Nuclear-Powered Submarine Construction Yard EIS – Physical Environment

URPS

Draft Report (RevC)

JBS&G 67064 | 160,339

11 November 2024

JBS&G

We acknowledge the Traditional Custodians of Country throughout Australia and their connections to land, sea and community.

We pay respect to Elders past and present and in the spirit of reconciliation, we commit to working together for our shared future.

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Abbreviations

Term	Definition
ACM	Asbestos Containing Material
AEP	Annual Exceedance Probability
ANI	Australian Naval Infrastructure
ANSIS	Australian National Soil Information System
ASA	Australian Submarine Agency
ASS	Acid Sulfate Soils
ASSMP	Acid Sulfate Soil Management Plan
CEMP	Construction Environment Management Plan
COPC	Chemicals of Potential Concern
CT	Certificate of Title
DMP	Dewatering Management Plan
EIS	Environmental Impact Statement
EPA SA	Environment Protection Authority South Australia
GDE	Groundwater Dependent Ecosystems
IFD	Intensity-Frequency-Duration
mAHD	Metres Australian Height Datum
PASS	Potential Acid Sulfate Soils
PCA	Potentially Contaminating Activities
PSI	Preliminary Site Investigation
SAQP	Sampling, Analysis and Quality Plan
SCY	Submarine Construction Yard
TDS	Total Dissolved Solids
WDF	Waste Derived Fill

Executive Summary

Overview

JBS&G Australia Pty Ltd (JBS&G) was engaged by URPS, acting on behalf of Australian Naval Infrastructure (ANI), to complete the Physical Environmental chapter of the Environmental Impact Statement (EIS) for the nuclear-powered Submarine Construction Yard (SCY). The investigations completed by JBS&G (and this chapter of the EIS) relate only to the land-based portion of the subject site.

This report provides a summary of the existing conditions and potential impact and risk for the physical environment including soil, landform, geology, surface water and groundwater. It is based on the outcomes of the investigation report included as **Appendix A.**

Existing Environment

The site is underlain by the St Kilda Formation, which includes light grey shelly stranded beach ridge deposits and shelly silts and sand overlain in places by modern intertidal and swamp deposits. However, over the last 50 to 100 years, mangroves and swamp areas on the Lefevre Peninsula have been reclaimed through the deposition of fill (including spoil dredged from the Port River, and less commonly, industrial by-products such as Penrice grit, ash / cinders and slag).

Due to the soils present and the locality, the site may be impacted by land subsidence and seawater inundation in the future.

The subject site is not considered to be in an area of elevated seismic hazard for the purposes of this assessment.

Hydrogeology in the Lefevre Peninsula comprises five to six Quaternary aquifers and three to four Tertiary aquifers. The upper three Quaternary aquifers are the only aquifers likely to be impacted by the development (i.e. by dewatering through construction). The first Quaternary aquifer (Q1) is present at depths of approximately 3 mbgl, with an average thickness of 2 m. The Q2 and Q3 aquifers are expected to be present at depths of approximately 16 mbgl and 31 mbgl, respectively. Both the Q2 and Q3 aquifers have an average thickness of 2 m (Gerges 2006[1]).

A search of current licenced bores (installed in the Q1 and Q2 aquifers) indicates there are bores within close proximity to the subject site which are registered for domestic and irrigation purposes, noting these bores are installed in the Q1 aquifer. Potential changes to hydrology due to the development (e.g. dewatering) has the potential to impact on these registered bores.

An assessment of site contamination was undertaken in accordance with the *National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM)*[2] provides, which included a limited preliminary site investigation (PSI), soil investigation and groundwater investigation (JBS&G 2024a[3]). The following key outcomes were noted:

- Several potentially contaminating activities (PCAs) were identified as having previously occurred onsite, including:
    - Dredge spoil disposal or storage;

[1] *Overview of the hydrogeology of the Adelaide metropolitan area, DWLBC Report 2006/10*, Nabil Gerges, June 2006 (Gerges 2006).
[2] *National Environment Protection (Assessment of Site Contamination) Measure,* National Environment Protection Council, 1999 as amended 2013 (NEPC, 2013).
[3] *Nuclear-Powered Submarine Construction Yard – Site Contamination Assessment,* JBS&G Australia Pty Ltd, 11 November 2024 (JBS&G 2024a).

- Fill or soil importation;
- Wetlands or detention basins; and
- Potential burial and asbestos containing materials (ACM).

Several offsite PCAs were also identified, noting that with the exception of the railway line, these PCAs were considered unlikely to impact the contamination status of soils at the site. Groundwater offsite is known to be impacted by a number of contaminants, including metals, per- and polyfluoroalkyl substances (PFAS) and cyanide, and hence there is potential that groundwater beneath the site would be similarly impacted;

- All soil samples collected returned results below the adopted criteria for commercial / industrial landuse with the exception of copper in one sample from Area 1 which exceeded ecological criteria only (noting this was not considered to be significant in the context of the proposed development), and lead in one sample from Area 2 which exceeded both ecological and human health criteria. This elevated lead concentration appeared to be isolated, however, further investigation has been proposed to assess the extent of lead in this area;
- Acid sulfate soils (ASS) and potential acid sulfate soils (PASS) were not encountered, noting the testing to date has been limited to the upper 3 m of the site. Further investigation has been proposed in the area where dewatering is likely to be required (Area 3) to allow assessment of deeper soils;
- Site contamination of groundwater exists across the site, with a number of contaminants reported at concentrations above the adopted Tier 1 groundwater screening levels for relevant environmental values of groundwater. However, with the potential exception of PFAS, the site contamination is unlikely to be site derived, given the site history and reported soil concentrations;
- Whilst site contamination of groundwater exists across the site, it is unlikely to be associated with a risk to onsite receptors (workers) following completion of construction. Construction workers may be exposed to groundwater during the construction stage of the project, and this exposure requires management;
- Methane was reported at elevated concentrations in the majority of wells (mainly Area 1 and 2), noting this is likely to be naturally occurring rather than a result of PCAs at the site. Whilst there are no screening levels provided by the adopted sources for assessment of methane and it is unlikely to present a risk via the direct contact pathway, methane is a volatile chemical and has the potential impact the project (both construction and operation) via the vapour pathway. Further investigation has been proposed to assess the risks from methane via the vapour pathway; and
- It is likely that dewatering waste water will require treatment prior to disposal to marine or freshwater, due to elevated concentrations of a number of contaminants which exceed the criteria provided by EPA 1093/21 (EPA, 2021).

Impact Assessment

Construction

The following potential impacts were identified as associated with the construction phase:

- Disturbance of contaminated soil through excavation;
- Potential disturbance of coastal acid sulfate soils;
- Potential contamination of soils / groundwater from spills during construction;
- Management of soil generated from earthworks;
- Importation of additional soil required to achieve the derived site levels;

- Erosion and sedimentation;
- Soil compaction;
- Seismic hazard; and
- Dewatering of excavations.

Operation

The following potential impacts were identified as associated with the operational phase:

- Potential contamination of soils / groundwater from spills during site operation;
- Erosion and sedimentation;
- Seawater inundation; and
- Dewatering of excavations (if required during the operational phase).

Mitigation Measures

A summary of the key mitigation measures relating to soil, terrain and hydrology are included in **Table ES-1**.

Table ES-1: Key Mitigation Measures – Soils, Terrain and Hydrology

Mitigation Measure	Construction	Operation
Undertake storage and handling of fuel and chemicals in accordance with relevant standards and guidelines (e.g. storage in bunded areas in accordance with AS 1940 and EPA guidelines).	✓	✓
Maintain an incident procedure to contain and clean up spills if they occur.	✓	✓
Avoid refuelling activities in close proximity to the Port River (e.g. 50 m).	✓	✓
Ensure any additional soils required to achieve the derived site levels are either virgin quarry material or waste derived fill (WDF) suitable for commercial / industrial landuse (to be assessed as suitable for use at the site by a Site Contamination Consultant or a Site Contamination Auditor, depending on the classification).	✓	
Ensure that any surplus soils are classified in accordance with the WDF standard (EPA SA, 2013) for re-use in a different area of the site, re-use offsite or disposal to a licensed landfill.	✓	
Ensure that any stockpiles onsite are managed in accordance with EPA *Guideline for Stockpile Management* (Updated 2020).	✓	
Install sediment and erosion controls where required (e.g. temporary berms, drainage controls, stockpile management and stabilisation of non-paved operational areas).	✓	✓
Restrict heavy vehicle traffic to access tracks.	✓	
Develop a protocol for dealing with acid sulfate soils, if encountered during construction.	✓	
Develop a protocol for dealing with potentially contaminated soils and groundwater, if encountered during construction.	✓	
Regularly monitor for potential impacts to soils and hydrology (e.g. erosion, subsidence, bunding and storage, leaks from machinery) and implement further mitigation measures where required.	✓	✓

Mitigation Measure	Construction	Operation
Proposed building at the subject site will be designed in accordance with the requirements of AS 1170.4 (Standards Australia, 2007) at a minimum to ensure that seismic hazard is appropriately addressed. It is noted that further seismic investigation is being completed in the Siting and Site Evaluation Report (SSER) as part of the nuclear approvals process for Area 2 and Area 3. The SSER should be referred to in relation to seismic hazard for Area 2 and Area 3.	✓	
Implement appropriate measures for trench dewatering and waste water disposal (such as water treatment, removal, or disposal).	✓	✓
Further investigation of HGG (the scope of these proposed works are detailed in the SAQP included as **Appendix C**, with these additional works to be implemented prior to the commencement of site works). Should these further works identify a potential risk for the construction phase, mitigation measures will be included in an updated EIS (Physical Environment).	✓	✓

Limitations / Assumptions

The outcomes of this EIS chapter are subject to the following:

- The limitations in **Section 7**;
- The limitations of the reports on which this EIS chapter is based (see **Appendix A**); and
- The outcomes of the further works detailed in two Sampling, Analysis and Quality Plans (SAQP; **Appendix B** and **Appendix C**).

Note: At time of writing and parallel to this assessment, it is understood the Siting and Site Evaluation Report (SSER) was being prepared for the SCY site. The SSER documents and characterises the natural and human induced hazards that could affect the safety of the nuclear licenced activities where they occur at the site. The SSER may identify additional considerations and mitigations needed for this discipline, specific to undertaking nuclear licenced activities that have not been specifically considered in this assessment. Furthermore, results of any assessment works undertaken as part of the SSER have not been shared with JBS&G, and there is potential these results could affect the managements measures outlined in this EIS. The SSER (and any associated assessment reports) should be reviewed on completion, and the EIS updated if these reports alter the understanding of the site contamination status of the site.

1. Introduction

The Australian Submarine Agency (ASA) was established in July 2023 to safely and securely acquire, construct, deliver, technically govern, sustain and dispose of Australia's conventionally-armed nuclear-powered submarine capability for Australia.

Australian Naval Infrastructure (ANI) as the owner and manager of the existing Osborne Naval Shipyard is proposing the development of adjacent land to construct a new, purpose-built, secure, nuclear-powered Submarine Construction Yard (SCY) – shown in **Figure 1-1**. The SCY will provide a facility for the construction of the submarines by a third-party ship builder, for delivery to ASA.

The Minister for Planning declared the SCY as an impact assessed development under section 108 (1)(c) of the *Planning, Development and Infrastructure Act 2016*, which requires the preparation of an Environmental Impact Statement (EIS).

JBS&G Australia Pty Ltd (JBS&G) was engaged by URPS, acting on behalf of ANI, to complete the Physical Environmental chapter of the EIS for the SCY. The investigations completed by JBS&G (and this chapter of the EIS) relate only to the land-based portion of the subject site.

This report provides a summary of the existing conditions and potential impact and risk for the physical environment including soil, landform, geology, surface water and groundwater. It is based on the outcomes of the investigation report included as **Appendix A**.

Note: At time of writing and parallel to this assessment, it is understood the Siting and Site Evaluation Report (SSER) was being prepared for the SCY site. The SSER documents and characterises the natural and human induced hazards that could affect the safety of the nuclear licenced activities where they occur at the site. The SSER may identify additional considerations and mitigations needed for this discipline, specific to undertaking nuclear licenced activities that have not been specifically considered in this assessment. Furthermore, results of any assessment works undertaken as part of the SSER have not been shared with JBS&G, and there is potential these results could affect the managements measures outlined in this EIS. The SSER (and any associated assessment reports) should be reviewed on completion, and the EIS updated if these reports alter the understanding of the site contamination status of the site.

Legend

- Site Boundary
- Not Subject to Site Contamination Investigation - Not Included in EIS

JBS&G

Job No: 67064	
Client: URPS	
Version: FINAL	Date: 05-Nov-2024
Drawn By: JS	Checked By: KL
Scale 1:15,000	

0 250 500
Metres

Coord. Sys. GDA2020 MGA Zone 54

Osborne, South Australia

LOCATION OF THE NUCLEAR-POWERED SUBMARINE CONSTRUCTION YARD (OSBORNE)

FIGURE 1

File Name: C:\Users\jstrauss\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\URPS\64648_OsborneSouthAustralia\02_MapProjects\67064_URPS_Osborne_Consolidated2023-2024.aprx; Name:67064_01_Location of Nuclear Submarine Construction Yard (Osborne)
Reference: ESRI Imagery Hybrid Basemap - Accessed Imagery: 05/11/2024 & www.nearmap.com - Imagery Date: 4/05/2024

2. Setting the context

2.1 EIS Assessment Requirements

The final EIS Assessment Requirements for the Project were issued by PLUS on 8 August 2024 and include an assessment of the effect on the Physical Environment as set out in **Table 2-1**. As noted in **Section 1**, the investigations completed by JBS&G (and this chapter of the EIS) relate only to the land-based portion of the subject site.

Table 2-1: EIS Assessment Requirements - Physical Environment

Library Ref.	Environmental Attribute	Objective	Assessment Requirement Addressed	Assessment Level
HR3	Site and Groundwater Contamination	To ensure the risk of, and adverse impacts from natural and man-made hazards from the development are avoided, minimised or mitigated to protect people, property and the environment.	• Describe the historical land use and potential for contamination of soils and sediments and describe any known or suspected soil contamination that could be re-suspended, released or otherwise disturbed as a result of past or future development. This investigation would also consider any previous use of waste fill or similar materials, including the deposition of dredge spoil from the Port River. • Detail any known or potential sources of contaminated groundwater that could be impacted by the development. • Detail procedures to be adopted to confirm whether site contamination exists (such as site history, site audit, and site contamination reporting) and any remedial measures proposed. • Detail management measures that will be required during construction and operation to prevent site contamination. • Demonstrate compliance with the assessment methodology and site acceptability requirements for the intended use(s) of the development sought by Practice Direction 14 Site Contamination Assessment 2021, Plan SA. • Describe how site and groundwater contamination assessment will be undertaken in accordance with the National Environment Protection (Assessment of Site Contamination) Measure, the EPA Guidelines for the assessment and remediation of site contamination (2019), the PFAS National Environmental Management Plan 2.0, and other relevant guidance issued or referred to by the EPA.	DETAILED

Library Ref.	Environmental Attribute	Objective	Assessment Requirement Addressed	Assessment Level
PE1	Coastal and Marine	To ensure the natural features and processes of coastal systems are protected so that the environmental values of the coast are maintained. To ensure the quality and productivity of marine waters, sediment and biota are protected so that environmental values are maintained.	• Identify any potential for Coastal Acid Sulfate Soils (CASS) to be encountered on the site and how this might be mitigated (refer to the Coast Protection Board policy on CASS).	DETAILED

Library Ref.	Environmental Attribute	Objective	Assessment Requirement Addressed	Assessment Level
PE2	Soils, Landform and Geology	To ensure development is undertaken in a manner that protects the productivity and quality land including, soil, subsoil and landform and avoids impact to other environmental values.	• Provide a description of the soils, landform and geology in the area of the development including the potential for water and wind erosion, soil salinity, acid sulfate soils and soil contamination. The description should: o Characterise soil types and structures in the development area and identify the potential location and disturbance of dispersive, acid sulfate, saline or potentially contaminated soils, or soils of other special characteristics that could affect or be affected by the development. o Identify hydrological, geomorphic or meteorological conditions that may contribute to susceptibility to erosion (e.g., channels, steep slopes, wind). o Identify any areas of ground instability and any ground conditions that may be susceptible to subsidence from development activities (e.g. tunnelling, deep excavation, dewatering) and direct and indirect changes to vegetative cover. Identify properties, structures and infrastructure that may be susceptible to subsidence. Land subsidence may be a relatively significant contributor to sea flood risk in this location and may occur regionally without being generated from incoming development. • Describe the development activities with potential to impact on soils and ground stability. • Address the implications of seismicity in the area in relation to both the construction and operation of the development. • Identify the risks of contamination of land from spills of fuel (or other toxic substances). Describe measures for the prevention and containment of spills, describe the contingency plans to be implemented in the event of spills, and comment on their expected effectiveness. • If acid sulfate soils would be disturbed or unexpectedly encountered during construction, describe measures to avoid oxidation of the sulfides, treat and neutralise the acid if it forms and manage any excavated material. • Ensure that appropriate soil contamination investigations have been undertaken and that soil generated from earthworks is managed in accordance with EPA guidelines, including for re-use on site or removal of material off-site for re-use, treatment or disposal	STANDARD

Library Ref.	Environmental Attribute	Objective	Assessment Requirement Addressed	Assessment Level
PE3	Surface Water and Groundwater	To ensure the quality of groundwater and surface water is protected so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.	• Describe the known groundwater related environmental conditions including quality and significance of groundwater in the area of the development and any surrounding area potentially affected by the proposed development's activities o describe the nature, type, geology / stratigraphy and depth to and thickness of the aquifers, and hydraulic properties. o any existing site contamination, and any identified potential sources of groundwater pollution o characterise the quality and volume of the groundwater including seasonal variations of groundwater levels o describe existing groundwater supply infrastructure (e.g. bores, wells, or excavations). • Describe the legislative, regulatory and planning contexts for groundwater that apply to the development (if applicable). • Describe present and potential users and uses of groundwater water in areas potentially affected by the development, including residential, municipal, agricultural, industrial, recreational and environmental uses of water including groundwater dependent ecosystems (GDE). • Describe the potential changes to hydrology (including water quality), as a result of the proposal, and the implications of these changes. Water quality impacts should consider any parameters (e.g. metals, non-metal inorganics) considered important for existing groundwater users / uses in the vicinity of the projected area of impact. • Where groundwater would be taken by the development, quantify the volume of water that would be taken, the timeframe over which the take would occur and the potential impact on groundwater users (if applicable), noting that as the subject land is in the Central Adelaide Prescribed Wells Area, a water licence will be required for the taking of any groundwater for industrial uses. Include details as to how any dewatered water would be managed and used or disposed of, taking into consideration the waste management hierarchy and any nearby known site contamination. • Describe stormwater and wastewater management and the potential impact on groundwater resources in particular with regard to fuel and chemicals used in construction and / or operation of the development. Describe measures proposed for management of stormwater and wastewater during construction and operation to avoid impacts to groundwater.	DETAILED

2.2 Legislation, Policies and Other Standards

This section provides a high level overview of the key legislation, policies and standards which are relevant to this Project in relation to soil, landform, geology, surface water and groundwater.

The *Landscape South Australia Act 2019* provides for the protection and management of the State's natural resources, including provisions relating to land management, water resources management and pest plant and animal control. Regional landscape plans and control policies are in force under the Act to guide management of water, soil and biological assets and define water affecting activities which require a permit and the regulation framework for surface and groundwater quantity in prescribed areas. The proposed development is within the Green Adelaide Landscape Management Region.

The *Coast Protection Act 1972* was formed to protect, restore and manage the coast to prevent erosion, damage, deterioration, pollution and misuse. Under this Act the Coastal Protection Board is formed and provides a number of guidelines specific to coastal environments.

The *Environment Protection Act 1993* creates a general environmental duty to take all reasonable and practical steps to prevent or minimise any resulting environmental harm. It outlines requirements standards within Environment Protection Policies, including the *Environment Protection (Water Quality) Policy 2015* (Water Quality EPP) which provides the structure for managing and regulating surface and groundwater quality within SA. The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG)*[4] are referenced by the Water Quality EPP and provide additional guidance on planning and managing water quality or sediment quality, including the derivation of guidance values.

The *National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM)*[5] provides nationally consistent guidance on assessment and management of soil contamination.

Guidelines that pertain to the aspects of physical environment discussed in this chapter include:

- *A strategy for Implementing Coast Protection Board Policies on Coastal Acid Sulfate Soils in South Australia*, South Australian Coast Protection Board, January 2003 (South Australian Coast Protection Board, 2003)
- *Australian Standard AS 1940 The storage and handling of flammable combustible liquids*, Standards Australia, 29 October 2004 (Standards Australia, 2004)
- *EPA 080/016, Liquid Storage Guideline – Bunding and spill management,* Environment Protection Authority South Australia, May 2016 (EPA SA, 2016a)
- *EPA 1093/21, Water Quality Guideline – Environmental management of dewatering during construction activities,* Environment Protection Authority South Australia, June 2021 (EPA SA, 2021)
- *EPA 1095 /24 Construction Environmental Management Plan*, Environment Protection Authority South Australia, April 2024 (EPA SA, 2024)
- *EPA 517/16, Information Sheet – Stormwater management for wash bays*, Environment Protection Authority South Australia, March 2016 (EPA SA, 2016b)
- *EPA Guidelines, Site Contamination – acid sulfate soil materials,* Environment Protection Authority South Australia, November 2007 (EPA SA, 2007)

[4] *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management council of Australia and New Zealand, 2018 (ANZG, 2018)
[5] *National Environment Protection (Assessment of Site Contamination) Measure,* National Environment Protection Council, 1999 as amended 2013 (NEPC, 2013).

- *Guidelines for the assessment and remediation of site contamination*, Environment Protection Authority South Australia, November 2019 (EPA SA, 2019)
- *PFAS National Environmental Management Plan, Version 2.0*, National Chemicals Working Group of the Heads of EPAs Australia and New Zealand, January 2020 (HEPA, 2020)
- *Practice Direction 14 – Site Contamination Assessment 2021,* Plan SA, 20 October 2023 (Plan SA, 2023)[6]
- *Standard for the production and use of Waste Derived Fill*, Environment Protection Authority South Australia, October 2013 (EPA SA, 2013)
- *Stormwater Pollution Prevention Code of Practice for the Building and Construction Industry,* Environment Protection Authority South Australia, March 1999 (EPA SA, 1999)
- *Water Sensitive Urban Design Technical Manual – Greater Adelaide Region,* Government of South Australia, December 2010 (Government of South Australia, 2010)

2.3 Views of Stakeholders

No community stakeholder feedback has been received specifically related to water or soil quality. The Environment Protection Authority are responsible for regulation of water quality and soil and water contamination under the legislation and guidelines outlined above, which set out their views.

[6] The site is not changing to a more sensitive landuse, and hence assessment of site contamination was not required under PD14 (Plan SA, 2023). The assessment has been undertaken in response to the Assessment Requirements (see **Section 2.1**).

3. Assessment Method

A limited preliminary site investigation (PSI) and soil investigation was undertaken to assess the contamination status of Area 2 and 3 in 2023, with the same process (i.e. limited PSI and soil investigation) undertaken to assess the contamination status of Area 1 in 2024. A groundwater investigation to assess the contamination status of groundwater beneath the subject site (Area 1, 2 and 3) was also undertaken as part of the scope of work completed in 2024. Reports for the above were consolidated into a single report[7], included in **Appendix A**.

The limited PSI included a desktop review of the site setting, review of the historical land ownership, review of historical use of the site by review of historic directories, review of historical aerial photographs from 1949 to 2023, review of SA EPA information, and site inspection.

The soil investigation included a review of historic data for Area 1, and drilling of a total of 235 soil boreholes to depths between 0.6 mbgl and 3 mbgl across Area 1, 2 and 3, with over 400 samples analysed for a broad range of chemicals. This included the chemicals of potential concern (COPC) associated with the potentially contaminating activities (PCAs) identified at the site (see **Section 4.1**) and contaminants known to be present in the broader Osborne area and Port River. In addition, testing was undertaken for Acid Sulfate Soils (ASS) and Potential Acid Sulfate Soils (PASS). Soil results were assessed against the ASC NEPM (NEPC 2013) criteria for commercial / industrial landuse, and also criteria for offsite disposal / reuse to provide indicative classification should soils be surplus to requirements.

The groundwater investigation included installation of an additional eight groundwater wells targeting the shallow aquifer (Q1 aquifer), at targeted locations across the subject site (Area 1, 2 and 3). These newly installed wells and seven existing wells were sampled to provide a broad assessment of the quality and contamination status of groundwater across the site.

[7] *Nuclear Powered Submarine Construction Yard – Site Contamination Assessment,* JBS&G Australia Pty Ltd, 11 November 2024 (JBS&G 2024a).

4. Description of the Existing Environment

4.1 Potentially Contaminating Activities

The following PCAs were identified in the limited PSIs (JBS&G 2024a) as having occurred onsite:

- Dredge spoil disposal or storage;
- Fill or soil importation;
- Wetlands or detention basins; and
- Potential burial and asbestos containing materials (ACM).

Several offsite PCAs were also identified, noting that with the exception of the railway line these PCAs were considered unlikely to impact the contamination status of soils at the site. Groundwater offsite is known to be impacted by a number of contaminants, including metals, per- and polyfluoroalkyl substances (PFAS) and cyanide, and hence there is potential that groundwater beneath the site would be similarly impacted.

4.2 Climate

Osborne has a mediterranean climate with hot summers and mild winters. Temperature recorded at the Parafield Airport BOM station (the closest BOM station to the subject site for which long term temperature data is available) ranged between an average maximum of 29.9°C in January and an average minimum of 6.3°C in July (see **Figure 4-1**).

Average rainfall recorded at the Parafield Airport BOM station (the closest BOM station to the subject site for which long term rainfall data is available) was approximately 447 mm/year, with the highest rainfall generally between May and September (see **Figure 4-2**).

The Adelaide Airport BOM station (the closest BOM station to the subject site for which wind speed data is available) shows 9 am wind direction predominantly north to north easterly (average monthly speeds between 11.7 and 18.5 km/h) (**Figure 4-3**) and the 3 pm wind direction predominantly south easterly (average monthly speeds between 17.4 to 23.1 km/h) (**Figure 4-4**).

The Annual Exceedance Probability (AEP) for the site was calculated using the 2016 Intensity-Frequency-Duration (IFD) tool available on the BOM website (BOM, 2024[8]). The AEPs are presented in **Figure 4-5**.

[8] http://www.bom.gov.au/water/designRainfalls/revised-ifd/ (accessed online 17 June 2024)

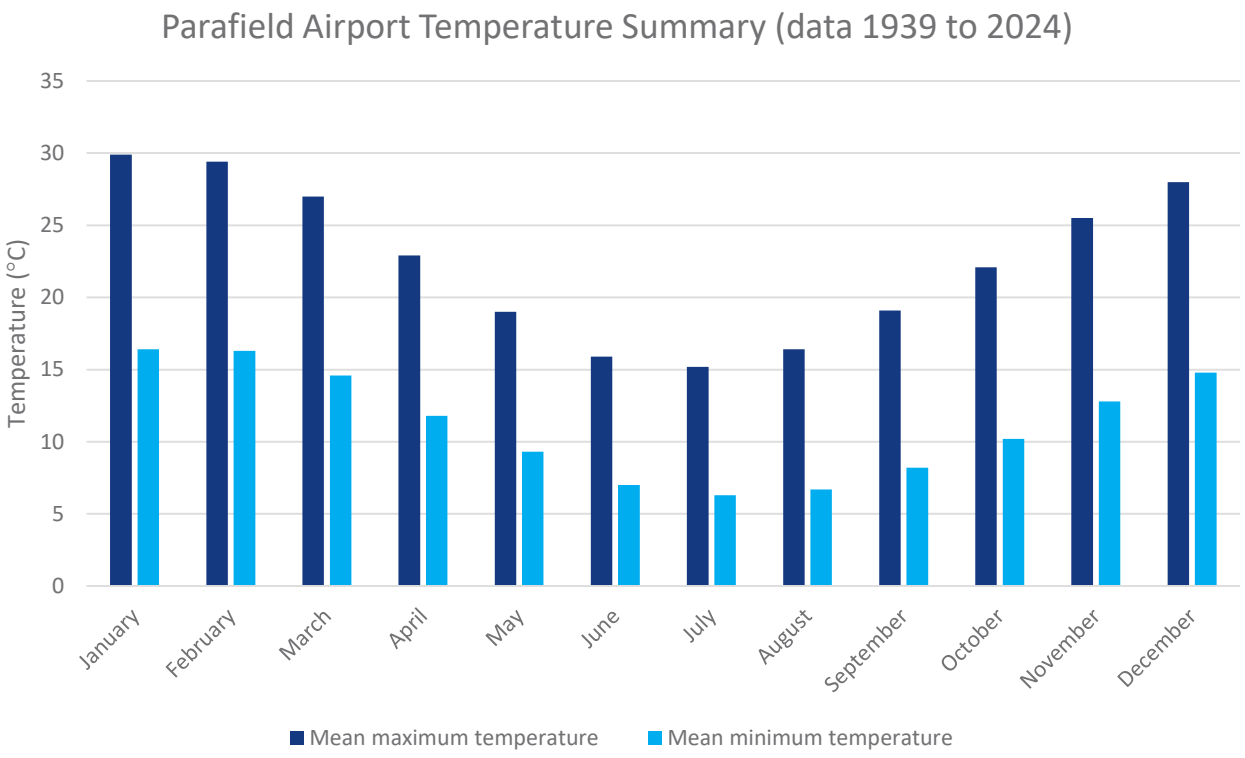


Figure 4-1: Summary of mean temperature at Parafield Airport (BOM, 2024)

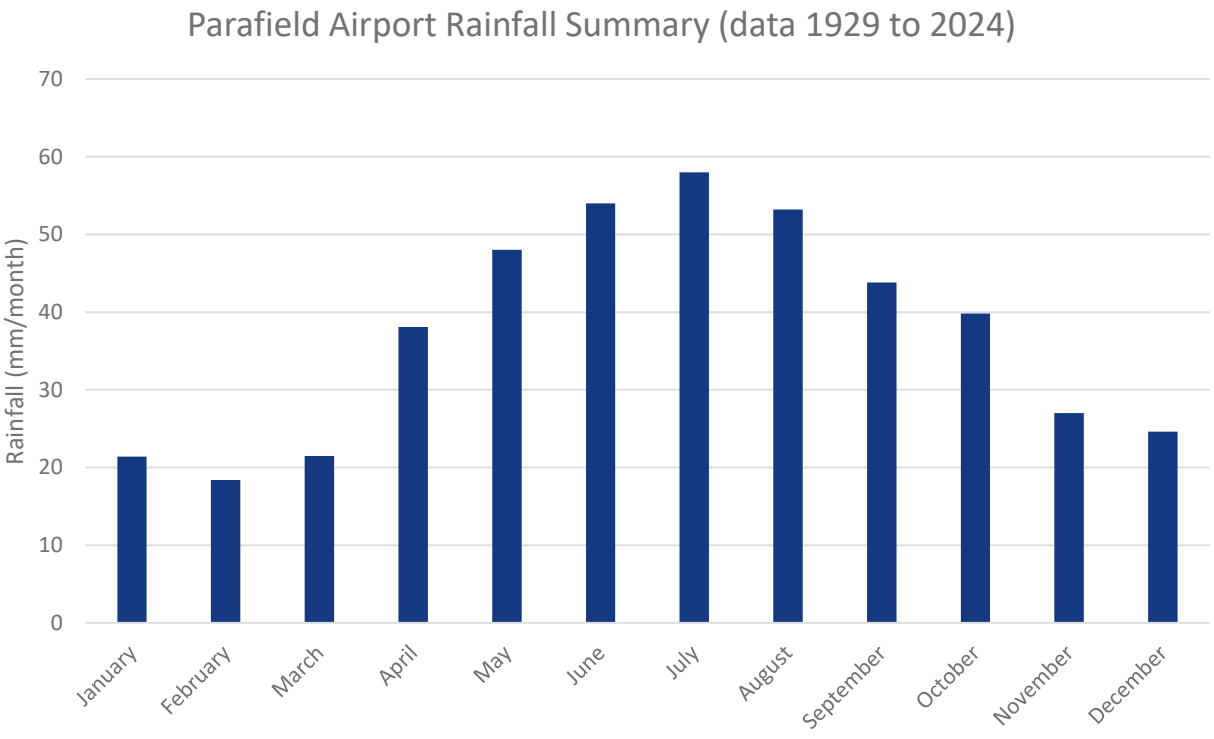


Figure 4-2: Summary of average monthly rainfall at Parafield Airport (BOM, 2024)

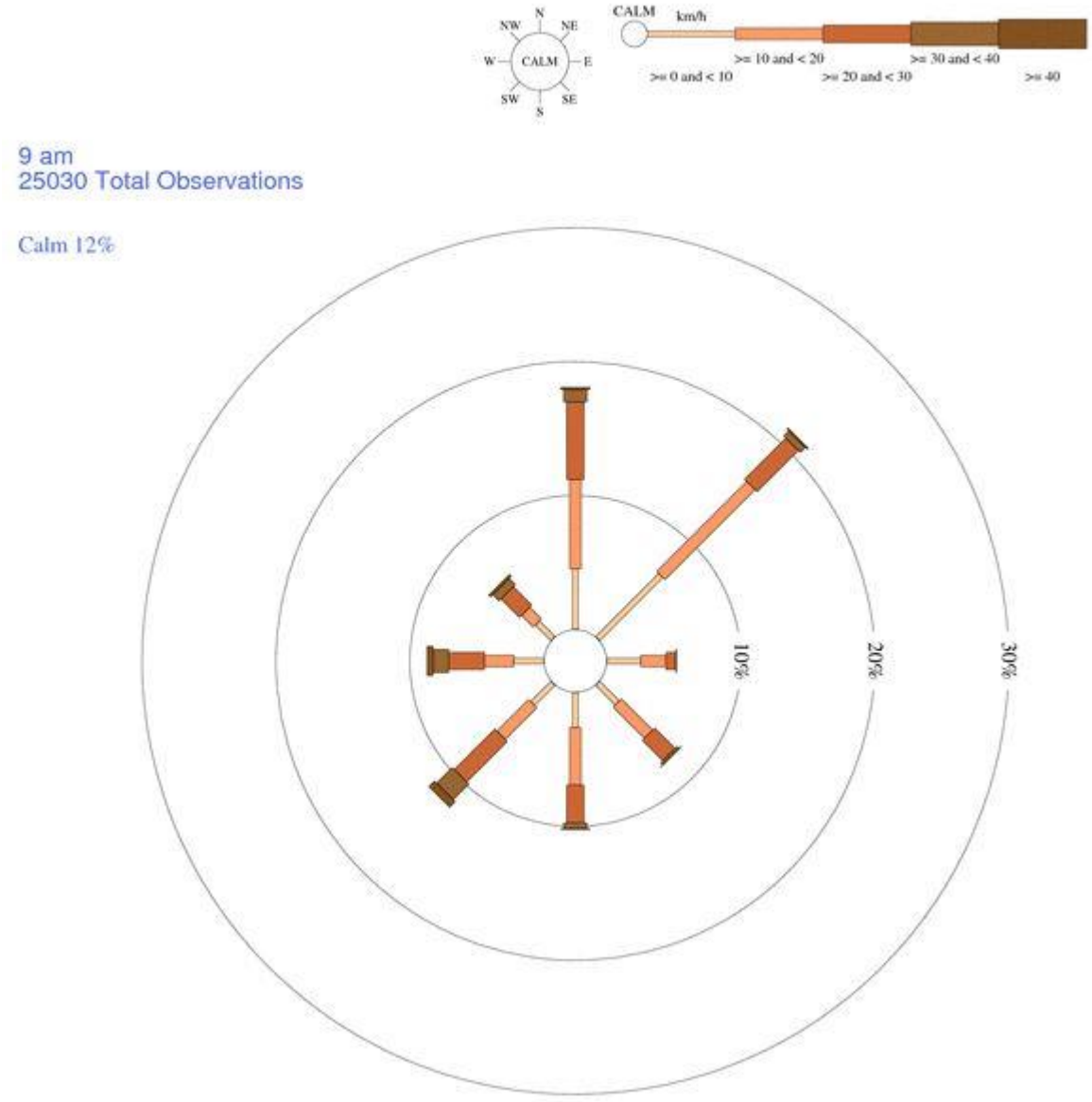


Figure 4-3: Adelaide Airport BOM Station (data 1955 to 2019) – 9am Wind Rose (BOM, 2024)

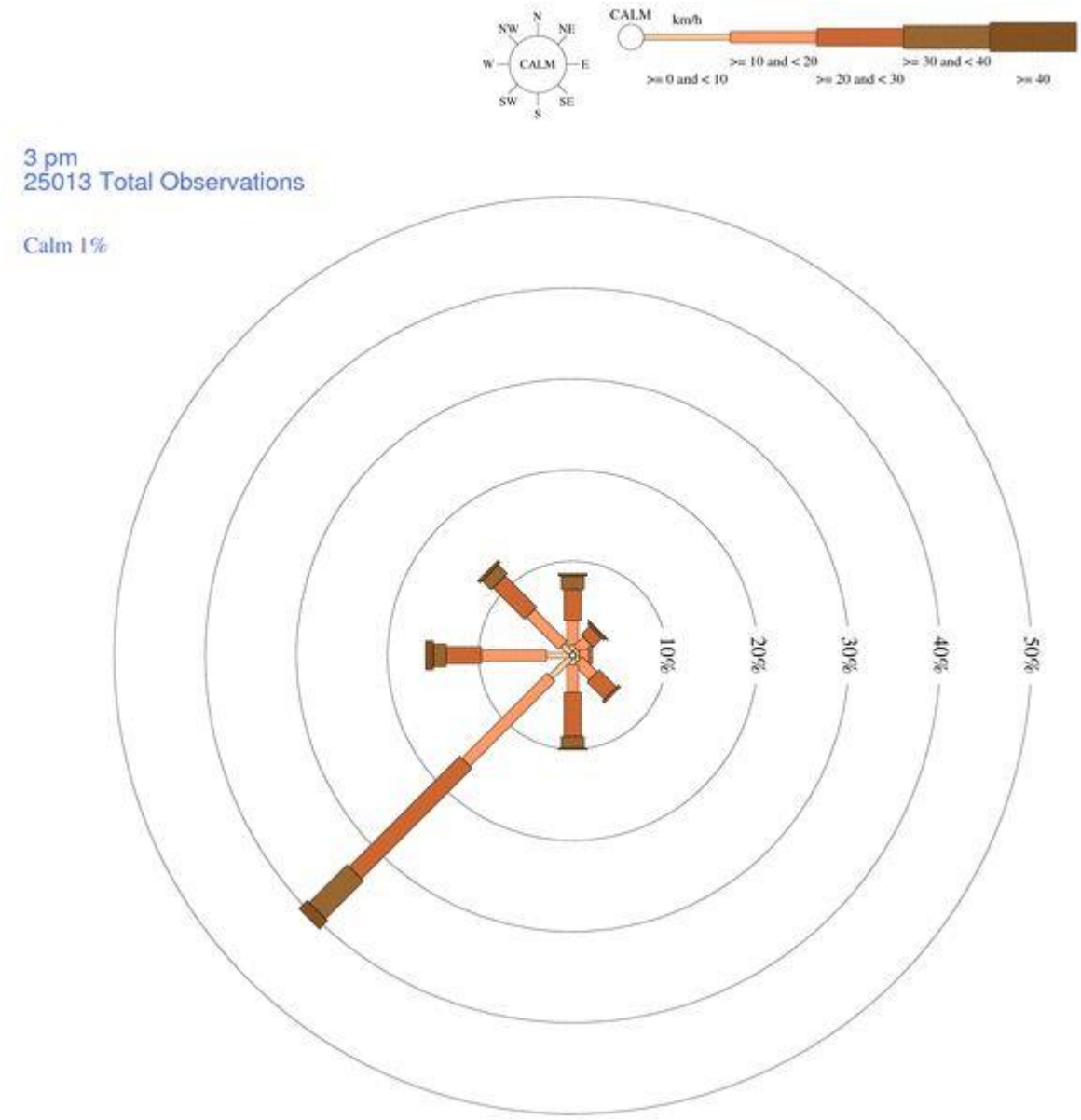


Figure 4-4: Adelaide Airport BOM Station (data 1955 to 2019) – 3pm Wind Rose (BOM, 2024)

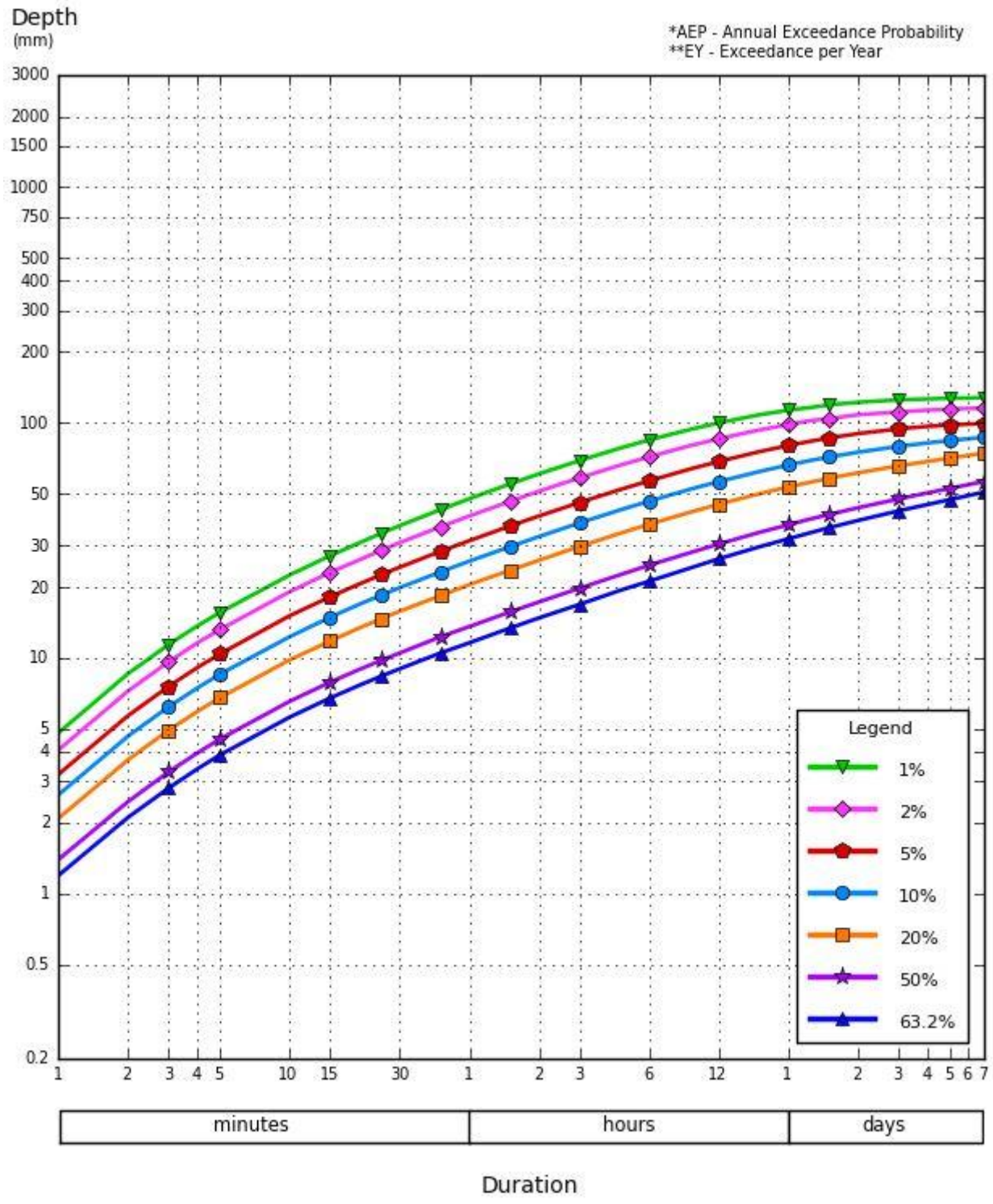


Figure 4-5: Annual Exceedance Probability Graph for the Subject Site (BOM, 2024)

4.3 Earthquake risk

National Seismic Hazard Assessment mapping[9] indicates that the subject site is not in an area of elevated seismic hazard (see **Figure 4-6**), noting seismic hazard is below levels for the Adelaide region.

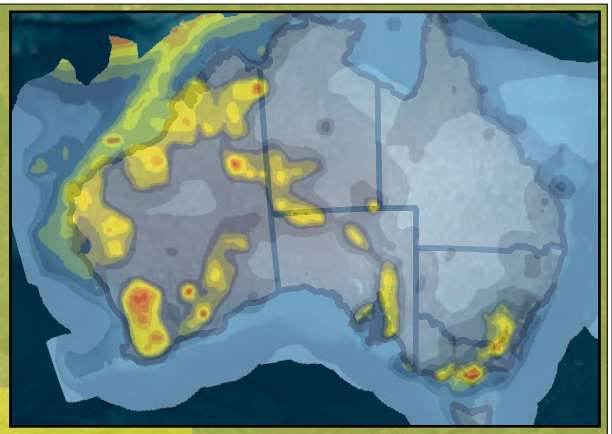
The closest earthquake to the subject site was located approximately 15 km south-east (in North Adelaide), with a magnitude of 2.3 recorded in September 1886 (Geoscience Australia, 2024). Other earthquakes were located between 20 km and 25 km from the subject site, with magnitude ranging between 0.2 and 5.5 recorded between 1840 and 2016 (see **Figure 4-7**).

Based on the above, seismic hazard during construction is not a significant concern for the purpose of this assessment.

The design of structures in Australia is governed by *AS 1170.4 Structural design actions, Part 4: Earthquake actions in Australia*[10]. Proposed building at the subject site will be designed in accordance with the requirements of AS 1170.4 (Standards Australia, 2007) at a minimum to ensure that seismic hazard is appropriately addressed. The portions of the site subject to nuclear licencing requirements may require additional design considerations.

It is noted that further seismic investigation is being completed in the SSER as part of the nuclear approvals process for Area 2 and Area 3. The SSER should be referred to in relation to seismic hazard for Area 2 and Area 3.

[9] http://earthquakes.ga.gov.au (accessed online 25 June 2024; Geoscience Australia, 2024)
[10] *AS 1170.4-2007 Structural design actions, Part 4: Earthquake actions in Australia,* Standards Australia, 2007 (Standards Australia 2007)



Legend (units of g)

0.00 - 0.02	0.12 - 0.16
0.02 - 0.04	0.16 - 0.2
0.04 - 0.06	0.2 - 0.3
0.06 - 0.08	0.3 - 0.5
0.08 - 0.1	0.5 - 0.7
0.1 - 0.12	0.7 - 1

Legend

Site Boundary

Not Subject to Site Contamination Investigation - Not Included in EIS

JBS&G

Job No: 64648

Client: URPS

Version: FINAL | Date: 07-Nov-2024

Drawn By: JS | Checked By: KL

Scale 1:296,000

0 5 10

kilometres

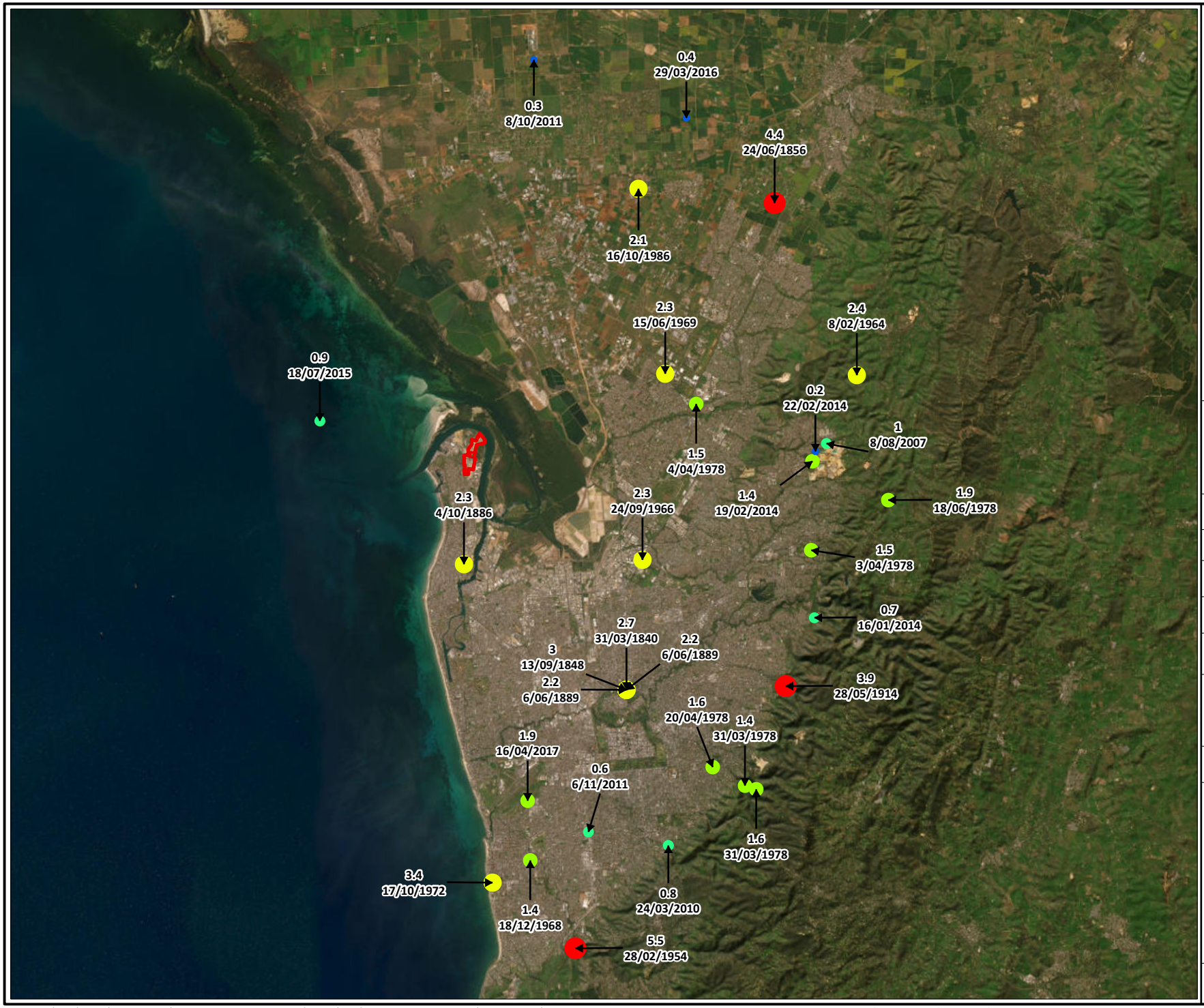
Coord. Sys. GDA2020 MGA Zone 54

Osborne, South Australia

SEISMIC HAZARD MAP OF THE SUBJECT SITE (PEAK GROUND ACCELERATION – 2 % IN 50 YEAR MEAN HAZARD [G])

FIGURE 4-6

File Name: C:\Users\jstrauss\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\URPS\64648_OsborneSouthAustralia\02_MapProjects\67064_URPS_Osborne_FigReq_v2.aprx; Name:67064_06_Seismic Hazard Map of the Subject Site
Reference: ESRI Imagery Basemap - Accessed Imagery: 07/11/2024



Legend

- Site Boundary
- Not Subject to Site Contamination Investigation - Not Included in EIS

MAGNITUDE

- 0.2 - 0.4
- 0.4 - 1.0
- 1.0 - 1.9
- 1.9 - 3.4
- 3.4 - 5.5

JBS&G

Job No: 64648	
Client: URPS	
Version: FINAL	Date: 07-Nov-2024
Drawn By: JS	Checked By: KL
Scale 1:296,000	

0 5 10
Kilometres

Coord. Sys. GDA2020 MGA Zone 54

Osborne, South Australia

SEISMIC EVENTS IN THE VICINITY OF THE SUBJECT SITE (WITHIN 25 KM)

FIGURE 4-7

File Name: C:\Users\jstrauss\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\URPS\64648_OsborneSouthAustralia\02_MapProjects\67064_URPS_Osborne_FigReq_v2.aprx; Name:67064_07_Seismic Events in the Vicinity of the Subject Site (within 25 km)
Reference: ESRI Imagery Basemap - Accessed Imagery: 07/11/2024

4.4 Soils and geology

4.4.1 Regional geology

The site is underlain by the St Kilda Formation, which include light grey shelly stranded beach ridge deposits and shelly silts and sand overlain in places by modern intertidal and swamp deposits. However, over the last 50 to 100 years, mangroves and swamp areas on the Lefevre Peninsula have been reclaimed through the deposition of fill (including spoil dredged from the Port River). This was noted in the review of historical aerial photographs (see **Appendix A**).

The Glanville Formation is present beneath the St Kilda Formation. The Glanville Formation consists of coastal sediments including silt, sand and clay, often with shell inclusions.

A summary of the regional geology is included in **Table 4-1**.

Table 4-1: Summary of Regional Geology

Soil Type	Description
Dredge Fill	• Dredge material from the Port Adelaide River. • Predominantly comprises sand, clayey and silty sand, fine to coarse grained (with shells • and shell pieces). • The sediment may also contain pockets of industrial by-products (e.g. Penrice grit, ash / cinders and slag). • Thickness is variable – from absent to several metres.
St Kilda Formation (Quaternary - Holocene)	• Coastal marine sediments, including calcareous, fossiliferous sand and mud of intertidal sand flats, beaches and tidal marshes. • Average thickness of 4 m.
Glanville Formation (Quaternary)	• Highly fossiliferous limestone containing silt, sand and clay. Often includes shelly material. • Average thickness of 6 m.

4.4.2 Soils encountered at the subject site

Soils encountered across the subject site consisted of fill to an average depth of 1 mbgl to 1.5 mbgl, noting there were locations where no fill was reported and locations where fill was reported at the extent of drilling (3 mbgl). Fill materials commonly consisted of grey silty / gravelly / clayey sands / sand, with sandy silt / silt and sandy gravels also reported frequently. East of the railway line, surface fill commonly consisted of yellow brown / orange brown sandy gravel / gravelly sand (often with inclusions of brick), likely to be building rubble, which was underlain by the aforementioned fill layer. This building rubble layer was largely absent across the remainder of the site.

Inclusions (such as brick, glass, bitumen, slag, ash and cinders) were noted at more than 30 % of soil borehole locations across the site. Shells / shellgrit was commonly present within the grey silty / gravelly / clayey sands / sand layer, with these inclusions most commonly encountered in the northern half of CT DD and CT GG of Area 1, and Area 2 and 3.

The observation of grey silty / gravelly / clayey sands / sand (often with shells / shellgrit) is consistent with widespread filling of the northern portion of the LeFevre Peninsula (historically swampy marshland). Where present, natural materials were similar to these most commonly reported fill materials, indicating this fill is likely to have been locally sourced.

A summary of the soils encountered across the subject site are included in **Table 4-2**.

Table 4-2: Soils Encountered Across the Subject Site

Soil Type	Description	Thickness
Fill	• Most commonly, grey silty / gravelly / clayey sands / sand with shell grit and shells at some locations (commonly in the northern half of CT DD and CT GG of Area 1, and Area 2 and 3) (likely to be dredged material / locally sourced material) • Surface / near surface (overlying the above) yellow brown / orange brown sandy gravel / gravelly sand, often with inclusions of brick – limited to Area 1 east of the railway line (likely to be building rubble; imported fill) • Sandy silt / silt, sandy gravels and sandy clay were also reported frequently, often in near surface soils (likely imported fill)	Variable – absent to 3 mbgl (typically 1 m to 1.5 m)
Silty Sand / Sand	• Typically grey with shellgrit and shells • Consistent with the St Kilda Formation	Encountered to the extent of drilling (3 mbgl), where present

4.4.3 Soil contamination

As outlined in **Section 3.1**, a limited PSI and soil investigation was undertaken across the site to assess the contamination status, with soil results assessed against the ASC NEPM (NEPC 2013) criteria for commercial / industrial landuse (see **Appendix A** for report).

4.4.3.1 Suitability for proposed use (industrial purposes)

All soil samples collected returned results below the adopted criteria for commercial / industrial landuse with the exception of the following:

- Copper in surface soil at one location within the north-eastern portion of Area 1. The concentration reported exceeded the ecological criteria but was below the human health criteria. It is noted the concentration reported was only slightly above the ecological criteria, and is not considered to be significant in the context of the current and proposed landuse (this area is currently [and proposed to be] hardstand); and
- Lead in one sample (depth 2.3 mbgl, with a layer of fill consistent of dark grey green sand) from Area 2 which exceeded both ecological and human health criteria. It is noted the overlying layers were also analysed and reported lead below the adopted criteria. This layer was not encountered in the surrounding boreholes, acknowledging the relatively large distances between boreholes. Further investigation has been proposed to assess the extent of lead in this area – the scope of these proposed works are detailed in the Sampling, Analysis and Quality Plan (SAQP) included as **Appendix B**.

4.4.3.2 Indicative classification for offsite disposal

A number of metals (including arsenic, cadmium, copper, lead and mercury) were reported at concentrations above Waste Fill criteria, with the elevated copper (Area 1) and lead (Area 2) discussed above in **Section 4.4.3.1** also exceeding Intermediate criteria.

Indicative offsite disposal / reuse chemical classifications were summarised as follows:

- Area 1 – generally Waste Fill or Intermediate;
- Area 2 – generally Waste Fill or Intermediate, with one area of Low Level (associated with elevated lead); and
- Area 3 – Intermediate.

It is highlighted that the indicative offsite disposal / reuse classifications were based on certificate of title (CT) boundaries, with any exceedance of criteria resulting in that CT receiving the most conservative classification (i.e. classification based on the highest level of contamination). Given the above, surplus soils from areas with indicative disposal / reuse classifications of Intermediate or Low Level may potentially be classified as Waste Fill, depending on the extent of surplus soils on these CTs and the number of samples analysed.

Further detail on the above is included in the investigation report (**Appendix A**).

4.4.4 Acid sulfate soils

A search of the Australian National Soil Information System (ANSIS)[11] undertaken on 17 June 2024 indicated the site lies within an area of 'low probability' of acid sulphate soils in the land-based portion of the subject site, noting there is low confidence in this assessment.

The soil investigation included testing for ASS and PASS across the site (total of 79 samples), noting this testing was generally limited to the upper 1 m of the soil profile, with nine samples from between 2 mbgl and 3 mbgl analysed. Laboratory analytical testing did not identify the presence of AASS or PASS materials onsite.

There is potential for ASS or PASS to be encountered at depths beyond 3 mbgl. The assessment depth of 2 mbgl is considered suitable for the majority of the subject site, with the exception of Area 3 where significant dewatering will be required. Further investigation has been proposed to assess ASS and PASS at depths beyond 3 mbgl in Area 3 – the scope of these proposed works are detailed in the SAQP included as **Appendix B**.

4.5 Terrain

The original land surface of northern Lefevre Peninsula has been significantly altered by the land reclamation that has been undertaken over the preceding 50 to 100 years. The subject site is located on a relatively flat to gently undulating coastal plain.

Digital elevation data and survey data from groundwater well locations indicate that the lowest point of the site is approximately 1.5 mAHD in Area 3, noting elevations in Area 3 vary between 1.5 mAHD and 3 mAHD. Digital elevation data and survey data from groundwater well locations indicate Area 1 and Area 2 are generally around 2.5 mAHD to 4 mAHD.

4.5.1 Land subsidence

Land subsidence has been identified as a potential issue in the Port Adelaide region in studies dating back to the 1970s. Key contributing factors are understood to be groundwater withdrawal, land reclamation by draining of wetlands, or by filling (Southfront 2018[12]). Land subsidence across the Lefevre Peninsula is expected to occur at a rate of 1.5 mm/yr, which is within the 1-2 mm/yr for expected land subsidence along the Adelaide coastline (Southfront 2018).

Comprehensive geotechnical assessment to address the potential for land subsidence at the subject site will be undertaken as part of the detailed design.

4.6 Surface water at the subject site

There is currently one significant surface water body present on the subject site – the large stormwater drainage swale across the western portion of Area 1. This surface water body is to be retained as part of the proposed development and utilised for stormwater management.

A Stormwater Management Plan is currently in preparation and will form part of the detailed design.

[11] https://portal.ansis.net/ (accessed online 17 June 2024)
[12] *City of Port Adelaide Enfield Lefevre Peninsula Stormwater Management Plan*, Southfront, 20 April 2018 (Southfront 2018).

The major surface water feature in the region is the Port River which forms the sea entrance to the Port of Adelaide. The Port River has been utilised as a shipping channel since European settlement and is also used by smaller commercial vessels and recreational boaters. The Port River is tidal, and at Outer Harbor has been subject to regular dredging programs to maintain channel depth and width which allows larger container and cruise ships to be accommodated. The Adelaide Dolphin Sanctuary extends into the Port River (and along the coast to the north).

Marine water quality in the Port River is discussed further in other chapters of the EIS.

4.7 Potential for seawater inundation

Portions of the subject site are low-lying to the extent that some areas are below recorded high tide levels at their current elevations. A large portion of Area 3 is below the Highest Astronomical Tide (HAT) level of 1.39 mAHD (Southfront 2018), with the majority of Area 3 below the highest observed historical sea level (i.e. tide plus storm surge) of 2.51m AHD in May 2016 (Southfront 2018). This indicates the potential for seawater inundation of Area 3 at the current site elevations. Area 1 and 2 are above both the HAT level and highest observed historical sea level.

4.8 Groundwater

4.8.1 Regional hydrogeology

Hydrogeology in the Lefevre Peninsula comprises five to six Quaternary aquifers and three to four Tertiary aquifers (Gerges 2006). The upper three Quaternary aquifers are discussed in further detail below, as these aquifers are the only aquifers likely to be impacted by the development.

The first quaternary aquifer (Q1) is present at depths between 3 mbgl and 10 mbgl across the greater Adelaide area (shallower end of the range expected at the subject site), with an average thickness of 2 m. This aquifer is considered to be confined in the majority of areas. Average supply from this aquifer rarely exceed 2 L/second (Gerges 2006[13]).

The groundwater investigation (JBS&G 2024a) was limited to the Q1 aquifer. Due to the proximity of the subject site to the Port River, groundwater was present at shallow depths (generally reported between 0.4 mbgl and 2.7 mbgl / 0.42 mAHD and 1.6 mAHD in JBS&G 2024a) and was of high salinity (above 5,000 mg/L total dissolved solids [TDS] based on field data, and above 29,000 mg/L TDS based on laboratory data [JBS&G 2024a]).

The groundwater flow direction was inferred to be to the east (towards the Port River) across Area 1, while in Area 2 it was inferred to be to the west. It is noted that a groundwater sink was reported in vicinity of MW06 (groundwater reported at 0.069 mAHD). The inferred flow was more complex in Area 3, with that in Area 3 generally to the south-east. It is likely groundwater is tidally influenced, with areas closer to the Port River more likely to be affected. The timing of the gauging event may result in alternate flow regimes being reported. (JBS&G 2024a).

The Q2 aquifer is present between depths of 16 mbgl and 30 mbgl across the greater Adelaide area (shallower end of the range expected at the subject site). The thickness of the Q2 aquifer ranges between 0.5 m and 10 m, with an average thickness of 2 m. (Gerges 2006)

The Q3 aquifer is present between depths of 31 mbgl and 41 mbgl across the greater Adelaide area (shallower end of the range expected at the subject site), with an average thickness of 2 m. (Gerges 2006)

The Quaternary aquifers below the subject site are not used for water storage or irrigation due to low yields, shallow water table, potential for water logging, and salinity problems (Southfront 2018).

[13] *Overview of the hydrogeology of the Adelaide metropolitan area, DWLBC Report 2006/10*, Nabil Gerges, June 2006 (Gerges 2006).

The subject site is located in the Central Adelaide Prescribed Wells Area which requires licences for commercial taking of groundwater.

4.8.2 Registered users of groundwater (Q1 and Q2 aquifers)

A search of the WaterConnect database[14] was undertaken on 14 June 2024 in order to assess whether operational bores were present within close proximity to the subject site, and if present, whether these bores were likely targeting the shallow aquifer and used for beneficial purposes.

The search identified a total of 643 registered bores on, and within close proximity to, the subject site. The following registered bores were then excluded:

- Bores with type other than 'water well' (i.e. engineering wells);
- Bores which have been backfilled, abandoned or were listed as blocked or dry;
- Bores registered for drainage purposes, exploration purposes, environmental purposes or investigation / monitoring / observation purposes;
- Bores with no listed purpose; and
- Bores likely to be installed in a deeper aquifer than Q1 / Q2 (installed to depths greater than 25 mbgl).

Following the above exclusions, a total of 148 bores remained, registered for the following purposes:

- 132 bores for domestic use (all installed of depths below 10 mbgl and likely to be targeting the Q1 aquifer); and
- 16 bores for irrigation purposes (all installed of depths below 10 mbgl and likely to be targeting the Q1 aquifer).

The above indicates that despite being of poor quality and low yield, there are registered users of the Q1 aquifer for domestic and irrigation purposes. No bores likely to be targeting the Q2 aquifer meeting the above criteria were identified.

4.8.3 Groundwater contamination

A groundwater investigation was undertaken in 2024 to assess the quality and contamination status of groundwater across the site (report included in **Appendix A**), with groundwater results assessed against criteria for relevant environmental values and beneficial uses of groundwater at the subject site (i.e. drinking water, recreation and aesthetics, marine ecosystem, freshwater ecosystem, irrigation and aquaculture).

The following key outcomes were noted regarding groundwater at the subject site (Area 1 to Area 3) by JBS&G (2024a):

- Site contamination of groundwater exists across the site, with a number of contaminants reported at concentrations above the adopted Tier 1 groundwater screening levels for relevant environmental values of groundwater. A S83A notification of groundwater has been provided to EPA on the basis of these results;
- With the potential exception of PFAS, the site contamination is unlikely to be site derived, given the site history and reported soil concentrations. PFAS was reported at higher concentrations and in more wells across Area 1 than Area 2 and 3, and hence this distribution could be associated with the wetlands / detention basins if they were not constructed appropriately (suitably lined);
- Whilst site contamination of groundwater exists across the site, it is unlikely to be associated with a risk to onsite receptors (workers) following completion of construction. Construction workers may be exposed to groundwater during the construction stage of the project, and this exposure requires management;

[14] https://www.waterconnect.sa.gov.au/Systems/GD/Pages/Default.aspx (accessed online 14 June 2024)

- Methane was reported at elevated concentrations in the majority of wells (mainly Area 1 and 2). Whilst there are no screening levels provided by the adopted sources for assessment of methane and it is unlikely to present a risk via the direct contact pathway, methane is a volatile chemical and has the potential impact the project (both construction and operation) via the vapour pathway. Further assessment is required to assess the risks from methane via the vapour pathway – the scope of these proposed works are detailed in the SAQP included as **Appendix C**; and
- It is likely that dewatering waste water will require treatment prior to disposal to marine or freshwater, due to elevated concentrations of a number of contaminants which exceed the criteria provide by EPA 1093/21 (EPA, 2021).

5. Potential Impacts and Proposed Mitigation Measures

5.1 Construction

5.1.1 Disturbance to contaminated soil through excavation

Soil contamination presents a potential risk to human and environmental receptors. The investigation completed to date (report included in **Appendix A**) did not identify soil contamination when considering the proposed landuse (commercial / industrial), with all soil samples returning results below both human health and ecological criteria, with the exception of one result for lead in Area 2. It is noted that further investigation of several areas are to be undertaken – the scope of these proposed works are detailed in the SAQP included as **Appendix B.**

Based on the results to date, it is unlikely that construction activities will result in soil and/or surface water contamination.

Notwithstanding, the Construction Environment Management Plan (CEMP) for the project, which will be developed in accordance with the relevant EPA SA guideline for CEMPs (EPA, 2024) and ASS (EPA, 2007), and will include Unexpected Finds protocols should soils encountered during construction works be inconsistent with those encountered during the site investigations. Unexpected Finds may include, but are not limited to, stained or odorous soils, presence of potential ASS (field indictors to be included in the CEMP), presence of ACM in soils, and presence of rubbish / waste in soils. The CEMP will include procedures for the assessment and management of Unexpected Finds.

5.1.2 Potential disturbance of coastal acid sulphate soils

The site is mapped as low probability (low confidence) for ASS (ANSIS 2024) and investigations completed to date did not identify potential or actual ASS, noting these investigations were limited to the upper 3 m of the site. Further investigation of Area 3 is to be completed to assess the likelihood for potential ASS to be present in the area where deeper excavation and dewatering is likely to be required. The scope of these proposed works are detailed in the SAQP included as **Appendix B.**

Should ASS be identified in the further investigation of Area 3, or unexpectedly encountered during construction works (field indictors to be included in the CEMP), an Acid Sulfate Soil Management Plan (ASSMP) in accordance with EPA SA (2007) should be prepared for areas where soil disturbance cannot be avoided. The ASSMP would outline measures to avoid / minimise oxidisation of sulfides, measures to contain and treat / neutralise acid drainage, and management measures required for any excavated stockpiled material (minimise surface area, minimise storage duration, cover to minimise infiltration, etc).

5.1.3 Potential contamination of soils / groundwater from spills during construction

The CEMP will include management strategies for hazardous materials use, storage and handling, and spill response during construction.

The risk of contamination from spills will be reduced by storage and handling of fuel and other chemicals in accordance with relevant standards and guidelines (e.g. storage in bunded areas in accordance with Standards Australia [2004] and EPA SA [2016a]), and the implementation of a contingency plan with clean up procedures, which will be outlined in the CEMP.

Other measures to mitigate the risk of fuel and chemical spills (which will be detailed in the CEMP) include the use of bunded areas for chemical storage / decanting, regular inspection of machinery for leaks, regular machinery maintenance and avoiding refuelling near Port River.

5.1.4 Management of soil generated from earthworks / additional soil required to achieve the derived site levels

It is likely additional soils will be required to achieve the required site levels for the development.

Any imported soils should be virgin quarry material, or waste derived fill (WDF) suitable for commercial / industrial landuse. Any WDF proposed to be used onsite is required to be classified in accordance with the WDF standard (EPA SA, 2013) and assessed as suitable for use at the site by a Site Contamination Consultant (if classified as Waste Fill) or a Site Contamination Auditor (if classified as Intermediate Waste Soil).

Any surplus soils from the site (i.e. from service trenches, footings, piling, excavation etc.) should be classified in accordance with the WDF standard (EPA SA, 2013), with these materials then potentially able to be re-used in a different area of the site or offsite as WDF, or disposed to a licensed landfill. Treatment will be required prior to disposal if materials are classified as High Level Contaminated Waste, noting this has not occurred in the investigations completed to date (JBS&G 2024a). It is noted that indicative offsite disposal / reuse classifications have been provided, however, additional testing may be required to facilitate classification in accordance with the WDF standard (EPA SA, 2013) depending on the extent and volume of the surplus soil.

Where present, stockpiles should be managed in accordance with *Guideline for Stockpile Management*[15], with management measures to be included in the CEMP.

5.1.5 Hazardous ground gas

The investigation completed to date (report included in **Appendix A**) identified elevated concentrations of methane in groundwater across the site. Methane is a volatile chemical and has the potential to impact the project (both construction and operation) via the vapour pathway.

Further investigation of HGG is to be undertaken – the scope of these proposed works are detailed in the SAQP included as **Appendix C**, with these additional works to be implemented prior to the commencement of site works. Should these further works identify a potential risk for the construction phase, mitigation measures will be included in an updated EIS (Physical Environment).

5.1.6 Erosion and sedimentation

During rainfall events, areas disturbed by construction activities may be subject to erosion resulting in transportation and deposition of sediment in surface water. During the summer months, where rainfall is less frequent, wind erosion is more likely to occur.

The CEMP will include erosion and sedimentation and control measures which will be implemented during site earthworks. Controls will include installation of berms or drains where appropriate (e.g. on slopes leading to the Port River), silt fences and / or hay bales for interim onsite erosion control, appropriate stockpile management and erosion controls for excavations. Contingency plans for expected storm or flood warnings will be developed. Ongoing monitoring of the effectiveness of implemented controls (to be outlined in the CEMP) will be undertaken.

Any identified sodic or dispersive soils will be managed in accordance with the CEMP and EPA guidance on stockpile management (EPA, 2020), noting field indictors of sodic and dispersive soils will be included in the CEMP.

5.1.7 Soil compaction

Construction activities could result in soil compaction in areas used for vehicle access and laydown areas, and can change local drainage. Compaction from heavy vehicle traffic may also increase land subsidence, changing local drainage patterns and increasing erosion potential.

[15] *Guideline for stockpile management,* Environment Protection Authority South Australia, October 2020 (EPA SA, 2020).

To minimise the impact of compaction, heavy vehicle traffic will be restricted to access tracks, with heavily compacting activities will be further restricted in wet and boggy conditions.

5.1.8 Seismic hazard

Proposed building at the subject site will be designed in accordance with the requirements of AS 1170.4 (Standards Australia, 2007) to ensure that seismic hazard is appropriately addressed.

5.1.9 Dewatering of excavations

Across the majority of the site, the potential for intersection with shallow groundwater during construction activities is expected to be low, as it is understood the site is to be built up and used mainly for large slab on grade industrial buildings with no basements. However, groundwater is likely to be intersected as part of the construction of the non-tidal wet basin, caisson and potentially the launch facility, and it is likely that wastewater will be required to be discharged (rather than reused). It is noted that investigations are to be completed to assess deeper soil and groundwater in this area of the site, with this data to inform disposal options for both soil and wastewater from dewatering, as well as assessing for potential indicators of acid sulphate soils in this area. The scope of these proposed works are detailed in the SAQP included as **Appendix B.**

A Dewatering Management Plan (DMP) will be prepared for the dewatering activities in accordance with EPA SA (2021) by a suitably qualified professional. The DMP will include any requirements to treat dewatering wastewater prior to discharge, ongoing monitoring requirements during the dewatering program, while also considering potential changes to local hydrology due to the dewatering which could impact on registered users of groundwater or any known groundwater contamination in the vicinity of the dewatering (onsite or offsite).

Dewatering also has the potential to oxidise ASS, if present. As stated above, further investigation of the area where dewatering is likely to be required (Area 3) is to be completed to assess deeper soils and groundwater to assess the likelihood for potential ASS to be present. If present, an ASSMP would be prepared (as per **Section 5.1.2** above).

5.2 Operation

5.2.1 Potential contamination of soils/groundwater from spills

The potential for contamination to soils, surface water and shallow groundwater at the site during operations as a result of a spill of fuel / chemicals is expected to be low. Storage and handling of fuel and other chemicals will be in accordance with Standards Australia (2004) and EPA SA (2016a), and procedures for the management of spills will be outlined in operational environment and safety management plans. The presence of hardstand across the site will further decrease the potential for any spill to impact soil and groundwater. Any requirements for hazardous waste stored onsite would be done under an EPA licence, with any hazardous waste generated disposed to a licenced facility under tracking documentation.

It is highlighted that the nuclear licence process is being managed by the Australian Submarine Agency (ASA) and hence any mitigation measures associated with nuclear products and/or waste have not been included in this EIS.

5.2.2 Hazardous ground gas

The investigation completed to date (report included in **Appendix A**) identified elevated concentrations of methane in groundwater across the site. Methane is a volatile chemical and has the potential to impact the project (both construction and operation) via the vapour pathway.

Further investigation of HGG is to be undertaken – the scope of these proposed works are detailed in the SAQP included as **Appendix C**, with these additional works to be implemented prior to the commencement of site works. Should these further works identify a potential risk during site operation, mitigation measures will be included in an updated EIS (Physical Environment).

5.2.3 Erosion and sedimentation

Following completion of construction activities, the majority of the site will be sealed with bitumen, concrete or paving. There will minimal non-sealed areas east of the railway line, largely limited to small garden beds in close proximity to buildings and along road verges. The largest unsealed area will be the area associated with the stormwater swales on Area 1, west of the railway line.

A Stormwater Management Plan is currently in preparation and will be part of the detailed design.

Non-paved surfaces should be designed for a 50-year design life and take into account impacts of hydraulic wear and tear from overland flow depths and velocities, wind erosion, foundation settlement and consolidation. To minimise the risk of soil erosion, areas subject to overland flow should be stabilised with geofabric liner or compacted hardstand (e.g. road base) if flows are above 1.2 m/s or rock scour if flows are above 3.0 m/s. Surface treatment for areas not within overland flow paths can be formed from compacted hardstand material, turfed or hydroseeded. Throughout the operational life of the project, maintenance and repair of any non-paved surfaces will be continually undertaken as appropriate in order to mitigate the potential for erosion and sedimentation from occurring as a result.

5.2.4 Dewatering

There is potential that ongoing dewatering may be required following construction of the non-tidal wet basin, caisson and potentially the launch facility. Should this be required, the DMP (see **Section 5.1.7**) will include assessment and requirements for the ongoing dewatering proposed to be undertaken, noting that the DMP will need to provide evidence demonstrating no potential for environmental harm as a result of the ongoing dewatering. This DMP would be presented to EPA for approval.

It is highlighted that the need for ongoing dewatering post-construction should be assessed and considered early in the design stage, noting the potential cost implications for treatment and/or disposal of wastewater.

5.2.5 Seawater inundation

The Coastal Areas Overlay applies to the coastal fringe of the site (portion of Area 3). The Hazard Risk Minimisation objectives of the Overlay require that development be designed to take into account anticipated sea level rise and land subsidence. In order to protect against long-term seawater inundation risks, site structures should be designed to be located above the 100-year ARI tide level, with an allowance for projected future sea level rise, land subsidence, stormwater, wave action and freeboard. The Project design will need to ensure the site meets minimum height specifications to mitigate coastal inundation (finished ground levels 0.3 m or more above the standard sea flood risk level; finished floor levels 0.55 m or more above the standard sea flood risk level).

5.3 Summary of Key Mitigation Measures

A summary of the key mitigation measures relating to soil, terrain and hydrology are included in **Table 5-1**.

Table 5-1: Key Mitigation Measures – Soils, Terrain and Hydrology

Mitigation Measure	Construction	Operation
Undertake storage and handling of fuel and chemicals in accordance with relevant standards and guidelines (e.g. storage in bunded areas in accordance with AS 1940 and EPA guidelines).	✓	✓
Maintain an incident procedure to contain and clean up spills if they occur.	✓	✓
Avoid refuelling activities in close proximity to the Port River (e.g. 50 m).	✓	✓
Ensure any additional soils required to achieve the derived site levels are either virgin quarry material or WDF suitable for commercial / industrial landuse (to be assessed as suitable for use at the site by a Site Contamination Consultant or a Site Contamination Auditor, depending on the classification).	✓	

Mitigation Measure	Construction	Operation
Ensure that any surplus soils are classified in accordance with the WDF standard (EPA SA, 2013) for re-use in a different area of the site, re-use offsite or disposal to a licensed landfill.	✓	
Ensure that any stockpiles onsite are managed in accordance with EPA SA (2020)	✓	
Install sediment and erosion controls where required (e.g. temporary berms, drainage controls, stockpile management and stabilisation of non-paved operational areas).	✓	✓
Restrict heavy vehicle traffic to access tracks.	✓	
Develop a protocol for dealing with acid sulfate soils, if encountered during construction.	✓	
Develop a protocol for dealing with potentially contaminated soils and groundwater, if encountered during construction.	✓	
Regularly monitor for potential impacts to soils and hydrology (e.g. erosion, subsidence, bunding and storage, leaks from machinery) and implement further mitigation measures where required.	✓	✓
Proposed building at the subject site will be designed in accordance with the requirements of AS 1170.4 (Standards Australia, 2007) at a minimum to ensure that seismic hazard is appropriately addressed. It is noted that further seismic investigation is being completed in the SSER as part of the nuclear approvals process for Area 2 and Area 3. The SSER should be referred to in relation to seismic hazard for Area 2 and Area 3.	✓	
Implement appropriate measures for trench dewatering and waste water disposal (such as water treatment, removal, or disposal).	✓	✓
Further investigation of HGG (the scope of these proposed works are detailed in the SAQP included as **Appendix C**, with these additional works to be implemented prior to the commencement of site works). Should these further works identify a potential risk for the construction phase, mitigation measures will be included in an updated EIS (Physical Environment).	✓	✓

6. Conclusion

The development has the potential to impact soils and hydrology through erosion and sedimentation, soil compaction and inversion, exposure of acid sulfate soils, soil and groundwater contamination, and dewatering. Impacts are also possible from inundation as a result of the low elevation and proximity to tidal waters of the subject site.

These potential impacts are mostly associated with the construction phase. The potential impacts associated with the construction phase can be appropriately managed through development and implementation of the following:

- CEMP;
- DMP; and
- ASSMP (if acid sulfate soils are encountered).

The potential impacts associated with the operation phase can be managed through the following:

- Ensuring the project design meets requirements for the site location, including taking into account impacts of hydraulic wear and tear from overland flow depths and velocities, wind erosion, foundation settlement and consolidation, and avoiding seawater inundation;
- Development and implementation of a Stormwater Management Plan;
- Development and implementation of a DMP (if ongoing dewatering is required); and
- Appropriate storage and handling of fuels / chemicals (noting the nuclear licence process is being managed by the ASA and hence any mitigation measures associated with nuclear products and/or waste have not been included in this EIS).

7. Limitations

Scope of services

This report ("the report") has been prepared by JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. JBS&G has also not attempted to determine whether any material matter has been omitted from the data. JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to JBS&G. The making of any assumption does not imply that JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made, including to any third parties, and no liability will be accepted for use or interpretation of this report by any third party.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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Concurrent Siting and Site Evaluation Report (SSER)

At time of writing and parallel to this assessment, it is understood the Siting and Site Evaluation Report (SSER) was being prepared for the SCY site. The SSER documents and characterises the natural and human induced hazards that could affect the safety of the nuclear licenced activities where they occur at the site. The SSER may identify additional considerations and mitigations needed for this discipline, specific to undertaking nuclear licenced activities that have not been specifically considered in this assessment. Furthermore, results of any assessment works undertaken as part of the SSER have not been shared with JBS&G, and there is potential these results could affect the managements measures outlined in this EIS. The SSER (and any associated assessment reports) should be reviewed on completion, and the EIS updated if these reports alter the understanding of the site contamination status of the site.

8. References

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