470	55	130	3	10

PFAS concentrations have been compared to the ecological direct and indirect exposure guidelines for soil from the PFAS NEMP Table 3. PFAS leachability results have been compared to the ecological water quality guideline values developed by water regulators, PFAS NEMP.

6.1.3 Acid Sulfate Soils Assessment Criteria

Acid sulfate soils have been assessed against the action criteria in Table 1.1 of the National Acid Sulfate Soils Guidance (Sullivan, 2018) for disturbance volumes exceeding 1,000 tonnes based on all three texture categories defined by approximate clay content, sulfur percentage, and acidity in mol H^+/tonne.

6.1.4 Leachability Results

Leachability Results have been compared to the adopted groundwater criteria for marine ecosystems (Section 6.2.4) and recreation and aesthetics (Section 6.2.3).

6.1.5 Waste Screening Criteria

Soil analytical results have been compared to the WDF Standard waste soil classification criteria and the PFAS in waste soils interim guideline (SA EPA, 2023).

6.2 Groundwater Assessment Framework

6.2.1 Groundwater Environmental Values (EVs)

An Environmental Values (EV) assessment has been undertaken in accordance with Section 4.2 of the GAR (SA EPA 2019) to identify the most appropriate values of groundwater to be protected. The EV assessment is summarised here, with more detail provided in the PSI (Agon, 2024c).

Applicable environmental values have been assessed as aquatic ecosystems and recreation/aesthetics.

Aquatic ecosystems are applicable as any site derived contaminants may reach surface water receptors including the Barker Inlet and Port Adelaide River, along with the Magazine Creek (which discharges into the Barker Inlet) and Range Wetlands. Regarding the wetlands, PAEC reports that they are highly saline due to shallow groundwater intrusion (PAEC, 2015). It is noted however, that the salinity of wetland ponds decreases towards the wetlands' entry points (points where stormwater discharges into wetlands). Therefore, both marine and freshwater aquatic ecosystem criteria were adopted. Also, the wetlands are considered to have an ecological value and habitat for numerous species (birds, frogs, and plants; refer Section 4.5).

Recreation/aesthetics are applicable as Schedule 1 of the WQ EPP defines the default protected environmental values of public stormwater systems as including both aquatic ecosystems and recreational and aesthetics. Water extraction for recreational use is unlikely, however, recreational activities take place on the Port Adelaide River such as kayaking and boating. The Adelaide Speed Boat Club is also situated to the north-west of the site.

6.2.2 Drinking Water

The salinity of the groundwater of the uppermost aquifer is considered to preclude the use of groundwater by future site users and therefore there is no groundwater exposure pathway via extraction for ingestion.

6.2.3 Recreation and Aesthetics

Agon has applied the Guidelines for Managing Risks in Recreational Water (GMRRW-NHRMC, 2008) as the primary criteria for assessing the protection of Recreation and Aesthetics environmental values:

- Table 9.4 - pH range for recreational waters
- Section 9.3.2 – ADWG criteria x 10 for assessment of the acceptability of recreational water quality.

Although the NHMRC 2008 does not distinguish between volatile and non-volatile chemicals Agon considers it appropriate to adopt more conservative drinking water criteria for volatile chemicals of concern in groundwater, as the risks to human health associated with the presence of these chemicals in recreational waters includes the inhalation of vapours as wells as digestion of chemicals.

Recreational criteria outlined in NEMP 2.0 for PFAS chemicals sum of PFOS and PFHxS and PFOA are also adopted EVs for the project.

6.2.4 Marine/Freshwater Ecosystems

Agon considers that the marine/freshwater ecosystem receptors can be categorised according to the Australian and New Zealand Guidelines for fresh and Marine Waster Quality (ANZG, 2018) as a *slightly to moderately disturbed system. A* 95% species protection level has therefore been considered as conservative criteria for most analytes. The more protective 99% species protection level has been adopted for PFAS in accordance with the PFAS NEMP version 2.0 due to its potential to bioaccumulate. The criteria adopted are summarised as follows:

- ANZG 2018: Groundwater criteria for Marine/Freshwater aquatic ecosystem (95% species protection).
- PFAS NEMP version 2.0: Table 5. Ecological water quality guideline values (Interim Marine, 99% species protection).

6.2.5 Commercial/Industrial Workers

Exposure to groundwater may occur through direct contact, as any excavations may encounter shallow groundwater. The criteria adopted is:

- ASC NEPM: Groundwater HSLs for vapour intrusion.

6.3 Surface Water

Surface water analytical results have been compared with same criteria adopted for groundwater (refer Section 6.2), due to the shallow groundwater and likely connection between surface water and groundwater.

7.0 SITE INVESTIGATION METHODS

7.1 Data Quality Objectives

A detailed description of the seven-step data quality objective (DQO) process can be found in the SAQP (Agon, 2023) and SAQP – Groundwater (Agon, 2024b) with a summary provided in Sections 7.1.1 and 7.1.2

7.1.1 Soil

The soil investigation data has been collected to address the data quality objectives summarised in Table 8. Where the results suggest a risk to human health or the environment, and the decision rules as defined in the SAQP (Agon, 2023) are:

1. If PASS and ASS are found to be present:
    a. An ASS management plan may be required to manage future site filling works and any associated infrastructure.
    b. Leachability results from site soil will be considered in an ASS context for potential impact on surface and marine waters, to inform the WDF audit.
2. If evidence of soil contamination suggests a risk to human health and the environment, further detailed interpretation and investigation may be required, comprising one or more of the following:
    a. Further assessment of soils to determine nature and extent of impacts.
    b. Site specific risk assessment.
    c. Further consideration of potential for groundwater impacts in a further SAQP.
    d. Further consideration of soil vapour in a further SAQP.
    e. Development of remediation plans; and/or management plans.
3. If evidence of offsite impacts is found in the site soil, these findings will be further investigated through soil vapour and/or landfill gas investigations.

Table 8: Soil Data Quality Objectives

Decision	Input
Is the site safe from UXO risk before detailed site investigations begin?	Engage a specialist (G-tek Australia Pty Ltd) to undertake a desktop study and risk assessment on UXO on site. UXO investigation and/or remediation will be undertaken if warranted based on the desktop risk assessment.
Is Piece 501 contaminated by past Dean Rifle Range and Defence activities?	Complete targeted soil investigations across suspected areas of soil contamination If required, complete additional judgmental graduated targeted sampling to delineate the linear extent and depth of contamination.
What is the lateral and vertical extent of ASS materials?	Systematic soil investigations across suspected areas.
Do any other chemicals exist above thresholds in soils across the site?	Systematic soil investigations across entire site. Compare soil analytical results to the screening levels and investigation levels in the ASC NEPM.
Are there any soil impacts from offsite sources?	Targeted soil investigations along site boundaries adjacent potential offsite sources.
Is there adequate information to provide baseline data before large-scale filling of the site occurs?	Sampling plan includes adequate site coverage and selection of broad screens to capture a strong baseline data set.

7.1.2 Groundwater

The groundwater investigation data has been collected to address the data quality objectives summarised in Table 9. The decision rule is that where the results suggest a risk to human health or the environment, the following actions may be required:

- Further assessment of groundwater to determine nature and extent of impacts.
- Site specific risk assessment.
- Update of groundwater model.
- Assessment of deeper aquifer.
- Further consideration of vapour if there is a potential vapour risk from impacted groundwater.
- Development of remediation plans; and/or management plans.
- If evidence of offsite impacts is found in the groundwater underlying the site, these findings will be further considered in consultation with the Auditor and DIT.

Table 9: Groundwater Data Quality Objectives

Decision	Input
Is groundwater contaminated by vertical migration of soil contaminants from past Dean Rifle Range and Defence activities?	Systematic groundwater investigations across entire site.
Is groundwater impacted by ASS materials?	Analysis of groundwater samples for indicators of impacts from ASS materials, for baseline information.
Do any other chemicals exist above thresholds in groundwater across the site?	Systematic groundwater investigations across entire site. Compare groundwater analytical results to the adopted screening levels and investigation levels in the ASC NEPM following GAR recommendations.
Are there any groundwater impacts from offsite sources?	Targeted groundwater investigations along site boundaries adjacent potential offsite sources.
Is there adequate information to provide baseline data before large-scale filling of the site occurs?	Sampling plan includes adequate site coverage and selection of broad screens to capture a strong baseline data set.

7.1.3 Surface Water

The surface water investigation data has been collected to address the data quality objectives summarised in Table 10. The decision rule is that where the results suggest a risk to human health or the environment, the following actions may be required:

- Further assessment of surface water to determine nature and extent of impacts.
- Site specific risk assessment.
- Further assessment of surrounding water courses.
- Further consideration of VOCs if there is a potential VOC risk from impacted water.
- Development of remediation plans; and/or management plans.
- If evidence of offsite impacts is found in the surface water on the site, these findings will be further considered in consultation with the Auditor and DIT.

Table 10: Surface water Data Quality Objectives

Decision	Input
If surface water is contaminated by site derived soil contaminants from historical activities namely past Dean Rifle Range and Defence activities?	Systematic surface water investigations across surface water bodies present on site.
Is surface water impacted by ASS materials?	Analysis of surface water samples for indicators of impacts from ASS materials, for baseline information.
Do any other chemicals exist above thresholds in surface water across the site?	Systematic surface water investigations across entire site. Compare surface water analytical results to the adopted screening levels and investigation levels in the ASC NEPM following GAR recommendations.
Are there any surface water impacts from offsite sources?	Targeted surface water investigations along site boundaries (where possible) adjacent potential offsite sources.
Is there adequate information to provide baseline data before large-scale filling of the site occurs?	Sampling plan includes adequate site coverage and selection of broad screens to capture a strong baseline data set.

7.2 Stakeholder Engagement

A permit was obtained from Renewal SA prior to site access with all investigations undertaken under the permit terms and conditions. The permit was updated as the investigations progressed to include access to offsite wells to the north of the site boundary that were also on Renewal SA land.

Renewal SA was engaged with directly around rusted padlocks on offsite wells which no key was available for. Agon removed and replaced the padlocks in consultation with Renewal SA and provided keys to Renewal SA. Agon also spoke with Jason Rollison, Renewal SA regarding the removal of the former Dean Rifle Range shooting butt and the following advice was provided:

> *"My understanding is that DIT (as the former DTEI) completed an assessment for lead within part of the DRR Range head area, but not the overshoot in 2004-05 as part of the Port River Expressway project, with the primary objective of the assessment being to classify the backstop mound (which previously existed in the vicinity of the road reserve for North Arm Road) as a source of fill for the then-proposed road project. I don't believe that I ever saw a copy of a report on this assessment (if a separate report was produced), however I note that at the time of the assessment, the land in question was jointly owned by the Office for Recreation Sport and Racing and the Corporation of the City of Adelaide, and I therefore wouldn't expect that Renewal SA was consulted".*

It is noted that engagement with other stakeholders such as PAEC has been undertaken by DIT.

7.3 Site Inspection

An inspection of the site was undertaken by environmental consultants from Agon on 5 October 2023 prior to commencement of intrusive site investigations. The inspection was undertaken alongside representatives of DIT and AEA. At the time of the inspection the site was noted to be vacant, open space, comprising predominantly wetlands, grassed areas and low-lying vegetation (photolog included in Agon PSI, 2024c). The topography was noted to be undulating with an overall flat site gradient.

Surface water was present through the site in the form of tidal creeks and a man-made cut channel in the centre of the site which, according to information provided by Renewal SA, was excavated by Veolia to manage water onsite during winter. Agon notes that a levee embankment is present along the northern boundary of Piece 501, which acts to minimise any tidal impacts. Stormwater was inferred to flow overland into the onsite creeks and infiltrate into site soils and into the groundwater table.

Piece 501 of the site was entered via an access road from Eastern Parade (to the west), while Piece 502 of the site was accessed via a continuation of Hanson Road (south). The site is bound by the Port River Expressway and Range Wetlands to the south, the Wingfield Waste and Recycling Centre to the East, the Barker Inlet and levee embankment to the north, Magazine Creek Wetlands and industrial land to the west.

A significant number of bullets were observed on Piece 501 and appear to be associated with the historical operation of Piece 501 as the Dean Rifle Range. Bullets were also identified on Piece 502 and are inferred to have resulted from overshooting of the stop butt. The stop butt at the boundary of Piece 501 and Piece 502 was not visible and appears to have been removed. Evidence of the firing lines remains, including remnant wooden benches and evidence of underground services. Four small man-made ponds were also identified at the western end of Piece 501. It is unknown if these ponds are connected to the Magazine Creek wetlands. A large, cleared area was also visible to the east of North Arm Road within Piece 501 along with several circular cleared sections. The circular sections are within the Defence Danger area identified by G-Tek Australia (G-Tek, 2023) as a part of the unexploded ordinance risk assessment and may have been associated with firing mounds. Aerial imagery obtained by Agon (Agon, 2023) indicates that the large, cleared area to the east of North Arm Road appeared at some time between 1935 and 1949, which coincides with the construction of the levee embankment along the northern boundary.

A large number of stockpiles of both soils and construction & demolition (C&D) wastes were also observed immediately offsite at the eastern end of Piece 502 (adjacent to the Hanson Road entrance) and at the western end of Piece 501. Stockpiled materials included soil, crushed rock, ballast and inert anthropogenic materials (asphalt, brick, concrete). Agon understands these materials were imported by Veolia and are associated with a former WDF Audit, although it is considered possible that some opportunistic dumping (by others) may have contributed to the quantities observed onsite.

No buildings or above ground structures were observed during the inspection, although marker signposts were observed for both the SEA Gas pipeline and the Penrice Brine pipeline. Motorbike tracks were visible across the site and a large clearing was also visible in the western end of Piece 502.

7.4 Soil Investigations

Grid-based sampling densities have been adopted, based on a density of 1 location per hectare across the site. This sampling density has been adopted based on professional judgement, in the knowledge that the site material comprises predominantly natural soils. As noted in Section 3.2.1, the western part of the site was filled using dredged material between 1892 and 1930, however dredged fill is considered unlikely to contain anthropogenically derived chemicals that would impact soil and groundwater leading to the expectation that there will be minimal lateral heterogeneity in soil contaminant concentrations. Additionally, Piece 502 has been a long-term vacant site, and Piece 501 has been long-term vacant with past potentially contaminating uses of shooting range and mortar firing. The grid was unable to be fully extended to the northern site boundary due to access constraints posed by the low-lying boggy ground.

The sampling density for ASS materials have been adopted as 1 location per 5 hectares. This equates to 31 locations which is around 10% of the 2 samples per hectare that is suggested in DIT (DIT, 2021) and National guidance (Sullivan, 2018). As the site is greater than 20 ha, professional judgement has been used to determine that the reduced sampling density should satisfactorily characterise the soils, based on the strong correlation between landscape units (Thomas, 2011) and ASS materials, with each landscape unit having been captured in the sampling (refer Section 4.3). A reduced sampling density is considered appropriate given the known correlation between ASS materials and landscape units.

The soil sampling locations are shown on Figure A7; Appendix A with borelogs included in Appendix C, boreholes photolog in Appendix D and laboratory reports provided in Appendix E. A total of 134 soil sampling locations were drilled across the site.

7.4.1 Underground Services Location

Prior to soil sampling activities:

- Agon engaged a specialist UXO company (G-tek Australia Pty Ltd) to undertake a desktop screening of the site for UXO risk; G-tek confirmed that borehole drilling could go ahead.
- Agon engaged an accredited service locator to identify underground and overhead services across the investigation area.
- Agon liaised with SEA Gas regarding borehole locations adjacent to the pipeline that crosses the site. SEA Gas provided onsite supervision for the location of these boreholes.
- Proposed locations were located on site using Google Platform and KML files, then locations were marked with pink flags in most of the locations and identified services were marked over on a map. The location for the intrusive works were selected where no underground services were identified.

7.4.2 Sampling Plan and Rationale

The soil intrusive investigation works were undertaken during December 2023, January, and part of February 2024 under the supervision of a qualified environmental professional. A total of 136 soil bores (designated as BH001_ENV to BH153_ENV were drilled at the site (Soil assessment methodologies applied during the intrusive soil sampling (including PFAS sampling) programme are detailed in Table 12:

Table 11) under the scope provided by DIT and endorsed by the Auditor. Boreholes were pre-numbered, however, 16 soil bores were unable to be drilled along the northern site boundary due to access constraints posed by the low-lying boggy ground and 1 borehole location was met with refusal.

7.4.3 Soil Field Methodology

Soil assessment methodologies applied during the intrusive soil sampling (including PFAS sampling) programme are detailed in Table 12:

Table 11: Borehole Location Summary

Area of Interest	Boreholes
Adjacent Area H (Caltex Petrol Station)	BH001_ENV, BH002_ENV
Adjacent Branches North Arm Creek	BH044_ENV, BH052_ENV, BH082_ENV, BH091_ENV, BH092_ENV, BH104_ENV, BH105_ENV, BH143_ENV, BH144_ENV.
Adjacent Landfill (Wingfield Waste)	BH142_ENV, BH148_ENV, BH149_ENV, BH153_ENV.
Adjacent Levee North Arm (Stop Butt)	BH039_ENV, BH040_ENV, BH041_ENV, BH042_ENV
Adjacent Magazine Wetland	BH004_ENV, BH009_ENV, BH013_ENV, BH017_ENV, BH022_ENV, BH027_ENV, BH032_ENV, BH037_ENV
Adjacent Range Wetland	BH086_ENV, BH096_ENV
Adjacent Veolia Preowned area	BH097_ENV, BH098_ENV, BH099_ENV, BH115_ENV, BH123_ENV, BH131_ENV, BH139_ENV
General Soil Coverage (Parcel 501)	BH003_ENV, BH005_ENV, BH006_ENV, BH007_ENV, BH008_ENV, BH010_ENV, BH011_ENV, BH012_ENV, BH014_ENV, BH015_ENV, BH016_ENV, BH018_ENV, BH019_ENV, BH020_ENV, BH021_ENV, BH023_ENV, BH024_ENV BH025_ENV BH026_ENV, BH028_ENV BH029_ENV BH030_ENV, BH031_ENV, BH033_ENV, BH034_ENV, BH035_ENV, BH036_ENV
General Soil Coverage (Parcel 502)	BH043_ENV, BH046_ENV, BH047_ENV, BH048_ENV, BH049_ENV, BH050_ENV, BH051_ENV, BH055_ENV, BH056_ENV, BH057_ENV, BH058_ENV, BH059_ENV, BH060_ENV, BH061_ENV, BH062_ENV, BH063_ENV, BH065_ENV, BH066_ENV, BH067_ENV, BH068_ENV, BH069_ENV, BH070_ENV, BH071_ENV, BH074_ENV, BH075_ENV, BH076_ENV, BH077_ENV, BH078_ENV, BH079_ENV, BH080_ENV, BH081_ENV, BH085_ENV, BH087_ENV, BH088_ENV, BH089_ENV, BH090_ENV, BH093_ENV, BH100_ENV, BH101_ENV, BH102_ENV, BH103_ENV, BH108_ENV, BH109_ENV, BH110_ENV, BH111_ENV, BH112_ENV, BH113_ENV, BH116_ENV, BH117_ENV, BH118_ENV, BH119_ENV, BH120_ENV, BH121_ENV, BH124_ENV, BH125_ENV, BH126_ENV, BH127_ENV, BH128_ENV, BH129_ENV, BH132_ENV, BH133_ENV, BH134_ENV, BH135_ENV, BH136_ENV, BH137_ENV, BH140_ENV, BH141_ENV, BH145_ENV, BH147_ENV, BH150_ENV, BH151_ENV, BH152_ENV
Locations not drilled as due to low-lying boggy ground	BH045_ENV, BH053_ENV, BH054_ENV, BH064_ENV, BH072_ENV, BH073_ENV, BH083_ENV, BH084_ENV, BH094_ENV, BH095_ENV, BH106_ENV, BH114_ENV, BH122_ENV, BH130_ENV, BH138_ENV, BH146_ENV

Table 12: Soil Field Methodology

Task	Description
Service location	Prior to the commencement of intrusive investigations, the site was cleared for underground utilities by licensed contractors. Copies of Dial Before You Dig records were reviewed onsite by the locators.
Prior to starting works	• Field staff wore clothing and Hi Viz PPE during the site investigations that had been laundered more than 6 times without fabric softener (MDEQ, 2018). • Personal care products and food wrappers were kept away from the sampling area and not used during sample collection (MDEQ, 2018). • After use of personal care products or food consumption, all waste was disposed of appropriately, hands washed, and a new pair of disposable nitrile gloves put on (MDEQ, 2018).
Drilling method	Generally, boreholes were pushtubed until materials became loose due to water, when the drilling method was switched to solid auger to reach the desired depth. In areas inaccessible by the drill rig, hand auger was used.
Logging and sample screening	• Soil bores were extended 1.0 m into natural soils. • Soils were logged in general accordance with the Unified Soil Classification System (USCS). • Visual and olfactory observations specific to acid sulfate soil types were made during soil logging including sulfidic odour, monosulfidic black ooze, presence of shell or carbonate material, and soil texture. • Where visual and olfactory evidence of contamination was present, samples were field screened for volatile organic compounds (VOCs) using a routinely calibrated photoionisation detector (PID) with a 10.6 eV ultraviolet lamp • Visible shell or carbonate material was physically removed from CRSS soil samples before they were placed in the laboratory-supplied jar, as these materials interfere with accurate CRSS analysis (Sullivan, 2018).
Sample collection	• A GPS position was calculated using a handheld meter, in case a location was moved from the pre-determined grid. • Sample names included borehole name and sample depth interval. All containers were labelled with project name, number, date, sampler as required. • Judgement was applied in the field with regard to increasing sampling densities based on whether they contain heterogenous material. • Samples were typically collected from each investigation location at the surface, sub surface and where changes in lithology were observed and where visual/olfactory observations indicated the presence of contamination. • Soil samples were collected at regular intervals (0.0 0.1, 0.2-0.3, 0.4-0.5, 0.9-1.0 and 1.4-1.5), including from the surface, major strata changes, and from the top of natural materials. Additional samples were collected for ASS materials assessment from intervals (0.7 – 0.8 and 1.2 – 1.3) to meet compliance with the SAQP. • Quality assurance/quality controls were collected in the form of soil replicate samples, trip blanks and equipment rinsate. A copy of calibration certificates are provided in Appendix F. • All sample locations were inspected for the presence of potential ACM, which provided a systematic visual inspection of the site which in turn provided good site coverage. • Twenty-two (22) soil bores were extended to the groundwater interface so that PFAS samples could be collected from this part of the soil profile. • Samples were collected using disposable nitrile gloves and placed in clean laboratory provided jars (including PFAS-specific containers for PFAS samples). • Samples were placed immediately into a portable cooler with freezer blocks (not gel-based coolant products) prior to transport to the Adelaide office or Eurofins. • Samples for pH and CRSS analyses were collected in both plastic snap-lock bags and glass soil jars, with the plastic bags frozen upon receipt at the laboratory (for CRSS analysis) and the glass jars kept refrigerated for other analyses. • Sample container lids were opened immediately before the sample was placed inside and lids were not placed on any surface.
Decontamination	• Prior to drilling each location all equipment used to collect soil samples was decontaminated with Liquinox between sample locations.

7.4.4 Soil Laboratory Analysis

A total of 549 samples were selected from fill and natural materials. Thirty-four (34) duplicates and twenty-seven (27) interlaboratory samples were collected. Soil samples were analysed for the following potential chemicals of concern (PCOC) identified in the PSI (Agon, 2024c) and SAQP (Agon, 2023) (see Table 13).

Table 13: Soil Sample Analyses

Analyte	Target	Number and Locations for Analyses
TRH, BTEXN, PAH, VOCs, metals	Uncontrolled fill	203 Samples
pH f, field pH peroxide (pH fox)	ASS materials	280 Samples
NEPM 2013 basic suite	Uncontrolled fill and offsite	118 Samples
CEC, Clay content, CRS	Sulfuric/Sulfidic soils	37 Samples CRS-
NEPM EIL suite	Uncontrolled fill	10 Samples
PFAS (long screen) + ASLP leachability	Uncontrolled fill and offsite	55 Samples PFAS Long Screen 12 ASLP
Explosive organics and nitroglycerine	Explosives residues	1 Sample
Asbestos	Uncontrolled fill	One piece of potential ACM fragment.
Leachability Metals	Dry weight concentrations above criteria	58 Samples

The selection process for soil sample analysis was as follows:

- Samples were analysed according to the analytical schedule in Table 13.
- The uppermost sample from soil test locations was typically submitted for laboratory analysis at each location, representing the interval where the greatest level of contamination can be expected.
- Laboratory analysis on samples collected from underlying fill and natural material was selective, based on field observations and to provide sufficient spatial coverage and representativeness of all soil domains encountered.
- When the soil bore intersected groundwater, the sample collected from the groundwater interface was selected for analysis (where evidence is observed only) to allow for acid sulfate soils CRSS analysis and for PFAS analysis of samples from the groundwater interface.
- Samples collected and not submitted for analysis were placed on hold.
- Additional analyses were undertaken for vertical delineation due to exceedances of the relevant guidelines in the overlying samples: 81 samples for arsenic, 6 for lead, 4 for manganese and 3 for zinc.
- All samples were held in storage by the laboratory under appropriate conditions.
- Where visual or olfactory evidence of contamination was identified, a specific sample of this material was analysed.
- Samples were screened in field for the presence of volatile contaminants using a PID. Readings were detected from 0.0 to 0.6 ppm, with no volatile organic compounds detected above 50 ppm to indicate the need for extra analysis.
- Samples were selected for CRSS and AVS based on site coverage, field observations and pHf /pH fox analyses and where pH indicates MBO- like geochemistry.

- A silica gel clean up analysis was requested for three samples with detections of TPH C29-C34 (BH001_ENV_004_J_0.9_1.0, BH001_ENV_005_J_1.4_1.5 and BH002_ENV_001_J_0.0_0.1) due to the absence of any visual or olfactory signs of contamination. It is noted that the silica gel clean up was not undertaken on the sample with the highest TRH detection, however results are considered representative of all TRH detections, noting that silica gel clean up results were overwhelmingly non-detect.
- All soil analyses were selected to ensure that the limit of reporting was equal to or lower than the adopted criteria.

7.5 Groundwater Investigations

7.5.1 Groundwater Sampling Plan and Rationale

A total of 22 groundwater wells were sampled, including 7 existing offsite groundwater wells and 15 onsite wells. These wells were drilled to the maximum depth of 3 metres below ground level and are designated (GW01 to GW15). The top of the uppermost aquifer (water cut) was encountered at the depths ranging between 0.5 m BGL and 0.9 m BGL.

Groundwater sampling locations are summarised in Table 14 and shown on Figure A8, Appendix A with laboratory reports provided in Appendix E and groundwater borelogs included in Appendix G.

The locations for groundwater sampling have been selected to:

- Assess the quality of groundwater within the site area to form a baseline understanding.
- Provide an understanding of potential impacts associated with identified offsite contaminations sources.
- Provide an understanding of potential extents of groundwater plumes (if any).
- Understand which offsite receptors may be at risk from onsite groundwater impacts.
- Understand a potential relationship between surface water and groundwater at the site as well as tidal influence.

Table 14: Summary of Wells Locations

Areas of Interest	Well Names
Onsite	GW01, GW02, GW03, GW04, GW05, GW07, GW10, GW11,
Onsite closest to landfill sites	GW06, GW08, GW09, GW12 GW13, GW14, GW15
Offsite	RSA01, RSA02, RSA03, 6628-30381 (named 30381), 6628-30387 (named 30387), 6628-30388 (named 30388) and 6628-30390 (named 30390)

7.5.2 Well Installation Methodology

Field methodologies adopted during the groundwater investigation are detailed in Table 15 and groundwater installation details are provided in Table 16.

Table 15: Groundwater Field Methodology

Task	Description
Service location	Prior to the commencement of intrusive investigations, the site was cleared for underground utilities by licensed contractors. Copies of Dial Before You Dig records were reviewed onsite by the locators.
Prior to starting works	Field staff wore clothing and Hi Viz PPE during the site investigations that had been laundered more than 6 times without fabric softener (MDEQ, 2018). Personal care products and food wrappers were kept away from the sampling area and not used during sample collection (MDEQ, 2018). After use of personal care products or food consumption, all waste was disposed of appropriately, hands washed, and a new pair of disposable nitrile gloves put on (MDEQ, 2018). Laboratory-supplied sample containers were used that are designed for PFAS sampling. Sample container lids were only opened immediately before the sample is placed inside. Lids will not be placed on any surface (MDEQ, 2018). Samples were placed directly into a portable cooler so that exposure to light was minimised (PFAS NEMP, 2020). Freezer bricks were used in the portable coolers rather than gel-based coolant products (PFAS NEMP).
Drilling method	A total of fifteen monitoring wells were drilled within the site by a Class 1 licensed well driller, employed by SMS Geotechnical Pty Ltd. Drilling of monitoring wells (GW01 to GW15) were undertaken from 22 of February to 25 February 2024 using a Rockmaster Drill GT20.
Well installation	Fifteen onsite wells were installed in accordance with the National Uniform Drillers Licensing Committee (2020) Minimum Construction Requirements for Water Bores in Australia. Prior to installing the wells, fifteen well permits were obtained from the Department for Environmental and Water. Well installation details are summarised in Table 14, and a copy of well construction details are provided in Appendix G. and the permits are included in Appendix H. The monitoring wells were drilled to a depth of approximately 3 metres below ground level, i.e. approximately 2-2.5 m below encountered water strike. Each well was completed with a 2.5-m slotted 50mmID PVC casing (screen) installed at the base of each borehole connected to blank PVC casing extended above the ground level. Due to unstable boreholes preventing installation of gravel packs, the screens were equipped with filter socks. Gravel packs (where possible) were installed above collapsed sediments in boreholes advancing 0.2-0.3m above screen tops. Bentonite plugs were installed above gravel packs to prevent surface water infiltration into well screens. Monitoring wells were completed with above ground standpipes concreted in place with a monument concrete pad preventing accumulation of surface water. During the installation, no obvious indications of contamination (e.g. discoloured soils and/or odours) were noted except at location GW02 (refer Figure A8, Appendix A), which was noted to have a hydrogen sulphide odour (rotten egg) from approximately 1m depth.
Well Development	Following installation, the wells were developed using a steel bailer (decontaminated between each well) and disposable Waterra foot valve and tubing. The development was completed when the majority of entrained fines were removed from the screens and groundwater inflow was sufficient for the collection of groundwater samples. In addition, as required by NEPM water quality parameters, DO, EC, pH, ORP and temperature were monitored using a calibrated water quality meter (YSI Pro Plus). The development was also considered to be completed when the water quality parameters stabilised. A copy of well development field sheets are included in Appendix I.
Survey	All onsite monitoring wells were surveyed to Australian Height Datum to allow for the assessment of groundwater flow direction.
Gauging	Each groundwater monitoring well was gauged prior to sampling using an interface probe (IP). The IP was used to check for any presence of Light Non-Aqueous Phase Liquid (LNAPL). The water level and well depth measurements were conducted from a clearly marked surveyed point on top of each well casing. No LNAPL presence was encountered. The IP was decontaminated between locations using the procedure outlined below.
Sample Collection	Each well was allowed to equilibrate for one to two weeks following well development. The majority of wells were sampled using low-flow sampling technique in general accordance with the SA EPA (2019) Guidelines for Regulatory Monitoring and Testing Groundwater sampling. Groundwater purging was conducted using a peristaltic pump (Geopump Series 2) at a stable low rate and with stabilised drawdown. Water quality parameters including temperature, dissolved oxygen (DO), electrical conductivity, pH and oxidation reduction potential were monitored during purging and prior to sampling using a calibrated water quality meter (YSI Pro Plus).

Task	Description
	Groundwater samples were collected when the parameters stabilised within the ranges recommended in the SA EPA groundwater sampling guidelines. The low-flow sampling technique was not able to be used during sampling of two offsite wells RSA01 and 30390 as groundwater inflow was not sufficient for low-flow purging. These wells were purged dry and samples collected when water level recovery provided sufficient water volumes to fill necessary sampling containers. The water quality parameters for these two wells were measured during purging. All groundwater samples were collected in appropriately preserved lab-prepared containers. Groundwater samples for testing for dissolved metals were field filtered using inline 0.45 micron filters prior to filling sampling containers. Sampling involved collections of QA/QC samples including intra and inter laboratory duplicates, rinsate and trip blanks (as per the groundwater SAQP). The collected samples were placed with eskies with ice bricks and delivered to analytical laboratories accompanied a chain of custody documentation (COC). Groundwater sampling field sheets are included in Appendix I.
Decontamination	All reusable equipment used to install, develop and sample groundwater wells was appropriately decontaminated between each location using Liquinox for cleaning and demineralised water for rinsing. Rinsate samples were collected and tested to demonstrate that the equipment was adequately decontaminated.

Table 16: Groundwater Well Installation Details

Well ID	Permit No.	Total Depth (m BGL)	Screen Interval (m BGL)	Depth to groundwater (m BGL)
GW01	456943	2.9	0.3-2.8	0.65
GW02	456944	2.975	0.3 -2.95	0.78
GW03	456945	2.95	0.5 – 2.95	1.81
GW04	456946	2.56	0.5 – 2.56	1.38
GW05	456947	3.0	0.5 -3.0	1.42
GW06	456853	2.93	0.5 -2.93	0.905
GW07	456854	2.74	0.4 – 2.74	0.874
GW08	456855	2.65	0.3 – 2.65	0.51
GW09	456856	2.95	0.5 – 2.95	0.545
GW10	456857	2	0.3 – 2.0	0.77
GW11	456858	2.05	0.4 – 2.05	0.71
GW12	456859	2.0	0.5- 2.0	1.1
GW13	456860	2.0	0.2 -2.0	0.85
GW14	455861	1.84	0.2 -1.84	0.74
GW15	455862	1.96	0.5 -1.96	0.76

7.5.3 Groundwater Laboratory Analysis

Groundwater samples were submitted to Eurofins MGT for analysis. Duplicate samples were forwarded from Eurofins MGT to Envirolab for analysis. Both laboratories are accredited by the National Association of Testing Authorities for all analyses. Groundwater samples were analysed for potential contaminants listed in Table 17.

Table 17: Summary of Groundwater Sample Analyses

Well Type	Analyses
Assessing baseline site conditions and onsite PCOCs **+** **Targeting PCOCs from Offsite sources:** **GW06, GW08, GW09, GW12, GW13, GW14, GW15**	• TRH, VOC, PAH, Phenols, Metals 8 (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg) • Nutrients #5 TN, TKN, NOX, NO2, NO3, NH3 • Metals (Al Ag, Be, B, Co, Hg, Mn, Mo, Sb, Se, Sn, V) +Cr6+ • Explosive Organics (1.3-DNB, 1.3.5-TNB, 2-NT, 2.4-DNT & 2.6-DNT, 3-NT, 4-NT, RDX, NB, TNT) • Nitroglycerine (NG) • PFAS (30 compounds). If PFAS is detected, Total oxidizable Precursor Assay (TOPA) will be carried out to detect the presence of undetected precursor PFAS chemicals which can transform into persistent PFAS chemicals. • Total Coliforms (CFU)* • Major cations, anions and alkalinity • TDS • pH • Turbidity • Volatile Fatty Acids (VFA) • Biochemical Oxygen Demand • Chemical Oxygen Demand (COD) • Total Organic Carbon (TOC) • Methane (CH4) • Carbon Dioxide (Total) • Fluoride (F)
Assessing baseline site conditions and onsite PCOCs: **GW01, GW02, GW03, GW04, GW05, GW07, GW10, GW11, RSA1, RSA2, RSA3, 30381,30387,30390***	• TRH, VOC, PAH, Phenols, Metals 8 (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg) • Nutrients #5 TN, TKN, NOX, NO2, NO3, NH3 • Metals (Al Ag, Be, B, Co, Hg, Mn, Mo, Sb, Se, Sn, V) +Cr6+ • Explosive Organics (1.3-DNB, 1.3.5-TNB, 2-NT, 2.4-DNT & 2.6-DNT, 3-NT, 4-NT, RDX, NB, TNT) • Nitroglycerine (NG) • PFAS (30 compounds). Where PFAS was detected, Total oxidizable Precursor Assay (TOPA) was carried out to detect the presence of undetected precursor PFAS chemicals which can transform into persistent PFAS chemicals. • Total Coliforms (CFU)* • Major cations, anions and alkalinity • TDS • pH • Turbidity

**GW08, RSA01, 30368, GW05 These groundwater samples were not tested for Total Coliforms.*

A retesting of 8 groundwater samples for PFAS was undertaken to verify the concentrations that were detected in the initial round of testing (Table 7, Appendix J). The reanalysis results were very similar to the initial results, indicating that the initial results were repeatable and accurate. The reanalysis results were adopted for further assessment of the results in Section 8.2.6 and for presentation in Table 6, Appendix J.

7.5.4 Water Level Monitoring

Electronic water level transducers (data loggers) were installed (and remain in situ) in a total of 8 locations as illustrated on Figure A12, Appendix A

- Tidal influence is being assessed using 3 data loggers installed along a north-south transect in groundwater wells.

- Potential surface water and groundwater interaction are being assessed using 3 data loggers installed along an east-west transect in groundwater wells. A barometric logger was also used to allow for barometric pressure compensation.
- Tidal movements are being assessed using 2 data loggers in the open channel of North Arm Creek (at safe locations).

The data loggers have been programmed to monitor groundwater level and temperature at 15-20 minutes intervals.

The information from data loggers was downloaded two weeks after installation, with further downloads to occur monthly for the next two months and then the frequency will be decreased to two-monthly or quarterly depending on the quality of data and loggers' integrity.

7.6 Surface Water

7.6.1 Surface Water Quality Screening

In accordance with the SAQP on and offsite surface water quality screening was undertaken on 29 February 2024 by measuring field parameters such as electrical conductivity (EC), pH, DO, redox potential and temperature using a calibrated portable water quality meter (YSI). The results and the calibration certificate are included in Appendix F and discussed in Section 8.

7.6.2 Surface Water Sampling Plan and Rationale

A total of 12 nominated surface water sampling locations were attempted for the surface water sampling program on 9 and 10 April 2024 as follows:

Magazine Creek Wetland:

- **SW-1** – The Magazine Creek pond that receives extracted groundwater and the 'end-pond' of the wetland water, from which water is released into the environment. Water from this pond may be pooling offsite along the levee bank (the northern boundary of the site).
- **SW-2 to SW-4** – Magazine Creek ponds located in close proximity to sampled offsite groundwater wells. These locations were selected to allow a comparison between offsite surface water and offsite groundwater.

Range Wetland

- **SW-9** – The Range pond that receives extracted groundwater and the 'end-pond' of the wetland water, from which water is released into the environment. Water from this pond is believed to be pooling onsite along the levee bank (the northern boundary of the site).
- **SW-10 and SW-11** – The Range ponds located in the close proximity to the sampled offsite groundwater well - the locations were selected to allow a comparison between offsite surface water and groundwater.
- **SW-12** - The Range entry pond that receives water from a large stormwater channel – this location was selected to assess potential impacts on onsite groundwater from water infiltrations from the pond (possible source of onsite groundwater contamination).

Onsite

- **SW-5** – This location targets the excavated dams – there are four dams identified in the north western corner of the site. SW-5 was selected to assess water quality in one of these dams, which presumably contain groundwater rather than surface water. This location was selected to serve two purposes: influence from wetlands on onsite groundwater and the site coverage.
- **SW-6 to SW-8** – These locations have been selected along the northern site boundary to assess whether onsite surface water is contaminated (and potential for migration of contamination impacts to/ from groundwater).

Only 9 locations were found to contain water sufficient to be sampled, with onsite sample locations SW-6, SW-7 and SW-8 found to be dry and unable to be sampled.

Some locations encountered access constraints requiring relocation of the sampling locations as follows:

- Onsite location SW-5 was also found to be dry. A water sample was collected from the nearby dam to the south-west which contained water.
- Magazine Creek wetland location SW-3 was moved to the eastern edge of the pond due to access constraints (extended reed coverage).
- Range wetland location SW-9 was moved to the western edge of the pond due to access constraints (area of the pond is fenced off). It is noted that on-surface groundwater discharge from three windmills was observed at SW-9.
- Range wetland locations SW-10 and SW-11 were moved to the eastern edges of the ponds due to access constraints (extended reed coverage).
- Range wetland location SW-12 was moved to nearest downgradient pond due to access constraints (area of the pond is fenced off).

Surface water sampling locations nominated and actual are shown on Figure 12, Appendix A with laboratory reports provided in Appendix E.

Surface water sampling was undertaken using guidance from the SA EPA document: *Regulatory Monitoring and testing. Water and wastewater sampling,* dated June 2007, with the methodology summarised in Table 18.

Table 18: Summary of Surface Water sample locations

Task	Description
Prior to starting works	Field staff wore clothing and Hi Viz PPE during the site investigations that had been laundered more than 6 times without fabric softener (MDEQ, 2018). Personal care products and food wrappers were kept away from the sampling area and not used during sample collection (MDEQ, 2018). After use of personal care products or food consumption, all waste was disposed of appropriately, hands washed, and a new pair of disposable nitrile gloves put on (MDEQ, 2018). Laboratory-supplied sample containers were used that are designed for PFAS sampling. Sample container lids were only opened immediately before the sample is placed inside. Lids will not be placed on any surface (MDEQ, 2018). Samples were placed directly into a portable cooler so that exposure to light was minimised (PFAS NEMP, 2020). Freezer bricks and ice were used in the portable coolers rather than gel-based coolant products (PFAS NEMP).
Sampling	Water samples were collected from the side of the water bodies (with a spotter on standby and appropriate PPE) using an extendable Swing Sampler with a laboratory prepared bottle attached to the end. The bottle was then lowered into the water body with the nozzle faced down to minimize the collection of floating films and organic matter and achieve a representative sample of the surface water. The bed of the water body was similarly avoided during sampling to minimise the sampling of the situated sediments. The sample was then transferred to the appropriate laboratory prepared bottles which were prelabelled with sample location and time of sampling. As required for dissolved heavy metal analysis the sample was field filtered using a 45-micron filter. All samples were collected in appropriately preserved lab-prepared containers. Sampling involved collections of QA/QC samples including intra and inter laboratory duplicates and trip blanks. The collected samples were placed in eskies with ice bricks and delivered to analytical laboratories accompanied a chain of custody documentation (COC). Surface water sampling field sheets are included in Appendix I.
Decontamination	An individual laboratory provided sampling container was used at each sampling location. No reusable equipment was used negating the risk of cross contamination and decontamination needs.

7.6.3 Surface Water Laboratory Analysis

The primary surface water samples and the intra laboratory duplicate were submitted to Eurofins MGT (used as the primary laboratory). The inter laboratory duplicate sample was forwarded to Envirolab, used as a secondary laboratory. Both laboratories are accredited by the National Association of Testing Authorities for all analyses conducted. Surface water samples were analysed for potential contaminants listed in Table 19.

Table 19: Summary of Surface Water Sample Analyses

Well Type	Analyses
Assessing baseline site conditions and onsite PCOCs **+** **Targeting PCOCs from Offsite sources:** **SW-9, SW-10, SW-11, SW12**	• TRH, BTEX, PAHs, Phenols • Total and Dissolved Metals (Al, As, Ag, Be, B, Cd, Cr, Co, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Sn, V, Zn) and Dissolved CrVI+ • PFAS (30 compounds) • Nutrients (Total N, TKN, NOx, NH3, Total P) • OCP, OPP, PCB, VOC • Coliform bacteria • Major cations and anions • TDS, pH • Turbidity • Explosive Organics and Nitroglycerine. • Speciated Volatile Fatty Acids • Chemical Oxygen Demand (COD) • Biochemical oxygen demand (BOD) • Total organic carbon (TOC) • Dissolved gases (Methane and Carbon dioxide).
Assessing baseline site conditions and onsite PCOCs: **SW-1, SW-2, SW-3, SW-4, SW-5**	• TRH, BTEX, PAHs, Phenols • Total and Dissolved Metals (Al, As, Ag, Be, B, Cd, Cr, Co, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Sn, V, Zn) and Dissolved CrVI+ • PFAS (30 compounds) • Nutrients (Total N, TKN, NOx, NH3, Total P) • OCP, OPP, PCB, VOC • Coliform bacteria • Major cations and anions • TDS, pH • Turbidity • Explosive Organics and Nitroglycerine.

An additional silica gel clean up analysis was requested for six samples with detections of TRH as follows:

- SW-3
- SW-4
- SW-5
- SW-10
- SW-11
- SW-12

8.0 RESULTS

Results have been compared to generic investigation levels and/or screening levels for protection of human health and the environment as a Tier 1 assessment. The Tier 1 assessment provides an initial screening of the data to determine whether further assessment is required.

8.1 Soil Results

8.1.1 Soil Observations

There was no visual or olfactory evidence of site contamination of soils in any of the boreholes drilled across the site. Across both Pieces 501 and 502, isolated small stockpiles of waste and surficial debris (plastic, glass, metal fragments and household waste) and bullets were observed. No potential asbestos containing material was observed except for a single isolated fragment of bonded asbestos cement located immediately offsite at the eastern end of Piece 502. This fragment of asbestos cement was confirmed as asbestos cement by the laboratory (Appendix E) and was removed from site.

Fill materials were identified in 10 boreholes, extending from a depth of 0.2 to 0.7 m BGL and described as gravelly silty sands, gravelly sands, sandy clays and gravelly clays. The fill materials identified across the site were limited to Piece 501 (the former Dean Rifle Range) and the western portion of Piece 502. Anthropogenic inclusions were limited to metal fragments in BH032, tile fragments in BH009 and bluestone or quartz gravels in BH022, BH023 and BH032. A summary of the fill identified during the soil investigations is presented in Table 20.

Table 20: Fill Materials Summary

Borehole	Fill depth (m)	Soil description	Anthropogenic Inclusions	Location
BH023	0.0 – 0.5	Gravelly Silty Sand	Blue stone gravels	Dean Rifle Range
BH022	0.0 – 0.2	Gravelly Sand	-	Dean Rifle Range
BH013	0.0 – 0.2	Gravelly Sand	Quartz gravels	Dean Rifle Range
	0.2 – 0.7	Gravelly Silty Sand	-	Dean Rifle Range
BH052	0.0 – 0.2	Sand	-	Western end of Piece 502
	0.2 – 0.7	Sandy Clay	-	
BH063	0.0 – 0.2	Sand	-	Western end of Piece 502
	0.2 – 0.7	Sandy Clay	-	
BH028	0.0 – 0.3	Gravelly Sand	-	Dean Rifle Range
BH032	0.0 – 0.2	Gravelly Silty Sand	Blue stone gravels	Dean Rifle Range
BH002	0.0 – 0.2	Gravelly Clayey Sand	Metal fragment	Dean Rifle Range
	0.2 – 0.5	Gravelly Clay	-	Dean Rifle Range
BH009	0.0 – 0.2	Gravelly Sand	Tile fragments	Dean Rifle Range
	0.0 – 0.7	Gravelly Silty Sand		Dean Rifle Range
BH042	0.0 – 0.5	Sand	-	Western end of Piece 502, adjacent North Arm Road.

The natural soils underlying the fill materials were noted to be predominantly brown, grey, and blue grey sands, along with shallow bands of clayey sands and deeper bands of clays. Pockets of gravelly sands were also identified with sub-rounded gravels. These field observations are consistent with historical information obtained for the site (Dept Mines and Energy, 1989) which identifies the shallow soils beneath the site consisting primarily of the Saint Kilda Formation and to a lesser extent the Pooraka Formation. Agon has nominated the relevant formations to all samples collected from the site, which are detailed within the results tables presented within Table 1 and Table 2, Appendix J.

Agon notes that crushed shells were identified in several boreholes across the site, and while these do occur as a result of the weathering within the Saint Kilda Formation, the presence of crushed shells can be an indication of dredged material used in land reclamation. Whilst dredged materials have not specifically been logged during the field investigations, it can be difficult to differentiate between natural soils of the Saint Kilda Formation and dredged materials, and it remains likely that dredged materials are present across the western part of the site in particular.

8.1.2 Soil Analytical Results

A comparison of the soil analytical results to the human health and ecological criteria outlined within the NEPM (2013) indicated that all contaminant concentrations were below the assessment criteria for a commercial/industrial land use.

The Silica gel clean up results of selected samples with TRH and TPH detections indicate that the concentrations reported are primarily biogenic in nature and are not of anthropogenic origins. Minor TRH remained in sample BH002_ENV_001_J_0.0-0.1 in the C29-C34 fraction, with no detections in the TPH fractions. This minor TRH concentration may be indicative of anthropogenic sources such as stormwater runoff, or minor vehicle leaks from vehicles driving on the site. This TRH concentration is near to the laboratory limit and an order of magnitude lower than the corresponding TRH criteria and is not considered to be a site contamination risk.

A further comparison of the analytical results to the ecological investigation levels detailed within the NEPM (2013) was undertaken for Areas of Ecological Significance given the presence of sensitive ecological receptors both onsite and offsite (refer Section 6.1.2). Exceedances of the ecological investigation levels were B(a)p and metals including arsenic, lead, copper, zinc, and manganese. A summary of the soil analytical results obtained from the site is presented in Table 21.

Table 21: Summary of Soil Analytical Results

Analyte	Samples Analysed	Min (mg/kg)	Max (mg/kg)	Assessment Criteria Exceedances	Soil type
Arsenic	211	2.4	160	SA EPA (2013) Waste Fill (20 mg/kg) – 124 Samples	Natural (121) Fill (3 samples)
				NEPM (2013) EIL (Ecologically Significant; 40 mg/kg) - 77 Samples	Natural (75 samples) Fill (2 samples)
Lead	324	<5	1,200	SA EPA (2013) Waste Fill (300 mg/kg) – 4 Samples	Natural (4 samples)
				NEPM (2013) EIL (Ecologically Significant; 470 mg/kg) - 4 Samples	
Copper	328	<1	180	SA EPA (2013) Waste Fill (60 mg/kg) – 6 Samples	Natural (5 samples) Fill (1 sample)
				NEPM (2013) EIL (Ecologically Significant; 70 mg/kg) - 4 Samples	Natural (4 samples)
Zinc	130	<5	340	SA EPA (2013) Waste Fill (200 mg/kg) – 6 Samples	Natural (5 samples) Fill (1 sample)
				NEPM (2013) EIL (Ecologically Significant; 130 mg/kg) - 12 Samples	Natural (10 samples) Fill (2 samples)
Manganese	121	<5	1,700	SA EPA (2013) Waste Fill (500 mg/kg) – 6 Samples	Natural (6 samples)
Benzo(a) pyrene TEQ	314	<0.05	1.1	SA EPA (2013) Waste Fill (1 mg/kg) – 1 Sample	Natural (1 sample)
				NEPM (2013) EIL (Ecologically Significant; 0.7 mg/kg) - 2 Samples	Natural (2 samples)
Total PAH	314	<0.	9.1	SA EPA (2013) Waste Fill (5 mg/kg) – 2 Samples	Natural (2 samples

Agon notes that except for arsenic, the EIL exceedances were limited in number and may be either naturally occurring or representative of minor anthropogenic impacts associated with the historical operation of the site rather than historical dredge spoil placement.

The arsenic impacts however were widespread spatially across the site (Figure A9, Appendix A) and occurred at a wide range of depths and overwhelmingly within natural soils, indicating that the arsenic concentrations are naturally occurring. This is supported by previous reports on adjacent land that indicate arsenic is present at elevated concentrations of up to 150 mg/kg in natural surface soils at 0 to 0.1 m depth (Agon, 2018).

A summary of the vertical distribution of all arsenic exceedances of the ecological criteria across the site is presented in Table 22, which indicates that surface samples contained the highest proportion of arsenic exceedances. As arsenic is overwhelmingly present in natural soils rather than fill material, the vertical distribution pattern may be due to different geological units, organic matter content, soil porosity, distribution of minerals and/or bacterial communities.

Table 22: Arsenic Sample Exceedance Summary

No. samples	Fill Samples	Natural Samples	EIL Exceedances	Exceedances	Depth BGL
73	1	46	47	64.38%	0.0-0.1
79	1	22	23	29.11%	0.2-0.3
45	0	4	4	8.89%	0.4-0.5
3	0	0	0	0.00%	0.7-0.8
19	0	2	2	10.53%	0.9-1.0
1	0	0	0	0.00%	1.2-1.3
6	0	1	1	16.67%	1.4-1.5

Further comparison of the soil analytical results to the SA EPA (2013) WDF criteria was undertaken to assess possible offsite disposal or reuse requirements under a proposed redevelopment of the site. All contaminant concentrations were reported below the SA EPA (2013) Waste Fill Criteria with the exception of arsenic, lead, copper, zinc, manganese, B(a)p and Total PAH which were all reported at an Intermediate Waste level.

8.1.3 Statistical Analysis

In accordance with the NEPM and SA EPA guidance, a range of summary statistics were examined for all analytes exceeding the adopted criteria.

Statistical calculation of the 95% Upper Confidence Limit of the mean (95% UCL) was undertaken using the United States Environmental Protection Agency (US EPA) ProUCL software (Version 5.1). Statistical analysis of the data was performed on sub-sets of the data separated into fill and natural (refer Appendix J. Results below the laboratory detection limit were input as half the detection limit. Statistical analysis is considered appropriate as the data sets are typically of an appropriate size (more than 10 samples) with site-wide coverage and are generally homogeneous within each material type.

In accordance with SA EPA guidance, the application of statistics is appropriate if all of the following criteria are met:

- No results greater than 250% of the criteria which the classification is aiming to meet.
- A standard deviation of results no greater than 50% of the criteria.

Summary statistics are summarised in Table 23 with cells shaded gray where the data did not meet the acceptability criteria for the application of statistics. Analytes were confirmed as exceeding the criteria where the rules for the application of statistics were not met.

Ecological Investigation Levels

The statistical assessment indicates that in natural soils, arsenic, lead and copper are confirmed as exceeding the EILs. Zinc and B(a)p in natural soil meets the EILs.

The statistical assessment indicates that in fill materials on site, only arsenic and zinc exceed the EILs.

Waste Fill Criteria

The statistical assessment indicates that in natural soils, arsenic, lead, copper and manganese are confirmed as exceeding the Waste Fill criteria. Zinc, B(a)p and total PAH meet the Waste Fill criteria.

The statistical assessment indicates that in fill materials on site, only arsenic exceeds the Waste Fill criteria.

Table 23: 95% UCL Results for All Analytes Exceeding Adopted Criteria

Analyte	Criteria (mg/kg)	No. of Analyses	Max	SD	Mean	95% UCL	Statistical Assessment
Ecological Criteria							
Arsenic - Natural	40	214	160	34.36	38.21	48.44	Exceeds EIL.
Arsenic - Fill		10	100	29.41	22.61	50.97	Exceeds EIL.
Lead – Natural	470	334	1,200	109.7	42.96	69.14	Exceeds EIL.
Lead - Fill		NA – all results below the criteria.					
Copper – Natural	70	337	180	17.54	10.37	14.53	Exceeds EIL.
Copper – Fill		26	81	19.94	19.26	36.31	Meets EIL.
Zinc – Natural	130	135	340	60.03	39.19	61.72	Meets EIL.
Zinc – Fill		9	220	70.04	77.14	120.6	Exceeds EIL.
B(a)p - Natural	0.7	321	1.1	0.074	0.244	0.251	Meets EIL.
B(a)p - Fill		NA – all results below the criteria.					
Waste Fill Criteria							
Arsenic - Natural	20	214	160	34.36	38.21	48.44	Exceeds Waste Fill.
Arsenic - Fill		10	100	29.41	22.61	50.97	Exceeds Waste Fill.
Lead – Natural	300	334	1,200	109.7	42.96	69.14	Exceeds Waste Fill.
Lead - Fill		NA – all results below the criteria.					
Copper – Natural	60	337	180	17.54	10.37	14.53	Exceeds Waste Fill.
Copper – Fill		26	81	19.94	19.26	36.31	Meets Waste Fill.
Zinc – Natural	200	135	340	60.03	39.19	61.72	Meets Waste Fill.
Zinc – Fill		9	220	70.04	77.14	120.6	Meets Waste Fill.
Manganese – Natural	500	126	1,700	256.6	110.4	210.1	Exceeds Waste Fill.
Manganese – Fill		7	310	111.9	154.4	236.5	Meets Waste Fill.
B(a)p - Natural	1	321	1.1	0.074	0.244	0.251	Meets Waste Fill.
B(a)p - Fill		NA – all results below the criteria.					
Total PAH – Natural	5	321	9.1	0.61	0.287	0.436	Meets Waste Fill.
Total PAH - Fill	5	NA – all results below the criteria.					

8.1.4 Leachate Results

Leachability analysis was undertaken for PFAS chemicals (Table 3, Appendix J) as well as all chemicals reporting dry weight concentrations above the adopted criteria (selected metals and B(a)p). Leachability analysis was undertaken in accordance with the Australian Standard Leaching Procedure (ASLP) under both acidic (pH 5.0) and neutral (reagent water) conditions.

All PFAS leachability results were below the detection limit. Metals and B(a)p leachability results (see Table 4, Appendix J) were reported below the Waste Derived Fill leachate criteria, apart from the lead leachability result (pH 5.0) for BH021_ENV_001_J_0.0-0.1 which had a concentration (5.0 mg/L) at the maximum allowable leachate concentration. The sample was comprised of Clayey SAND (Natural), coarse to medium grained, grey to brown, and it was located at Piece 501 where Dean Rifle Range was once situated.

A comparison of the leachability data to the groundwater assessment criteria outlined in Section 6.2 was also undertaken to provide an initial indication of risk to sensitive receptors. Analytes reported above the adopted freshwater, marine and recreational guidelines are summarised in Table 24. Agon notes that while all analysis for B(a)p was reported below the laboratory LOR (<0.0005 mg/L), the LOR is above the adopted ANZG (2018) Freshwater and NHMRC (2008) Recreational Guidelines of 0.0001 mg/L. This is considered to be a minor issue, as all other PAH were all below detection and typically had detection limits lower than the criteria.

It is also noted that except for arsenic, leachability was generally observed to be greater under acidic (pH 5.0) extraction compared to the neutral extraction.

Table 24: Summary of Leachability Results

Analyte	No. Samples Analysed	Min (mg/L)	Max (mg/L)	Assessment Criteria Exceedances	Soil type
Arsenic (pH 5.0)	21	<0.01	0.16	NHMRC (2008) Recreational (0.1 mg/L) – 9 Samples ANZG (2018) Freshwater 95% (0.013 mg/L) – 26 Samples	Natural (All samples)
Arsenic (neutral)	21	<0.01	0.41		
Lead (pH 5.0)	3	0.74	5.0	NHMRC (2008) Recreational (0.1 mg/L) – 3 Samples ANZG (2018) Freshwater 95% (0.0034 mg/L) – 5 Samples ANZG (2018) Marine 95% (0.0044 mg/L) – 5 Samples	Natural (All samples)
Lead (neutral)	3	0.03	0.06		
Copper (pH 5.0)	5	0.07	0.36	ANZG (2018) Freshwater 95% (0.0014 mg/L) – 9 Samples ANZG (2018) Marine 95% (0.0013 mg/L) – 9 Samples (note: LOR exceeds assessment criteria)	Fill (1 sample)
Copper (neutral)	5	<0.01	0.06		Natural (8 samples)
Zinc (pH 5.0)	4	0.18	1.4	ANZG (2018) Freshwater 95% (0.008 mg/L) – 7 Samples ANZG (2018) Marine 95% (0.015 mg/L) – 7 Samples	Fill (1 sample)
Zinc (neutral)	4	<0.01	0.12		Natural (6 samples)
Manganese (pH 5.0)	3	0.05	0.91	ANZG (2018) Marine 95% (0.08 mg/L) – 2 Samples	Natural
Manganese (neutral)	3	<0.05	0.08		
B(a)p (pH 5.0)	1	<0.0005	<0.0005	NHMRC (2008) Recreational (0.0001 mg/L) – 2 Samples (note: LOR exceeds assessment criteria)	Natural
B(a)p (neutral)	1	<0.0005	<0.0005		

8.1.5 Acid Sulfate Soil Assessment Results

Agon undertook acid sulfate soil sampling from 153 sample locations across the site. pH analysis was undertaken to assess for the likely presence of sulfuric and hypersulfidic ASS materials, including pH f and pH fox. pH f results under 4 pH units were considered indicative of sulfuric soil, and pH fox under 3 pH units indicative of hypersulfuric soil. A difference of more than 1 pH unit from pH f to pH fox may also indicate hypersulfidic soil. pH f and pH fox analyses were conducted on 243 individual samples originating from uncontrolled fill materials, the St Kilda Formation and the Pooraka Formation.

The pH analytical results were used to determine an indicative ASS classification for the samples (Table 21). Of the 226 St Kilda Formation samples analysed, 50 samples (22% of the population) were found to be AASS/PASS (sulfuric) with an additional 82 samples (36%) classified as PASS (hypersulfidic). The remaining 94 samples (42%) were found to be neutral (hyposulfidic). Of the 7 Pooraka Formation samples analysed, 2 samples were found to be AASS/PASS (sulfuric) with the remaining 5 samples found to be neutral (hyposulfidic).

The ASS characteristics of the uncontrolled fill within the site are unknown. As such, 10 samples were analysed for pH, with the findings that 1 sample was AASS/PASS (sulfuric) with an additional 3 samples classified as PASS (hypersulfidic). The remaining 7 samples were found to be neutral (hyposulfidic).

The pH testing results were used to guide chemical analysis for Chromium Reducible Sulfur (CRS) to provide more definitive indication of the presence of absence of ASS materials. CRS analysis as well as total iron, clay content, and total organic carbon, was undertaken on 33 samples from the St Kilda Formation and 6 samples of uncontrolled fill (Table 25).

The CRS results (see Table 26) determined that 45% of the samples exceeded the action criteria and were sulfuric (AASS) and 36% of samples were PASS (present as both hypersulfidic or monosulfidic materials). Sulfuric and monosulfidic material would require neutralisation if exposed to atmospheric oxygen. Hypersulfidic material has the potential to oxidise upon disturbance and may also require neutralisation. Hyposulfidic material is unlikely to become acidic upon disturbance.

Chemical analysis of uncontrolled fill samples indicated a range of potential ASS materials including sulfuric, hypersulfidic and/or monosulfidic classifications. The results suggest that the fill material on site may have been derived from a source site affected by acid sulfate soil types potentially including dredged material. Analytical results are in Table 5, Appendix J and the distribution of ASS material types is shown on Figure A10, Appendix A.

Overall, the data indicates the potential for the widespread distribution of sulfuric and hypersulfidic materials across the site which will require management if disturbed. There is also the potential for monosulfidic materials to occur in the south eastern corner of the site, as well as potentially along existing drainage pathways in the northern and north western boundaries of the site. If these areas may be disturbed during the project, further targeted intrusive sampling should be undertaken to refine the management measures. This may be particularly relevant within the St Kilda Formation, where reported net acidity was up to 510 H+/t with a consequent liming rate of 38 kg $CaCO_3$/t.

Moisture content of some samples was as high as 44%, indicating poorly consolidated sediments underlying the site to a depth of 1.0 m BGL. These sediments will have a high susceptibility to dewatering and compaction. DIT advise that they intend to avoid dewatering, however there remains the requirement for a detailed hydrogeological, geochemical and geotechnical model of the receiving site to determine the magnitude of subsidence and potential impacts of hydrogeological changes to offsite receptors, i.e. whether a higher hydraulic gradient could push metals and acidity offsite.

Table 25: pH assessment summary

Geological Domain	ASS Samples	pH Analyses	pH-based Classification	CRS Samples		ASS Classification	Matrix description
St Kilda Formation	226	50	AASS/PASS	33	7	Sulfuric	Predominantly SAND with minor Clayey SAND and Sandy CLAY
		82	PASS		5	Hypersulfidic	Predominantly SAND with minor Clayey SAND
					7	Monosulfidic	Predominantly SAND with minor Clayey or Gravelly SAND and Sandy CLAY
		94	Neutral		14	Hyposulfidic	Predominantly SAND with minor Clayey SAND and Sandy CLAY
Pooraka Formation	7	2	PASS	NT*		Hypersulfidic	SAND
		5	Neutral	NT*		Hyposulfidic	SAND
Fill Materials	10	1	AASS/PASS	6	1	Sulfuric	Sandy CLAY
		3	PASS		2	Hypersulfidic	Gravelly silty CLAY & SAND
					1	Monosulfidic	Gravelly SAND
		7	Neutral		2	Hyposulfidic	Gravelly silty CLAY & SAND

**NT Not Tested*

Table 26: ASS Chemical assessment summary

Geological Domain	CRS Samples		ASS Classification	Iron Content (wt%)	Clay Content (wt%)	Moisture Content (wt%)	Total Organic Carbon (wt%)	Net Acidity >0.03 %S	Net Acidity >18 mol H+/t	Liming Rate (kg CaCO3/t)
St Kilda Formation	33	15	Sulfuric	0.4-0.5	<2.5-10	15-44	<0.1-1.3	0.5-0.8	21-510	1.1-38
		7	Hypersulfidic	0.3-0.5	<2.0-2.5	7-34	0.2-0.7	0.33*	ND	1*
		5	Monosulfidic	0.3-3.1	<2.5-11	15-39	<0.1-3.4	0.04-0.37	19-230	1.4-17
		7	Hyposulfidic	0.5*	<2.5*	14-39	<0.1*	0.08-0.3	51-200	<1
Fill Materials	6	1	Sulfuric	NT	NT	26-30	NT	0.04*	25*	1.9*
		2	Hypersulfidic	NT	NT	3.2-21	NT	0.31*	200*	<1
		1	Monosulfidic	2*	7.4*	14*	4.6*	NT	NT	NT
		2	Hyposulfidic	NT	NT	7.6-38	NT	0.04-0.3	26-190	<1

**N = 1, NT = Not Tested*

8.1.6 Comparison of Site Soil Results to Tunnel Spoil Results

Summary statistics for the natural site soil (Section 8.1.3) have been compared with the same summary statistics for all chemicals that exceed the Waste Fill criteria in the tunnel spoil to be generated from the Southern Tunnels and the Northern Tunnels of the T2D (Section 2.3.1; Agon, 2024). The purpose of this comparison is to determine whether chemical concentrations in tunnel spoil are similar to concentrations already present on site, to provide a preliminary assessment of the risk of importing tunnel spoil that exceeds Waste Fill. Results are presented by tunnel section to assist with assessing the risk on a smaller scale than the entire tunnel spoil volume. Only natural material at the site has been used in the comparison rather than fill, due to the dominance of natural material encountered in site investigations.

In accordance with SA EPA guidance, the application of statistics is appropriate if all of the following criteria are met:

- No results greater than 250% of the criteria which the classification is aiming to meet.
- A standard deviation of results no greater than 50% of the criteria.

Summary statistics are summarised in Table 27 with cells shaded gray where the data did not meet the acceptability criteria for the application of statistics. Analytes are considered to exceed the Waste Fill criteria where the rules for the application of statistics were not met.

The comparison shows that the arsenic and zinc concentrations at the site are typically equal to or higher than arsenic concentrations in the tunnel spoil, indicating that there is likely to be negligible additional risk to future site receptors posed by arsenic or zinc concentrations in the tunnel spoil. Nevertheless a tier 2 environmental risk assessment is considered necessary for arsenic concentrations on site, on the basis of the maximum arsenic concentration which is 3 times higher in the tunnel spoil than in the natural site soil.

Barium, copper, manganese and nickel concentrations are broadly higher in the tunnel spoil than at the site, and this may require further consideration in a Tier 2 environmental risk assessment.

8.1.7 Comparison of Site Soil Results to In Situ Excavation Spoil Results

A comparison of site soil results with in situ excavation spoil results is yet to be completed and will be undertaken when the in situ excavation spoil results are available.

Table 27 Comparison of Metal Concentrations on Site and in the Tunnel Spoil

Analyte	Waste Fill Criteria	Intermediate Waste Soil Criteria	Site Soil			Tunnel Spoil		
			Max Conc (mg/kg)	Std Deviation (mg/kg)	95% UCL (mg/kg)	Max Conc (mg/kg)	Std Deviation (mg/kg)	95% UCL (mg/kg)
Site Comparison with Tunnel Section 1								
Arsenic	20	200	160	34.36	48.44	550	66.2	43.89
Barium	300	-	81	15.87	20.64	1,200	130	69.59
Manganese	500	6,000	1,700	256.6	210.1	5,700	627.4	350.2
Copper	60	2,000	180	17.54	14.53	290	28.26	17.55
Nickel	60	600	32	6.142	8.652	96	15.44	19.46
Zinc	200	14,000	340	60.03	61.72	290	25.26	28.82
Site Comparison with Tunnel Section 2								
Arsenic	20	200	160	34.36	48.44	180	39.62	29.76
Manganese	500	6,000	1,700	256.6	210.1	720	159.5	212.5
Nickel	60	600	32	5.831	12.12	68	10.55	17.68
Site Comparison with Tunnel Section 3								
Arsenic	20	200	160	34.36	48.44	23	3.662	5.556
Manganese	500	6,000	1,700	256.6	210.1	880	189.2	316.8
Site Comparison with Tunnel Section 4								
Manganese	500	6,000	1,700	256.6	210.1	1,100	188.1	274.7
Copper	60	2,000	180	17.54	14.53	170	29.73	29.34

NOTE: Shaded cells indicate value exceeds SA EPA Waste Fill Criteria. Std Deviation required to be below 50% of criteria. Maximum concentration to be below 250% of criteria.

8.2 Groundwater Results

Hydrogeological settings were discussed in Section 4.3.2, with sampling dates and applied sampling procedures outlined in Section 7. The locations of sampled groundwater wells are illustrated on Figure A8, Appendix A with analytical results in Table 6, Appendix J.

8.2.1 Groundwater Observations

As presented in Section 7, field parameters including DO, EC, pH, oxidation-reduction potential and temperature were monitored prior to sampling to ensure the groundwater samples collected were representative of the groundwater. Stabilised values of the field parameters and observations made are summarised in Table 28.

Table 28: Field Groundwater Parameters

Well ID	DO (mg/L)	Electrical Conductivity (µS/cm)	pH	Redox (mV)	Temperature (°C)	Field Observations
GW01	1.70	61,730	6.91	-107.3	21.9	No sheen, no odours
GW02	0.26	107,546	6.39	-160.1	19.8	Grey colour, 'rotten egg' odour
GW03	0.34	106,277	6.44	-199.4	21.1	No odours
GW04	0.16	93,030	6.73	-150.3	22.6	No sheen, no odours
GW05	0.42	87,972	6.64	-133.8	23.4	No sheen, no odours, yellow in colour, low turbidity
GW06	0.28	68,243	6.62	-152.9	22.7	No sheen, no odours
GW07	0.28	84,800	6.38	-76.0	22.4	No sheen, no odours
GW08	0.28	76,414	6.56	-132.6	23.6	No sheen, no odours, yellow in colour, low turbidity
GW09	0.01	123,861	6.66	-94.7	24.4	No sheen, no odours, mod. turbidity
GW10	0.77	60,008	5.84	-145.3	20.7	No sheen, no odours, low turbidity
GW11	1.35	96,035	6.20	-73.6	20.2	No sheen, no odours, low turbidity
GW12	0.10	90,813	6.81	-182.8	20.1	No sheen, 'rotten egg' like odours, low turbidity
GW13	0.08	100,252	6.79	-116.5	22.3	No sheen, no odours, low turbidity
GW14	0.01	104,604	6.7	-138.6	22.1	No sheen, no odours, low turbidity
GW15	0.01	117,582	6.68	-153.5	21.0	No sheen, no odours, low turbidity
RSA01	1.36	82,204	7.09	-77.3	20.3	No odour, slow water level recovery, purged dry
RSA02	0.01	78,445	6.66	-274.3	20.6	No sheen, no odours
RSA03	0.21	98,144	6.57	-266.2	20.2	No sheen, no odours
30381	0.33	50,139	6.59	-196.4	20.5	No sheen, no odours, low turbidity
30387	0.22	89,965	6.27	-145.7	21.6	No sheen, no odours, low turbidity
30388	0.12	62,144	6.62	-281.4	20.7	No sheen, no odours, yellow in colour, low turbidity
30390	0.31	95,912	6.74	-160.3	21.9	No sheen, no odours, brown in colour, high turbidity

Table 28 demonstrates that the groundwater within the uppermost aquifer is generally hypersaline (i.e. the measured EC were higher than typical seawater EC of 50,000 µS/cm), highly anoxic, characterised by negative redox values and slightly acidic. Rotten egg-like odours (possibly due to the presence of hydrogen sulphide gas) were noted at GW02 and GW12.

8.2.2 Groundwater Flow Direction

Groundwater level gauging was conducted on 13 February 2024 including both onsite and offsite wells shown on Figure A11, Appendix A.

Groundwater salinities reported by the laboratory ranged between 28,000 mg/L TDS and 120,000 mg/L TDS (Table 6, Appendix J), indicating that measured groundwater levels need to undergo density adjustments to enable a comparison of groundwater levels.

Typically, density corrections are carried out through conversion to the freshwater-equivalent density. However, as site groundwater is highly saline, it was considered more appropriate to make the density corrections with reference to the lowest reported salinity of 28,000 mg/L with a calculated density of 1,019 kg/m3 (calculated based on the reported TDS and measured groundwater temperature).

The density adjustments were made using the formula (Fetter et al):

$Hc=Hn*(\rho n/\rho f)+Z$ - where:

Hc – corrected groundwater level (m)

ρf – freshwater density (kg/m3)

ρn – density of water in the well "n" (kg/m3)

Hn – water level in well "n" (m)

Z – reference point (m Australian Height Datum, AHD)

The gauged groundwater levels together with the density corrected water levels are shown in Table 29. The density-corrected groundwater level gauging results were used to prepare groundwater level contours (Figure A11, Appendix A). Based on the groundwater level contours, the inferred groundwater flow direction is generally to the north west towards the Port Adelaide River. However, the contour pattern appears to be influenced by groundwater extraction at the Magazine Creek wetland which is inferred to be still occurring (refer Section 4.3).

Table 29: Density Corrected Groundwater Levels (February 2024)

Well ID	Reference Elevation (mAHD)	SWL (mbTOC)*	SWL (mAHD)	TDS (mg/L)	Temp (°C)	Density (kg/m3)	Corrected SWLs (mAHD)
GW01	1.544	1.828	-0.284	45,000	21.9	1032	-0.263
GW02	1.291	1.743	-0.452	84,000	19.8	1063	-0.361
GW03	2.042	2.776	-0.734	80,000	21.1	1059	-0.693
GW04	2.086	2.323	-0.237	38,000	22.6	1026	-0.228
GW05	1.564	2.374	-0.81	89,000	23.4	1066	-0.741
GW06	1.632	1.878	-0.246	63,000	22.7	1045	-0.196
GW07	1.265	1.857	-0.592	70,000	22.4	1051	-0.537
GW08	1.354	1.482	-0.128	55,000	23.6	1039	-0.088
GW09	1.126	1.503	-0.377	120,000	24.4	1090	-0.230
GW10	1.321	1.717	-0.396	44,000	20.2	1032	-0.374
GW11	1.256	1.649	-0.393	71,000	20.2	1053	-0.328
GW12	1.810	2.012	-0.202	86,000	20.1	1064	-0.123
GW13	1.633	1.797	-0.164	82,000	22.3	1060	-0.096
GW14	1.432	1.693	-0.261	100,000	22.1	1075	-0.167
GW15	1.355	1.654	-0.299	110,000	21.0	1083	-0.163
RSA01	0.56	1.165	-0.606	83,000	20.3	1062	-0.490
RSA02	0.68	1.187	-0.507	75,000	20.6	1056	-0.423
RSA03	1.14	1.646	-0.505	79,000	20.2	1059	-0.455
30381	2.78	2.871	-0.092	28,000	20.5	1019	-0.092
30387	3.65	4.644	-0.996	85,000	21.6	1063	-0.894
30388	3.70	4.449	-0.747	50,000	20.7	1036	-0.704
30390	4.79	5.622	-0.833	66,000	21.9	1048	-0.790

8.2.3 Hydraulic Conductivities and Groundwater Flow Velocity

The hydraulic conductivities for each well in the aquifer were estimated using data collected during groundwater sampling using low-flow sampling techniques. Hydraulic conductivities were not estimated for wells that purged dry. During sampling, the purging (pumping) rates and groundwater levels were stable, therefore the Thiem's equations developed for steady state conditions during pumping tests can be used as follows:

$K= 2.3*Q*\log(R/r)/2*\pi*s*m$ – where:

K = hydraulic conductivity;

Q = purging (pumping) rate;

R = radius of influence from the purging;

r = radius of well;

s = drawdown achieved during purging (pumping); and

m = aquifer thickness.

The radius of influence was estimated using the empirical Sichardt equation $R=3000*s*\sqrt{K}$. Expected ranges of K (0.1 to 10 m/day) were used in the calculations based on professional judgement. It was calculated that the radius of influence is about 10 times the drawdown (Table 26). It is noted that the radius of influence is not considered to be an overly sensitive parameter. The thickness of the uppermost aquifer was adopted as 4 m, which was the average thickness of the St Kilda Formation in past investigations (Belperio, 1989).

The results of hydraulic conductivity estimations are presented in Table 30

Table 30: Hydraulic Conductivity Estimates

Well ID	Purge Rate (L/min)	Drawdown (m)*	Radius of Influence (m)	Aquifer Thickness (m)	K[#] (m/day)	K (m/sec)
GW01	0.18	0.62	7	4	0.09	1.05E-06
GW02	0.26	0.08	1	4	0.69	7.97E-06
GW03	0.24	0.06	1	4	0.84	9.77E-06
GW04	0.32	0.07	1	4	0.95	1.10E-05
GW05	0.29	0.17	2	4	0.43	5.01E-06
GW06	0.23	0.07	1	4	0.70	8.06E-06
GW07	0.19	0.23	3	4	0.22	2.55E-06
GW08	0.31	1.15	1	4	0.06	6.49E-07
GW09	0.40	0.03	1	4	2.81	3.26E-05
GW10	0.26	0.17	2	4	0.38	4.39E-06
GW11	0.19	0.82	10	4	0.08	8.96E-07
GW12	0.39	0.29	3	4	0.37	4.25E-06
GW13	0.45	0.14	2	4	0.81	9.42E-06
GW14	0.40	0.13	2	4	0.77	8.93E-06
GW15	0.43	0.07	1	4	1.31	1.51E-05
RSA01	Purged dry					
RSA02	0.28	0.07	1	4	0.84	9.70E-06
RSA03	0.19	0.25	3	4	0.20	2.35E-06
30381	0.40	0.08	1	4	1.06	1.22E-05
30387	0.40	0.28	3	4	0.39	4.53E-06
30388	0.39	0.05	1	4	1.64	1.90E-05
30390	Purged dry					
Average					0.73	8.47E-06

** denotes difference between standing water level and water level during purging (pumping);*

[#] denotes hydraulic conductivity of the aquifer material

The groundwater flow velocity at the site was estimated using the following parameters:

- Average hydraulic conductivity value.
- A range of hydraulic gradients from 0.0004 (estimated for the eastern part of the site) and 0.0015 (estimated for the western part of the, possibly influenced by pumping at the wetland),
- An effective porosity of 0.2 (published data for sandy aquifers).

Based on the above data the groundwater flow velocity was estimated to range between 0.5 – 2m/year. This range is in line with expectations for the site, being considered representative for areas with a flat topography. It is noted that this range may only be representative of dry seasons due to the timing of groundwater sampling, and may change significantly during wet seasons when aquifer recharge may increase the hydraulic gradient.

8.2.4 Dataloggers

Eight electronic water level/temperature transducers (datalogger) were installed in selected groundwater wells and in surface water bodies to collect high frequency data at 20-minute intervals. Six dataloggers were installed in existing groundwater wells along two transects (north-south and east-west), and two dataloggers were installed in branches of the North Arm Creek (NA_East and NA_Central). The purpose of the dataloggers was to assess natural (baseline) variations in surface water and in groundwater levels as well as to assess any tidal influence from Barker Inlet. The locations of dataloggers are illustrated on Figure A12, Appendix A.

Considering that the groundwater underlying the site is hypersaline and potentially aggressive, the dataloggers used were Rugged TROLL 100 manufactured by In-Situ corporation (https://in-situ.com/us/rugged-troll-100), as these are made of titanium and operate well in aggressive environments.

As the Rugged TROLL 100 measures both atmospheric (barometric) and water pressure above the sensor, a Rugged BaroTROLL was also used to collect barometric pressure data so that results could be corrected to water pressure only.

The dataloggers were installed on the 19th and 20th of February 2024 with the first data download on 29 February 2024 and the second download on 9 and 10 April 2024. Water level and temperature variations over time in each transect (groundwater and surface water) were compared with predicted tide levels and rainfalls (Figures 1 to 6, Appendix K).

The datalogger results generally demonstrate the following:

- The tidal influence on surface water and groundwater levels appears to be extremely small (if any).
- The groundwater levels show a slight declining trend coinciding with gradual increase in water temperature. This is interpreted to be a result of evaporation from the groundwater surface.
- The water level at MW07 showed a slight response to a rainfall (~4mm) event that occurred on 17 March.
- The water level at the branch of the North Arm Creek that runs across the site (NA_Central) declined likely as a result of evaporation and has been dry since the beginning of March.
- The water level at the eastern branch of the North Arm Creek (NA_East) shows a slight increasing trend indicating a presence of a water source at the offsite area. Further water level increase is noted following the rainfall event on 17 March.
- Variations in the water temperature of surface water likely follow the daily cycle, increasing during daytime and decreasing during nighttime. The amplitude of temperature changes is related to the depth of the logger, i.e. greater amplitude for the data logger at the Central branch which was submerged 6-10cm below the water surface compared to the eastern location which was submerged by 25-30cm.

8.2.5 Hydrochemical Analysis - Groundwater

The hydrochemical signatures of the groundwater were assessed using the major anion and cation results reported during the most recent sampling event in February 2024. The major anions (Cl^-, $SO4^{2-}$ and HCO^{3-}, $CO3^{2-}$) and major cations (Ca^{2+}, Mg^{2+}, Na^+ and K^+) results are presented in the summary Table 6, Appendix J. Piper and Schoeller plots were drawn to assess the chemical relationships between wells (Figure 12); the plots show a reasonable consistency in the hydrochemical signatures for both onsite and offsite wells, indicating that the source of groundwater within the site area is of the same origin. Relatively parallel lines on the Schoeller plot demonstrate that the groundwater quality is likely influenced by freshwater recharge (e.g. rainwater) or evaporation, either of which would change the salinity of groundwater without significant alteration of the proportions of major ions.

Small variations between wells are noted in the proportions of HCO_3 relative to the other anions, which may indicate direct recharge is occurring in some locations as a HCO_3 may be derived from dissolved CO_2. Small variations in the proportions of sulfate relative to the other anions is also apparent which may be due to the effects of ASS materials varying between locations. These minor variations do not change the overall signatures significantly due to the very high dominance of chloride and sodium ions.

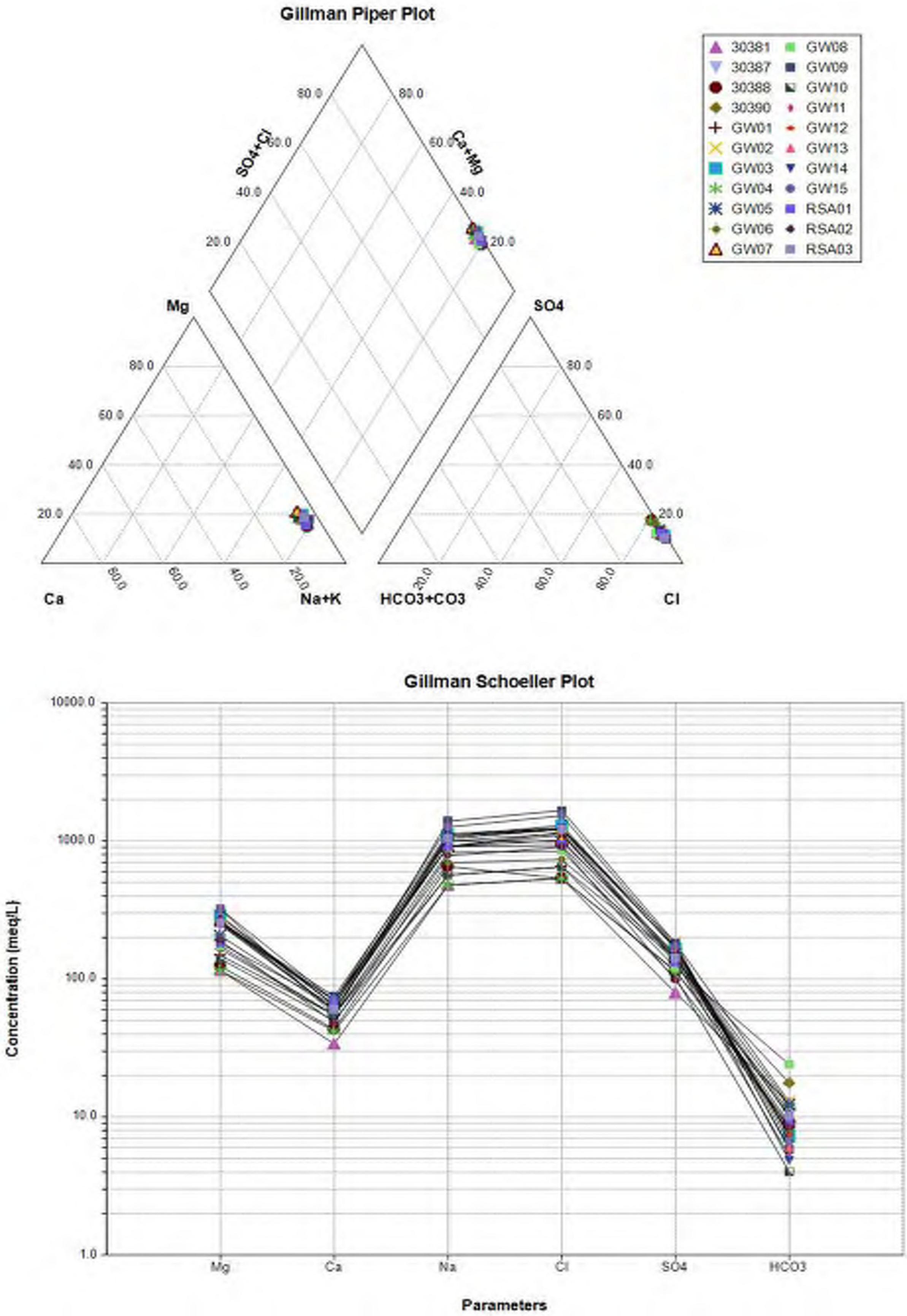


Figure 12: Piper and Schoeller Plots - Groundwater

8.2.6 Groundwater Analytical Results

The analytical program adopted for the groundwater sampling is outlined in Section 7.5 and the groundwater sampling results were compared to the criteria outlined in Section 6.2. The results are included in the summary Table 6, Appendix J.

The majority of the tested analytes and analytical groups were reported at concentrations below laboratory limits of reporting (LORs), with the exception of:

- Metals.
- TRH/BTEX.
- PFAS.
- Inorganic phosphorus and nitrogen compounds and fluoride.
- COD/TOC/CO2.
- Bacteria.
- PFAS.

Retesting of samples with PFAS detections was undertaken to verify the concentrations that were reported in the initial round of testing. The subsequent analysis of PFAS did not report any significant deviations from the first set of results. The second set of analytical results were adopted for presentation and are available in Table 7, Appendix J.

Exceedances

The exceedances of the adopted criteria for the above chemicals are summarised in Table 31. The wells in Table 31 are split into three groups: upgradient wells, onsite wells and downgradient wells based on the groundwater contour pattern on Figure A11, Appendix A.

Upgradient wells likely represent the quality of the groundwater which enters the site from the south and south-east. Downgradient wells represent the quality of groundwater which exits the site area.

The data generally demonstrates no plume-like pattern in groundwater exceedances, indicating that the impacts are not associated with a particular source area(s) but are sporadically distributed. Boron, manganese and ammonia had the greatest number of exceedances and their concentration distributions are illustrated on Figure A14, Appendix A. The exceedances of these three chemicals may be attributable to natural site conditions:

- Boron is likely to be of natural origin in groundwater and may be derived from seawater (typically 6 mg/L with increased concentrations caused by evaporation) and/or marine sediments (such as St Kilda Formation). It is noted that boron concentrations in offsite groundwater are similar (refer Table 5).
- Manganese is also likely to be of natural origin and its elevated concentrations are likely to be the result of a conversion of low solubility Mn^{4+} into highly soluble Mn^{2+} under the negative redox conditions known to exist in site groundwater. It is noted that manganese concentrations in offsite groundwater are similar (refer Table 5).
- Ammonia may be of natural origin, as natural plant decay processes release stored nitrogen into the environment as nitrate or ammonia (Colorado State University, 2024). The typical nitrogen cycle includes processes such as mineralisation, nitrification, denitrification and immobilisation. It is noted that ammonia concentrations in offsite groundwater are within the same range (refer Table 5).

Table 31: Groundwater Exceedances (mg/L)

Well ID	B	Cu	Mn	Mo	Ni	Zn	Ammonia as N	Fluoride	PFOS µg/L
Upgradient Wells									
30381	12	<0.001	0.14	<0.005	<0.001	<0.005	18	-	0.04
GW01	16	0.002	0.46	0.06	0.002	0.005	1.9	-	<0.01
GW04	16	<0.001	0.13	0.044	0.002	<0.005	2.9	-	<0.01
GW06	14	0.002	0.22	0.051	0.002	<0.005	2.2	3.2	<0.01
GW08	13	<0.01	0.23	<0.05	<0.01	<0.01	4.1	<0.5	<0.01
GW09	11	<0.01	0.16	-	0.02	<0.05	1.3	57	<0.01
GW12	13	0.003	0.43	0.027	0.002	0.006	2.5	3.4	<0.01
GW13	13	0.003	0.19	0.047	0.002	0.006	1.6	37	<0.01
GW14	23	0.004	0.39	0.084	0.011	0.005	1.5	2	<0.01
Onsite wells									
GW02	15	<0.001	0.52	0.015	0.013	<0.005	21	-	<0.01
GW07	8.2	<0.001	0.3	0.076	0.007	0.012	21	-	<0.01
GW10	6.3	<0.01	0.72	-	0.03	<0.05	0.49	-	<0.01
GW11	6	<0.01	0.19	-	0.013	<0.05	6.5	-	<0.01
GW15	11	0.004	0.11	0.038	0.003	<0.005	1.1	1.7	<0.01
Downgradient Wells									
GW03	9.4	<0.01	0.21	-	<0.01	<0.05	4	-	<0.01
GW05	12	<0.01	1.4	<0.05	<0.01	<0.05	3.1	-	<0.01
RSA01	8.1	<0.01	1.1	<0.05	<0.01	<0.05	1.7	-	<0.01
RSA02	7.3	<0.001	0.31	0.084	0.006	0.006	8.5	-	<0.01
RSA03	8.5	<0.001	0.18	<0.005	<0.001	<0.005	6	-	<0.01
30387	11	<0.001	0.64	<0.005	0.001	0.007	48	-	<0.01
30388	14	<0.01	0.068	0.065	<0.01	<0.05	1.6	-	<0.01
30390	8.4	<0.001	0.6	0.01	<0.001	<0.005	17	-	<0.01
ANZG (2018) Freshwater	0.94	0.0014	1.9	0.034	0.011	0.008	0.9		0.00023*
ANZG (2018) Marine		0.0013	0.08		0.07	0.015	0.91		
Recreational water quality	40	20	5	0.5	0.2			15	2

**NEMP 2.0 - 99% protection value*

The concentrations of nitrogen compounds are summarised in Table 32 and interpreted as follows:

- Total nitrogen is generally higher onsite compared to offsite areas, noting that downgradient well 30388 is an outlier to this overall pattern and further assessment would be required to confirm the general pattern of nitrogen speciation with more confidence.
- Total nitrogen is almost entirely comprised of organic and ammoniacal nitrogens, as measured by the Total Kjeldahl Nitrogen (TKN) method.
- Very little nitrate or nitrite is present, which would be indicated by the difference between total Nitrogen and TKN and is typical for anaerobic conditions.

- At least half of the measured TKN is in a form of ammonia (or ammonium) with the exception of GW10, where organic nitrogen is dominant due to mineralisation to ammoniacal nitrogen having not occurred to the same extent as in other wells (likely to be caused by local natural factors).
- The variations in proportions of organic and inorganic nitrogen may have a seasonal pattern and additional sampling rounds would be required to assess this further.

Table 32: Nitrogen Compounds (mg/L)

Well ID	Nitrogen (Organic)	Ammonia as N	Total Kjeldahl Nitrogen (TKN)	Nitrogen (Total)
Upgradient				
30381	13	18	31	31
GW01	3	1.9	4.9	5
GW04	4.1	2.9	7	7
GW06	4.4	2.2	6.6	7
GW08	7.9	4.1	12	12
GW09	1.3	1.3	2.6	3
GW12	1.2	2.5	3.7	4
GW13	1.1	1.6	2.7	3
GW14	1.5	1.5	3	3
Onsite				
GW02	<0.2	21	21	21
GW07	9	21	30	30
GW10	33.51	0.49	34	34
GW11	5.5	6.5	12	12
GW15	1.1	1.1	2.2	2
Downgradient				
GW03	0.4	4	4.4	4
GW05	2	3.1	5.1	5
RSA01	2.4	1.7	4.1	4
RSA02	3.5	8.5	12	12
RSA03	2.2	6	8.2	8
30387	28	48	76	76
30388	4.8	1.6	6.4	6
30390	<0.2	17	17	17

PFAS Chemicals

A single exceedance of the freshwater and marine 99% protection criteria for PFAS chemical PFOS was reported at offsite upgradient groundwater well 30381 (located at the Range wetland). The source of PFOS is not known and the sampling results indicate no other exceedances were reported in the onsite wells.

PFAS chemicals were also detected (but below criteria) in upgradient onsite wells GW08 and GW14, and in downgradient offsite wells RSA01, RSA02, RSA03 and 30388. Figure A15, Appendix A presents all detected PFAS chemicals in groundwater samples.

Total oxidisable precursor assay (TOPA) was undertaken on selected groundwater samples to assess whether PFAS precursor compounds are present in groundwater that have the potential to develop into regulated (and detectable) PFAS chemicals. TOPA results were very similar to primary PFAS analyses, indicating that there is negligible potential for unknown PFAS chemicals to transform into regulated and detectable PFAS chemicals in the future.

Reporting Limits

Although the majority of groundwater analyses had laboratory limits of reporting (LORs) below the adopted criteria, some analytes had LORs above the criteria. All analytes with LORs above the criteria are summarised in Table 33, with an explanation provided for each analyte. Explanations are outlined in detail as follows:

- High salinity of groundwater samples required several levels of dilution to enable metal analysis (as explained by the laboratories). These dilutions subsequently caused the rise of LORs for metals.
- High groundwater salinity and concentrations of some chemicals caused 'matrix interference' for analysis of some organic compounds.
- Extremely low default guideline values for chemicals of low solubility but high toxicity (e.g. pesticides, PCBs etc).

Table 33: Summary of LORs Above Criteria

Analyte	Default LOR[1]	Increased LOR[1]	Criteria	Criterion Value[1]	Explanation
Arsenic	0.001	0.02	ANZG (2018) Freshwater 95%	0.013	High Groundwater Salinity
Cadmium	0.0002	0.002	ANZG (2018) Freshwater 95%	0.0002	
Chromium (VI)	0.005	-	ANZG (2018) Freshwater 95%	0.001	
			ANZG (2018) Marine 95%	0.0044	
Cobalt	0.001	0.01	ANZG (2018) Freshwater 95%	0.0014	
Vanadium	0.005	0.01	ANZG (2018) Freshwater 95%	0.006	
Copper	0.001	0.01	ANZG (2018) Marine 95%	0.0013	
Mercury	0.0001	0.001	ANZG (2018) Freshwater 95%	0.004	
Molybdenum	0.005	0.05	ANZG (2018) Freshwater 95%	0.034	
Silver	0.005	-	ANZG (2018) Freshwater 95%	0.00005	
Zinc	0.005	0.01-0.05	ANZG (2018) Freshwater 95%	0.008	
OPP, OCP, PCB	0.0002-0.002	-	Multiple chemicals exceeding ANZG (2018) Freshwater/Marine	-	Extremely low default guidelines
Benzo(a) pyrene	0.001	-	ANZG (2018) Marine/Fresh 95%	0.0002	
1,2-dichloroethane	0.001	0.005	Recreational Water Quality	0.003	'Matrix interference'[2]
Dichloromethane	0.005	0.025	Adopted Recreational Criteria	0.004	
Carbon tetrachloride	0.001	0.005	Adopted Recreational Criteria	0.003	
Vinyl chloride	0.005	0.025	Adopted Recreational Criteria	0.0003	
PFOS	0.01 µg/L	-	PFAS NEPM (2020) Fresh/ marine 99% species protection	0.00023 µg/L	Extremely low default guidelines[3,4]

Notes:

1. *LOR expressed in mg/L unless otherwise noted.*
2. *Matrix interference - increased LOR due to presence of high concentrations of some chemicals and overall high salinity of groundwater.*
3. *NEMP 2.0 recognises that the adopted criteria is beyond typical laboratory detection limits.*
4. *The 99% species protection level for PFOS is close to the level of detection. Agencies may wish to apply a 'detect' threshold in such circumstances rather than a quantified measurement.*

Based on the historical and current site use, i.e. vacant undeveloped land with no historical industrial activities, the above chemicals would not have site-derived sources. In relation to offsite sources, although chlorinated hydrocarbons may travel to the onsite groundwater due to their high solubility and mobility, based on shallow groundwater, slow groundwater flow velocity, absence of impermeable surface cover and high volatilisation potential, the presence of elevated levels of these chemicals in onsite groundwater is considered unlikely. Pesticides and PCBs have extremely low mobility due to their extremely low solubility and high sorption potential, indicating that it is unlikely for these chemicals to travel to the site from offsite sources.

Summarising the above it is concluded that, although LORs were higher than the adopted criteria for some chemicals, these chemicals are unlikely to be found in groundwater samples with elevated concentrations.

Petroleum Hydrocarbons

Petroleum hydrocarbons were present in groundwater on site including trace levels of toluene and C_6-C_{34} fractions. Upon silica gel clean up, all TRH results were below the detection limit, indicating the concentrations initially detected were from a natural organic matter source rather than contaminant derived.

Toluene concentrations require verification in additional groundwater monitoring rounds, it is noted that toluene concentrations are at trace level and are spread across the site with no alignment to potential offsite landfill source sites. It is possible that toluene could be produced microbially in anaerobic environments (Srain and Pantoja-Gutiérrez, 2022).

Acetone

Acetone was detected in GW11 at 0.016 mg/L which is around 3 times the detection limit (Note: there is no adopted assessment criteria for acetone). Acetone is a potential landfill leachate chemical; however, the affected well is in the centre of the site and no other wells on site have detected acetone.

It is considered possible that the acetone result may be due to the use of laboratory cleaning chemicals when cleaning analytical apparatus; this will be verified with re-testing in the next groundwater monitoring round.

Landfill Impacts

In accordance with the SAQP, the 7 wells (GW06, GW08, GW09 and GW12 to GW15) located closest to the landfill sites to the south of the site area were tested for potential indicators of landfill leachate impacts on onsite groundwater:

- Speciated Volatile Fatty Acids (VFAs).
- Chemical Oxygen Demand (COD).
- Biochemical oxygen demand (BOD).
- Total organic carbon (TOC).
- Dissolved gases Methane and Carbon dioxide.
- Fluoride.

The sampling results showed no BOD or VFAs in groundwater samples above the LORs. Other chemicals were detected in groundwater (Figure A16, Appendix A) but with no discernible plume-like pattern, indicating that the source is not landfill leachate.

This conclusion will be verified following the results of subsequent monitoring events to confirm whether the pattern changes and/or whether there is any observed increase in concentrations of the landfill related indicators.

It is noted that a migration of landfill gases (e.g. methane and carbon dioxide) from existing landfills to the site area is highly unlikely due to the presence of The Range wetland and the discharge canal (refer Section 4.6). The presence of these water bodies together with extremely shallow groundwater would almost fully restrict the migration of gases through water saturated media.

Pathogenic Bacteria

The presence of pathogenic bacteria (in the form of Total Coliforms) in groundwater, which may also be a result of landfill impacts, was tested in the majority of the groundwater wells. Pathogenic bacteria were unable to be analysed in groundwater samples from 30381, 30387, GW07, RSA02 and RSA03 as the delivery of the samples to the laboratory was delayed by the courier such that the holding time was exceeded for bacteria to be analysed confidently. It is noted that the LOR for total coliforms is typically 1 MPN/100ml (most probable number of colonies per 100mL), but it was elevated to 10 MPN/100ml due to matrix interference (salinity and suspended material) in several wells.

The total coliform sampling results are shown on Figure A17, Appendix A and indicate the bacteria counts were identified mainly along the upgradient site boundary and in the middle of the eastern portion of the site. The bacteria distribution does not show a plume-like pattern (i.e. decreasing in counts with the distance from the inferred landfill activities) and may be attributed to natural sources, like animal/bird faeces, which could enter shallow groundwater with infiltrated surface water.

Additional groundwater sampling rounds will be required to undertake coliform speciation and analyse samples from wells that were unable to be tested in this round, at a local laboratory (SA Water). This will allow further assessment into whether there is a source of bacterial contamination onsite or offsite and whether reported concentrations show increasing trends.

Section 83A Notification

A Section 83A notification was prepared by Agon and submitted to DIT on 19 March 2024 on the understanding that DIT would share the Section 83A with Renewal SA and submit it to the SA EPA. Upon DIT's request, Agon also submitted the Section 83A directly to the SA EPA on 9 April 2024. The Section 83A included the full groundwater table and specified that the Section 83A was in relation to metals & metalloids, petroleum hydrocarbons, non-metallic inorganics, PFAS and nutrients (Appendix L).

8.2.7 Potential Impact of ASS materials

To assess groundwater impacts arising from ASS disturbance, an analysis of the sulfate/chloride ratio was carried out. The following is presented in National Acid Sulfate Soils Guidance, National acid sulfate soils sampling and identification methods manual Sullivan (2018a and 2018b):

> *The analysis of groundwater for* $SO_4^{2-}:Cl^-$ *ratio has frequently been used as an indicator of ASS. As seawater has a sulfate concentration of approximately 2,700 mg/L and chloride concentration of approximately 19,400 mg/L, the* $SO_4^{2-}:Cl^-$ *ratio of seawater on a mass basis is 0.14. The ratio of dominant ions in saline water remains approximately the same when diluted with rainwater, and therefore, estuaries, coastal saline creeks and associated groundwater can be expected to have similar dominant anion ratios to seawater. Any other source of sulfate ions (such as the oxidation of PASS) in these locations can increase this ratio and hence provide an indication of the possible presence of ASS materials in the surrounding landscape.*

The sulfate/chloride ratio was calculated using groundwater sampling results and is illustrated in Table 34 and Figure 5, Appendix K. The results indicate that onsite and offsite groundwater may have been impacted by ASS oxidation processes.

Table 34: Sulfate/Chloride Ratio (mg/L)

Well ID	Chloride	Sulfate	Ratio
Seawater	19,400	2,700	0.14
Onsite			
GW01	23,000	6,800	0.30
GW02	44,000	8,700	0.20
GW03	46,000	7,900	0.17
GW04	19,000	5,400	0.28
GW05	35,000	7,300	0.21
GW06	26,000	7,000	0.27
GW07	36,000	6,800	0.19
GW08	30,000	5,800	0.19
GW09	59,000	8,700	0.15
GW10	23,000	4,900	0.21
GW11	41,000	6,500	0.16
GW12	43,000	8,100	0.19
GW13	43,000	8,100	0.19
GW14	44,000	8,100	0.18
GW15	54,000	8,200	0.15
Offsite			
RSA01	33,000	6,300	0.19
RSA02	32,000	4,700	0.15
RSA03	43,000	6,800	0.16
30381	19,000	3,800	0.20
30387	39,000	7,100	0.18
30388	19,000	5,500	0.29
30390	40,000	6,500	0.16

8.2.8 Comparison to Background

As discussed in Section 5.2 there have been a number of groundwater investigations and sampling events that led to Section 83A notifications as summarised in that section. Table 5 from Section 5.2.3 lists chemicals which have been reported to exceed the adopted (83A site specific) criteria and their maximum concentrations reported. The locations of the 83A notification sites are shown on Figure A18 included in Appendix A. Table 35 below presents the ranges of concentration of the chemicals of concern reported for onsite upgradient wells and 83A notification concentrations for upgradient offsite areas, inferred as background areas groundwater from which could enter the site from south and south east and impact onsite groundwater.

Table 35: Groundwater Exceedance Comparison with Offsite (mg/L)

Chemicals of Concern	ANZG (2018) Freshwater	ANZG (2018) Marine	Recreational water quality	Onsite (upgradient)	Offsite (upgradient)
Boron	0.94		40	11-23	7.9-21
Copper	0.0014	0.0013	20	<0.001 - 0.004	0.011-0.0235
Manganese	1.9	0.08	5	0.13-0.43	0.46-1.1
Molybdenum	0.034		0.5	0.027-0.084	0.073
Nickel	0.011	0.07	0.2	0.002-0.011	0.017-0.0571
Ammonia as N	0.9	0.91	-	1.5-4.1	2.18-42
Fluoride	-	-	15	2-57	3.6
Zinc	0.008	0.015	-	<0.005-<0.05	0.029-0.3
PFOS (µg/L)	0.00023*	0.00023*	2	<0.01	1

**NEMP 2.0 - 99% protection value*

Table 35 demonstrates that the ranges of concentration of chemicals of concern (listed in

Table 31) reported for the onsite wells located along eastern, south-eastern and southern boundaries of the site, inferred to be upgradient boundaries, were similar or below the ranges of the same chemicals within offsite upgradient areas included in 83A notifications.

With the exception of fluoride, the reported concentration exceedances may be attributable to the offsite sources of impacts. This conclusion however requires additional sampling rounds to be undertaken to enable a more confident judgment.

8.3 Surface Water Results

8.3.1 Surface Water Screening

A surface water quality screening was conducted on 29 February 2024 by ensuring field parameters of surface water were recorded at several offsite and onsite locations.

Sampling locations and the inferred flow directions of surface water in The Range and Magazine Creek wetlands and discharge locations (refer Section 4.6) are shown on Figure A19, Appendix A. The surface water quality results are summarised in Table 36.

Overall, the surface water screening indicates:

- The EC values water in wetland ponds increases from upstream to downstream ponds.
- The water in discharge ponds in both wetlands is hypersaline and this discharges onto the site area.
- The water on the surface along the northern boundary of the site on both onsite and offsite sides of the levee bank is hypersaline with the EC values similar to groundwater. The high EC values may be a result of evaporation which would increase the salinity of surface water.
- The overall salinity of water on the surface of the site and of groundwater underlying the onsite and offsite areas is of the same levels, i.e. hypersaline.

Table 36: Surface Water Parameters (29 February 2024)

Well ID	Easting (GPS)	Northing (GPS)	DO (mg/L)	Electrical Conductivity (µS/cm)	pH	Redox (mV)	T (ºC)	Field Observations
NA-Central	274392	6143570	2.22	122,724	7.33	97	28.8	Onsite. Clear
NA-East	275393	6144343	1.72	150,846	7.49	-8.7	28	Offsite. Yellow grey med turbidity
SW01	275525	6143040	16.3	59,543	8.75	88.4	23.4	The Range Wetland Pond. Orange-brown, med turbidity
SW02	275519	6143051	7.14	78,628	7.67	104.57	22.7	The Range Wetland – discharge Pond. Yellow grey low turbidity
SW03	275457	6142971	7.51	8,208	8.39	64.2	24.3	The Range Wetland Pond. Grey, low turbidity
SW04	273671	6143402	3.9	68,861	8.04	114.9	24.3	Magazine Creek Wetland Pond. Yellow grey, low turbidity
SW05	273660	6143422	9.97	70,411	7.75	117	22.8	Magazine Creek Wetland discharge pond. Yellow grey low turbidity
SW06	273637	6142830	6.16	11,955	8.12	102.7	23.8	Magazine Creek Wetland Pond. Clear-yellow, low turbidity
SW07	275477	6144363	0.4	129,994	7.13	-168.7	28.1	Offsite. Clear-yellow, low turbidity
SW08	274524	6143661	6.26	105,414	8.18	97.7	28.8	Onsite. Yellow green, med turbidity, seawater odour

8.3.2 Surface Water Sampling

Surface water sampling was conducted on 10 and 11 April 2024. The sampled locations are shown on Figure A13 in Appendix A.

The laboratory results of the surface water samples are presented in the summary table attached and field measurements are shown in Table 37.

Table 37: Surface Water Field Parameters

Name	Date	Time	DO (%sat)	Conductivity (mS/cm)	pH	Redox (mV)	Temp °C	Turbidity
SW-1	10/04/2024	9:50	7.59	54,583	7.66	-283.5	16.5	15,500
SW-2	10/04/2024	10:20	6.40	45,771	8.14	-247.2	17.0	28,780
SW-3	10/04/2024	10:40	9.66	25,582	8.67	-259.5	17.6	21,280
SW-4	10/04/2024	11:10	11.78	21,010	8.65	-237.2	18.2	4,538
SW-5	10/04/2024	11:50	3.24	3,216	7.13	-272.1	20.0	6,990
SW-9	11/04/2024	10:35	7.09	75,435	6.77	-245.9	18.8	9,750
SW-10	11/04/2024	9:25	8.53	5,777	7.72	-348.2	17.9	21,656
SW-11	11/04/2024	9:59	10.19	8,480	8.38	-298.3	18.4	11,304
SW-12	11/04/2024	8:37	7.88	7,978	8.37	-392.2	17.5	22,340

Table 37 indicates that salinity levels of the surface water range from brackish to hypersaline with lowest EC measured at the onsite dam and a general increase in measured EC is noted from entry to exit at Magazine Creek wetland ponds. Surface water across the area has neutral to slightly alkaline pH levels and is characterised by negative redox potential and relatively high turbidity.

The laboratory reporting results show the following:

- The concentrations of PAHs, BTEX, OCPs/OPPs, Phenolic compounds, PCBs, explosives and the majority of VOCs (except TCE at SW-5) were below the laboratory reporting limits (LORs).
- Exceedances of marine and/or fresh aquatic ecosystem criteria were reported for total metals: aluminium, copper, lead and zinc at both wetlands and at the dam (SW-5).
- A single exceedance of freshwater aquatic ecosystem criteria was reported for filtered zinc at the entry pond of the Range wetland (SW-12).
- Exceedances of marine and/or fresh aquatic ecosystem criteria for ammonia were reported at the exit ponds at each wetland.
- Presence of C10-C40 TRH fractions was reported at the entry ponds at each wetland and at the dam (MW-5). Following silica gel cleanup analysis, the TRH concentrations were reported to be below LORs, generally indicating that reported hydrocarbons were not of petroleum origin.
- Traces of PFAS chemicals were reported in all samples collected from the Range wetland ponds, and in the dam and entry ponds at the Magazine Creek wetland. No exceedances were reported, except for PFOS above the 99% protection of aquatic ecosystem criteria due to the extremely low guideline criteria.
- The presence of coliforms was reported in all samples collected. The highest coliform counts were generally attributable to entry ponds compared to exit ponds at both wetlands.

As indicated earlier in this report the primary purpose of the surface water sampling was to identify the current surface water conditions around the site (with regards to contamination) and enable assessment the potential for surface water at the site to influence groundwater quality or otherwise impact sensitive receptors. Therefore, the surface water sampling results were compared with the groundwater results included in Section 8.2.

Figures A14 to A17 and Figures A20 to A22 (Appendix A) present concentrations of chemicals of concern (including bacteria) identified during groundwater assessment and concentrations of the same chemicals reported for the surface water samples. An analysis of these figures shows the following:

- The concentrations of boron (both filtered and total) were reported to be lower in the surface water samples compared to the groundwater results from the adjacent wells indicating the surface water is not a source of identified groundwater impacts.
- The manganese concentrations were reported to be of the same range as groundwater concentration indicating that manganese in both waters may represent ambient water quality rather than source specific impacts.
- The overall concentrations of ammonia were reported to by higher in groundwater wells compared to the surface water results. This concentration difference may be driven by the negative redox potential in groundwater compared to the positive redox potential in surface water.
- Based on the distribution and concentration patterns of PFAS chemicals it is concluded that the source of PFAS in onsite groundwater may be the surface water discharges from wetlands, with PFAS chemicals present in stormwater discharges entering the wetlands from wider offsite catchments.
- The coliforms counts were generally higher in surface water samples compared to groundwater samples (as expected). No conclusion can be drawn regarding coliform migration between surface water and groundwater bodies.
- Concentrations of TOC and BOD were reported to be higher in surface water samples compared to groundwater results. This is with the exception of the exit pond of the Range wetland which was noted to be receiving groundwater discharge from windmills on the date of sampling. COD concentrations were higher in groundwater compared to surface water results which is due to low oxygen availability in groundwater compared to surface water.

Reporting Limits

Although the majority of surface water analyses had laboratory limits of reporting (LORs) below the adopted criteria, some analytes had LORs above the criteria. All analytes with LORs above the criteria are summarised in Table 38, with an explanation provided for each analyte. Explanations are outlined in detail as follows:

- High salinity of surface water samples required several levels of dilution to enable metal analysis (as explained by the laboratories). These dilutions subsequently caused the rise of LORs for metals, mainly for total (unfiltered) metal concentrations.
- High surface water salinity and concentrations of some chemicals caused ‘matrix interference’ for analysis of some organic compounds.
- Extremely low default guideline values for chemicals of low solubility but high toxicity (e.g. pesticides, PCBs etc).

Table 38: Summary of LORs Above Criteria

Analyte	Default LOR[1]	Increased LOR[1]	Criteria	Criterion Value[1]	Explanation
Aluminium (total)	0.05	0.5	ANZG (2018) Freshwater 95%	0.055	High Salinity/Dilution
Antimony (total)	0.005	0.05	Recreational Water Quality	0.03	
Cadmium (total)	0.0002	0.002	ANZG (2018) Freshwater 95%	0.0002	
Chromium (VI) (both Total and filtered)	0.005	-	ANZG (2018) Freshwater 95%	0.001	
			ANZG (2018) Marine 95%	0.0044	
Cobalt (total)	0.001	0.01	ANZG (2018) Freshwater 95%	0.0014	
Vanadium (total)	0.005	0.01	ANZG (2018) Freshwater 95%	0.006	
Copper (total)	0.001	0.01	ANZG (2018) Marine 95%	0.0013	
Lead (total)	0.001	0.01	ANZG (2018) Freshwater 95%	0.0034	
Mercury (total)	0.0001	0.001	ANZG (2018) Freshwater 95%	0.004	
Molybdenum (total)	0.005	0.05	ANZG (2018) Freshwater 95%	0.034	
Silver (total)	0.005	0.05	ANZG (2018) Freshwater 95%	0.00005	
Zinc (total)	0.005	0.05	ANZG (2018) Freshwater 95%	0.008	
OPP, OCP, PCB	0.0002-0.002	-	Multiple chemicals exceeding ANZG (2018) Freshwater/Marine	-	Extremely low default guidelines
Benzo(a) pyrene	0.001	-	ANZG (2018) Marine/Fresh 95%	0.0001	
Dichloromethane	0.005	-	Adopted Recreational Criteria	0.004	'Matrix interference'[2]
Vinyl chloride	0.005	0.025	Adopted Recreational Criteria	0.0003	
PFOS	0.01 µg/L	-	PFAS NEPM (2020) Fresh/ marine 99% species protection	0.00023 µg/L	Extremely low default guidelines[3,4]

Notes:

1. *LOR expressed in mg/L unless otherwise noted.*
2. *Matrix interference - increased LOR due to presence of high concentrations of some chemicals and overall high salinity of surface water.*
3. *NEMP 2.0 recognises that the adopted criteria is beyond typical laboratory detection limits.*
4. *The 99% species protection level for PFOS is close to the level of detection. Agencies may wish to apply a 'detect' threshold in such circumstances rather than a quantified measurement.*

Section 83A Notification

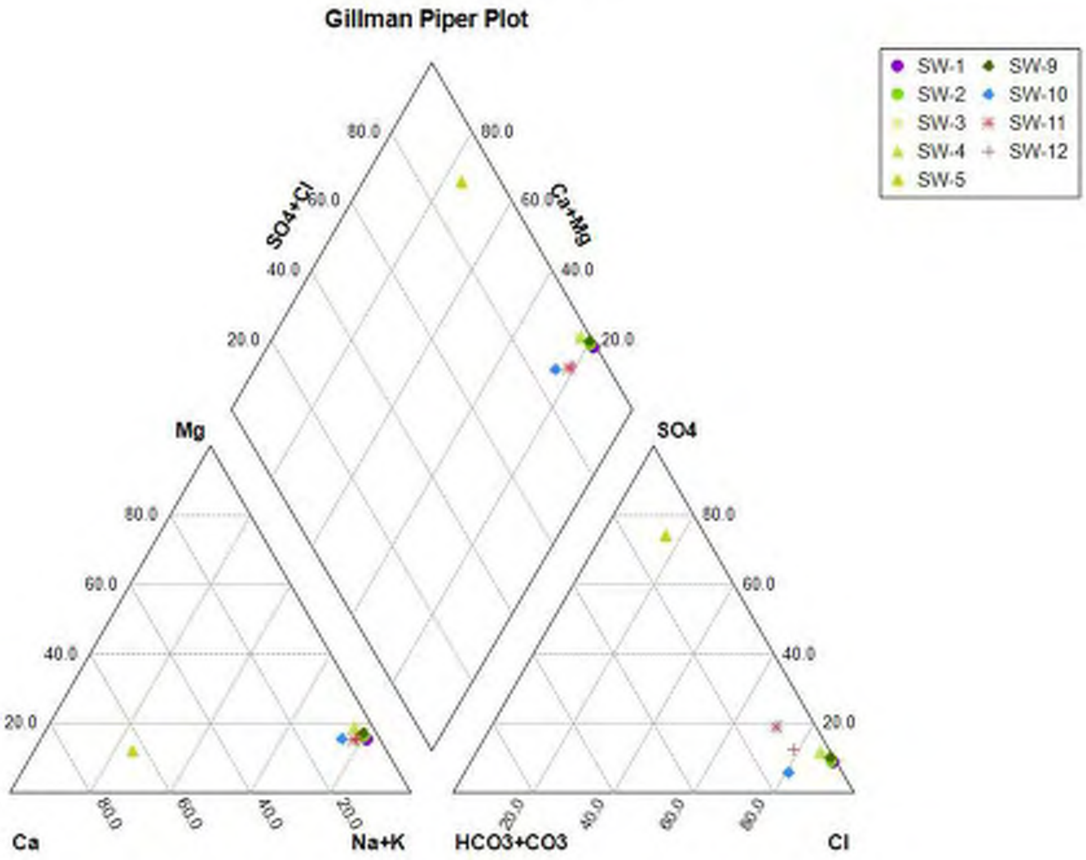
A Section 83A notification relating to the surface water results was prepared by Agon and submitted to the SA EPA on 10 May 2024. The Section 83A included the full surface water table and specified that the Section 83A was in relation to metals & metalloids and PFAS (Appendix L).

8.3.3 Hydrochemical Analysis – Surface Water

The hydrochemical signatures of the surface water were assessed using the major anion and cation results reported during the sampling event in April 2024. The major anions (Cl^-, $SO4^{2-}$ and HCO^{3-}, $CO3^{2-}$) and major cations (Ca^{2+}, Mg^{2+}, Na^+ and K^+) results presented in the summary Table 6, Appendix J used to construct Piper and Schoeller plots shown on Figure 13.

Figure 13 shows a reasonable consistency in the hydrochemical signatures on the Piper plot and a typical dilution/evaporation pattern characterised by relatively parallel lines on the Schoeller plot. The outlier is the signature for the onsite dam (SW-5) which shows elevated proportions of sulphate and calcium and reduced proportion of sodium, chloride and magnesium. The signature of SW-5 may be a result of local stormwater interaction with local soils (ASS as a source of sulphate and calcium from shell debris).

Figure 14 present combined sets of surface water and groundwater signatures. With the exception of SW-5 explained above, all signatures show a consistency on the Piper and parallel lines on the Schoeller plot. This suggests that groundwater and surface water are interconnected with the surface water in the ponds receiving fresh water from stormwater discharges which does not alter major ion proportion significantly.


Gillman Piper Plot
SW-1
SW-2
SW-3
SW-4
SW-5
SW-9
SW-10
SW-11
SW-12
SO4+Cl
Ca+Mg
80.0
60.0
40.0
20.0
Mg
SO4
Ca
Na+K
HCO3+CO3
Cl

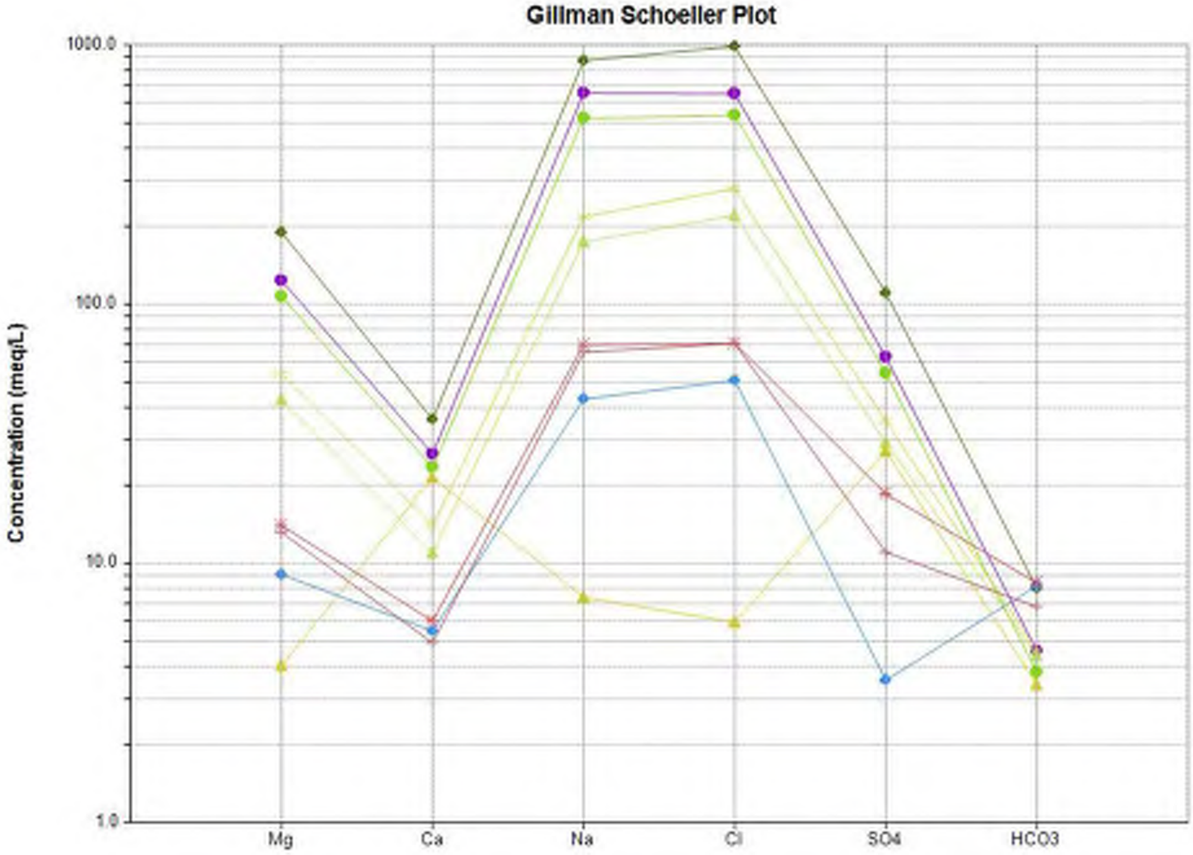
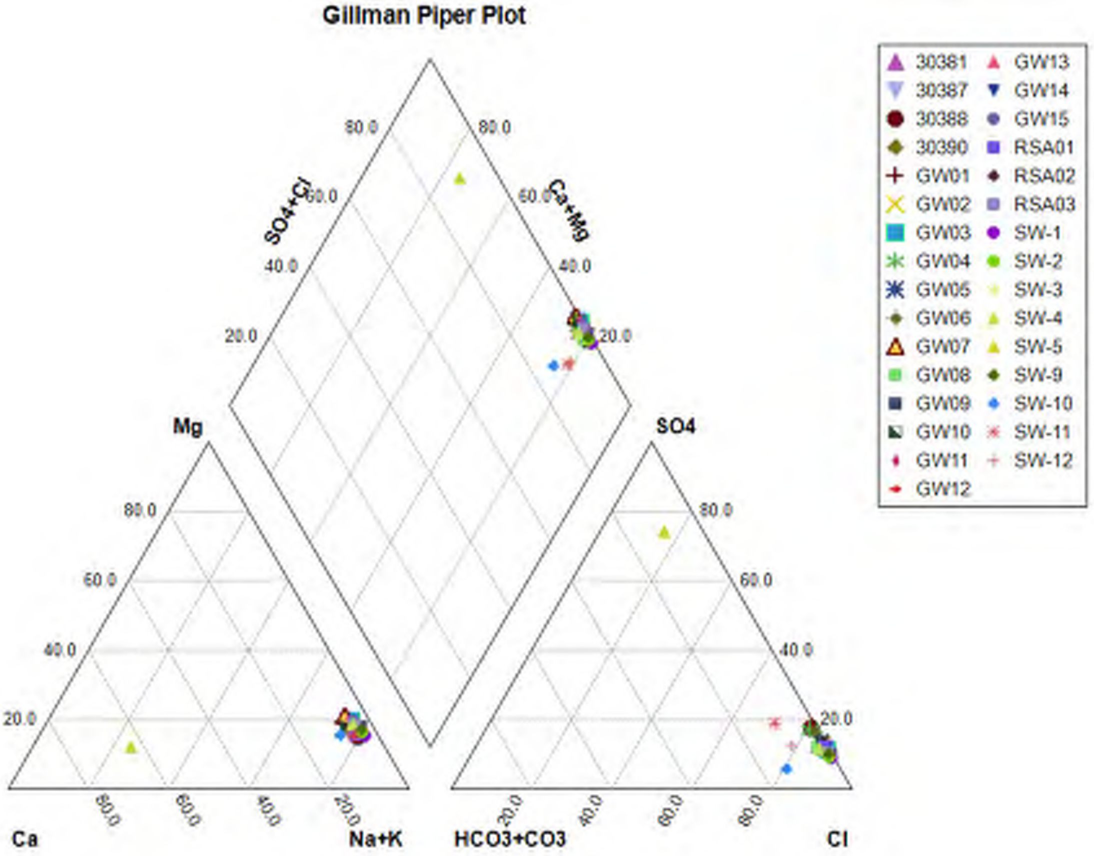

Gillman Schoeller Plot
Concentration (meq/L)
1000.0
100.0
10.0
1.0
Mg
Ca
Na
Cl
SO4
HCO3

Figure 13: Piper and Schoeller Plots – Surface Water



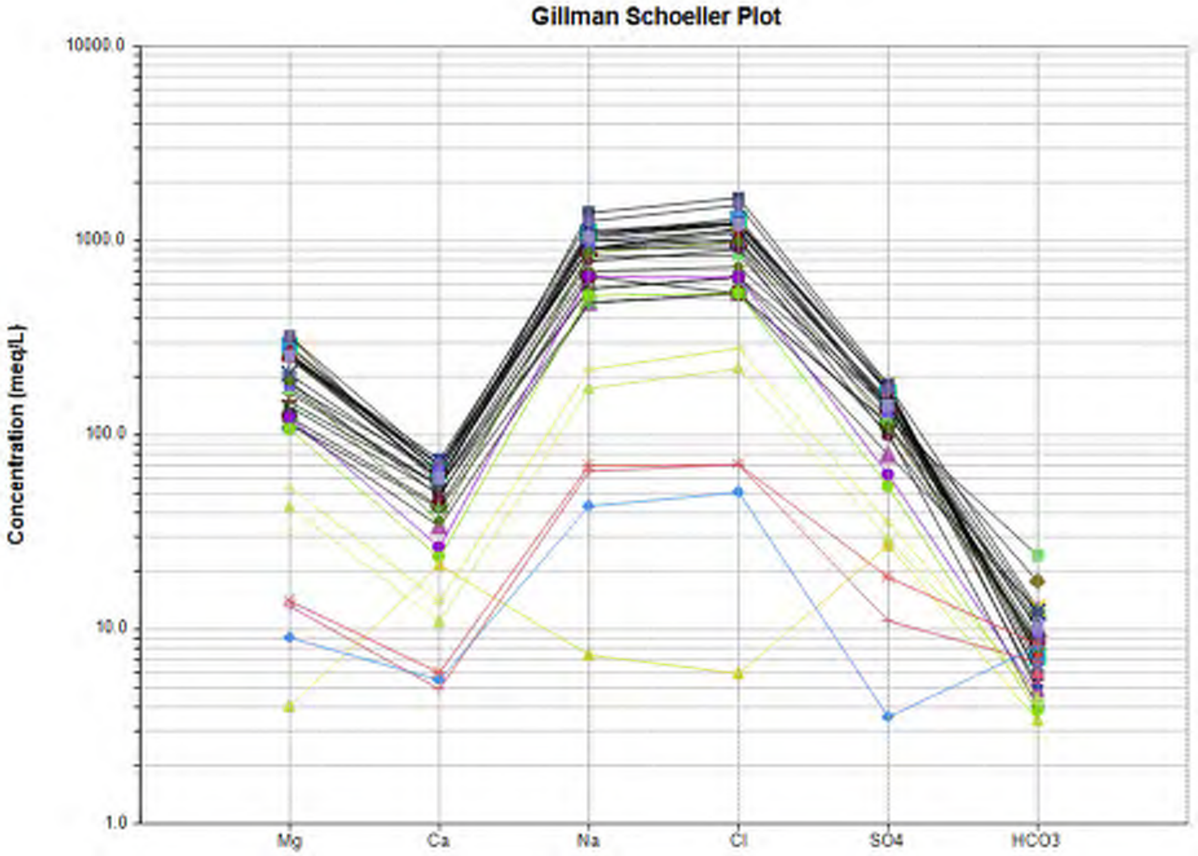


Figure 14: Piper and Schoeller Plots Combined Groundwater & Surface Water

8.4 Groundwater and Surface Water Interaction

Due to the shallow depth of groundwater and the presence of groundwater level control systems at Magazine Creek and Range wetlands, it is possible that groundwater and surface water at the site area are hydraulically connected.

The level of connection was not able to be confidently established due to insufficient data to cover seasonal variations. However, the existing data was analysed to provide an indicative understanding of the surface water-groundwater interaction.

Figure A18, Appendix A was prepared to assess for potential interactions and presents:

- Ground elevations.
- Elevations of groundwater levels measured during the gauging round conducted on 13 February 2024.
- Elevations of surface water levels surveyed by a professional surveyor on 29 February 2024.

The elevations of surface water and groundwater are very similar (Figure A23, Appendix A). At locations where groundwater levels are higher compared to surface water levels upward leakage of groundwater into surface water bodies may occur and vice versa.

It is noted that the surface water and groundwater levels are not time-correlated, as the gauging of surface water and groundwater levels were conducted two weeks apart. Datalogging results (Figure 1, Appendix K) showed that surface water and groundwater levels declined over the two-week period of monitoring. This is effect is believed to be due to a combination of lack of recharge and evaporation (groundwater shallower than 2 m BGL is known to be subject to evaporation processes). Therefore, these results are indicative only and surface water and groundwater levels need to be time-correlated to provide a more accurate understanding of their interaction and potential for contaminant exchange.

Two schematic cross-sections comparing surface water and groundwater levels are shown in Figure 15 (west-east) and Figure 16 (south-north). No groundwater discharge from the site is expected into North Arm Creek as site groundwater levels are lower than the inferred seawater levels (Figure 15), assuming that the water level at the North Arm Creek is the same as the sea level of 0 mAHD. Site groundwater may potentially discharge offsite into the low lying creek channels when the groundwater level is seasonally high (Figure 16). However, if creek channels are filled with water (e.g. discharged from wetlands, refer Figure 16) then seasonal groundwater recharge would occur due to potentially higher surface water elevations compared to groundwater.

The above generally indicates that the interaction between surface water and groundwater at the site and immediate surrounds would likely have a seasonal pattern. The recharge and discharge mechanisms between groundwater and surface water is likely to be complex and requires further water quality testing and continuous water level/water salinity logging to assess.

A comparison of groundwater and surface water hydrochemistry as well as concentrations of chemicals of concern confirms some level of interaction and potential ‘exchange’ of chemicals. Seasonal surface water release and flooding in some parts of the site may result in infiltration and recharging groundwater, i.e. impacting on groundwater. On the other hand, during seasonal groundwater level rise groundwater may be exposed at the surface, causing some water logging and mixing with surface water causing surface water impacts. Additional investigations including water level gauging and sampling conducted during the wet season would improve the understanding of the surface water and groundwater interaction.

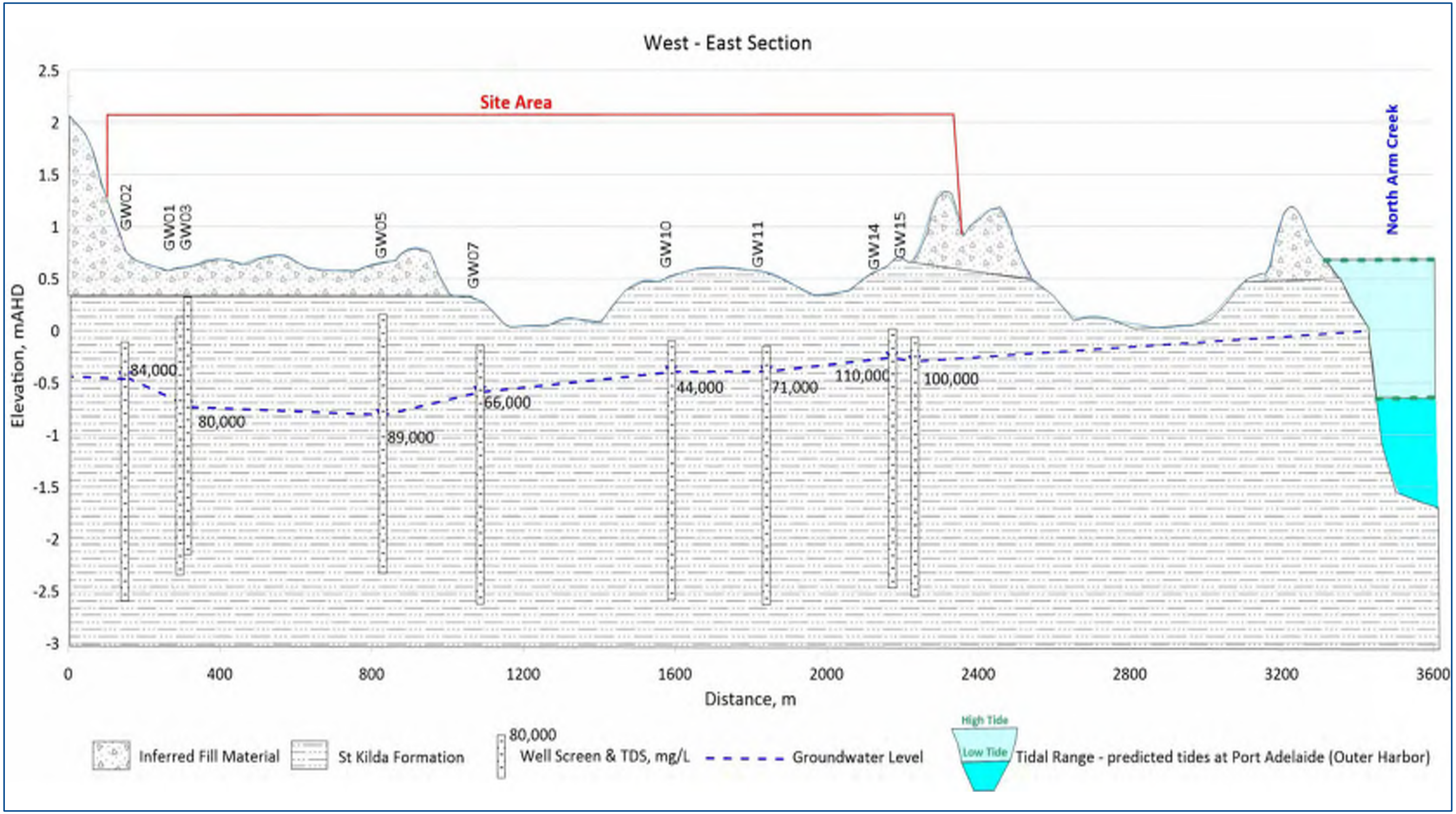

West - East Section
Site Area
North Arm Creek
Elevation, mAHD
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
Distance, m
0
400
800
1200
1600
2000
2400
2800
3200
3600
GW02
GW01
GW03
GW05
GW07
GW10
GW11
GW14
GW15
84,000
80,000
89,000
66,000
44,000
71,000
110,000
100,000
Inferred Fill Material
St Kilda Formation
80,000
Well Screen & TDS, mg/L
Groundwater Level
High Tide
Low Tide
Tidal Range - predicted tides at Port Adelaide (Outer Harbor)

Figure 15: West-East Schematic Cross Section

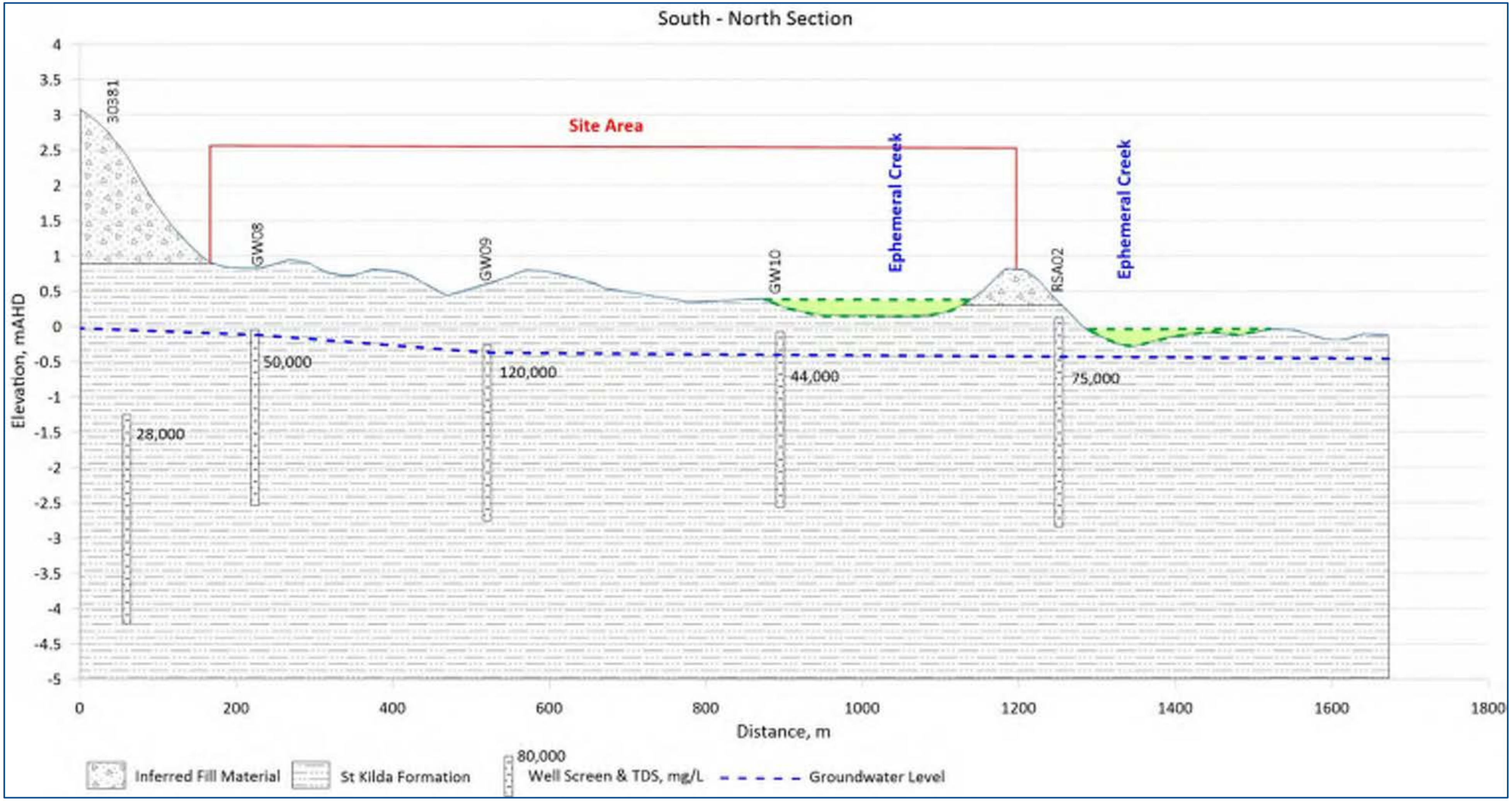


Figure 16: South – North Schematic Cross Section

8.5 Determination of Site Contamination

The existence of site contamination is determined with reference to the SA EPA *Environment Protection Act 1993* which defines site contamination exists if:

A. "Chemical substances are present on or below the surface of the site in concentrations above the background concentrations (if any); and
B. The chemical substances have, at least in part, come to be present there as a result of an activity at the site or elsewhere; and
C. The presence of the chemical substances in those concentrations has resulted in—
   i. actual or potential harm to the health or safety of human beings that is not trivial, taking into account current or proposed land uses; or
   ii. actual or potential harm to water that is not trivial; or
   iii. other actual or potential environmental harm that is not trivial taking into account current or proposed land uses."

Based on the results obtained during the soil and groundwater investigations Agon has made the initial determination that site contamination exists at the site with respect to a land use as an area of ecological significance.

For site soils, the presence of minor concentrations of copper and lead above the ecological criteria (following statistical analysis) may indicate the potential for environmental harm.

Agon does not consider that the arsenic and manganese identified in soil across the site is representative of site contamination.

Site contamination does not exist with respect to a potential future land use of commercial/industrial, as no exceedances of the commercial/industrial criteria have been observed.

Groundwater results indicate that site contamination of groundwater exists, based on concentrations of chemicals above the adopted criteria. It is noted that chemical concentrations have not been proven to be above background at this stage.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

In order to satisfy the overall aims of the assessment, Agon implemented a Quality Assurance program during the assessment. Specific elements of the Quality Assurance program Included:

Field Quality Control

- The use of qualified/trained environmental scientists to perform the assessment.
- The use of standardised field sheets to record the findings of the site investigation activities.
- Undertaking appropriate equipment decontamination to avoid/minimise sample cross-contamination and to ensure confidence in the sampling methodology employed, which in-turn allows the quantitative dataset to be relied upon.
- The use of Chain of Custody procedures to ensure the traceability of sample transport and handling.
- The selection of analytical methods that have a limit of reporting that is equal to or lower than the adopted criteria, where possible.

The collection and analysis of field quality control samples was in accordance with NSW EPA, 2022.

Duplicate samples provide an assessment of precision in the primary laboratory analysis. Relative percent difference between duplicate and primary samples is calculated in accordance with the method outlined in AS4482.1-2005 (now rescinded but used in the absence of any other guidance).

Interlaboratory duplicate samples provide an assessment of the accuracy of primary laboratory analysis compared to the secondary laboratory. Relative percent difference between interlaboratory duplicate and primary samples is calculated in accordance with the method outlined in AS4482.1-2005 (now rescinded but used in the absence of any other guidance).

Rinsate Blanks are used to assess whether detected chemicals may be derived from the re-use of sampling equipment. Rinsate blanks are obtained by pouring laboratory deionised water over decontaminated sampling equipment into laboratory supplied bottles.

Trip Blanks are used to assess whether detected chemicals may be transferred during the transport and storage of samples from the time of sampling to and during shipment to the laboratory. Trip Blanks are provided by the laboratory prefilled with deionised water. Trip blanks are generally analysed for voltaic organic chemicals that may have introduced into samples during handling and transit.

Laboratory Quality Control

- The use of laboratories accredited by the National Association of Testing Authorities, Australia (NATA) for the analysis of samples.
- As part of their NATA Accreditation, the laboratories undertake quality control assessment including:

Internal duplicates are analysed to assess for precision.

Matrix Spikes (MS) –are field samples to which known spiked concentrations of target analytes have been added prior to sample preparation and analytical testing. The MS is analysed as a method performance assessment by measuring the effects of interferences caused by the specific sample matrix. Poor spike recoveries for MS samples could mean the sample matrix is causing matrix interference issues.

Laboratory Control Samples (LCS) are analysed to assess the laboratory performance to successfully recover target analytes from a control matrix on a purified sample material, like homogenous sand or de-ionised water. Recovering the target analytes in the LCS assesses whether the analytical procedure is in control and evaluates the laboratory capability to report unbiased measurements.

Method Blanks – a method blank is a sample that is deionised water or contaminant-free homogenous sand. The method blank is prepared and analysed following the same process as the primary samples. The method blank sample results should be non-detect indicating they are free from laboratory contamination.

9.1 Assessment of Soil Quality Control

9.1.1 Laboratory Batch Assessed

The following batches were assessed:

- 1050811
- 1051728
- 1052250
- 1053251
- 1054145
- 1056441
- 1056581
- 1056811
- 1056817
- 1057783
- 1058104
- 1058828
- 1059205
- 1059214
- 1060712
- 1060731
- 1060747
- 1061117
- 1061503
- 1061968
- 1069427
- 1070082
- 1070077
- 41149
- 41231
- 41418
- 41423
- 41424
- 41471
- 41506
- 41525
- 41595
- 41623
- 41624
- 42130

9.1.2 Sample Preservation

All samples were within the preservation and holding times with the exception of batch 1057783 and 1061117.

9.1.3 Duplicate and Interlaboratory Samples

Agon collected the following primary and duplicate sample pairs (refer Table 38).

Table 39 - Primary and Duplicate Sample Pairs

Primary Sample (s)	Duplicate Sample(s)	Interlaboratory Sample (s)	Analysis
BH002_ENV_001_J_0.0_0.1	QC03		Basic Suite NEPM
BH003_ENV_003_J_0.4_0.5		QC11	PFAS
BH004_ENV_005_J_1.4_1.5	QC12		pH- pH Fox
BH006_ENV_003_J_0.4_0.5	QC10		Basic Suite NEPM
BH011_ENV_002_J_0.2_0.3	QC09		Metals/PAH/BTEX/VOC/TRH
BH012_ENV_004_J_0.9_1.0		QC14	PFAS
BH015_ENV_004_J_0.9_1.0	QC19	QC20	Metals/PAH/BTEX/VOC/TRH/PFAS/pH- pH Fox
BH016_ENV_003_J_0.4_0.5	QC15		PFAS/Leachate PFAS
BH020_ENV_004_J_0.9_1.0	QC22	QC23	Metals/PAH/BTEX/VOC/TRH/PFAS/Leachate PFAS
BH022_ENV_003_J_0.4_0.5	QC18		pH- pH Fox
BH024_ENV_005_J_1.4_1.5	QC25	QC26	Basic Suite - NEPM
BH030_ENV_001_J_0.0_0.1	QC24		Metals/Nitroglycerine/Strontium/PAH/Explosive/BTEX/VOC/TRH
BH049_ENV_002_J_0.2_0.3	QC114	QC115	PFAS
BH056_ENV_001_J_0.0_0.1	QC44	QC45	Metals/Nitroglycerine/Strontium BTEX/VOC/TRH/pH- pH Fox/NEPM Basic Suite
BH057_ENV_007_J_1.4_1.5	QC65	QC64	PAH/VOC/pH- pH Fox
BH058_ENV_005_J_0.9_1.0	QC106	QC107	pH- pH Fox
BH067_ENV_005_J_0.9_1.0	QC63+QC62		PAH/pH- pH Fox/VOC/PFAS
BH069_ENV_003_J_0.4_0.5	QC112	QC113	Metals/PAH/BTEX/VOC/TRH/pH- pH Fox
BH076_ENV_005_J_0.9_1.0	QC80	QC81	pH- pH Fox
BH078_ENV_005_J_0.9_1.0	QC67	QC66	pH- pH Fox/PFAS
BH087_ENV_005_J_0.9_1.0	QC79+QC78		NEPM Basic Suite
BH097_ENV_002_J_0.2_0.3	QC76	QC77	Metals/PAH/BTEX/VOC/TRH
BH099_ENV_001_J_0.0_0.1	QC72	QC73	Metals/PAH/BTEX/VOC/TRH
BH099_ENV_004_J_0.7_0.8	QC74	QC75	pH- pH Fox
BH100_ENV_003_J_0.4_0.5	QC47	QC48	Metals/PAH/BTEX/VOC/TRH NEPM Basic Suite/pH- pH Fox/PFAS
BH101_ENV_001_J_0.0_0.1	QC84	QC85	Metals/PAH/BTEX/VOC/TRH
BH111_ENV_005_J_0.9_1.0	QC90		pH- pH Fox
BH116_ENV_003_J_0.4_0.5	QC53-QC52		Metals/PAH/BTEX/VOC/TRH/pH- pH Fox/PFAS
BH119_ENV_003_J_0.4_0.5	QC88	QC89	NEPM Basic Suite/pH- pH Fox
BH121_ENV_002_J_0.2_0.3	QC135		pH- pH Fox
BH127_ENV_001_J_0.0_0.1	QC104	QC105	NEPM Basic Suite
BH131_ENV_001_J_0.0_0.1	QC58	QC59	Metals/PAH/BTEX/VOC/TRH
BH149_ENV_007_J_1.4_1.5		QC99	pH- pH Fox
BH151_ENV_005_J_0.9_1.0	QC97		pH- pH Fox
BH153_ENV_002_J_0.2_0.3	QC94	QC95	Metals/PAH/BTEX/VOC/TRH
BH068_ENV_001_0.0-0.1	QC156	QC157	Metals/PAH/BTEX/VOC/TRH/pH- pH Fox
BH150_ENV_001_0.0-0.1		QC159	NEPM Basic Suite
BH132_ENV_001_0.0-0.1	QC160	QC161	Metals

9.1.4 Data Precision Assessment Method

Data precision is measured by comparing the Relative Percentile Difference (RPD%) between results from a primary sample and a duplicate. The absolute value of the percent ratio of the difference between the primary and duplicate results, and the mean of the two results, is referred to as the RPD. Table 8 in Appendix J presents results for duplicates and RPD calculations.

Calculation of Relative Percentage Difference

A quantitative measure of the accuracy of the duplicate laboratory results was made using the calculated RPD values. The RPD values were calculated using the following equation:

$$\text{RPD (\%)} = \frac{(Co-Cs)}{[(Co)+Cs)/2]} \times 100$$

Co = concentration obtained from the primary sample; and
Cs = concentration obtained from the blind replicate or split sample.

9.1.5 Field Quality Control Sample Collection Rates

The number of field replicate samples assessed was in accordance with the recommended rates outlined in AS4482.1(rescinded).

9.1.6 Duplicate Samples – Relative Percentage Differences

In accordance with the DQOs, field quality control results were assessed according to their RPD values. For field duplicates, triplicates, and laboratory duplicates, RPDs should generally be below 30%.

RPDs for all primary/duplicate analyte pairs were within acceptance limits, except for those outlined in the Table 40 below:

Table 40: Duplicate pair RPDs exceeding acceptance limits

Batch	Samples (Primary/ Duplicate)	Analytes	RPD %	Discussion
1050811	BH002_ENV_001_J_0.0_0.1 QC03	Zinc	38	The distribution of analytes throughout a soil matrix is generally heterogenous, and although the primary and quality control samples were homogenised, in the field, some contaminants may remain heterogeneously distributed throughout the matrix. The data is considered reliable.
1051728	BH011_ENV_002_J_0.2_0.3 QC09	Strontium	125	
		Magnesium	84	
		Lead	131	
1053251	BH015_ENV_004_J_0.9_1.0 QC19	Strontium	48	
	BH024_ENV_005_J_1.4_1.5 QC25	Manganese	123	
	BH030_ENV_001_J_0.0_0.1 QC24	Arsenic	52	
		Magnesium	42	
		Lead	90	
		Molybdenum	85	
		Zinc	105	
1056811	BH056_ENV_001_J_0.0_0.1 QC44	Zinc	102	
		pH fox	54	
1056817	BH116_ENV_003_J_0.4_0.5 QC53	Magnesium	71	
	BH131_ENV_001_J_0.0_0.1 QC58	Strontium	161	
		Nickel	82	
	BH067_ENV_005_J_0.9_1.0 QC63	pH fox	86	
	BH067_ENV_005_J_0.9_1.0 QC62	pH fox	106	
1058104	BH099_ENV_004_J_0.7_0.8 QC74	pH f	47	
		pH fox	33	
1059214	BH127_ENV_001_J_0.0_0.1 QC104	Arsenic	117	
		Chromium (III+VI)	112	
		Lead	106	
		Manganese	103	
		Zinc	164	
1070082	BH068_ENV_001_0.0-0.1 QC156	Lead	33	
	BH132_ENV_001_0.0-0.1 QC157	Copper	53	
		Zinc	56	

9.1.7 Interlaboratory Duplicate Samples – Relative Percentage Differences

In accordance with the DQOs, field quality control results were assessed according to their RPD values. For field duplicates, triplicates, and laboratory duplicates, RPDs should generally be below 30%.

RPDs for all primary/interlaboratory duplicate analyte pairs were within acceptance limits, except for those outlined in the Table 41 below.

Table 41: Interlaboratory pair RPDs exceeding acceptance limits.

Batch	Samples (Primary/ Duplicate)	Analytes	RPD %	Discussion
1051728 41149	BH003_ENV_003_J_0.4_0.5 QC11	pH fox	41	The distribution of analytes throughout a soil matrix is generally heterogenous, and although the primary and quality control samples were homogenised in the field, some contaminants may remain heterogeneously distributed throughout the matrix. The data is considered reliable.
	BH012_ENV_004_J_0.9_1.0 QC14	Strontium	36	
1053251 41231	BH015_ENV_004_J_0.9_1.0 QC20	Magnesium	32	
	BH024_ENV_005_J_1.4_1.5 QC26	Boron	97	
		Chromium (III+VI)	106	
		Lead	120	
		Manganese	105	
1056817 41423	BH131_ENV_001_J_0.0_0.1 QC59	Barium	87	
		Strontium	179	
		Lead	38	
		Nickel	105	
1059214 41525	BH127_ENV_001_J_0.0_0.1 QC105	Arsenic	98	
		Chromium (III+VI)	114	
		Lead	113	
		Manganese	86	
		Nickel	87	
		Zinc	154	
	BH153_ENV_002_J_0.2_0.3 QC95	Strontium	31	
1060731 41624	BH069_ENV_003_J_0.4_0.5 QC113	Magnesium	58	
		Copper	90	
		Lead	44	
1070082 42130	BH068_ENV_001_0.0-0.1 QC157	Lead	87	
	BH132_ENV_001_0.0-0.1 QC161	Copper	32	
		Lead	49	

9.1.8 Laboratory Quality Control Assessment

For internal laboratory quality assurance/quality control (QA/QC), an assessment for accuracy through matrix spikes should generally achieve at least 70% recovery, in accordance with the project DQOs. Most matrix spikes achieved the required recovery with exceptions noted in Table 42 for the primary laboratory and the secondary laboratory.

Table 42: Exceptions to Laboratory Internal Quality Control Acceptance Limits

Type	Quality Control Target	Exceptions
Eurofins Reports: 1050811, 1070082, 1070077, 1069427, 1061968, 1061503, 1061117, 1060747, 1060731, 1060712, 1059214, 1059205, 1058828, 1058104, 1057783, 1056817, 1056811, 1056581, 1056441 1054145, 1053251, 1052250, 1050811, 1051728.		
Method Blanks	Results for method blanks were reported within acceptance limits.	Nil
Laboratory Control Samples	Laboratory control samples were reported within acceptance limits.	Nil
Matrix Spike Recoveries	Matrix spike recoveries were reported within acceptance limits.	• **1052250** Toluene, Ethylbenzene, m&p-Xylenes, Xylenes Total, 2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol(N-EtFOSE) • **1053251** MPCA • **1053251-W** Naphthalene • **1056581** Lead • **1056817** 2.4 D • **1056817 -W** Perfluoropropanesulfonic acid • **1058104** 2.4 D • **1058828** Manganese • **1059205** Manganese • **1059214** Barium, Lead • **1060731** Zinc • **1061117** Barium, Strontium • **1070077** Lead • 1070082 2 ,4 D The Matrix spike recoveries were outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control samples indicating sample matrix interference.
Laboratory Duplicates	RPDs for duplicates were reported within acceptance limits	• **1051728** Copper, Arsenic • **1052250** TRH C29-C36 • **1053251** Molybdenum, Tin • **1056441** Chromium Reducible Sulfur (a-SCr) • **1057783** Zinc • **1058828** TRH C15-C28, TRH >C16-C34 • **1060712** TRH C15-C28 • **1060731** Arsenic, Copper, Lead, Chromium, Manganese • **1060747** TRH >C10-C16, Barium, Chromium, Lead, Manganese, Nickel, Zinc, Magnesium • **1061117** Magnesium • **1061968** Magnesium • **1070077** Arsenic, lead, zinc • **1051728** Lead, Arsenic The RPDs reported pass Eurofins Environment Testing's QC - Acceptance Criteria as defined in the Internal Quality Control Review

Type	Quality Control Target	Exceptions
Envirolab Reports: 42130, 41624, 41623, 41595, 41525, 41506, 41471, 41424, 41423, 41418, 41231 and 41149		
Method Blanks	Results for method blanks were reported within acceptance limits.	Nil
Laboratory Control Samples	Laboratory control samples were reported within acceptance limits.	Nil
Matrix Spike Recoveries	Matrix spike recoveries were reported within acceptance limits.	41424 N-Methyl perfluorooctane sulfonamide The Matrix spike recoveries were outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control samples indicating sample matrix interference.
Laboratory Duplicates	RPDs for duplicates were reported within acceptance limits	Nil

9.2 Assessment of Groundwater Quality Control

9.2.1 Laboratory Batch Assessed

The following batches were assessed:

- 1068825
- 1069543
- 1070156
- 1069809
- 42080
- 42099

9.2.2 Duplicate Samples

Agon collected the following primary and duplicate samples to demonstrate data precision (refer Table 43):

Table 43: Exception to Laboratory Internal Quality Control Acceptance Limits

Sample(s)	Analysis
GW09 **Duplicate: QC148** **Interlaboratory: QC149**	• TRH, VOC, PAH, Phenols, Metals 8 (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg) • Nutrients #5 TN, TKN, NOX, NO2, NO3, NH3 • Metals (Al Ag, Be, B, Co, Hg, Mn, Mo, Sb, Se, Sn, V) +Cr6+ • Explosive Organics (1.3-DNB, 1.3.5-TNB, 2-NT, 2.4-DNT & 2.6-DNT, 3-NT, 4-NT, RDX, NB, TNT) • Nitroglycerine (NG) • PFAS (30 compounds). If PFAS is detected, Total oxidizable Precursor Assay (TOPA) will be carried out to detect the presence of undetected precursor PFAS chemicals which can transform into persistent PFAS chemicals. • Total Coliforms (CFU) • Major cations, anions and alkalinity • TDS • pH • Turbidity • Volatile Fatty Acids (VFA) • Biochemical Oxygen Demand • Chemical Oxygen Demand (COD) • Total Organic Carbon (TOC) • Methane (CH4 • Carbon Dioxide (Total) • Fluoride (F)
GW04 **Duplicate: QC150** **Interlaboratory: QC151**	• TRH, VOC, PAH, Phenols, Metals 8 (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg) • Nutrients #5 TN, TKN, NOX, NO2, NO3, NH3 • Metals (Al Ag, Be, B, Co, Hg, Mn, Mo, Sb, Se, Sn, V) +Cr6+ • Explosive Organics (1.3-DNB, 1.3.5-TNB, 2-NT, 2.4-DNT & 2.6-DNT, 3-NT, 4-NT, RDX, NB, TNT) • Nitroglycerine (NG) • PFAS (30 compounds). If PFAS is detected, Total oxidizable Precursor Assay (TOPA) will be carried out to detect the presence of undetected precursor PFAS chemicals which can transform into persistent PFAS chemicals. • Total Coliforms (CFU)* • Major cations, anions and alkalinity • TDS • pH • Turbidity

9.2.3 Duplicate and Interlaboratory Samples Relative Percentage Differences

Data precision is measured by comparing the RPD% between results from a primary sample and a duplicate. The absolute value of the percent ratio of the difference between the primary and duplicate results, and the mean of the two results, is referred to as the RPD.

In accordance with the DQOs, field quality control results were assessed according to their RPD values. For field duplicates, triplicates, and laboratory duplicates, RPDs should generally be below 30%. A copy of Groundwater RPD results are included in Table 9, Appendix J.

RPDs for all primary/interlaboratory duplicate analyte pairs were within acceptance limits, except for those outlined in the Table 44:

Table 44: RPDs outside of acceptance limits.

Batch	Samples	Analytes	RPD %	Discussion
1068825	GW09 QC148	Nitrogen (Organic)	106	The calculated RPD values were exaggerated due to very low reported concentrations. All reported duplicate and primary concentrations were below the adopted assessment criteria. Agon considers that the data is considered reliable.
1069543	GW04 QC150	Nitrogen (Organic)	65	
		TKN	74	
		Nitrogen (Total)	33	
Interlaboratory Analyte Pairs				
1068825 **42080**	GW09 QC149	Ammonia as N	59	The calculated RPD values were exaggerated due to very low reported concentrations. All reported duplicate and primary concentrations were below the adopted assessment criteria. Agon considers that the data is considered reliable.
		COD	157	
		TKN	74	
		Nitrogen (Total)	74	
		Fluoride	192	
		Turbidity	52	
1069543 **42099**	GW04 QC151	TKN	55	
		Nitrogen (Total)	55	
		Turbidity	41	

9.2.4 Laboratory Quality Control Assessment

For internal laboratory quality assurance/quality control (QA/QC), an assessment for accuracy through matrix spikes should generally achieve at least 70% recovery, in accordance with the project DQOs. Most matrix spikes achieved the required recovery with exceptions noted in Table 45 for the primary laboratory and the secondary laboratory.

Table 45: Eurofins Quality Control Lab Assessment

Type	Quality Control Target	Exceptions
Eurofins Reports 1068825, 1069543, 1069809, 1070156		
Method Blanks	Results for method blanks were reported within acceptance limits.	Nil
Laboratory Control Samples	Laboratory control samples were reported within acceptance limits.	Nil
Matrix Spike Recoveries	Matrix spike recoveries were reported within acceptance limits.	42099 PFNA
Laboratory Duplicates	RPDs for duplicates were reported within acceptance limits	Nil
Envirolab Reports: 42080 and 42090		
Method Blanks	Results for method blanks were reported within acceptance limits.	Nil
Laboratory Control Samples	Laboratory control samples were reported within acceptance limits.	Nil
Matrix Spike Recoveries	Matrix spike recoveries were reported within acceptance limits.	Nil
Laboratory Duplicates	RPDs for duplicates were reported within acceptance limits	Nil

9.3 Assessment of Surface Water Quality Control

9.3.1 Laboratory Batch Assessed

The following batches were assessed:

- 1087081
- 1089695
- 1086579
- 43029

9.3.2 Duplicate Samples

Agon collected the following primary and duplicate samples to demonstrate data precision (refer**Error! Not a valid bookmark self-reference.**).

Table 46: Exception to Laboratory Internal Quality Control Acceptance Limits

Sample(s)	Analysis
SW-5 **Duplicate: SWQ01** **Interlaboratory: SWQC-02**	• TRH, BTEX, PAHs, Phenols • Total and Dissolved Metals (Al, As, Ag, Be, B, Cd, Cr, Co, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, Sn, V, Zn) and Dissolved CrVI+ • PFAS (30 compounds) • Nutrients (Total N, TKN, NOx, NH3, Total P) • OCP, OPP, PCB, VOC • Coliform bacteria • Major cations and anions • TDS, pH • Turbidity • Explosive Organics and Nitroglycerine.

9.3.3 Duplicate and Interlaboratory Samples Relative Percentage Differences

Data precision is measured by comparing the RPD% between results from a primary sample and a duplicate. The absolute value of the percent ratio of the difference between the primary and duplicate results, and the mean of the two results, is referred to as the RPD.

In accordance with the DQOs, field quality control results were assessed according to their RPD values. For field duplicates, triplicates, and laboratory duplicates, RPDs should generally be below 30%. A copy of Groundwater RPD results are included in Table 11, Appendix J.

RPDs for all primary/interlaboratory duplicate analyte pairs were within acceptance limits, except for those outlined in Table 47.

Table 47: RPDs outside of acceptance limits.

Batch	Samples	Analytes	RPD %	Discussion
1086579	SW-5 SWQ01	Aluminium	65	The calculated RPD values were exaggerated due to very low reported concentrations. All reported duplicate and primary concentrations were below the adopted assessment criteria. Agon considers that the data is considered reliable.
		C6-C10 (F1 minus BTEX)	53	
		C10-C16	53	
		C10-C16 (F2 minus Naphthalene)	43	
		C10-C40 (Sum of total)	46	
		C15-C28	45	
		C29-C36	52	
		+C10-C36 (Sum of total)	48	
Interlaboratory Analyte Pairs				
1086579 **43029**	SW-5 SWQC-02	Manganese (filtered)	34	The calculated RPD values were exaggerated due to very low reported concentrations. All reported duplicate and primary concentrations were below the adopted assessment criteria. Agon considers that the data is considered reliable.
		Molybdenum (filtered)	60	
		C16-C34	82	
		C10-C40 (Sum of total)	76	
		C15-C28	70	
		C29-C36	110	
		+C10-C36 (Sum of total)	68	
		Ammonia as N	90	
		Turbidity	58	

9.3.4 Laboratory Quality Control Assessment

For internal laboratory quality assurance/quality control (QA/QC), an assessment for accuracy through matrix spikes should generally achieve at least 70% recovery, in accordance with the project DQOs. Most matrix spikes achieved the required recovery with exceptions noted in Table 48 for the primary laboratory and the secondary laboratory.

Table 48: Eurofins Quality Control Lab Assessment

Type	Quality Control Target	Exceptions
Eurofins Reports 1087081,1089695, 1086579		
Method Blanks	Results for method blanks were reported within acceptance limits.	Nil
Laboratory Control Samples	Laboratory control samples were reported within acceptance limits.	Nil
Matrix Spike Recoveries	Matrix spike recoveries were reported within acceptance limits.	Nil
Laboratory Duplicates	RPDs for duplicates were reported within acceptance limits	**1087081** Naphthalene **1086549** Bicarbonate Alkalinity (as CaCO3)
Envirolab Reports: 43029		
Method Blanks	Results for method blanks were reported within acceptance limits.	Nil
Laboratory Control Samples	Laboratory control samples were reported within acceptance limits.	Nil
Matrix Spike Recoveries	Matrix spike recoveries were reported within acceptance limits.	Nil
Laboratory Duplicates	RPDs for duplicates were reported within acceptance limits	Nil

9.4 Data Representativeness

The current analytical data set was considered to have effectively characterised the sampled soil and groundwater with regards to stablishing the site’s environment conditions. Holding times for soils, and groundwater samples were all in conformance with Table 3 in AS4482.1-2005 (now rescinded but used in the absence of any other guidance).

To ensure sample representativeness and sterility, soil and groundwater samples were collected as follows:

- Single use nitrile gloves which were utilised and changed between each sample collected during this assessment.
- Reusable sampling equipment such as hand towels, hand augers, drilling stems, and low flow pumps were routinely decontaminated during the soil and groundwater sampling programme undertaken.
- Soil and groundwater samples were placed into clean, laboratory prepared jars and bottles (preserved and unpreserved); and
- Soil and groundwater samples were placed on ice in a cooler box prior to transport to the laboratory.

To support this process. Agon also collected quality control samples from soil (Table 49) and groundwater (

Table 50) as follows:

- Soil rinsate samples were analysed for BTEX and TRH (C6-C10) and trip blanks were analysed TRH, BTEXN, PAH, Metals and PFAS.
- Groundwater rinsate samples were analysed for TRH/BTEXN/PAH and trip blanks were analysed for TRH C6-C9 and BTEXN.

Table 49: Soil Field Blank Quality Control Samples

Quality Control Name	Date	Sample Type	Equipment
QC01	04 Dec 2023	Trip Blank	-
QC02	04 Dec 2023	Rinsate	Gloves
QC06	05 Dec 2023	Trip Blank	-
QC07	05 Dec 2023	Rinsate	Gloves
QC08	05 Dec 2023	Rinsate	Gloves
QC16	06 Dec 2023	Trip Blank	-
QC17	06 Dec 2023	Rinsate	Gloves
QC28	07 Dec 2023	Rinsate	Gloves
QC29	07 Dec 2023	Trip Blank	-
QC40	19 Dec 2023	Trip Blank	-
QC41	19 Dec 2023	Rinsate	Gloves
QC49	20 Dec 2023	Trip Blank	-
QC50	20 Dec 2023	Rinsate	Gloves
QC60	21 Dec 2023	Rinsate	Gloves
QC61	21 Dec 2023	Trip Blank	-
QC70	08 Jan 2024	Trip Blank	-
QC71	08 Jan 2024	Rinsate	Gloves
QC82	09 Jan 2024	Trip Blank	-
QC83	09 Jan 2024	Rinsate	Auger
QC92	10 Jan 2024	Trip Blank	-
QC93	10 Jan 2024	Rinsate	Gloves
QC108	11 Jan 2024	Trip Blank	-
QC109	11 Jan 2024	Rinsate	Gloves
QC120	12 Jan 2024	Trip Blank	-
QC122	12 Jan 2024	Rinsate	Gloves
QC132	12 Jan 2024	Rinsate	Gloves
QC133	12 Jan 2024	Trip Blank	-
QC138	17 Jan 2024	Rinsate	Gloves
QC139	17 Jan 2024	Trip Blank	-

Table 50: Groundwater Field Blank Quality Control Samples

Quality Control Name	Date	Sample Type	Equipment
QC145	14 Feb 2024	Trip Blank	-
QC146	14 Feb 2024	Trip Blank	-
QC147	14 Feb 2024	Rinsate	Tubing
QC153	15 Feb 2024	Trip Blank	-
QC154	15 Feb 2024	Trip Blank	-
QC155	15 Feb 2024	Rinsate	Tubing
QC152	16 Feb 2024	Rinsate	Tubing
QC162	16 Feb 2024	Trip Blank	-
QC163	16 Feb 2024	Trip Blank	-
QC164	19 Feb 2024	Rinsate	Tubing
QC165	19 Feb 2024	Trip Blank	-
QC166	19 Feb 2024	Trip Blank	-

In accordance with the DQOs, trip blank and rinsate results should be at or less than the LOR. All quality control samples (refer Table 10 and Table 11, Appendix J) reported concentrations less than the LOR with the exception of QC132, which reported a zinc concentration of 0.014 mg/L. This concentration exceeds the freshwater criteria; however, Agon considers that this result is unlikely to influence the reliability of the collected data. It is considered the Field Blank results demonstrate that appropriate decontamination procedures were undertaken as part of the assessment.

9.5 QA/QC Conclusions

The QAQC results discussed above indicate that the data collected are reliable and form a suitable basis for the conclusions of this report, in accordance with the DQOs.

10.0 TIER 2 RISK ASSESSMENT

The data quality objectives outline that any exceedances of the Tier 1 investigation and screening levels for soil, groundwater or surface water may indicate the possibility of an adverse impact on the sensitive receiving environments thereby triggering the requirement for a Tier 2 risk assessment.

A Tier 2 risk assessment was not considered to be required for human health risks, as no results above the human health criteria have been reported in site soil. However, a number of exceedances of the ecological criteria for metals were reported and, accordingly, a site-specific ecological risk assessment (Tier 2) will be carried out to further assess the potential risks to identified ecological receptors (refer Section 12.1).

The reported groundwater exceedances are considered likely to be associated with natural processes. However, the intended use of the site for large-scale T2D spoil management has the potential to affect ASS materials and to cause significant changes to surface water and groundwater during the life of the project.

A comparison of groundwater and surface water hydrochemistry as well as concentrations of chemicals of concern confirms some level of interaction and potential ‘exchange’ of chemicals. Groundwater and surface water contain PFOS above the criteria, with groundwater concentrations assessed as likely to be surface water-derived, as a result of stormwater runoff from the surrounding areas. These future risks are considered to trigger the need for a Tier 2 assessment of groundwater and surface water (refer Section 12.3).

11.0 CONCEPTUAL SITE MODEL

11.1 Introduction

The Conceptual Site Model (CSM) is fundamental to site characterisation and provides the framework for identifying potential exposure pathways between sources of contamination and potential receptors. Where the pathway is incomplete the exposure to the chemical substances via that pathway cannot occur.

A preliminary CSM was first developed in the PSI (Agon, 2024c), which was informed by the review of previous reports (summarised in the PSI) and the research undertaken by Agon. Based on the findings of the PSI (Agon, 2024c), Agon:

- Identified potential onsite and offsite sources of contamination (including Potentially Contaminating Activities (PCAs) and Potential Contaminants of Concern (PCOCs), potential receptors and exposure pathways whereby contaminants could be transmitted to receptors.
- Developed the preliminary CSM.
- Developed Sampling Analysis and Quality Plan (SAQPs, Agon 2023 and 2024c) to guide the investigation of the potential sources and contaminants identified in the preliminary CSM.
- Implemented the SAQPs in the delivery of the DSI scope of works.

This DSI report updates the preliminary CSM in the light of the results of the intrusive investigations documented herein. An updated understanding of the contaminants, sources of contamination, chemical properties and affected media is provided in Table 48 and a summary of potential receptors is provided in Table 49. The updated CSM is then described in the following sections and source-pathway-receptor linkages are summarised in Table 50.

In addition, it is acknowledged that a number of data gaps regarding the site still exist, which are discussed in detail in Section 12 (such as soil vapour, landfill gas, surface water, ecology and hydrogeological modelling). Revisions to the CSM following additional data collection and interpretation will be required to support the project throughout its lifetime, including at key points of the project as outlined in Section 1. As the data gaps outlined in Section 12 are progressively addressed and further information becomes available, the CSM will be iteratively updated with relevant additional inputs.

It is noted that an Environment Heritage Impact Assessment Report (EHIAR) for the SRF has been completed by others (Mott MacDonald, 2024) and has:

- Assessed environment and heritage aspects.
- Assessed the potential impacts, risks or opportunities of the proposed spoil reuse facility activities on the existing environment.
- Provided descriptions of the possible measures that may be required to mitigate the impact or risks, or to enhance an opportunity.

The CSM and EHIAR can both be used to inform the SMP and the Alliance’s construction environmental management plan (CEMP) by being used as a basis for:

- The prioritisation of any further assessment works required to fill information and data gaps.
- The refinement of the specification of controls to mitigate the impact or risks, or to enhance an opportunity. It is anticipated that these controls will be detailed in future iterations of the SMP.

11.2 Key Features of the CSM

The CSM considers the site in its current state as well as in its future state undergoing Alliance filling activities. The CSM for the pre-construction site condition is presented graphically in Figure 17. The CSM for the post-construction site condition is presented graphically in Figure 18.

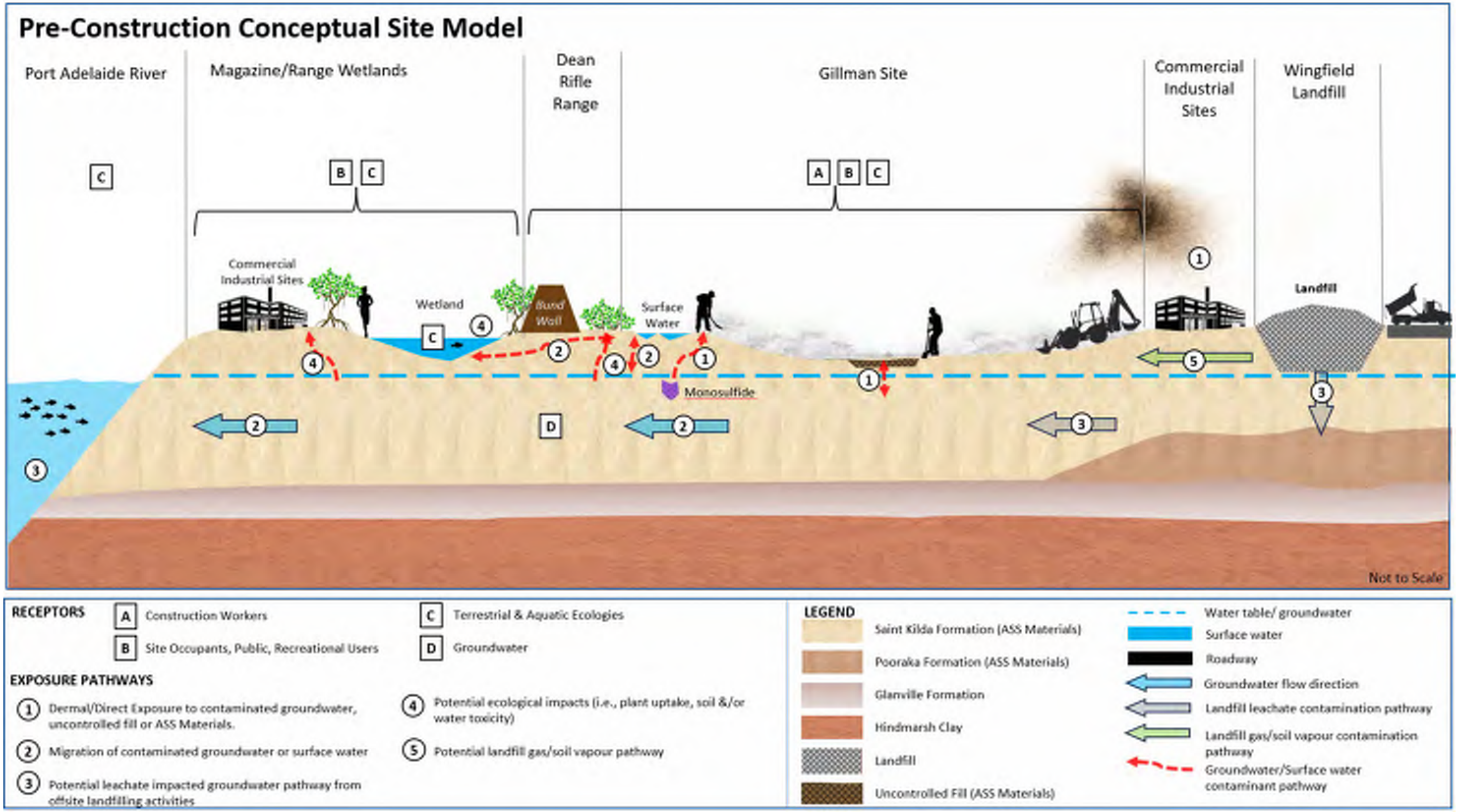
The CSM does not incorporate results which have not yet been received such as seasonal groundwater sampling events, longer term datalogging of surface water and groundwater levels, environmental risk assessment and geotechnical assessment.

The key features in Figure 15 are:

- The layered soils of the St Kilda Formation – comprising interbedded sands silts and clays.
- The meandering natural drainage courses incised into these layered soils. The northern, or more seaward portions of these drainage courses are intertidal (except where sea walls prevent tidal flows).
- The probability that the soil profile between existing natural drainage courses contains previous, now naturally infilled or silted up drainage courses.
- Hypersaline, shallow groundwater that has a direction of flow toward the Barker Inlet.
- The inflow of hypersaline groundwater into the lower portions of these drainage courses.
- The fluctuations of the levels of this hypersaline groundwater in response to the balance of rainfall and evaporation, runoff and infiltration and tidal influences.
- The lower elevation parts of the site are prone to more frequent waterlogging/inundation in periods of wet weather, or to desiccation with salinisation in periods of hot, dry weather.
- The soils of the St Kilda Formation class generally as acid sulfate soils and, as such are prone to acid formation under disturbance, with more natural buffering of potential acidity potentially available from the shells and shell fragments in the more sandy materials.

11.3 Potential Sources of Contamination

Potential onsite and offsite sources of contamination (including Potentially Contaminating Activities – PCAs as identified by the SA EPA), the associated potential chemicals of concern (PCOCs) and potentially affected media are summarised in Table 51, which outlines the current understanding of PCAs and PCOCs at the site.



RECEPTORS

A Construction Workers

B Site Occupants, Public, Recreational Users

C Terrestrial & Aquatic Ecologies

D Groundwater

EXPOSURE PATHWAYS

① Dermal/Direct Exposure to contaminated groundwater, uncontrolled fill or ASS Materials.

② Migration of contaminated groundwater or surface water

③ Potential leachate impacted groundwater pathway from offsite landfilling activities

④ Potential ecological impacts (i.e., plant uptake, soil &/or water toxicity)

⑤ Potential landfill gas/soil vapour pathway

LEGEND

Saint Kilda Formation (ASS Materials)

Pooraka Formation (ASS Materials)

Glanville Formation

Hindmarsh Clay

Landfill

Uncontrolled Fill (ASS Materials)

Water table/ groundwater

Surface water

Roadway

Groundwater flow direction

Landfill leachate contamination pathway

Landfill gas/soil vapour contamination pathway

Groundwater/Surface water contaminant pathway

Figure 17: Pre-Construction Conceptual Site Model

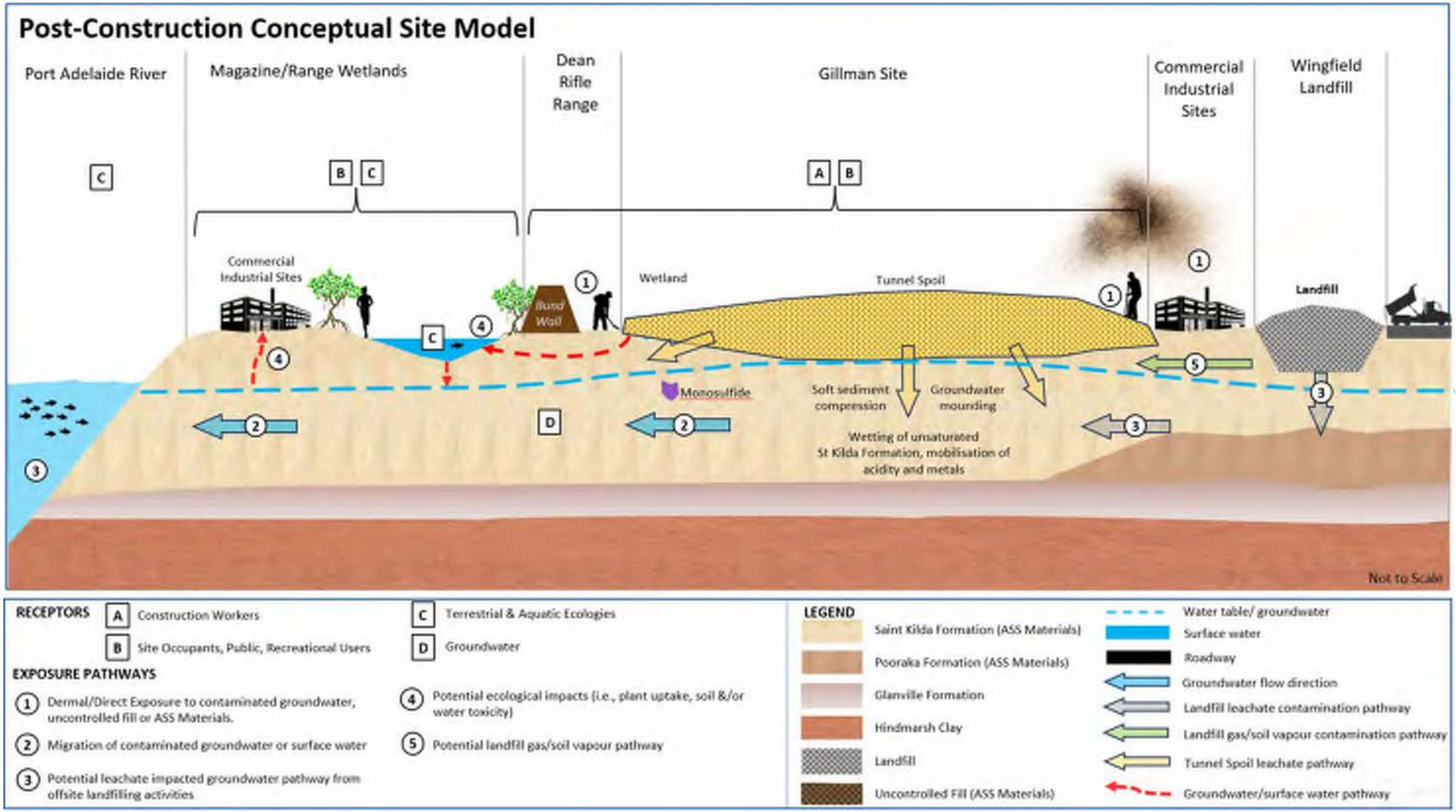


Figure 18: Post-Construction Conceptual Site Model

Table 51: Currently Identified Contaminants, Sources, Chemical Properties and Affected Media

Chemicals/ Contaminant	Source/ Potentially Contaminating Activity	Chemical Properties	Potentially Affected Media
Explosive Organics and Nitroglycerine	Defence works and the operation of the Dean Rifle Range	Nitroglycerine is highly mobile in soils and is not persistent in the subsurface but may mobilise readily to surface water or groundwater. It is understood to cause human health effects.	Soil, surface water, groundwater
Metals	Sulfuric soils and/or hypersulfidic soils disturbance	Metals are persistent in the environment and can bioaccumulate in the food chain, where they may cause toxicity effects in human and environmental receptors. Acidification from disturbance can lead to increased mobilisation of metals in soils.	Soil, surface water, groundwater
	Historic importation of uncontrolled fill material		
BTEX, TRH	Historic importation of uncontrolled fill material	BTEX chemicals and petroleum hydrocarbons are volatile known human carcinogens and hazardous air pollutants.	Soil, surface water, groundwater
PAH	Historic importation of uncontrolled fill material	Polycyclic aromatic hydrocarbons are moderately persistent in the environment and can bioaccumulate, with moderate to high short-term toxicity to aquatic life and birds.	Soil, surface water, groundwater
PFAS	Historic importation of uncontrolled fill material	PFAS chemicals are highly mobile and persistent, with uncertain risks.	Soil, surface water, groundwater
ACM	Historic importation of uncontrolled fill material	Asbestos containing materials (ACM) contain different amounts of asbestos fibre, and may be present in a range of forms, sizes and degrees of deterioration. ACM degrades in the environment through weathering and can release fibres into the air that can be breathed in and harm human health.	Soil, air
Sulfuric acid	Sulfuric soils and/or hypersulfidic soils disturbance	Sulfuric acid when dissolved in water has moderate short-term toxicity on aquatic life. Significant quantities may lower the pH of aquatic systems for extended periods of time, which have harmful effects on receptors. Sulfuric acid can generate hydrogen sulfide gas which is highly toxic and irritating.	Surface water, groundwater
Nutrients	Offsite landfill sites	Excess nutrients from offsite groundwater migrating onto the site can degrade water quality and limit its use for the intended purposes, creating a health risk to human and ecological receptors.	Groundwater
Chlorinated solvents	Offsite source sites	Volatile chlorinated hydrocarbons are highly mobile and pose both short and long-term risks to human health.	Groundwater, soil vapour
Methane, carbon dioxide	Offsite landfill sites	Landfill gases can be highly mobile and follow preferential pathways offsite. Safety risks can occur when gas concentrations reach the lower explosive limit (LEL) or asphyxiation level for intrusive maintenance workers.	Air, vapour
Salt	Changes to existing hypersaline groundwater regime	High salinity can be detrimental to the survival of aquatic and terrestrial flora and fauna.	Surface water, soil groundwater

11.4 Potential Receptors

Key potential receptors are summarised in Table 52.

Table 52: Examples of Potential Receptors

Receptor	Onsite	Offsite
Human Receptors	Future construction workers. Future commercial/industrial site users.	Offsite users of recreational water bodies
Flora and Fauna	Terrestrial ecosystems. The site contains the Threatened Ecological community of the *Subtropical and Temperate Coastal Saltmarsh* (vulnerable status). State rated fauna including the Little Egret - *Egretta garzetta nigripes* (rare) and Brown Quail - *Coturnix ypsilophora australis* (vulnerable). Potential habitat for migratory birds and other threatened species. Potential intertidal ecosystems around ephemeral creeks/drainage channels.	Marine ecosystems, including the Barker Inlet, North Arm and Port River. Marine fauna such as dolphins, fish, seals and invertebrates. The site is within the Barker Inlet-St Kilda Aquatic Reserve adjacent to the Adelaide Dolphin Sanctuary. Wetland ecosystems, including the Magazine Creek and Range constructed wetlands, and natural intertidal saltmarsh wetlands. The site is within the Nationally important Barker Inlet and St Kilda Wetlands.

NB: The EHIAR (Mott Mc Donald, 2024) provides a more complete description of potential receptors.

11.5 Potential Migration Pathways from Sources to Receptors

11.5.1 Potential Pathways under Current Site Conditions

The potential pathways for exposure to contaminated soil, groundwater, surface water, soil vapour or landfill gases, based on the current site conditions, include:

Soil

- Inhalation of contaminant laden dust.
- Ingestion (hand to mouth or direct ingestion) of contaminant laden dust/soil.
- Dermal contact with contaminated soil.
- Plant root uptake from contaminant laden soils.
- Mobilisation of acid (if ASS is exposed and oxidised).
- Mobilisation of leachable contaminants.

Groundwater

- Dermal contact with contaminated groundwater.
- Lateral migration of contaminants through groundwater.
- Surface water infiltration, contaminant mobilisation from soil and lateral migration via groundwater.
- Vertical migration to surface water from groundwater.
- Vertical migration to lower aquifers is not considered a likely migration pathway as the uppermost aquifer is believed to have a thickness of 4 m with possibly several metres of aquitard (heavy clays of the Hindmarsh Clay Formation) providing significant separation from the deeper Quaternary aquifer.

Surface Water

- Dermal contact with contaminated surface water.
- Lateral migration of surface water according to site topography.
- Lateral and vertical migration of surface water according to tidal influences. A levee bank is in place; however it is possible that tidal influence still occurs and seepage may occur through bunds.
- Vertical migration of surface water to groundwater.

Vapour and Landfill Gas

- Diffusion and inhalation of soil vapour derived from onsite volatile soil impacts.
- Diffusion and inhalation of soil vapour derived from offsite volatile soil impacts.
- Diffusion and inhalation of vapour derived from onsite groundwater.
- Diffusion and inhalation of vapour derived from offsite groundwater.
- Diffusion and inhalation of landfill gases from offsite sources.

The following kinds of pathway between source and receptor are potentially complete (see Figure 15):

- **Pathway 1** – Within the site, and from the existing soil profile, where this contains contamination:
    - Dust emission into air leading to inhalation by people or dusting of vegetation.
    - Ingestion or dermal adsorption of soil, or of surface water or groundwater impacted by the soil contamination.
    - Leaching of leachable chemicals (where these exist) into surface water or groundwater.
    - Mobilisation of metals from soils into groundwater or surface water from acidification produced by soil disturbance.
- **Pathways 2 and 4** – Transport of chemicals via preferential groundwater seepage pathways or surface water flow pathways from the source area to a point or an area of exposure:
    - In the root zones of vegetation on site or outside the site.
    - In a surface water body (e.g. natural drainage course or inundated depression in the topography) on site or outside the site.
- **Pathway 3** – Transport of chemicals from external landfills via preferential groundwater seepage pathways to a point or an area of exposure:
    - In the root zones of vegetation on site or outside the site.
    - In a surface water body (e.g. natural drainage course or inundated depression in the topography) on site or outside the site
- **Pathway 5** – Transport of landfill gas from external landfills via soil above the water table or via preferential groundwater seepage pathways to a point or an area of exposure:
    - In the root zones of vegetation on site or outside the site.
    - For people using or working on the site.

11.5.2 Potential Effects on Migration Pathways from Preparation and Operation of the SRF

Preparation and operation of the SRF (including excavation, construction, spoil processing and placement, and importation of significant quantities of relatively fresh water) may:

- Disturb contaminated soil (including mixing hypersaline/ acidic/ contaminant-laden soils).
- Generate dust.
- Cause erosion and runoff of sediment laden water.
- Cause consolidation of sediments (including ASS and hypersaline soils) which may affect the mobilisation and migration of acid, salt and contaminants from soil and groundwater.
- Expose and oxidise ASS, generating acid which may mobilise leachable contaminants (including metals).
- Alter surface water quality and surface water drainage patterns.
- Alter surface water and groundwater interactions.
- Alter groundwater quality and flow dynamics (both onsite and offsite), leading to mobilisation of soil contaminations and migration of groundwater contaminants (onsite and offsite).
- Cause groundwater mounding beneath the site which may affect groundwater at and beyond the boundaries of the site.
- Alter soil vapour and landfill gas migration mechanisms and dynamics.
- Preloading and importation of soil with a high moisture content may lead to (low salinity) water infiltration to groundwater, causing changes to the flow regime resulting in groundwater contaminants moving beyond the site boundaries.

11.5.3 Potential Effects on Migration Pathways Following Use of the SRF

Figure 18 indicates that most pathways between source and receptor may remain complete, with changes to the points or areas of exposure, and possibly also fluxes of contaminants along the pathways, and:

- **Pathway 1** – Within the site, and from the soil profile, where this contains contamination:
    - Dust emission into air from WDF rather than original site surface, leading to inhalation by people or dusting of vegetation.
    - Ingestion or dermal absorption of WDF, or of surface water or groundwater impacted by the soil contamination.
    - Ingestion or dermal absorption of surface water or groundwater impacted by the soil contamination.
    - Leaching of leachable chemicals (where these exist) into surface water or groundwater.
    - Mobilisation of metals from soils into groundwater or surface water from acidification produced by soil disturbance.
- **Pathways 2 and 4** – Transport of chemicals via preferential groundwater seepage pathways or surface water flow pathways from the source area to a point or an area of exposure:
    - In the root zones of vegetation on site or outside the site.
    - In a surface water body (e.g. natural drainage course or inundated depression in the topography) on site or outside the site.

- **Pathway 3** – Transport of chemicals from external landfills via preferential groundwater seepage pathways to a point or an area of exposure:
    - In the root zones of vegetation on site or outside the site.
    - In a surface water body (e.g. natural drainage course or inundated depression in the topography) on site or outside the site.
- **Pathway 5** – Transport of landfill gas from external landfills via soil above the water table or via preferential groundwater seepage pathways to a point or an area of exposure:
    - In the root zones of vegetation on site or outside the site.
    - For people using or working on the site.

11.6 Plausible Exposure Pathways

PCAs, PCOC, identified receptors and possible exposure pathways summarised in Table 53.

The qualitative risk ratings (low, medium or high) have been made based on whether site contamination is known, possible or unlikely from the relevant activity; and the potential human health/environmental implications.

Table 53: Summary of Source-Pathway-Receptor Linkages

PCA/Source of Contamination	PCOC	Potential Receptors	Plausible Exposure Pathways [1]	Comment [2]
Defence Works Information from the Defence UXO database indicates that mortars were used at the site in the 1950s. While UXOs are unlikely to represent a potential contaminant of concern, they still pose a potential risk to human health. **Dean Rifle Range** Rifle Ranges are a potential source of heavy metal contamination (including Sb, Cu, Pb, Ni, Sn, Sr, Mg, Ba, Hg) and a walkover of the site in October 2023 identified a significant amount of bullets on both Piece 501 and 502, suggesting that further bullets are likely to be present across the site.	UXO, Explosive organics, Nitroglycerine, Metals	Future Construction Workers Future Site Users Offsite Commercial Workers Terrestrial Flora and Fauna Marine Ecosystems Recreational Water Users	**1, 2, 4**	No site contamination impacts from explosives have been identified on site. Metal and B(a)p concentrations have been identified on site that are likely attributable to past Defence activities, however impacts are relatively minor and highly localised. Leachability results indicate metals (arsenic, copper, lead, manganese and zinc) and b(a)p may leach to groundwater at concentrations that pose a risk to receptors. This PCA is considered a **HIGH** likelihood source of risk via complete pathways.
Uncontrolled Fill Materials Uncontrolled fill is present in the soil profile across the site and may be derived from past dredging and other sources. It is possible that imported fill materials may also be present from uncontrolled waste burial and illegal dumping (including ACM). Previous environmental investigations undertaken on adjacent sites have revealed that PAH, TRH and BTEXN have been reported above the NEPM EILs and ESLs. (Golder, 2021). Fragments of ACM were also identified.	Metals, BTEXN, PAH, TRH, PFAS and ACM	Future Construction Workers Future Site Users Offsite Commercial Workers Flora and Fauna Marine Ecosystems Recreational Water Users	**1, 2, 4**	No site contamination has been identified to be associated with fill material on site, and only one piece of ACM was identified, which is considered to be an isolated occurrence. This PCA is considered a **LOW** likelihood source of risk via complete pathways.
Hypersulfidic (potential acid sulfate soil) or Sulfuric soils (actual acid sulfate soil) Screening of pH f, pH fox, CRS and SPOCAS from this DSI and previous investigations have revealed that ASS materials occur within the vicinity of the site (Aurecon, Kleinfelder 2023; Agon, 2018; LBW, 2016 and UoA, 2012).	Acidity, metals, H_2S	Future Construction Workers Future Site Users Offsite Commercial Workers Flora and Fauna Marine Ecosystems Recreational Water Users .	**1, 2, 4**	ASS materials have been identified to be widespread on site. Impacts associated with contaminated and/or hypersaline, acidic groundwater. This PCA is considered a **HIGH** likelihood source of risk via complete pathways. Hypersulfidic and sulfuric soil exposures may occur through excavations, dewatering or changes to the groundwater levels and flows. TBM water draining through the soil profile causing increased groundwater levels and re-wetting of sulfuric soil, mobilising acidity and metals into the groundwater. Surface water infiltration, contaminant mobilisation from soil and lateral migration through surface water and/or groundwater. Subsidence of sulfuric soils to below groundwater, mobilising acidity and metals into the groundwater. Preloading and importation of soil with a high moisture content, water infiltration to groundwater causing changes to the flow regime resulting in groundwater contaminants moving beyond the site boundaries. Longer term submergence of sulfuric soils may trigger the redox reactions necessary to remediate the sulfuric soils.
Migration of Contaminants from neighbouring properties Landfill sites including the Wingfield Waste and Recycling Centre and Adelaide Resource Recovery recycling centre occupy the industrial land to the east and south of the site. Additional offsite sources of contamination also include service stations, wetlands, auto wreckers and transport depots. Numerous Section 83A notifications existing for the surrounding area, indicating impacts to groundwater (above marine guidelines; no known exceedances of direct contact HSLs).	Metals, TRH, LNAPL, PAH, PFAS, TCE, PCE Nutrients, ammonia, sodium, chloride, sulfate, phosphorous, total nitrogen, TOC, fluoride, TDS, and BOD Landfill gases (including methane, CO2, H_2S)	Future Construction Workers Future Site Users Marine Ecosystems Recreational Water Users	**4, 5**	This PCA is considered a **LOW** likelihood source of risk via complete pathways for the following reasons: • Due to the open nature of the site and the proposed importation of fill to the site. • Most PCOCs associated with this PCA have not been identified in site groundwater. PFAS chemicals have been detected with PFOS above guidelines in most surface water locations in the adjacent wetlands, but only in one offsite well. Salinity of groundwater will preclude potable use. • As most concentrations of PCOCs are below relevant guidelines, if direct contact with groundwater occurs during excavations or dust suppression, it is considered risks will be managed through standard WHS protocols (e.g. PPE).

Notes:

1. For details of Plausible Exposure Pathways please refer to Sections 11.5.1 to 11.5.3 and Figures 15 and 16

2. This DSI does not assess or rate the significance of environmental or health impacts and risks; this is done in the EHIAR, (Mott Mc Donald, 2024)

12.0 DATA GAPS

The baseline site assessment and updated CSM have highlighted several data gaps in our understanding of the site in its current state. In addition, there are several data gaps in our understanding of how the site will respond to future activities. It is crucial that the data gaps that have the potential to pose significant risks to the success of the project are identified, prioritised (as agreed by DIT and the Auditor) and addressed in a timely manner prior to commencement of Alliance activities at the site.

Data gaps are outlined below and will need to be addressed as the scope and detail of the proposed Alliance activities on site become known. An iterative approach is envisaged, wherein data gaps are prioritised in consultation with DIT and the Auditor with respect to risk (project risk or environmental risk). These gaps will then be scoped and addressed in order of priority as further details become available, with the findings of data gap investigations used to revise the CSM and update the DSI (and other relevant reports, models or plans) where necessary, with remaining or emerging data gaps highlighted for future consideration.

12.1 Soils

Soil investigations generally achieved the spatial coverage planned in the SAQP and are considered to have achieved an adequate level of certainty which does not warrant further soil investigations. The exception to this is along the north west boundary of Lot 502, where planned boreholes were unable to be drilled due to inaccessibility. There is a higher level of uncertainty in this part of the site that would warrant further investigation should the Alliance include this area in future site operations or filling. It is noted that there is also residual uncertainty in areas of filling at the site (noting the potential for ACM) such as roads, around services, firing targets and mounds. These uncertainties will require management through the unexpected finds protocol in the CEMP.

Soil contains leachable metals and PAH, with leachable concentrations exceeding the adopted groundwater criteria. This indicates that leached contaminants may pose a risk to groundwater and surface water receptors. Further assessment is required through modelling to understand whether leachable concentrations may dilute upon contact with groundwater or surface water and be at acceptable concentrations once these media reach receptors through complete exposure pathways. Further assessment of the potential for leaching and migration of contaminants during operation of the site as a SRF (from both site soils and T2D spoil) will also need to be considered.

12.2 Acid Sulfate Soils

An initial screening investigation of acid sulfate soils has been carried out to provide baseline information on the presence and distribution of ASS materials on site. Having confirmed that ASS materials are widespread on site, it is crucial to the project's success to develop a robust understanding of how these materials may be disturbed during the project, and in turn how they can be managed appropriately.

It is currently unknown how ASS materials will react to site activities, preloading and filling during the course of the project. A number of sources of information are required to predict whether acidity and metals are likely to mobilise into groundwater and/or surface water and affect receptors:

- Hydrogeological modelling to predict what changes may occur in the water table and hydraulic gradient, i.e. whether hypersulfidic soils will become oxidised, or whether a combination of groundwater mounding and subsidence will create lower risk ASS materials by pushing the soil profile into a deeper and more reducing environment.
- Geotechnical advice around predicted extent of settlement/subsidence of the soil profile.

- Incubation testing for acidity upon drying or flooding over time (depending on what the hydrogeological modelling indicates is likely).
- Sequential extractions to measure metal mobilisation risks from different ASS materials upon drying or flooding over time (depending on what the hydrogeological modelling indicates is likely).

In further investigation phases, information on the development including extent, depth and volume of proposed soil disturbance should be obtained and used to update the CSM and inform a hydrogeological model (see Section 12.3). The findings of the CSM and hydrogeological model can then be used to scope further soil, surface water and groundwater investigations, in accordance with the Coast Protection Board and DIT policies (CPB, 2003; DIT, 2021).

Once the likely scope and impact of ASS materials' disturbance is well understood, methods can be identified to monitor and manage these materials in specific areas likely to be disturbed during construction and operation of the project, with development of an ASS management plan and calculations of liming rates.

Monosulfidic Black Ooze (MBO) remains a potential project risk; field observations were potentially indicative of the presence of MBO on site and previous investigations have documented their presence associated with low lying creek lines. They can severely deoxygenate and acidify surface waters if disturbed, and further detailed investigation, including analysis for acid volatile sulfide (AVS), will be required once the footprint of contractor activities on site are known.

In addition, further review of historical research may provide additional data regarding the distribution of acid sulfate soils in the area and may further inform management of these materials during the construction and operation of the SRF. In particular, the University of Adelaide's Acid Sulfate Soils Centre may yield useful information (where possible, considering confidentiality provisions).

12.3 Groundwater

As outlined in Section 10, the majority of reported groundwater exceedances are similar or lower than offsite concentrations. However, a detailed assessment of background groundwater concentrations has not been undertaken with respect to seasonality and is identified as a data gap to be addressed once draft SA EPA guidance on establishing baseline groundwater quality has been published.

The detection of acetone (a potential landfill leachate chemical) in groundwater requires further assessment to verify the results of the first sampling event, noting that acetone was only detected in one well not adjacent to offsite landfills, and may be an artefact of laboratory processes. High nitrogen in offsite groundwater immediately adjacent to the north may require verification testing to confirm the preliminary assessment that nitrogen speciation signatures are different in onsite and offsite downgradient wells.

In addition, the intended use of the site for the receival of T2D spoil has the potential to cause significant changes to surface water and groundwater during the life of the project. It is currently unknown how groundwater (both at and around the site) will react to site activities, preloading, and filling during the course of the project. For example, placing a large volume of fill on the site may consolidate the existing soils and change their transmissivities, creating a mound in the groundwater levels at the site. This has the potential to change the groundwater flow direction and velocity both on and offsite, including the potential for offsite groundwater plumes to be altered, change direction and pose a risk to the site.

The final elevation of the development and timeframe and staging of site filling to achieve the final elevation is unknown. For example, only part of the site may be filled with T2D spoil, or it may be spread across the entire site. It is possible that additional fill could be deposited above the spoil material as required by planning policies to achieve the minimum site elevation required by the Coast Protection Board. The impacts of the filling strategy require consideration, as it is possible there could be impacts on groundwater levels, water quality, subsurface drainage requirements, and potential flood mitigation requirements.

Therefore, development of a hydrogeological numerical model will be required to obtain a clear understanding of the baseline groundwater flow regime and surface and groundwater interactions (if any). The model would verify the current concepts of groundwater hydraulics, influences on water levels from storm events and water level variations in the nearby wetlands. The model would assess the relationship between K values and aquifer soil compositions to identify potential preferential flow paths in higher permeability materials and incorporate groundwater hydrochemistry and potential migration of contaminants (current or future).

A hydrogeological model would be able to predict changes in the water table that may occur during operation of the site as a SRF. For example, water table changes resulting from the placement of significant quantities of spoil and water could oxidise ASS materials, cause significant changes in water flow/quality and impact ecological receptors. This is of particular concern given the hypersaline groundwater and its interactions with onsite and offsite surface water, and, in future, the TBM spoil water. These impacts could present significant project risks if not anticipated and managed appropriately.

The hydrogeological model would provide a robust basis for future predictions throughout the life of the project on what impacts site establishment and filling may have on offsite or onsite groundwater, surface water and contaminant fate and transport and can be updated as filling strategies are confirmed or revised.

The potential for offsite groundwater chemicals to migrate towards the site during the project due to groundwater changes and affect receptors through groundwater-surface water interaction is a significant project risk. This risk could be better understood through database creation and visual mapping of PCA concentrations in groundwater onsite and offsite (using reports obtained through government agencies and SA EPA Section 83A notifications and public register), to show which groundwater chemicals have the potential to move towards the site during the project, and which contaminants are likely to be derived from site vs offsite sources. This is particularly important as offsite landfill wells have not been directly sampled. This data can be incorporated into the model to provide deeper insight into whether this is a potential project risk.

Seasonal groundwater changes are not yet well understood; however, data will be collected quarterly during 2024. The additional data will allow assessment of seasonal variation in contaminant concentrations, hydraulic gradients, rates/directions of seepage, and relationship with surface water level fluctuations in creek lines and drains, and Barker Inlet. Further work may be required, depending on the seasonal groundwater results, to determine whether there are significant factors affecting groundwater contaminant concentrations/distribution, for example advection, diffusion, biological or chemical degradation.

12.4 Surface Water/ Groundwater Interaction

Surface water/ groundwater interaction has undergone a preliminary assessment through recording of water levels and water quality parameters and sampling of surface water. However, the impacts of the levee bank, wetlands, windmills and surface water drainage on the surface water – groundwater interaction have not been assessed in detail and will require further assessment. For example, the levee bank may stop groundwater from exiting the site.

The surface water /groundwater relationship has not been fully assessed, with longer-term datalogger information yet to be collected and interpreted. It is considered likely that groundwater discharges to drainage channels and natural watercourses on site. Surface water likely experiences tidal ebbs and flows, and stream flows from catchment drainage and surface runoff. It has not been quantified whether the site experiences flooding from storm surges and king tides. It is likely that surface water from the wetlands interacts with groundwater based on the sampling undertaken to date, but this needs confirmation through further seasonal monitoring events.

Once further project details are known, it will be necessary to understand whether shallow channels on site could become preferential seepage pathways for water upon deposition of tunnelling spoil with a high moisture content. This could be further assessed through modelling and could be undertaken in conjunction with modelling the potential groundwater changes upon wet spoil deposition.

These data gaps could be better understood through development of a groundwater model (see Section 12.3) that can predict whether any of these processes are likely to have an impact on the project and site filling strategy (i.e. if excess moisture from tunnel spoil causes the groundwater level to rise, which in turn increases surface water coverage and floods the site, holding up the project). The groundwater model will also assist in evaluating potential impacts from the project on offsite surface water receiving bodies, including the adjacent wetlands, tidal creeks and the Port River Estuary.

12.5 Impact of Water within TBM Spoil

In order for the TBM to work effectively, water (source unknown) will need to be added to the cutting head as well as foaming agents (Agon, 2024d). It is Agon's experience that the water volume as a percentage of the total spoil volume produced by the TBM (ignoring effects of aeration on volume) can be indicatively in the order of 50%.

DIT have advised that the large volumes of water that will arrive on site with the TBM spoil will be required to be captured, treated and disposed of, to prevent discharge to groundwater. Some of this water will drain out before the spoil is loaded out for transport to the spoil receiving site; some will drain out during transport; some during its receipt and processing; and potentially some also following placement and compaction in its final destination at the receiving site.

The rate at which water will drain out will vary with the physical composition of the spoil, i.e., it will be faster in coarse grained spoil containing more gravel and sand and slower in spoil with a greater clay or silt content.

At this stage it is expected that at least 2 million m^3 of spoil (bulk volume, volume provided by DIT) will be delivered to site, noting the spoil volume could be larger than this. It is noted that the spoil volume is an estimate at this stage and the accuracy of this number is considered a data gap.

The excess water in the TBM spoil may be estimated as outlined below*:

Volume of water in recovered TBM spoil – volume of water of in situ spoil = Excess water in TBM spoil

Total volume of water in the recovered TBM spoil

2 million m^3 spoil at 50% water volume = 1 million m^3 water volume

1 million m^3 water = 1 billion litres = 1,000 megalitres

Volume of water in the in situ tunnel spoil

2 million m^3 spoil x 1.7t/m^3 bulk density = 3,400,000 tonnes or 3.4 million tonnes of in situ spoil.

3.4 million tonnes x 15%^ water content (W_w/W_s) = 510,000 tonnes or 0.5 million tonnes of water in the in-situ spoil

0.5 million tonnes of water = 0.5 billion litres = 500 Megalitres of water

Excess water in TBM spoil

1,000 ML – 500 ML = 500 ML

500 ML = 500,000 m^3

To put this into context, this amount of water is the equivalent of placing a 30cm deep pool across the entire site area of approximately 1,500,000 m^2 (150 ha) and is the equivalent of 200 Olympic-sized swimming pools.

Notes:
**calculations are preliminary only and do not take into account different moisture contents that may be required in the soil once placed and compacted at the site.*
^15% water content of the in situ spoil is based on the average laboratory-determined moisture contents from soil samples assessed in the tunnel spoil waste classification report (Agon, 2024).
W_W *= weight of water*
W_S *= weight of solids*

It is understood that water will be captured, treated and disposed of, however the detailed management methods for this large volume of water are currently unknown and have the potential to create significant project delays and project risks upon changes in groundwater and surface water flow/quality. If water is discharged to the environment, there is the potential for adverse impacts on a range of receptors, as water chemistry (DO, pH, turbidity and in particular significantly lower salinity) is likely to be dissimilar to that of the current receiving environment.

The key data gaps in our understanding of the impact of water from TBM spoil include:

- Potential presence of groundwater contaminants (including but not limited to PFAS) that may be present in TBM spoil water (derived from groundwater in the soil captured by the TBM), and that may interact with soil, surface water or groundwater at the site and/or result in impacts to identified receptors.
- Volume of water that may be managed through drainage downwards into groundwater.
- The oxygen content of spoil water may be higher than groundwater, requiring consideration of the potential for redox changes and associated effects on ASS materials.
- Additional water may place pressure on the in situ groundwater, it is unknown how this may affect saline groundwater, which has the potential to be pushed laterally and upwell offsite. This in turn could affect the function of the windmills in the wetlands which maintain the water quality in the wetlands, and expose ecological receptors to higher salinity water.
- Volume of water that may be managed through evaporation and what effect this process may have on salinity and contaminant concentrations in underlying soil.
- Volume of water that may be managed through drainage on site, how this water will be captured and managed to a suitable quality for discharge. It is unknown whether water could seep laterally into the wetlands and affect surface water quality.
- Time and space requirements for water management and whether these processes and footprint have the potential to hold up spoil deliveries.
- The hydraulic properties of the spoil material are unknown and have the potential to significantly affect the flow rate of large volumes of water. This could be assessed through trials and the results used to update the CSM and hydrogeological model.
- It is unknown whether water management methods will disturb ASS materials.
- The condition of the levee bank is unknown. A review is required to assess its adequacy and whether it will be necessary to redesign and replace it, considering whether spoil is likely to be placed against it and the lateral pressure that this would create. A well-functioning barrier between the spoil deposits and the estuary and between the estuary and the properties adjacent to the spoil deposit, is likely to be required to protect the area from erosion and mitigate against potential mobilisation of acid and metals from ASS materials.

- Future flood levels have not been assessed including potential climate change impacts on sea levels. A detailed review should be conducted and used to inform further assessment of the requirements for the design of a new levee bank or alterations to the existing levee bank.
- It is unknown how the Alliance will manage site drainage. A drainage system should be designed to mitigate risks of additional temporary increases in the groundwater levels water and associated water logging below the proposed future site development, that may be caused by rainfall recharge during extreme weather.
- It is unknown whether spoil deposition will impact existing surface drainage and groundwater management systems in adjacent properties. A separate assessment of water management, inclusive of the adjoining properties may be required to mitigate project risks around offsite stakeholders, who should be identified and consulted.

In addition, the technical details of which foaming agent (or mix of foaming agents, surfactants and other additives) will be used by the Alliance in TBM operations is not yet known. A preliminary risk assessment of foaming agent additives (Agon, 2024d) indicated that with appropriate control measures and use of readily biodegradable non-PFAS agents, there should be minimal environmental impact.

However, it is noted that such additives will take some time to degrade, resulting in the retention of water for an extended duration, which will influence the time required to drain the water from the spoil (immediately upon receival and before placement). Assessment of the degradation rate of additives will therefore assist in evaluating the potential impact to site in terms of settlement/ consolidation of sediments, management of spoil, management of spoil water, potential migration of "fresh" water and interaction with site surface water and groundwater, as well as the ability of the contractor to achieve the desired geotechnical compaction levels once placed. As such, details around the types and use of foaming agents remain a data gap to be addressed.

12.6 PFAS

Further assessment is required of the PFAS that has been detected in groundwater wells offsite along the northern boundary and adjacent to the wetlands. The source of PFAS needs to be assessed to understand if there is the potential for higher concentrations of PFAS to come onto the site or for changes to the hydrogeology at the site to affect PFAS in groundwater on other sites in the area. It is possible that PFAS has been detected in site groundwater due to potential impacts in the wetlands' surface water and the presence of a complete pathway between offsite surface water and onsite groundwater.

This is a data gap that could be addressed through pursuing another line of evidence through surface water sampling of the wetlands for PFAS.

12.7 Ecological Receptors

The extent to which site vegetation and/or habitats rely on groundwater has not been investigated. For example, where tidal ebbs and flows occur and/or where groundwater discharges to surface water, groundwater may be an important source of water to ecological communities. If the project significantly alters groundwater levels and/or spoil is placed on top of ecological communities (i.e. if the site is only partially filled), these communities may not survive.

The completeness of pathways to ecological receptors from sources has not been assessed, and the exposure concentrations for contaminants have not been determined for receptors at the end of complete pathways (under current and future conditions). It is noted that a baseline ecological risk assessment is under way and may close out, or partially close out, this data gap.

It is noted that the findings of the EHIAR (Mott Mc Donald, 2024) have not yet been fully reviewed and the findings of the EHIAR will assist in identifying the need for any further ecological investigations.

A preliminary screening Ecological Risk Assessment (ERA) is proposed to be undertaken on chemical substances that have exceeded the NEPM ecological screening criteria. The scope of work for the ERA is likely to involve a determination of chemicals of concern and other non-chemical substances (e.g. DO, pH, salinity, turidity, compression) that may pose an ecological risk to the sensitive receiving environments and may also consider the risk to the future onsite terrestrial ecology and offsite terrestrial and aquatic ecology (in the nearest surface water receiving environment).

The estuarine areas of Gillman and Dry Creek comprise tidal flats and salt marshes, and a significant volume of fill material needs to be placed prior to development activities. Vegetation on the site will need to be removed prior to filling the site with the T2D spoil so the impacts to the onsite vegetation will not be covered by this risk assessment.

The ERA will evaluate the risk to the water courses predominantly in the northern portion of the site and to the adjacent Magazine Creek and Range Wetlands. The next closest water bodies are the Greenfields Wetlands, Barker Inlet Wetlands and the North Arm of the Port Adelaide River. Surface water is expected to run from the site into Barker Inlet, the adjacent wetlands and infiltrate into site soils.

The ERA may also involve a toxicity and exposure assessment that will be used to provide a qualitative assessment of potential onsite and offsite ecological risk from exposure to key chemicals in soil and water derived from T2D spoil placed on the site.

12.8 Soil Vapour and Landfill Gas

A number of offsite PCAs have been identified (see Section 11) which have the potential to result in soil vapour and landfill gas risks to the subject site. This is a project risk as there is the potential for areas of the site to be unsuitable for the proposed future commercial/industrial land use due to the presence of soil vapours and/or landfill gases.

Landfill sites, including the Wingfield Waste and Recycling Centre and Adelaide Resource Recovery recycling centre, occupy the industrial land to the east and south of the site. Additional offsite sources of contamination include service stations, wetlands, auto wreckers and transport depots.

The diffusion and inhalation of intrusive vapours or landfill gases (from soil and/or groundwater) was identified in the PSI (Agon, 2024c) as the pathway by which future site users may be exposed to this risk. Given the open nature of the site and the proposed large-scale importation of fill to the site, the exposure of future construction workers and commercial/industrial site users to potential landfill gases and soil vapours from offsite sources is likely to pose a low risk, however additional lines of evidence are required to close this out.

Landfill gas is only a risk when it accumulates in structures, so a buffer or separation distance between the landfill and the structure is considered an effective mitigation measure. In the absence of any site specific data, a buffer distance of 500 m is considered sufficiently low that development can occur without any assessment of gas risks. The buffer distance is measured from the outer boundary of the area that contains or is licensed to contain waste (SA EPA, 2012).

Based on a review of all offsite investigation reports and SA EPA public register information in the PSI (Agon, 2024c), and in the Agon Groundwater SAQP (Agon, 2024b), three sites have been identified to be a potential source of soil vapour or landfill gas risk, within 500 m of the site boundary:

- ResourceCo (adjacent to the East) – landfill gas.
- Wingfield waste and recycling station (adjacent to the East) – landfill gas.

- 1-17 Kapara Road, Gillman (~120m South) – soil vapours (hydrocarbons).

The first two sites are SA EPA licensed facilities that are required to undertake monitoring and are regulated by the SA EPA. It is noted that modern landfills are appropriately designed and engineered with reliable landfill gas controls (SA EPA, 2019). It is noted that no anthropogenic TRH or dissolved gases (carbon dioxide and methane) were detected in the groundwater investigations. Toluene was detected in 5 wells at trace levels but is potentially of microbial origin with detections spread across the site and not aligned with offsite landfill source sites, requiring verification in a further monitoring round. However, no soil vapour or landfill gas data has been available to be reviewed for the offsite source sites which is considered a data gap necessary to close out this potential source-pathway-receptor linkage.

The Kapara Road site was a transport depot assessed in 2014, with dissolved phase and LNAPL hydrocarbon impacts to groundwater. The risk from soil vapour was not assessed in the documentation provided by the SA EPA and, as such, the potential offsite vapour risk is a data gap.

12.9 Geotechnical

A baseline geotechnical site investigation is yet to be undertaken and is required to understand how the site will react to the proposed large-scale filling project. It is understood that up to 3 m of fill will be placed on the site, plus preload. It is unknown how this may affect subsidence and/or heave of the existing site soils and soils adjacent to filling activities.

Subsidence, and the magnitude, scale and timing over which this may occur, is necessary to understand, because this will impact whether existing ASS materials may be displaced downwards below the water table where they may release metals and acidify the groundwater and/or undergo redox reactions and transform into other ASS materials. Other groundwater impacts may also occur due to subsidence/consolidation of sediments, including migration of hypersaline groundwater beyond its current extent, leading to interaction with onsite or offsite receptors (surface water, wetlands, etc., see Section 12.3).

12.10 Conceptual Site Model

A detailed CSM for the site in its baseline condition is presented in Section 11. A detailed CSM is required to consider all known or potential primary and secondary sources of contamination, potential preferential pathways, and to assess exposure to site contamination present in different environmental media. A robust and scientific understanding of the nature and extent of site contamination is needed to assess and manage risk throughout the project and aid in decision-making.

For this long-term project, which will have multiple stages of assessment work and management, the ongoing development of the CSM will be an iterative process and will be a crucial reference point for all environmental assessment on the project. Continual addition of further detail to an updated CSM will be invaluable in:

- Understanding conditions on and adjacent to the site under current and under the proposed construction and operation of the site as an SRF.
- Identifying the significance of data gaps and prioritising works required to address these gaps to mitigate risk for DIT and, in future, the Alliance.
- Keeping the environmental assessment scope targeted, relevant and limited to what is necessary to understand to mitigate material project risks.
- Achieving completion of the WDF audit and regulatory compliance.

13.0 SUMMARY AND CONCLUSIONS

Agon was engaged by the DIT to undertake a DSI to assess soil, groundwater and surface water conditions on a site comprising a portion of the following land parcels across a total area of 145.19 ha:

- Piece 501, 208 Eastern Parade, Gillman, SA 5013
- Piece 502, 208 Eastern Parade, Dry Creek SA 5093

The site is owned by the Urban Renewal Authority trading as Renewal SA and has been ear-marked for future commercial/industrial development, which would require site levels to be raised to at least 3.7 m AHD to meet Coast Protection Board Requirements. DIT proposes to assist Renewal SA by operating the site as a SRF, depositing the spoil from the T2D component of the NSC project.

The total quantity of spoil may be in the order of 7 million tonnes, comprising a mixture of excavated and tunnel boring spoil (which will contain soil, rock, water, and conditioning agents/tunnelling additives). The large scale of the proposed site filling means that there is the potential for significant:

- Compression and settlement of the existing soils under and adjacent to the area filled.
- Changes to groundwater levels and seepage patterns, both on and offsite.
- Changes to surface water drainage patterns, both on and offsite.

These changes could disturb acid sulfate soil types and cause mobilisation and transport of contaminants via groundwater and surface water pathways to impact the environment on and offsite, both during and after the project.

Past investigations identified several potential onsite and offsite sources of contamination at the site:

- Operation of the site for Defence Works leading to the potential for UXO, explosive organics and nitroglycerine residues and metals onsite.
- Offsite properties including landfills and waste depots, service stations, and auto wreckers. Potential contaminants of concern include landfill gases, nutrients, solvents, petroleum hydrocarbons, heavy metals and PFAS. Past investigations of surrounding sites have indicated that groundwater may have been contaminated by inorganics and nutrients (metals, fluoride, TDS, sodium, chloride, sulfate, phosphorous, total N, TOC and BOD) as well as organic compounds (BTEX, TRH, TCE, PCE, PAH, PFAS).
- Imported fill materials brought onto Pieces 501 and 502 including the presence of ACM and elevated levels of heavy metals, PAH and TRH in the subsurface. While these areas of filling have been excised from the site, it is still possible that imported fill materials may be present from uncontrolled waste burial and illegal dumping on other parts of the site.
- Acid generation from disturbance of ASS materials.

An intrusive site investigation was undertaken to assess the baseline condition of soil, groundwater and surface water as follows:

- Soil investigation comprising 136 grid-based soil boreholes.
- Groundwater investigation, comprising installation of 15 new groundwater wells and sampling of 22 wells (15 on site; 3 offsite adjacent to the north; 4 offsite in the Magazine and Range Wetlands).
- Surface water preliminary assessment comprising 9 electronic data loggers installed.
    - Barometric pressure – one logger.
    - Groundwater level and temperature in onsite wells – 6 loggers.
    - Surface water level and temperature in creek channels – one onsite and one offsite.

Surface water sampling in 9 locations.

A robust QAQC program was undertaken, the results of which were overwhelmingly supportive of the data being reliable and suitable to form the basis for the conclusions of this report, in accordance with the DQOs.

The data collected was used to:

- Compare soil and water results to adopted criteria.
- Complete a determination of site contamination of soils and groundwater.
- Refine the preliminary baseline CSM, identify potential risks to human health and the environment associated with feasible source-pathway-receptor linkages.
- Identify data gaps.
- Identify contamination risks associated with fill importation, in the context of the baseline site condition.
- Assess baseline soil and groundwater conditions at the site, including the presence of any site contamination.
- Develop a robust CSM including groundwater movements, tidal influences, salinity variations and groundwater recharge/discharge mechanisms.

13.1 Soil Summary

Site soil contains concentrations of metals and B(a)p above the ecological assessment criteria, with all other analytes below the criteria. No analytes were detected above the ecological investigation levels for commercial/industrial land use, or above any of the adopted human health criteria.

Chemicals above the ecological assessment criteria were arsenic, copper, lead, zinc and B(a)p. Arsenic is considered likely to be naturally occurring based on assessment of its vertical and spatial distribution on site. Copper, lead, zinc and B(a)p are considered to be potentially linked to past Defence activities. Following statistical assessment, B(a)p was found to no longer exceed the EILs, leaving only arsenic, copper, lead and zinc above the EILs.

In comparison with the WDF criteria, the site soils would fall within the Intermediate Waste soil classification, due to exceedances of the Waste Fill criteria for arsenic, copper, lead and manganese. Zinc, B(a)p and Total PAH were found to initially exceed Waste Fill criteria; however, following 95% UCL calculations, these no longer exceeded the criteria. In a broad comparison with the tunnel spoil, the site falls into the same waste classification (Intermediate Waste soil) as tunnel sections 1 & 2.

ASS materials are widespread across the site, with net acidity above the action criteria in approximately 45% of the locations tested. Triggering the action criteria indicates the requirement for a management plan to govern any future site works, as ASS materials are likely to be disturbed through excavations for site establishment, subsidence and changes to the water table brought on by site filling.

13.2 Groundwater Summary

Groundwater within the uppermost aquifer is generally hypersaline (more saline than typical seawater), highly anoxic and slightly acidic. The inferred groundwater flow direction is generally to the north west towards the Port Adelaide River but appears to be influenced by groundwater extraction at the Magazine Creek wetland. The groundwater flow velocity is estimated to range between 0.5m/year and 2m/year, which is in line with expectations for a site with a relatively flat topography.

- The tidal influence on surface water and groundwater levels appears to be extremely small (if any). Groundwater quality across the investigation area is likely influenced by freshwater recharge (e.g. rainwater) and evaporation, with minor variations between wells in bicarbonate and sulfate indicating possible localised effects of direct recharge and ASS materials.
- Groundwater contained a number of analytes above the detection limits including metals, BTEX, PFAS, acetone, inorganic phosphorus, nitrogen compounds, fluoride, COD, TOC, CO_2 and bacteria.
- Analytes above the adopted criteria were metals, ammonia, fluoride and PFOS.
- Groundwater may have been impacted by ASS oxidation processes, as indicated by the high sulfate to chloride ratio.
- No impacts were identified from offsite sources including landfill leachate, but this requires verification in subsequent monitoring events. The migration of landfill gases (e.g., methane and carbon dioxide) to the site area is considered highly unlikely due to the presence of The Range wetland and its discharge canal (refer Section 4.6). The presence of these water bodies together with extremely shallow groundwater would almost fully restrict the migration of gases through water saturated media
- The presence of heavy clays of the Hindmarsh Clay Formation would provide sufficient hydraulic separation between the uppermost aquifer and the aquifers below likely preventing downward leakage of groundwater from the uppermost aquifer.

13.3 Surface Water Summary

Both offsite wetlands collect stormwater from surrounding industrial catchments. The wetlands consist of a series of connected ponds, with salinity increasing from upstream to downstream ponds. The water in the discharge ponds in both wetlands is hypersaline and this water discharges onto the site area. Surface water along the northern boundary of the site either side of the levee bank (on and offsite) is hypersaline, consistent with the groundwater. Evaporation processes may contribute to the high salinity of surface water.

Surface water on and offsite contained a number of analytes above the detection limits including metals, PFAS, inorganic phosphorous, nitrogen compounds, BOD, COD, TOC, CO_2 and bacteria. Analytes above the adopted criteria were metals, ammonia and PFOS.

Based on the distribution and concentration patterns of PFAS chemicals, the source of PFAS chemicals in onsite groundwater may be surface water discharges from the wetlands. It is thought that PFAS chemicals may be present in stormwater discharges entering the wetlands from wider offsite catchments.

Due to the shallow depth of groundwater and the presence of a groundwater level control systems at Magazine Creek and Range wetlands, Agon assessed the potential for groundwater and surface water at the site to be hydraulically connected. A comparison of groundwater and surface water hydrochemistry as well as concentrations of chemicals of concern confirms some level of interaction and potential ‘exchange’ of chemicals. The elevations of surface water and groundwater are very similar, and seasonal surface water release and flooding in some parts of the site may result in infiltration and recharging groundwater, i.e impacting on groundwater. On the other hand, during seasonal groundwater level rise groundwater may be exposed at the surface, causing some water logging and mixing with surface water causing surface water impacts. Additional investigations including water level gauging and sampling conducted during the wet season would improve the understanding of the surface water and groundwater interaction.

Surface water management during site establishment, filling, operation and future use will be considered in the SMP and/or CEMP for the project.

13.4 Determination of Site Contamination

The existence of site contamination is determined with reference to the SA EPA *Environment Protection Act 1993* which defines site contamination exists if:

d) "Chemical substances are present on or below the surface of the site in concentrations above the background concentrations (if any); and
e) The chemical substances have, at least in part, come to be present there as a result of an activity at the site or elsewhere; and
f) The presence of the chemical substances in those concentrations has resulted in—
    iv. actual or potential harm to the health or safety of human beings that is not trivial, taking into account current or proposed land uses; or
    v. actual or potential harm to water that is not trivial; or
    vi. other actual or potential environmental harm that is not trivial taking into account current or proposed land uses."

Based on the results obtained during the soil and groundwater investigations Agon has made the initial determination that site contamination of soil exists at the site with respect to a land use as an area of ecological significance, with surface soils containing arsenic, copper, lead and zinc above the criteria for areas of ecological significance, after statistical assessment. Agon does not consider that the arsenic or zinc identified in soil across the site is site contamination; however, copper and lead may be attributable to past Defence activities.

Site contamination does not exist with respect to a potential future land use of commercial/industrial, as no exceedances of the commercial/industrial criteria have been observed.

Groundwater results indicate that site contamination of groundwater exists, based on concentrations of chemicals above the adopted criteria. A preliminary assessment of background concentrations was undertaken with the finding that groundwater concentration exceedances may be attributable to offsite sources (with the exception of fluoride). This preliminary assessment requires additional sampling rounds to be undertaken to allow a more reliable determination of background to be completed.

13.5 Conclusions

The baseline soil impacts at the site are limited to metals with arsenic being the key chemical above the ecological assessment criteria. Arsenic occurred above the criteria in over 30% of samples and was distributed site-wide at a range of depths and overwhelmingly within natural soils, indicating that the arsenic concentrations are naturally occurring. Copper, lead and zinc were also present above the ecological assessment criteria and were considered likely to be related to past Defence activities based on their distribution. These exceedances mean that effects on offsite ecological receptors will need to be considered as the project moves forward; it is not considered that onsite ecological receptors are relevant for further investigation as it is understood that vegetation clearance will be undertaken prior to spoil receival.

The baseline soil condition meets the criteria for a commercial/industrial land use; it is not envisaged that any remediation would be required as part of site preparation works ahead of spoil receival. The baseline soil condition should allow successful completion of the waste derived fill audit for a commercial/industrial land use, so long as the imported spoil meets auditor requirements.

The site in its baseline condition is not considered to pose a risk to intrusive maintenance workers, as compliance with commercial/industrial criteria is protective of intrusive maintenance workers. Therefore, it not envisaged that any remediation would be required to make the site safe for workers involved in establishing or operating the SRF. The exception to this is the presence of ASS materials, where there is a clear need to develop an ASS management plan to cover any intrusive work on site.

ASS materials are widespread across the site and will require further detailed assessment and careful management during the project. The placement of fill material on site is likely to disturb ASS materials through subsidence and excavation for project infrastructure, with the potential for metals and acidity to reach receptors.

Comparison of chemical concentrations in site soil with tunnel boring spoil demonstrated that both soils would fall within the same waste soil classification (Intermediate Waste Soil). Arsenic and zinc concentrations at the Site are typically equal to or higher than arsenic concentrations in the tunnel spoil, indicating that there is likely to be negligible additional risk to future site receptors posed by arsenic or zinc concentrations in the tunnel spoil. Nevertheless, a tier 2 environmental risk assessment is considered necessary for arsenic concentrations on site, on the basis of the maximum arsenic concentration which is 3 times higher in the tunnel spoil than in the natural site soil. Barium, copper, manganese and nickel concentrations are broadly higher in the tunnel spoil than at the Gillman site, and this may also require further consideration in a Tier 2 environmental risk assessment.

Groundwater contamination is present at the site with metals, ammonia and PFOS above the ecological criteria; in addition, groundwater at the site is hypersaline. As a result, there may be some baseline risk to the flora and fauna in the terrestrial, surface water and estuarine environment both at and down gradient from the site. Fluoride is also present above the recreational criteria which may preset a human health risk for users of the site and of the environment down gradient from the site.

Surface water contamination is present on and offsite with metals, ammonia and PFOS above the ecological criteria. Based on the distribution and concentration patterns, PFAS chemicals may enter onsite groundwater through surface water discharges from the wetlands. It is thought that PFAS chemicals may be present in stormwater discharges entering the wetlands from wider offsite catchments.

A comparison of groundwater and surface water hydrochemistry as well as concentrations of chemicals of concern confirms some level of interaction and potential ‘exchange’ of chemicals. The elevations of surface water and groundwater are very similar, and seasonal surface water release and flooding in some parts of the site may result in infiltration and recharging groundwater, i.e impacting groundwater. On the other hand, during seasonal groundwater level rise groundwater may be exposed at the surface, causing some water logging and mixing with surface water causing surface water impacts.

An overall summary of the PCOCs above the adopted criteria in all media assessed onsite is provided in Table 54. For brevity, analytes whose LOR was above the criteria have not been included in Table 54.

Table 54 - Summary of PCOCs above criteria in all media onsite.

Media	PCOC	Assessment Criteria Exceeded
Soil - Natural	Arsenic Lead Copper Manganese	EIL EIL EIL Waste Fill
Soil - Fill	Arsenic Zinc	EIL and Waste Fill EIL
Soil Leachate – Natural	Arsenic Lead Copper Zinc	NHMRC (2008) Recreational & ANZG (2018) Freshwater 95% NHMRC (2008) Recreational & ANZG (2018) Freshwater & Marine 95% ANZG (2018) Freshwater & Marine 95%
Soil Leachate - Fill	Copper	ANZG (2018) Freshwater & Marine 95%

	Zinc	ANZG (2018) Freshwater & Marine 95%
Groundwater	Boron	ANZG (2018) Freshwater 95%
	Copper	ANZG (2018) Freshwater & Marine 95%
	Manganese	ANZG (2018) Marine 95%
	Molybdenum	ANZG (2018) Freshwater 95%
	Nickel	ANZG (2018) Freshwater 95%
	Zinc	ANZG (2018) Freshwater 95%
	Ammonia as N	ANZG (2018) Freshwater & Marine 95%
	Fluoride	NHMRC (2008) Recreational
	PFOS	ANZG (2018) Freshwater 95%
Surface Water	Aluminium - total	ANZG (2018) Freshwater 95%
	Copper - total	ANZG (2018) Freshwater & Marine 95%
	Lead - total	ANZG (2018) Freshwater & Marine 95%
	Zinc – total	ANZG (2018) Freshwater & Marine 95%
	Zinc - dissolved	ANZG (2018) Freshwater 95%
	Ammonia	ANZG (2018) Freshwater & Marine 95%
	PFOS	Aquatic ecosystem freshwater & marine 99% protection

The results were used to update the CSM for the site in its current form as well as post-construction upon site filling. Most source-pathway-receptor linkages remained intact between each scenario, with the magnitude of the potential exposure identified as a key change. Potentially contaminating activities that were considered to be a likely source of risk via complete pathways were identified as past defence activities (metals) and ASS Materials (metals, acidity). Many pathways for exposure of environmental and human receptors to hypersulfidic and sulfuric soils were identified, for example through excavations, subsidence, dewatering and/or changes to the groundwater levels and flows.

Several data gaps remain at this stage of the project, with further work to be undertaken once more details of the contractor's activities on site are known.

Overall, the site is considered suitable for receipt of the T2D spoil subject to completion of the following additional work, with outcomes that support suitability of the site for receipt of the T2D spoil:

- Geotechnical assessment.
- Ecological risk assessment.
- Additional groundwater monitoring to assess seasonal variations and verify outlier results.
- Surface water monitoring.
- Hydrogeological modelling, including levee bank condition assessment.
- Waste classification report for excavated spoil.
- Site management plan
- Construction and environmental management plan.
- Prioritisation, scoping and addressing of data gaps.

In conclusion, this DSI provides an initial assessment of the current condition of the site with respect to site contamination, to inform the assessment of the risks associated with importing a large volume of spoil, and to form a baseline against which to monitor any changes to site conditions during and after large-scale site filling.

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Sullivan, L, Ward, N, Toppler, N and Lancaster, G (2018b) National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manua*l,* Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.

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15.0 LIMITATIONS OF THIS REPORT

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APPENDIX A: FIGURES

Figure A1: Site Locality Map

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

🟨 Local Government Areas
🟥 Boundary

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0 2,000 4,000 m N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2024

REVISION: 2
Date: 5/03/2024
Reference: JC1406
Prepared by Agon

Figure A2: Key Local Features

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

Veolia Imported Fill

- ▨ Area H
- ▨ Veolia
- ▨ Dean Riffle Range Location
- ━ Roads
- ━ Approximated Firing Lines
- ━ Approximated Range Stop Butt
- ┼┼ Levee Banks
- ☐ Site Boundary

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0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: SAPPA 2023

REVISION: 2
Date: 6/03/2024
Reference: JC1406
Prepared by Agon

Figure A3: Surrounding Land Use

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

- 🟨 AGRICULTURE
- 🟦 COMMERCIAL
- ⬜ EDUCATION
- 🟪 FOOD_INDUSTRY
- 🟪 MINE_QUARRY
- 🟥 NONPRIVATE_RESID
- ⬛ PUB_INSTITUTION
- 🟩 RECREATION
- 🟩 RESERVE
- 🟪 RESIDENTIAL
- 🟩 RET_COMMERCIAL
- 🟨 UTIL_INDUSTRY
- 🟧 VACANT
- 🟫 VACANT_RESID
- 🟥 Site Boundary

**Land use data based on Generalised Land Use 2022, Location SA (DIT 2024a) Piece 501 land use noted as Vacant Urban Land in SAPPA (PlanSA 2024)

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0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap, 2024
DIT (2024a) Location SA Map Viewer,
located at https://location.sa.gov.au/viewer/

REVISION: 1
Date: 5/03/2024
Reference: JC1406
Prepared by Agon

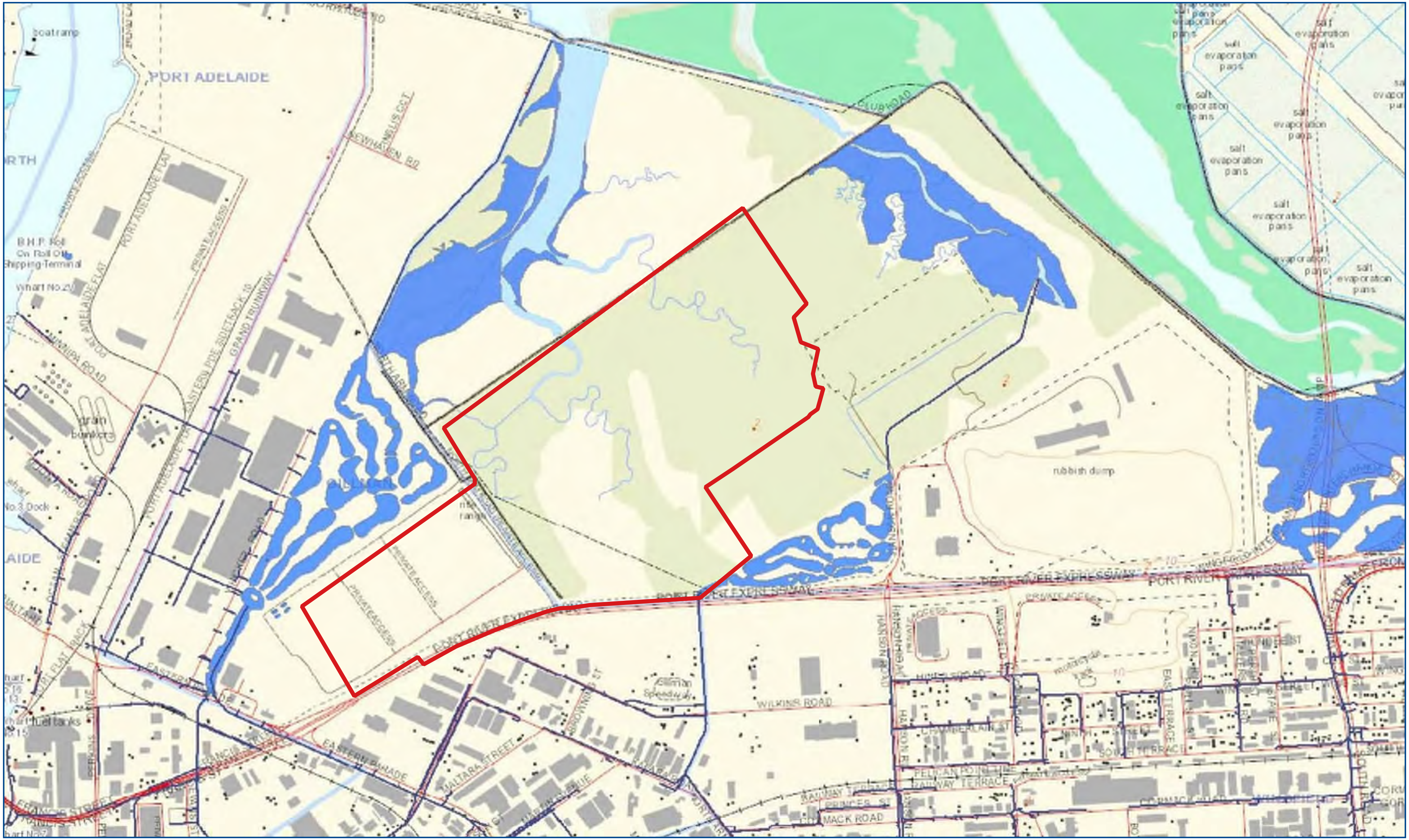

Figure A4: Local Topography and Stormwater

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

- ▭ Site Boundary
- 🟦 Water Bodies
- — Water Courses
- — Stormwater Drains
- — Contours

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0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Location SA Map Viewer, (DIT, 2024a)

REVISION: 1
Date: 16/10/2023
Reference: JC1406
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Figure A5: Bund Walls Construction

North South Corridor
Gillman, South Australia
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Legend

🟥 Boundary

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0 100 200 m

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2024
Historical Image: CPAE, 2024

N

REVISION: 1
Date 5/03/2024
Reference: JC1406
Prepared by Agon

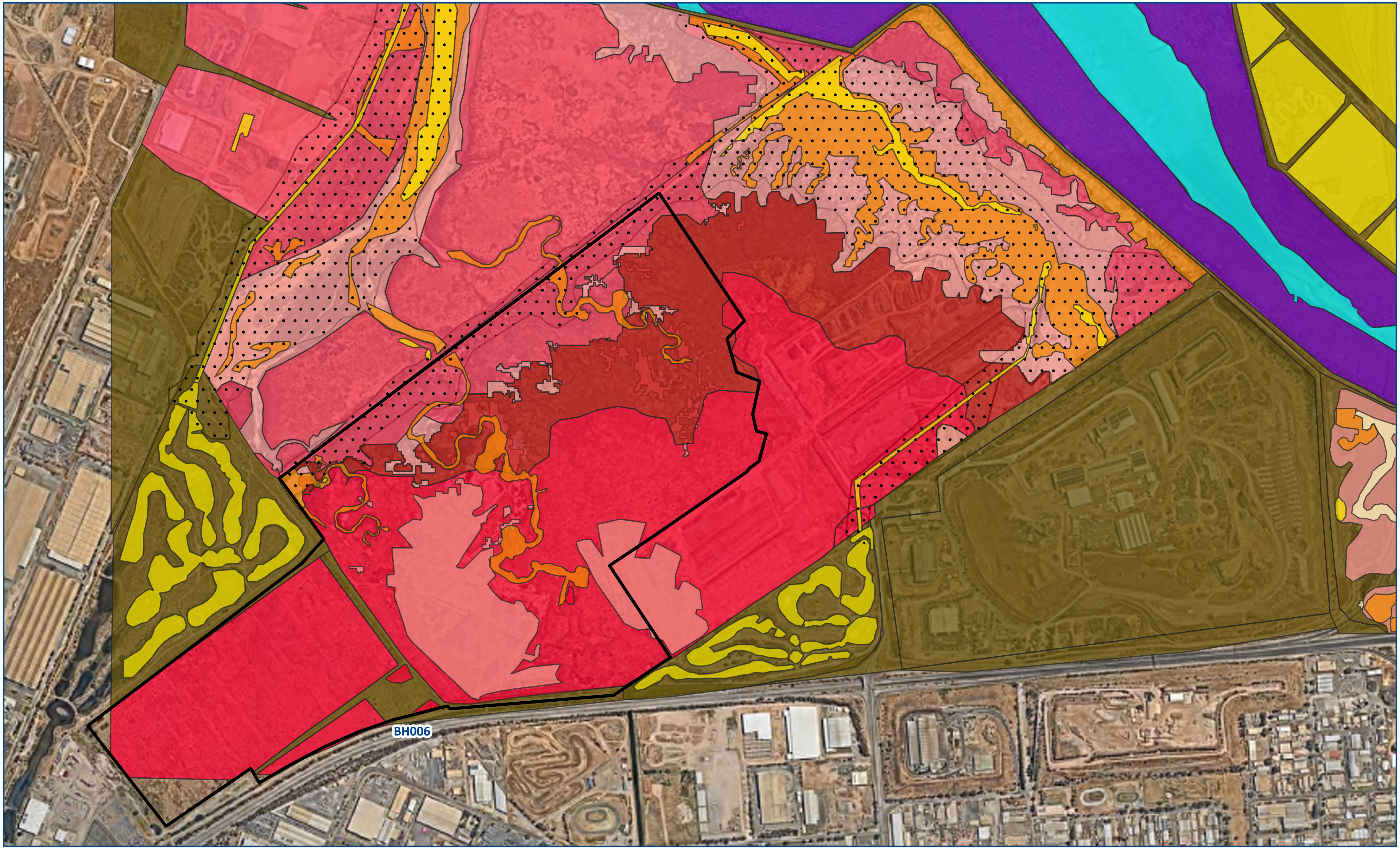

Figure A6: Soil Landscape Map Units Gillman

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

Non-tidal soils
- 🟨 Unit 1
- 🟧 Unit 2
- 🟥 Unit 3
- 🟥 Unit 4
- 🟥 Unit 5
- 🟥 Unit 6
- 🟧 Unit 7
- ⠿ Carbonate

Intertidal Soils
- 🟦 Unit 9
- 🟪 Unit 10
- 🟪 Unit 11
- ⬜ Unit 12

Fill Material
- 🟫 Unit 8

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0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap,2024
Source: Reproduced copy (Thomas, 2011)

REVISION: 1
Date: 13/02/2024
Reference: JC1406
Prepared by Agon

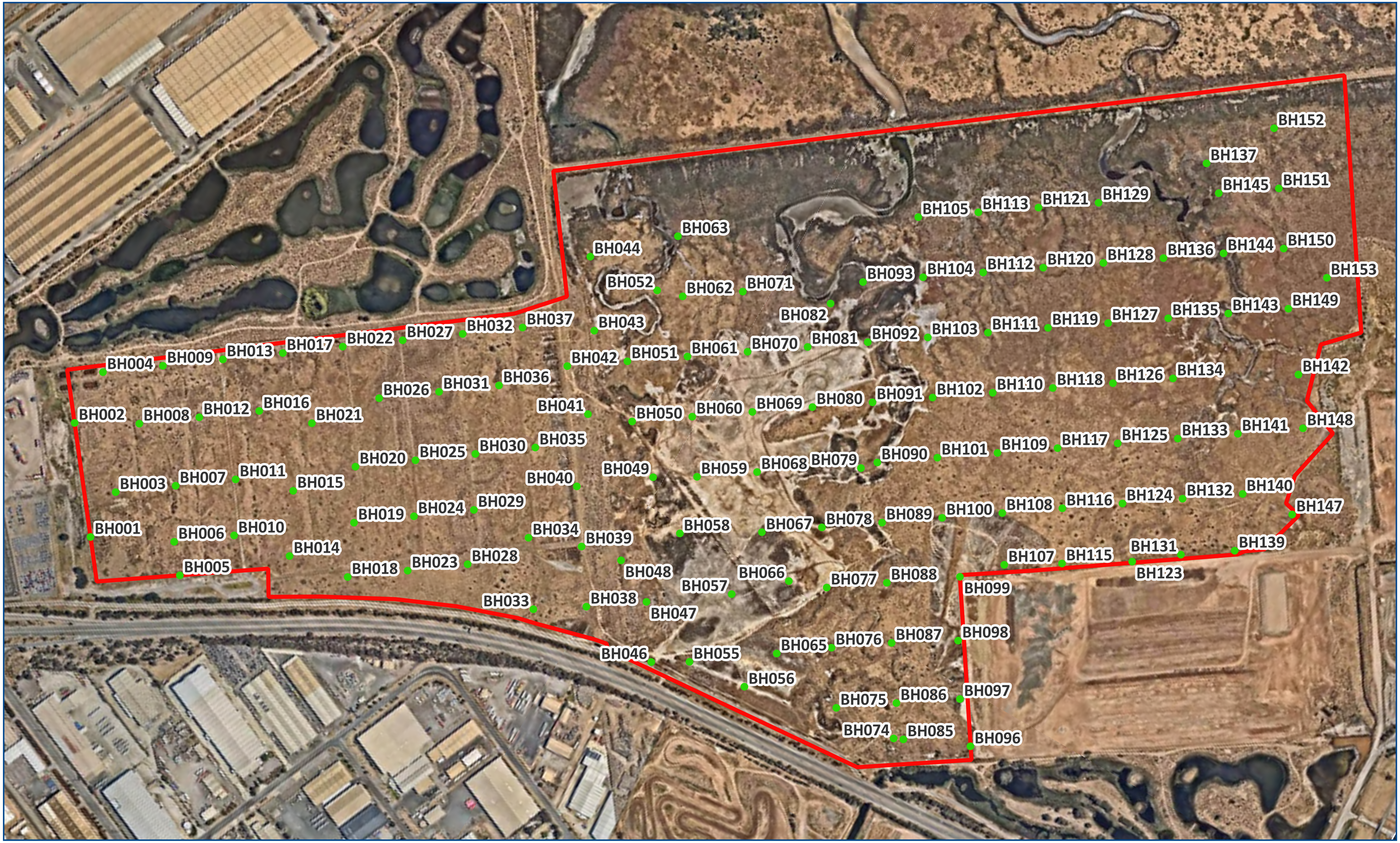

Figure A7: Soil Sample Locations

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

● Soil Sample Locations
▭ Site Boundary

Note: Soil samples have been abbreviated to improve visibility in the figure.
All soil sample names are followed by the discipline indentifier ENV, e.g., "BH001_ENV."

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0 100 200 m

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

N

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Date: 5/03/2024
Reference: JC1406
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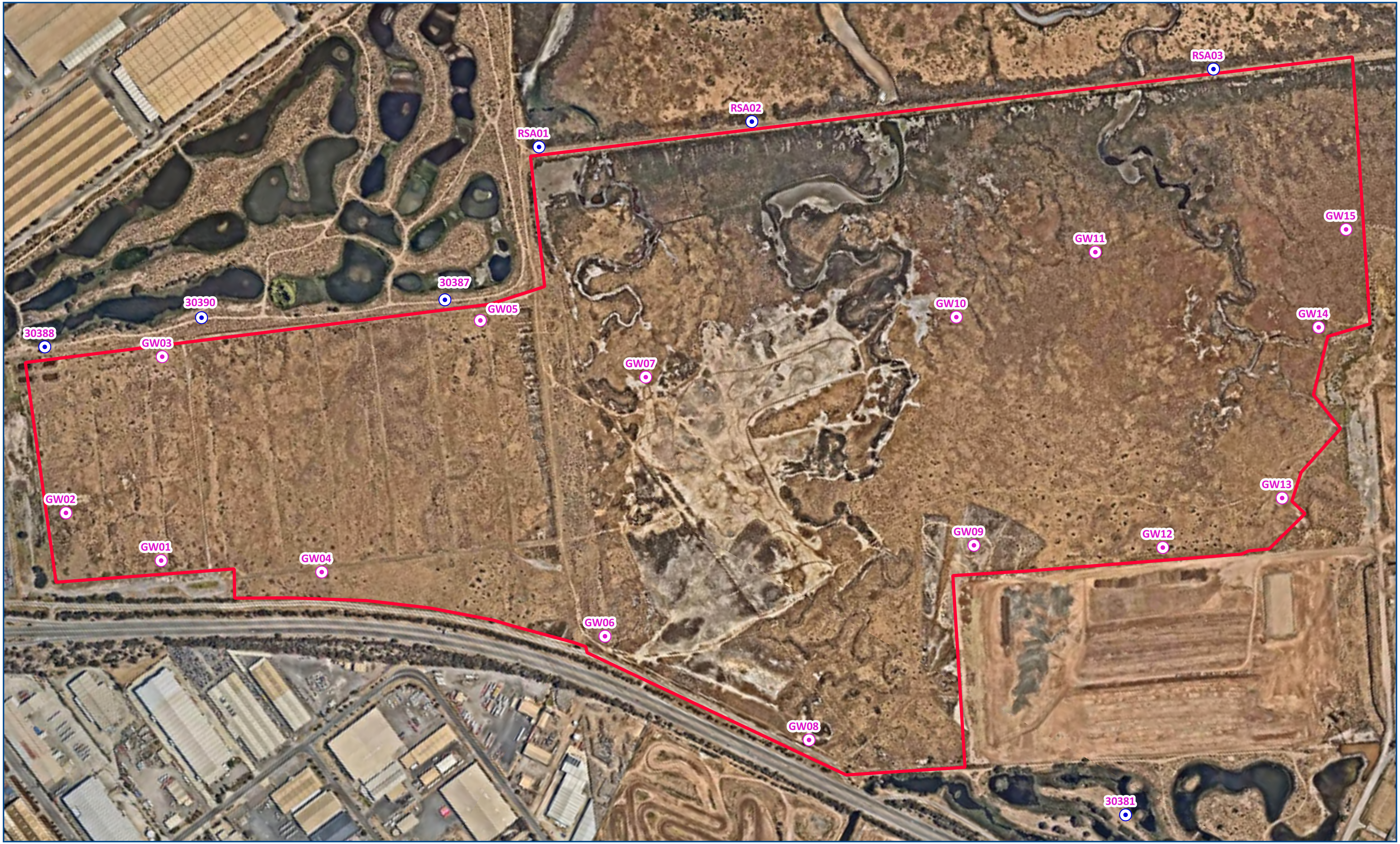

Figure A8: Groundwater Well Locations

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

- ⊙ Offsite groundwater well
- ⊙ Onsite groundwater well
- □ Boundary

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0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

REVISION: 1
Date 5/03/2024
Reference: JC1406
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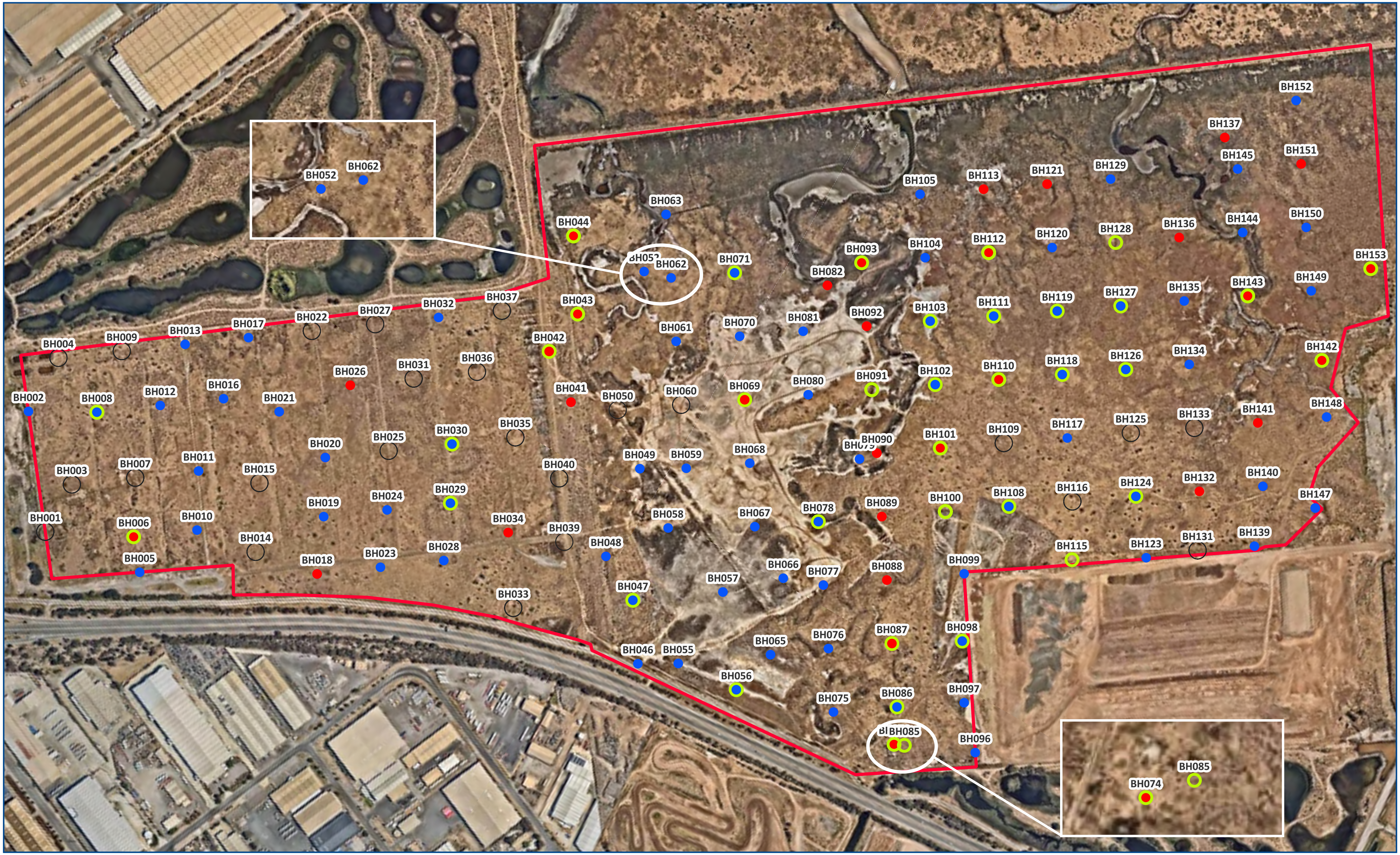

Figure A9: Arsenic concentrations

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

Arsenic Concentrations
- ● 2 - 19 mg/kg
- ○ 20 - 39 mg/kg exceeding SA EPA Waste Fill
- ● 40 - 160 mg/kg exceeding NEPM Generic EIL- Areas of Ecological Significance
- ○ Not Tested for Arsenic
- ▭ Site Boundary

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Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

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Figure A10: ASS material

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

ASS Classification
- 🟡 Hypersulfidic
- 🟢 Hyposulfidic
- ○ Monosulfidic
- 🔴 Sulfuric

▭ Boundary

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Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

REVISION: 1
Date 5/03/2024
Reference: JC1406
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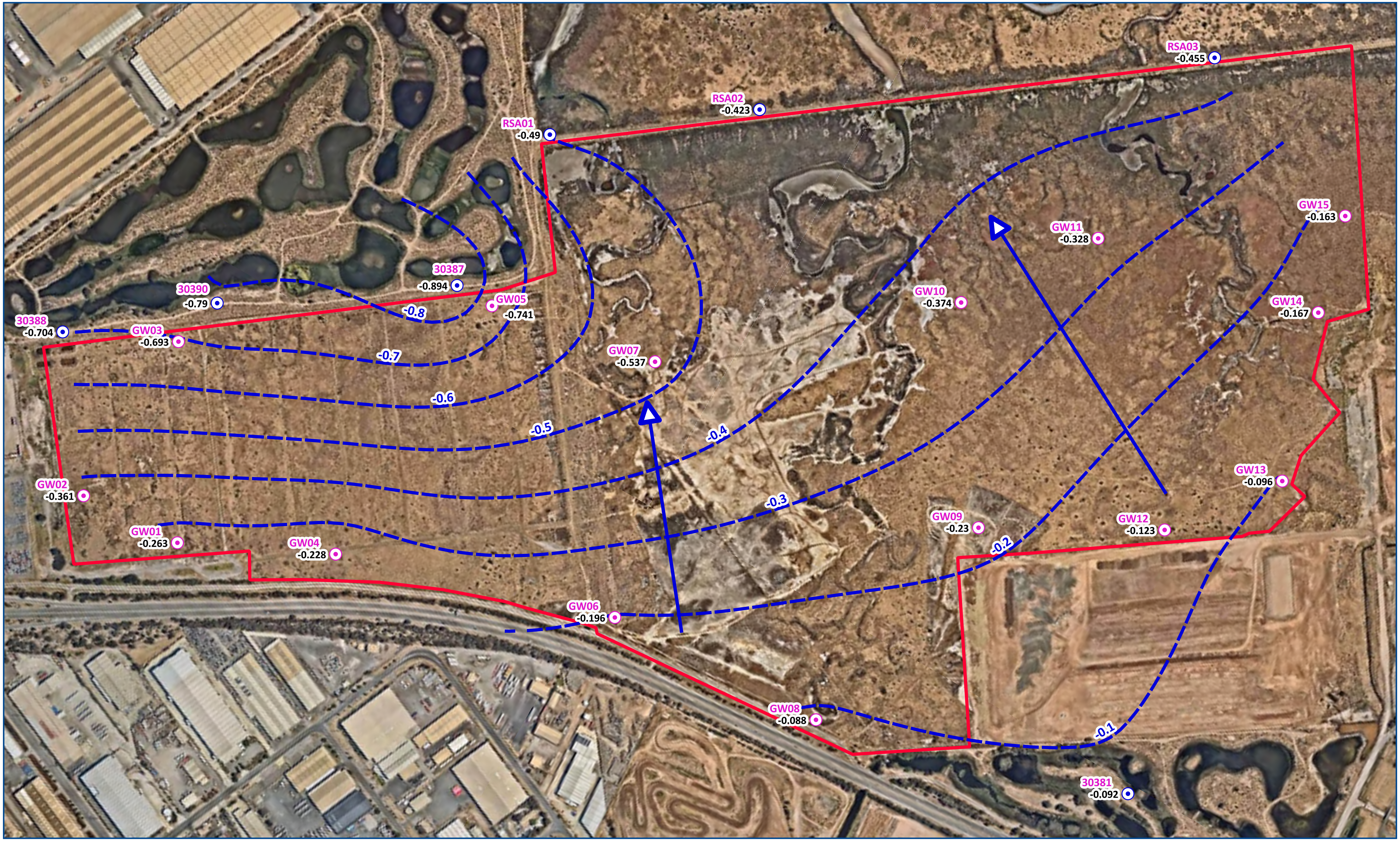

Figure A11: Groundwater Contours

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

- ⦿ Offsite groundwater well
- ⦿ Onsite groundwater well
- ▭ Boundary
- -- Groundwater Level Feb 2024 (mAHD)
- ← Inferred Direction of Groundwater Flow

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0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

REVISION: 1
Date 5/03/2024
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Figure A12: Locations of Electronic Dataloggers

North South Corridor
Gillman, South Australia
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Legend

⊙ Offsite groundwater well	X Datalogger Tides
⊙ Onsite groundwater well	→ Datalogger Transect Lines
● Well with Datalogger	
▭ Boundary	

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0 100 200 m

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

N

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Date 5/03/2024
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Figure A13: Surface Water Sampling Locations

North South Corridor
Gillman, South Australia
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Legend

Surface Water Sample Locations
◉ Actual sample locations
● Proposed sample locations
□ Site Boundary

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0 100 200 m

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

N

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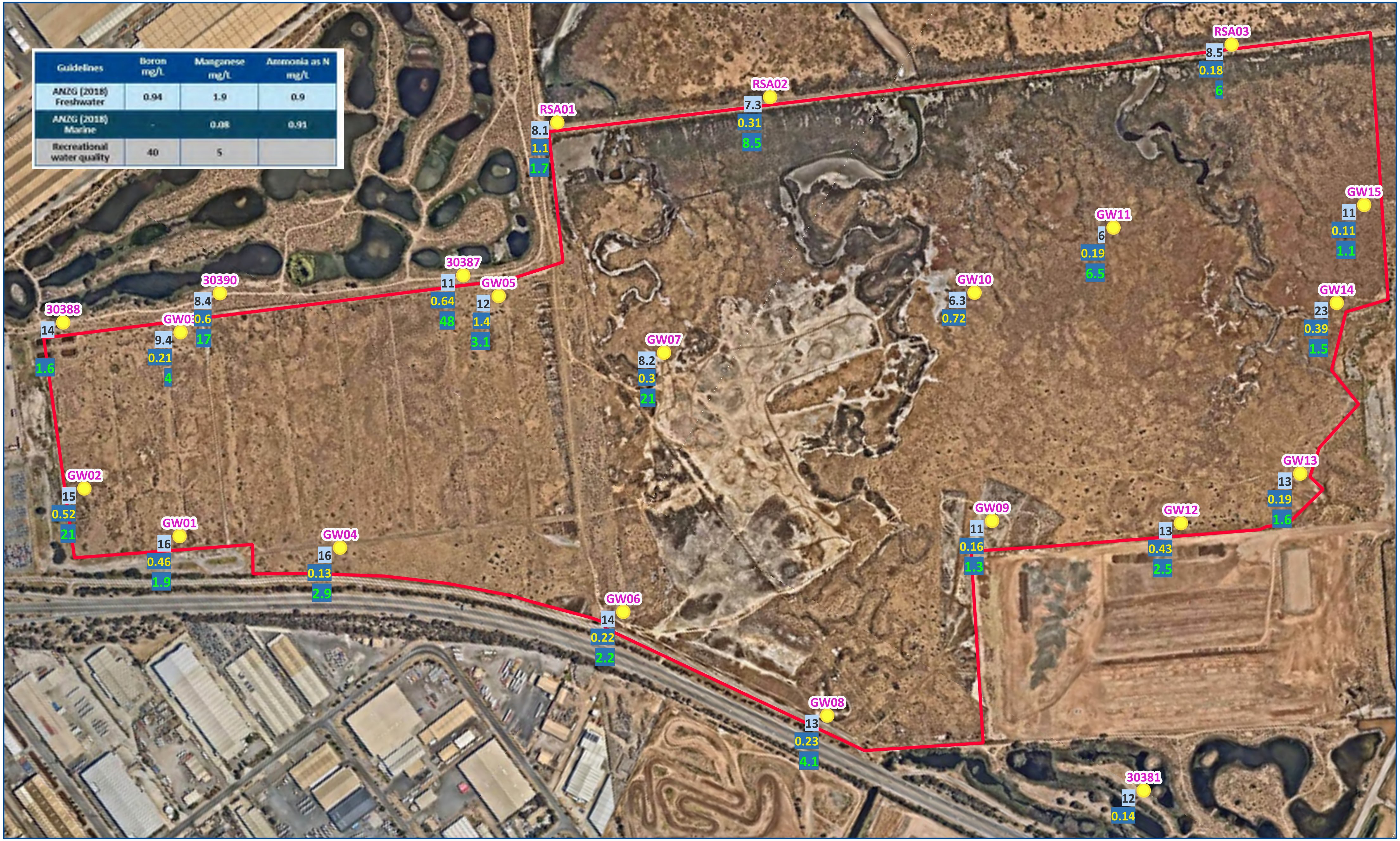

Guidelines	Boron mg/L	Manganese mg/L	Ammonia as N mg/L
ANZG (2018) Freshwater	0.94	1.9	0.9
ANZG (2018) Marine	-	0.08	0.91
Recreational water quality	40	5	

Figure A14: Groundwater Exceedances Boron, Manganese and Ammonia.

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

0,00 Boron Exceedances
0,00 Manganese Exceedances
0,00 Ammonia as "N" Exceedances
Boundary
Groundwater Contours

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0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

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Reference: JC1406
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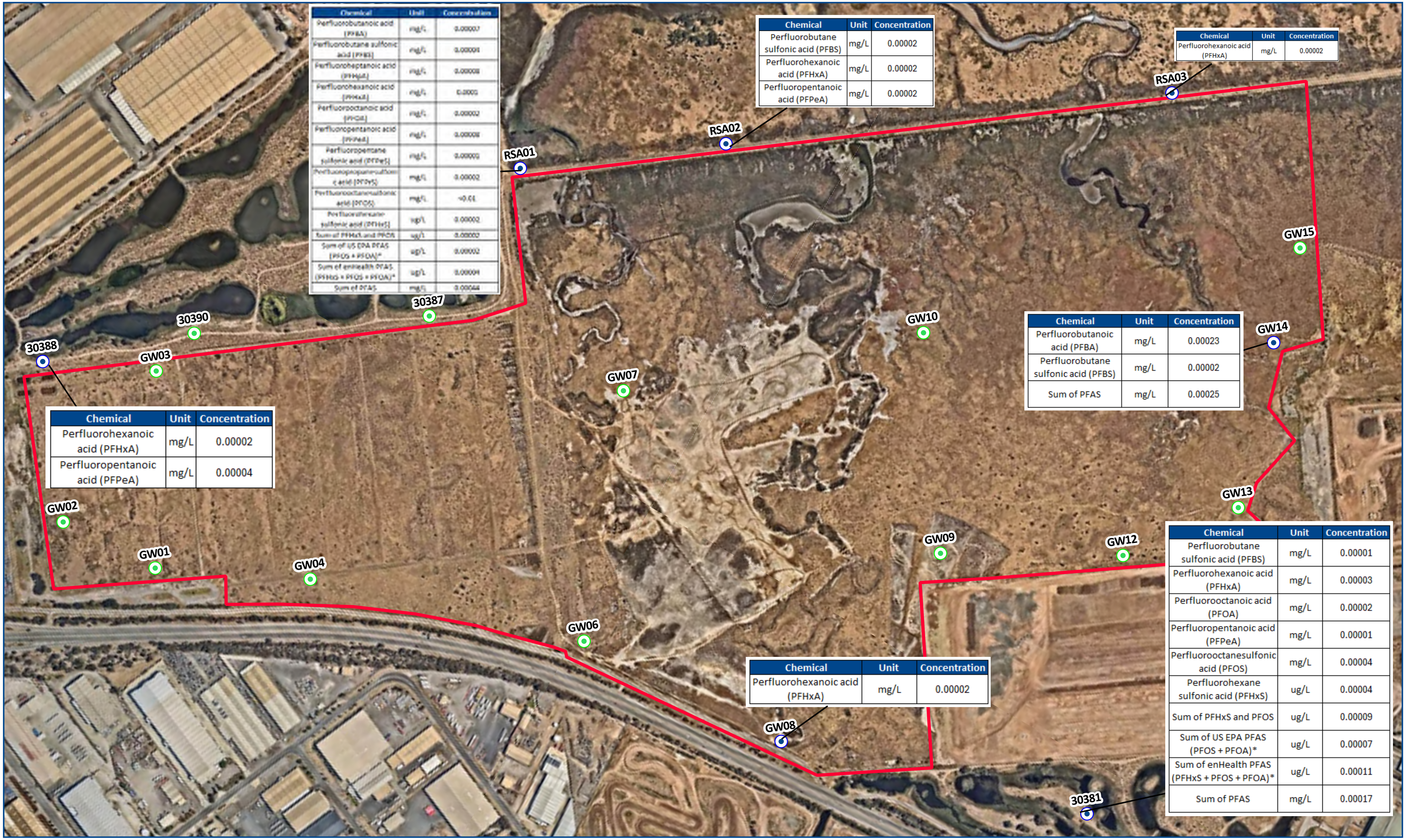

RSA01

Chemical	Unit	Concentration
Perfluorobutanoic acid (PFBA)	mg/L	0.00007
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00001
Perfluoroheptanoic acid (PFHpA)	mg/L	0.00008
Perfluorohexanoic acid (PFHxA)	mg/L	0.0001
Perfluorooctanoic acid (PFOA)	mg/L	0.00002
Perfluoropentanoic acid (PFPeA)	mg/L	0.00008
Perfluoropentane sulfonic acid (PFPeS)	mg/L	0.00003
Perfluoropropanesulfonic acid (PFPrS)	mg/L	0.00002
Perfluorooctanesulfonic acid (PFOS)	mg/L	<0.01
Perfluorohexane sulfonic acid (PFHxS)	ug/L	0.00002
Sum of PFHxS and PFOS	ug/L	0.00002
Sum of US EPA PFAS (PFOS + PFOA)*	ug/L	0.00002
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)*	ug/L	0.00004
Sum of PFAS	mg/L	0.00044

RSA02

Chemical	Unit	Concentration
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00002
Perfluorohexanoic acid (PFHxA)	mg/L	0.00002
Perfluoropentanoic acid (PFPeA)	mg/L	0.00002

RSA03

Chemical	Unit	Concentration
Perfluorohexanoic acid (PFHxA)	mg/L	0.00002

30388

Chemical	Unit	Concentration
Perfluorohexanoic acid (PFHxA)	mg/L	0.00002
Perfluoropentanoic acid (PFPeA)	mg/L	0.00004

GW14

Chemical	Unit	Concentration
Perfluorobutanoic acid (PFBA)	mg/L	0.00023
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00002
Sum of PFAS	mg/L	0.00025

GW08

Chemical	Unit	Concentration
Perfluorohexanoic acid (PFHxA)	mg/L	0.00002

30381

Chemical	Unit	Concentration
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00001
Perfluorohexanoic acid (PFHxA)	mg/L	0.00003
Perfluorooctanoic acid (PFOA)	mg/L	0.00002
Perfluoropentanoic acid (PFPeA)	mg/L	0.00001
Perfluorooctanesulfonic acid (PFOS)	mg/L	0.00004
Perfluorohexane sulfonic acid (PFHxS)	ug/L	0.00004
Sum of PFHxS and PFOS	ug/L	0.00009
Sum of US EPA PFAS (PFOS + PFOA)*	ug/L	0.00007
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)*	ug/L	0.00011
Sum of PFAS	mg/L	0.00017

Figure A15: Groundwater PFAS Detections

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

🟥 Site Boundary

Groundwater PFAS Detections

● Detected

● Non-Detect

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0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

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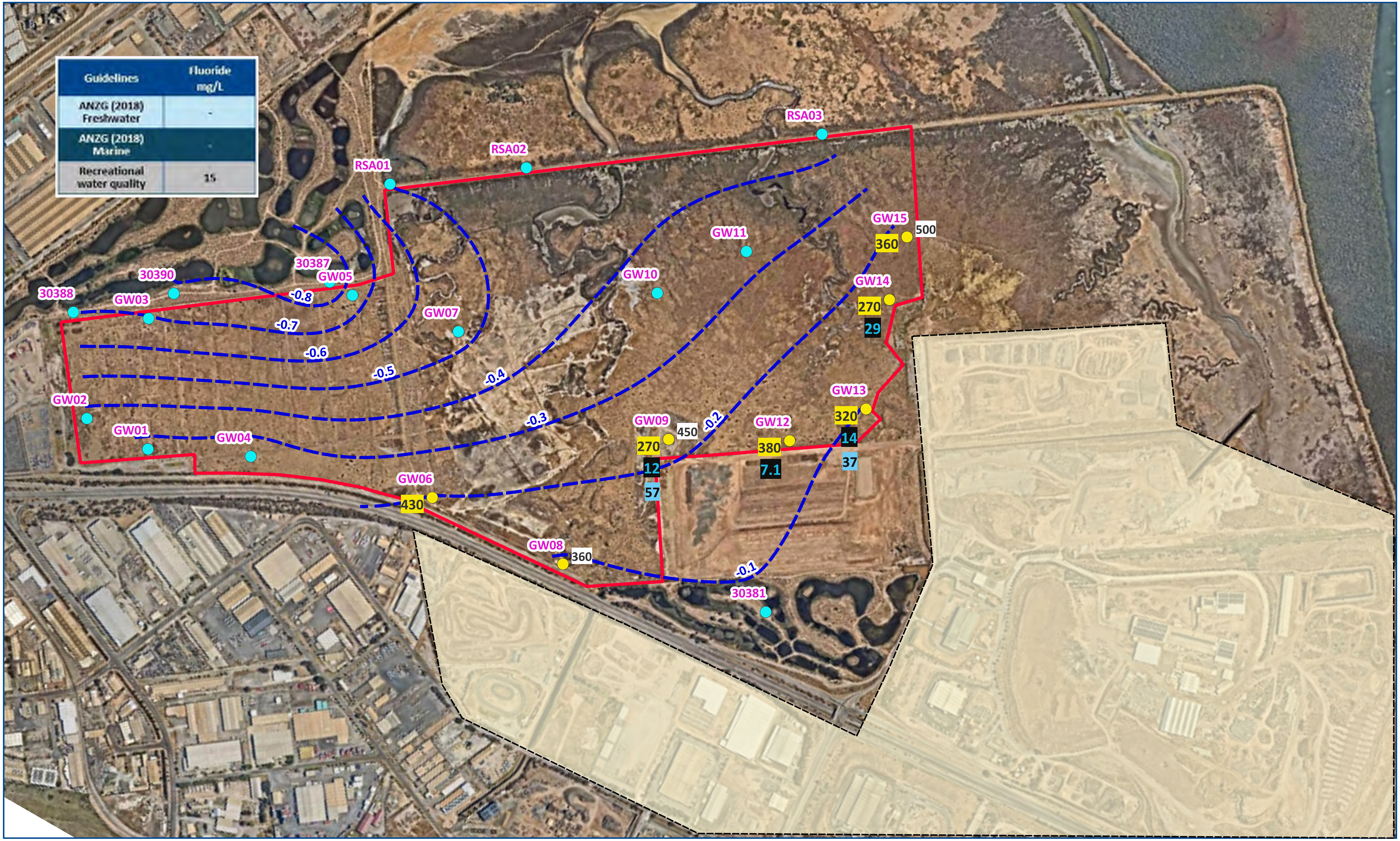
Prepared by Agon



Guidelines	Fluoride mg/L
ANZG (2018) Freshwater	-
ANZG (2018) Marine	-
Recreational water quality	15

Figure A16: Groundwater Landfill Related Chemicals

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

0,00	Fluoride Exceedances
0,00	Carbon dioxide Distribution
0,00	Total Organic Carbon Distribution
0,00	Chemical Oxygen Demand Distribution
▨	Inferred area of landfilling activities

Monitoring Well
- ● Tested
- ● Not Tested
- 🟥 Boundary
- — Groundwater Contours

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0 100 200 m

N

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Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

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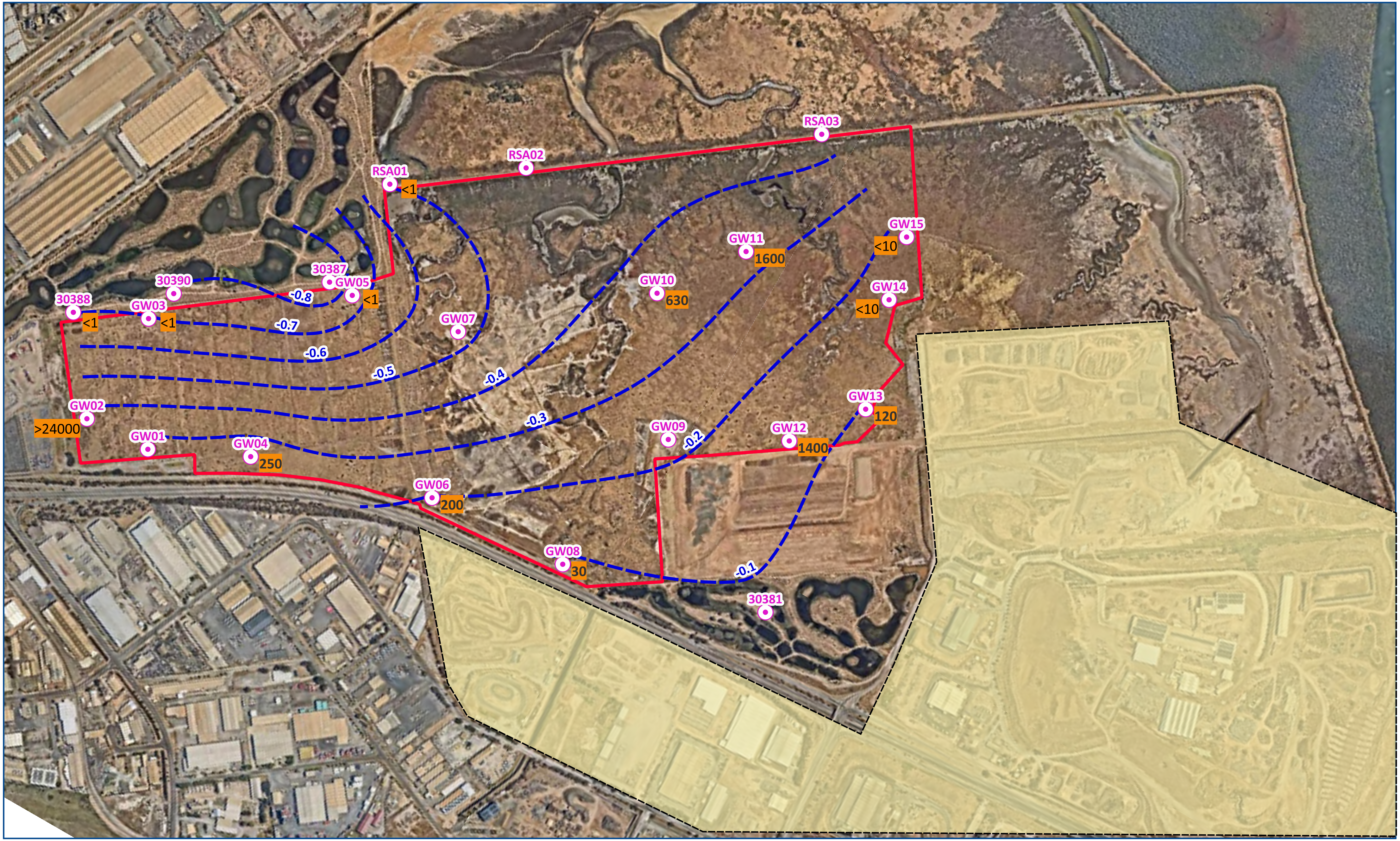

Figure A17: Coliforms Distribution

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

0,00 Total Coliform (MPN/100ml)
▨ Inferred area of landfilling activities
▭ Boundary
— Groundwater Contours
◉ Groundwater Locations

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0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

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Figure A18: Section 83A Notifications Relevant to the Site

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Legend

- ● Ground Water Well
- ▨ Section 83A Location Sites

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0 500 1,000 m
N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap,2024

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Figure A19: Surface Water and Groundwater Electrical Conductivity mS/cm (EC)

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

- 🟥 Boundary
- ⊙ Offsite groundwater well
- ⊙ Onsite groundwater well
- ✕ Datalogger Tides
- ✚ Surface Water Point
- → Inferred discharge water movements from wetlands

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0 100 200 m

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

N

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Guidelines	Analyte	Ammonia as N	Antimony	Aluminium	Copper	Lead	Zinc
	Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
ANZG (2018) Freshwater 95%		0.9	0.009	0.055	0.0014	0.0034	0.008
ANZG (2018) Marine water 95%		0.91	-	-	0.0013	0.0044	0.015
Recreational water quality and aesthetics			0.03	-	20	0.1	-

Figure A20: Surface Water Exceedances Ammonia, Copper, Aluminium, Lead, Zinc and Antimony

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

🟩 0,00	Ammonia as "N" Exceedances
🟨 0,00	Copper Exceedances
🟦 0,00	Aluminium Exceedances
■ 0,00	Lead Exceedances
🟪 0,00	Zinc Exceedances
0,00	Antimony Exceedances
●	Not Detected
—	Groundwater Contours
☐	Boundary

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N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

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Analyte	Unit	SW-4
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00001
Perfluoroheptanoic acid (PFHpA)	mg/L	0.00001
Perfluorohexanoic acid (PFHxA)	mg/L	0.00003
Perfluorooctanoic acid (PFOA)	µg/L	0.02
Perfluoropentanoic acid (PFPeA)	mg/L	0.00001
Sum of WA DWER PFAS (n=10)*	µg/L	0.12
Perfluorooctanesulfonic acid (PFOS)	µg/L	0.01
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.03
Sum of PFHxS and PFOS	µg/L	0.04
Sum of US EPA PFAS (PFOS + PFOA)*	µg/L	0.03
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	µg/L	0.06
Sum of PFAS	mg/L	0.00012

Analyte	Unit	SW-3
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00001
Perfluoroheptanoic acid (PFHpA)	mg/L	0.00001
Perfluorohexanoic acid (PFHxA)	mg/L	0.00004
Perfluorooctanoic acid (PFOA)	µg/L	0.02
Perfluoropentanoic acid (PFPeA)	mg/L	0.00002
Sum of WA DWER PFAS (n=10)*	µg/L	0.15
Perfluorooctanesulfonic acid (PFOS)	µg/L	0.01
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.04
Sum of PFHxS and PFOS	µg/L	0.05
Sum of US EPA PFAS (PFOS + PFOA)*	µg/L	0.03
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	µg/L	0.07
Sum of PFAS	mg/L	0.00015

Analyte	Unit	SW-9
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00003
Perfluoroheptanoic acid (PFHpA)	mg/L	0.00004
Perfluorohexanoic acid (PFHxA)	mg/L	0.00005
Perfluorooctanoic acid (PFOA)	µg/L	0.05
Perfluoropentanoic acid (PFPeA)	mg/L	0.00005
Perfluoropentane sulfonic acid (PFPeS)	mg/L	0.00001
Perfluoropropanesulfonic acid (PFPrS)	mg/L	0.00002
Sum of WA DWER PFAS (n=10)*	µg/L	0.28
Perfluorooctanesulfonic acid (PFOS)	µg/L	0.03
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.03
Sum of PFHxS and PFOS	µg/L	0.06
Sum of US EPA PFAS (PFOS + PFOA)*	µg/L	0.08
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	µg/L	0.11
Sum of PFAS	mg/L	0.00031

Analyte	Unit	SW-10
Perfluorobutanoic acid (PFBA)	mg/L	0.00006
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00002
Perfluoroheptanoic acid (PFHpA)	mg/L	0.00003
Perfluorohexanoic acid (PFHxA)	mg/L	0.00006
Perfluorooctanoic acid (PFOA)	µg/L	0.03
Perfluoropentanoic acid (PFPeA)	mg/L	0.00006
Sum of WA DWER PFAS (n=10)*	µg/L	0.3
Perfluorooctanesulfonic acid (PFOS)	µg/L	0.02
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.02
Sum of PFHxS and PFOS	µg/L	0.04
Sum of US EPA PFAS (PFOS + PFOA)*	µg/L	0.05
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	µg/L	0.07
Sum of PFAS	mg/L	0.0003

Analyte	Unit	SW-2
Perfluorohexanoic acid (PFHxA)	mg/L	0.00001

Analyte	Unit	SW-5
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00001
Perfluorohexanoic acid (PFHxA)	mg/L	0.00002

Analyte	Unit	SW-12
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00002
Perfluoroheptanoic acid (PFHpA)	mg/L	0.00002
Perfluorohexanoic acid (PFHxA)	mg/L	0.00004
Perfluorononanoic acid (PFNA)	mg/L	0.00002
Perfluorooctanoic acid (PFOA)	µg/L	0.03
Perfluoropentanoic acid (PFPeA)	mg/L	0.00002
Sum of WA DWER PFAS (n=10)*	µg/L	0.21
Perfluorooctanesulfonic acid (PFOS)	µg/L	0.03
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.05
Sum of PFHxS and PFOS	µg/L	0.08
Sum of US EPA PFAS (PFOS + PFOA)*	µg/L	0.06
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	µg/L	0.11
Sum of PFAS	mg/L	0.00023

Analyte	Unit	SW-12
Perfluorobutane sulfonic acid (PFBS)	mg/L	0.00002
Perfluoroheptanoic acid (PFHpA)	mg/L	0.00002
Perfluorohexanoic acid (PFHxA)	mg/L	0.00004
Perfluorononanoic acid (PFNA)	mg/L	0.00002
Perfluorooctanoic acid (PFOA)	µg/L	0.03
Perfluoropentanoic acid (PFPeA)	mg/L	0.00002
Sum of WA DWER PFAS (n=10)*	µg/L	0.21
Perfluorooctanesulfonic acid (PFOS)	µg/L	0.03
Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.05
Sum of PFHxS and PFOS	µg/L	0.08
Sum of US EPA PFAS (PFOS + PFOA)*	µg/L	0.06
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	µg/L	0.11
Sum of PFAS	mg/L	0.00023

Figure A21: Surface Water PFAS Detections

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

● Detected
● Non- Detected
🟥 Boundary

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Adelaide, SA 5063
agonenviro.com.au

0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

REVISION: 1
Date 10/05/2024
Reference: JC1406
Prepared by Agon

Figure A22: Surface Water Landfill Related Chemicals

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

- 0,00 Carbon dioxide Distribution
- 0,00 Total Organic Carbon Distribution
- 0,00 Chemical Oxygen Demand Distribution
- ▨ Inferred area of landfilling activities
- ● Surface Water Locations
- □ Boundary

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ENVIRONMENTAL

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3/224 Glen Osmond Rd,
Adelaide, SA 5063
agonenviro.com.au

0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023

REVISION: 1
Date 5/03/2024
Reference: JC1406
Prepared by Agon

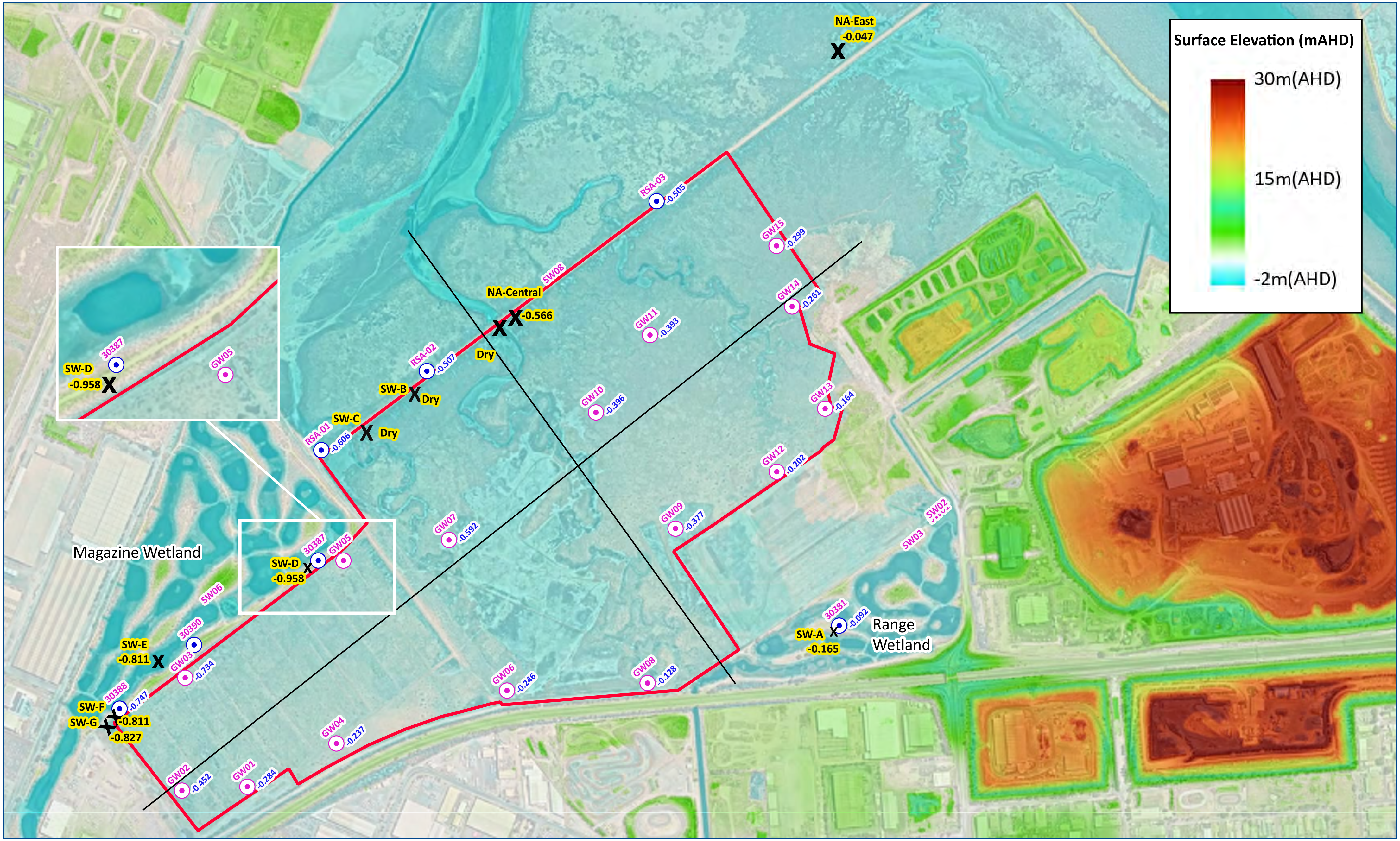

Figure A23: Surface Water and Groundwater Level Elevations

North South Corridor
Gillman, South Australia
Prepared for: Department for Infrastructure and Transport

Legend

- ▭ Boundary
- ⊙ Offsite Groundwater Location
- ⊙ Onsite Groundwater Location
- ✕ Surface Water Level Location (mAHD) 29 February 2024
- + Cross Section Lines
- -0.00 Groundwater Level Elevation (mAHD) 13 February 2024
- -0.00 Surface Water Level Elevation (mAHD) 29 February 2024

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0 100 200 m

N

Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA 2020 MGA Zone 54
Aerial Image: Nearmap 2023
Source: Adelaide Metro Lidar
Department of Environment, 2022

REVISION: 1
Date 5/03/2024
Reference: JC1406
Prepared by Agon

APPENDIX B: ECOLOGICAL INVESTIGATION LEVEL CALCULATIONS

Inputs
Select contaminant from list below
As
Below needed to calculate fresh and aged ACLs
Below needed to calculate fresh and aged ABCs
or for fresh ABCs only
or for aged ABCs only

Outputs		
Land use	Arsenic generic EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	20	40
Urban residential and open public spaces	50	100
Commercial and industrial	80	160

Inputs
Select contaminant from list below
DDT
Below needed to calculate fresh and aged ACLs
Below needed to calculate fresh and aged ABCs
or for fresh ABCs only
or for aged ABCs only

Outputs		
Land use	DDT generic EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	3	3
Urban residential and open public spaces	180	180
Commercial and industrial	640	640

Inputs
Select contaminant from list below
Naphthalene
Below needed to calculate fresh and aged ACLs
Below needed to calculate fresh and aged ABCs
or for fresh ABCs only
or for aged ABCs only

Outputs		
Land use	Naphthalene generic EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	10	10
Urban residential and open public spaces	170	170
Commercial and industrial	370	370

Inputs
Select contaminant from list below
Pb
Below needed to calculate fresh and aged ACLs
Below needed to calculate fresh and aged ABCs
or for fresh ABCs only
or for aged ABCs only

Outputs		
Land use	Lead generic EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	110	470
Urban residential and open public spaces	270	1100
Commercial and industrial	440	1800

Inputs
Select contaminant from list below
Cu
Below needed to calculate fresh and aged ACLs
Enter cation exchange capacity (silver thiourea method) (values from 0 to 100 cmolc/kg dwt)
23.24
Enter soil pH (calcium chloride method) (values from 1 to 14)
5.81
Enter organic carbon content (%OC) (values from 0 to 50%)
1.2
Below needed to calculate fresh and aged ABCs
Measured background concentration (mg/kg). Leave blank if no measured value
or for fresh ABCs only
Enter iron content (aqua regia method) (values from 0 to 50%) to obtain estimate of background concentration
1.07
or for aged ABCs only
Enter State (or closest State)
SA
Enter traffic volume (high or low)
low

Outputs		
Land use	Cu soil-specific EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	50	70
Urban residential and open public spaces	95	180
Commercial and industrial	140	260

Inputs
Select contaminant from list below
Ni
Below needed to calculate fresh and aged ACLs
Enter cation exchange capacity (silver thiourea method) (values from 0 to 100 cmolc/kg dwt)
23.24
Below needed to calculate fresh and aged ABCs
Measured background concentration (mg/kg). Leave blank if no measured value
or for fresh ABCs only
Enter iron content (aqua regia method) (values from 0 to 50%) to obtain estimate of background concentration
1.05
or for aged ABCs only
Enter State (or closest State)
SA
Enter traffic volume (high or low)
low

Outputs		
Land use	Ni soil-specific EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	20	55
Urban residential and open public spaces	100	300
Commercial and industrial	190	510

Inputs
Select contaminant from list below
Cr_III
Below needed to calculate fresh and aged ACLs
Enter % clay (values from 0 to 100%)
5
Below needed to calculate fresh and aged ABCs
Measured background concentration (mg/kg). Leave blank if no measured value
or for fresh ABCs only
Enter iron content (aqua regia method) (values from 0 to 50%) to obtain estimate of background concentration
1.05
or for aged ABCs only
Enter State (or closest State)
SA
Enter traffic volume (high or low)
low

Outputs

Land use	Cr III soil-specific EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	60	120
Urban residential and open public spaces	140	330
Commercial and industrial	230	540

Inputs
Select contaminant from list below
Zn
Below needed to calculate fresh and aged ACLs
Enter cation exchange capacity (silver thiourea method) (values from 0 to 100 cmolc/kg dwt)
23.24
Enter soil pH (calcium chloride method) (values from 1 to 14)
5.81
Below needed to calculate fresh and aged ABCs
Measured background concentration (mg/kg). Leave blank if no measured value
or for fresh ABCs only
Enter iron content (aqua regia method) (values from 0 to 50%) to obtain estimate of background concentration
1.05
or for aged ABCs only
Enter State (or closest State)
SA
Enter traffic volume (high or low)
low

Outputs		
Land use	Zn soil-specific EILs (mg contaminant/kg dry soil)	
	Fresh	Aged
National parks and areas of high conservation value	45	130
Urban residential and open public spaces	140	400
Commercial and industrial	220	600