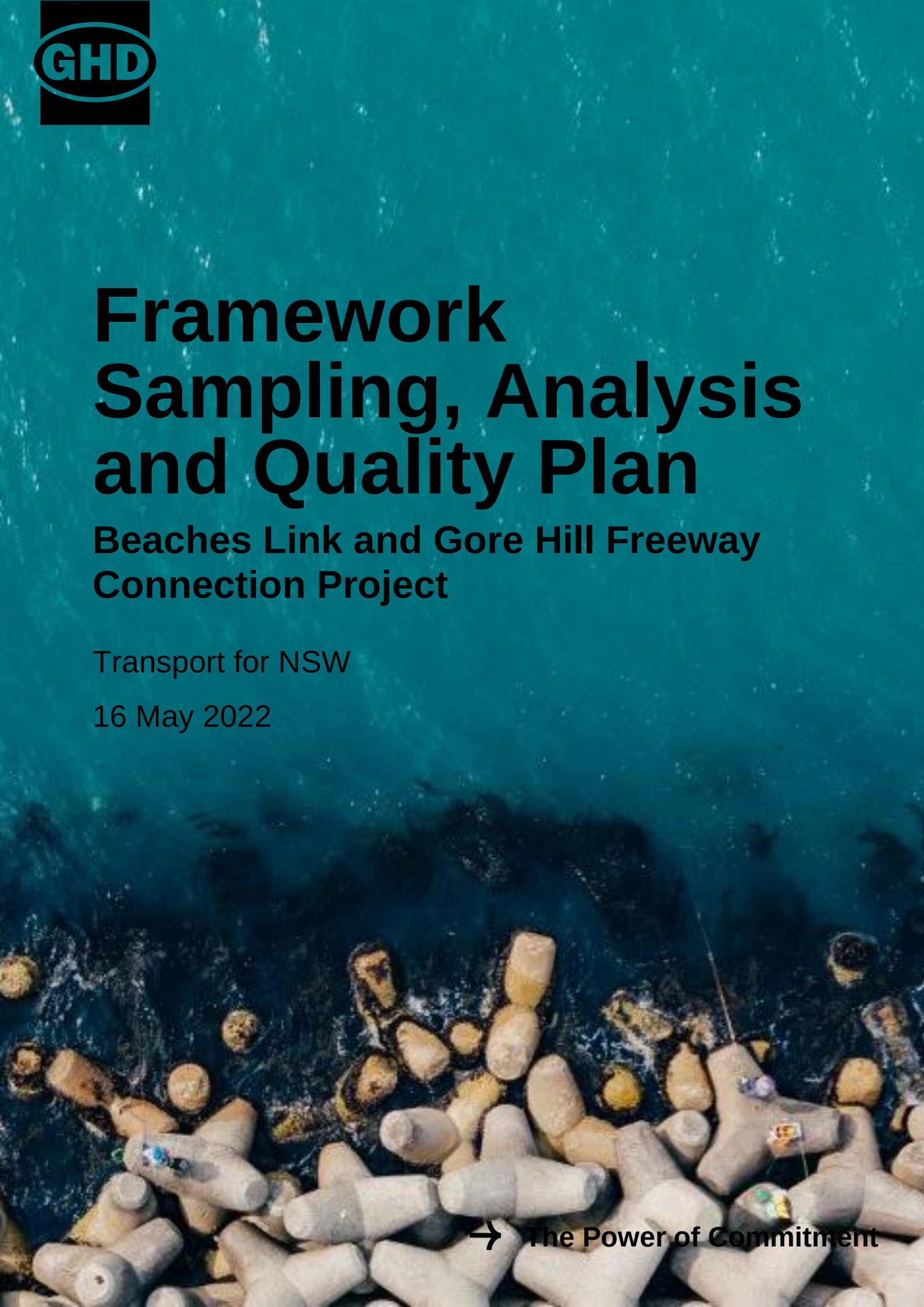
Framework Sampling, Analysis and Quality Plan

Beaches Link and Gore Hill Freeway Connection Project

Transport for NSW

16 May 2022



The Power of Commitment

GHD Pty Ltd | ABN 39 008 488 373| ABN 39 008 488 373
133 Castlereagh Street, Level 15
Sydney, New South Wales 2000, Australia
T [redacted] | **F** [redacted] | **E** [redacted] | **ghd.com**

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Executive summary

GHD Pty Ltd (GHD) was engaged by Transport for New South Wales (Transport) to develop a Framework Sampling Analysis and Quality Plan (Framework SAQP) for the Beaches Link and Gore Hill Freeway Connection project (the BLGHFC project). The BLGHFC project is part of the Western Harbour Tunnel and Beaches Link (WHTBL) program of works, proposed to provide additional road network capacity across Sydney Harbour and Middle Harbour thereby improving transport connectivity with Sydney's Northern Beaches.

Temporary construction support sites and construction sites are required as part of the BLGHFC project, and would include tunnelling and tunnel support sites, civil surface sites, laydown areas, parking, and workforce amenities. Jacobs (TfNSW, 2020b) conducted a desktop review and site inspection of these construction sites and temporary construction support sites and identified several Areas of Environmental Interest (AEIs) with a moderate to high risk of potential contamination being present. The desktop study included a review of project information, including environmental settings, project history and potential historical sources of contamination as detailed in the BLGHFC Environmental Impact Statement (EIS) (TfNSW, 2020a).

Subsequent to the lodgement of the EIS, submissions report and preferred infrastructure report (PIR), Transport has committed to the development of a Framework SAQP to provide the Department of Planning and Environment (the Department) with additional information for consideration in its assessment of the BLGHFC project. Specifically, Transport will provide the following: *A framework sampling analysis and quality plan (Framework SAQP), to set out the general context, justification and sampling and analytical framework that will be adopted post-determination in subsequent site-specific SAQPs.*

It is noted that this Framework SAQP was prepared considering the *Consultant Reporting on Contaminated Land Guidelines* (NSW EPA, 2020) and it provides framework guidance for the future development of site-specific SAQPs required for contamination investigations to be conducted post-determination. The overarching objective of the Framework SAQP is to:

– Provide Transport and the Department with the context, justification and scope of contamination sampling and analysis required across the BLGHFC project; and
– Outline the decision making process and the minimum requirements for contractor(s), in order for them to develop site-specific SAQP(s).

This Framework SAQP documents the generic assessment criteria, the sampling and analysis strategy, methodology and data quality indicators to be referenced by contractor(s) when developing their own site-specific SAQP(s) and reporting requirements.

A NSW EPA Accredited Site Auditor will be engaged to complete a Statutory Site Audit on each moderate to high risk of potential contamination AEI, in accordance with the project approval. This will include a review, as relevant, of the site-specific SAQPs and subsequent contamination investigation works.

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Appendices

Glossary

Acronym	Definition
AASS	Actual acid sulfate soils
ACM	Asbestos containing materials
ASS	Acid sulfate soils
AEIs	Areas of Environmental Interest
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASSMAC	Acid Sulfate Soils Management Advisory Committee
BaP TEQ	Benzo(a)Pyrene Toxic Equivalence Quotient
bgl	Below ground level
BOD	Biochemical oxygen demand
BLGHFC	Beaches Link and Gore Hill Freeway Connection project
BTEX	benzene, toluene, ethylbenzene and xylenes
BTEXN	benzene, toluene, ethylbenzene, xylenes and naphthalene
CEMP	Construction Environmental Management Plan
CLM Act	Contaminated Land Management Act 1997
COC	Chain of custody
COD	Chemical oxygen demand
Construction footprint	The total area required to facilitate the construction of the project
Construction phase	All activities required to construct the project, including early works, site establishment, tunnelling works, surface road works, earthworks, marine works and testing and commissioning prior to operation. Construction may be staged in and across areas of the project.
Construction support site	A temporary facility required for construction of the project where a compound will be established
COPC	Contaminants of potential concern
CRS	Certified Reference Standard
CSM	Conceptual site model
CT	Contaminant threshold
DO	dissolved oxygen
DPGA	Douglas Partners and Golder Associates
DPIE	Department of Planning, Industry and Environment
DQI	Data quality indicators
DQO	Data quality objectives
DSI	Detailed site investigations
DBYD	Dial before you dig
EC	electrical conductivity
EIL	Ecological investigation levels
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
ESL	Ecological screening levels

Acronym	Definition
Exit phase	Commencement of operation of all or part of the project, including but not limited to opening up the tunnels, surface connections and other built project infrastructure for public use. Operation may be staged in and across areas of the project.
GHD	GHD Pty Ltd
HDPE	High-density polyethylene
HIL	Health investigation levels
HRF	Heavy rainfall benchmark'
HSL	Health screening levels
JSEA	Job Safety and Environmental Analysis
LAA	Licensed Asbestos Assessor
LDPE	Low-density polyethylene
LFG	Landfill gas
LGA	Local government areas
LOR	Limit of reporting
NATA	National Association of Testing Authority
NEMP	PFAS National Environmental Management Plan
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Assessment of Site Contamination) Measure
NHMRC	National Health and Medical Research Council
NSW	New South Wales
OCP	Organochlorine pesticides
OPP	Organochlorine pesticides
ORP	oxidation reduction potential
PAH	Polycyclic aromatic hydrocarbons
PASS	Potential acid sulfate soils
PCBs	Polychlorinated biphenyls
PFAS	Perfluoroalkyl and polyfluoroalkyl substances
PID	Photo-ionisation detector
POEO Act	Protection of the Environment Operations Act 1997
PSI	Preliminary Site Investigation
PVC	Polyvinyl chloride
QA/QC	Quality assurance / quality control
QC	Quality control
RPD	Relative percentage difference
SAQP	Sampling Analysis and Quality Plan
SVOCs	Semi volatile organic compounds
TCLP	Toxicity characteristics leaching procedure
Transport	Transport for NSW
TRH	Total recoverable hydrocarbons
VOCs	volatile organic compounds
WHTBL	Western Harbour Tunnel and Beaches Link

1. Introduction

1.1 Project overview and background

GHD Pty Ltd (GHD) was engaged by Transport for NSW (Transport) to develop a Framework Sampling Analysis and Quality Plan (Framework SAQP) for the Beaches Link and Gore Hill Freeway Connection project (the BLGHFC project). The BLGHFC project is part of the Western Harbour Tunnel and Beaches Link (WHTBL) program of works, proposed to provide additional road network capacity across Sydney Harbour and Middle Harbour thereby improving transport connectivity with Sydney's Northern Beaches.

The BLGHFC project will comprise of a new tolled motorway tunnel connection across Middle Harbour from the Warringah Freeway and Gore Hill Freeway to Balgowlah and Killarney Heights and the surface upgrade of Wakehurst Parkway from Seaforth to Frenchs Forest. Fourteen temporary construction support sites are required as part of the BLGHFC project, and would include tunnelling and tunnel support sites, civil surface sites, laydown areas, parking and workforce amenities; and are labelled BL1 to BL14 and are presented on Figure 1 (as per the Environmental Impact Statement (EIS) (Transport, 2020b).

As part of the EIS, a Preliminary Site Investigation (PSI) (titled as a Technical Working Paper – Contamination as Appendix M of the EIS (TfNSW, 2020b)) was completed by Jacobs on the land and harbour areas to be utilised as construction support sites. The PSI comprised the completion of desktop reviews and site inspections. The results of the PSI identified that several terrestrial sites had a moderate to high potential risk of surface and/or sub-surface contamination being present, and some marine sites (within the harbour) that had a moderate to high risk of contaminated sediments being present.

These sites were nominated in the EIS as 'Areas of Environmental Interest' (AEIs). The EIS stated that, as part of the construction phase of the BLGHFC project, these sites would be subject to further investigations to assess for the presence of contamination. The results of these investigations would then be utilised to determine if any remediation and/or management would be required to be completed as part of the BLGHFC project. The location of these AEI sites is presented on Figure 2 and are labelled B1 to B17 (as per the EIS (Transport, 2020b)).

The NSW Environment Protection Authority's (EPA) submission on the BLGHFC EIS, recommended Transport be required to submit: *A Sampling and Analysis Quality Plan (SAQP) which details how the type, quantity, and extent of contamination for the areas of environmental interest will be assessed.*

Transport lodged the BLGHFC submissions report and preferred infrastructure report (PIR) with the Department of Planning and Environment (the Department) on 4 November 2021. Due to the current stage of the BLGHFC project in the design development and construction planning process, there remain many aspects of the BLGHFC project works that are not sufficiently progressed to allow for the preparation of site-specific SAQPs on the EIS nominated moderate to high risk sites that would satisfy the requirements for SAQPs set out in the NSW EPA *Guidelines for Consultants Reporting on Contaminated Sites* (NSW EPA, 2020).

Following the lodgement of submissions report and PIR, Transport has committed to the development of a Framework SAQP to provide the Department with additional information for consideration in its assessment of the BLGHFC project. Specifically, the Framework SAQP is required to satisfy the following commitments: *A framework sampling analysis and quality plan (Framework SAQP) to set out the general context, justification and general sampling and analytical framework that will be adopted post-determination in subsequent site-specific SAQPs.*

It is noted that the Framework SAQP was prepared considering the *Guidelines for Consultants Reporting on Contaminated Sites* (NSW EPA, 2020) and was also drafted with due consideration of NEPM 2013. The Framework SAQP provides guidance for the future development of site-specific SAQPs required for contamination investigation to be conducted post-determination.

The purpose of the Framework SAQP is to meet the Transport commitment outlined above to ensure that, across the different stages of the BLGHFC project, consistent decision making processes are

achieved for determining whether site-specific SAQPs are required and also the context, justification and scope of contamination sampling and analysis where site-specific SAQPs are required. The requirements of the Framework SAQP will be implemented by contractors, post contract award. The development of site-specific SAQPs will inform the investigation requirements for detailed site investigations (DSIs) or other investigation works for each AEI identified in Appendix M of the EIS as well as for any additional AEIs. The results of the DSIs or other investigation works will determine the requirements, if any, for remediation and/or management.

A NSW EPA Accredited Site Auditor will be engaged to complete a Statutory Site Audit on each moderate to high risk of potential contamination AEI, in accordance with the project approval. This will include a review, as relevant, of the site-specific SAQPs and subsequent contamination investigation works.

1.2 Categorisation of AEIs

The AEI can be categorised as follows:

– Terrestrial AEIs that have been identified by the EIS and are located within the BLGHFC project footprint only - B7 to B11, B13 to B17, herein referred to as ‘Project Specific T-AEIs’;
– Terrestrial AEIs that have been identified by the EIS and that are located within both the BLGHFC project footprint and the Western Harbour Tunnel and Warringah Freeway Upgrade (WHTWFU) project footprints, and are also subject to Infrastructure Approval SSI 8863 – B1 to B6, herein referred to as ‘Crossover T-AEIs’; and
– Marine AEIs that have been identified by the EIS and that are located are within the BLGHFC project footprint - herein referred to a ‘M-AEIs’.

In addition to these AEIs, it is noted that at the time of preparation of this document, the BLGHFC project was in its planning phase and as such, there is a potential for additional AEIs as follows:

– Additional AEIs that are not currently identified by the EIS for the BLGHFC project – herein referred to as ‘A-AEIs’.

Given these different categories of AEIs, Section 3 of this this Framework SAQP provides decision making processes to be applied to each AEI, and any future additional AEIs.

At the time of preparation of this Framework SAQP it was well understood that the Project Specific T-AEIs that are only within the BLGHFC project footprint will require the completion of further investigations, in the form of DSIs. For the Project Specific T-AEIs, this Framework SAQP summarises the information in relation to the environmental setting and history of use of the AEIs, as provided in the EIS and subsequent reports (see Appendix B). This information has been used to set out the preliminary Conceptual Site Model (CSM) and the requirements for the site-specific SAQPs that will be prepared to inform the DSIs.

For the Crossover T-AEIs, M-AEIs and A-AEIs the decision making processes set out in this document will need to be applied by the contractor(s) to determine whether site-specific SAQPs are required for DSIs or other investigative works.

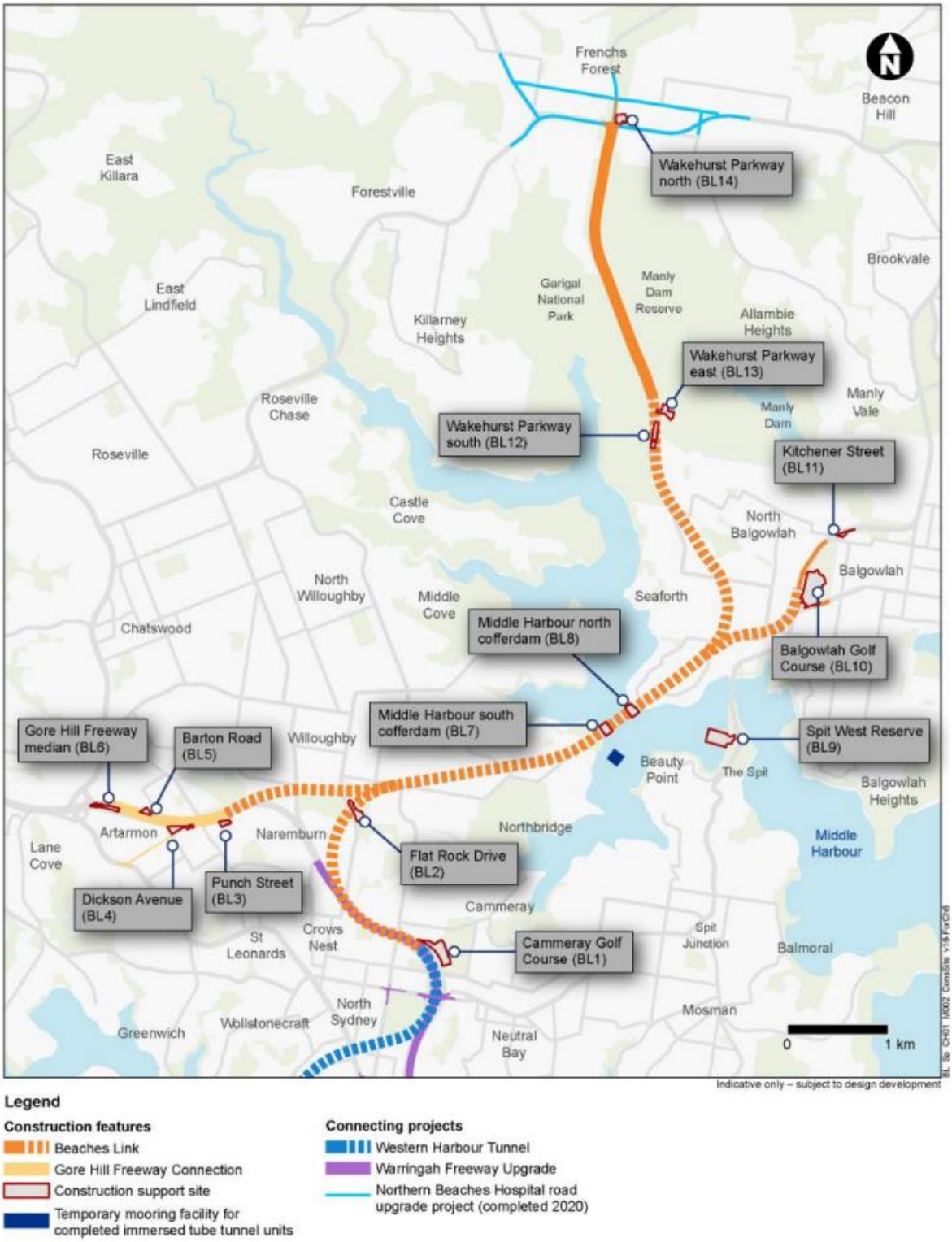
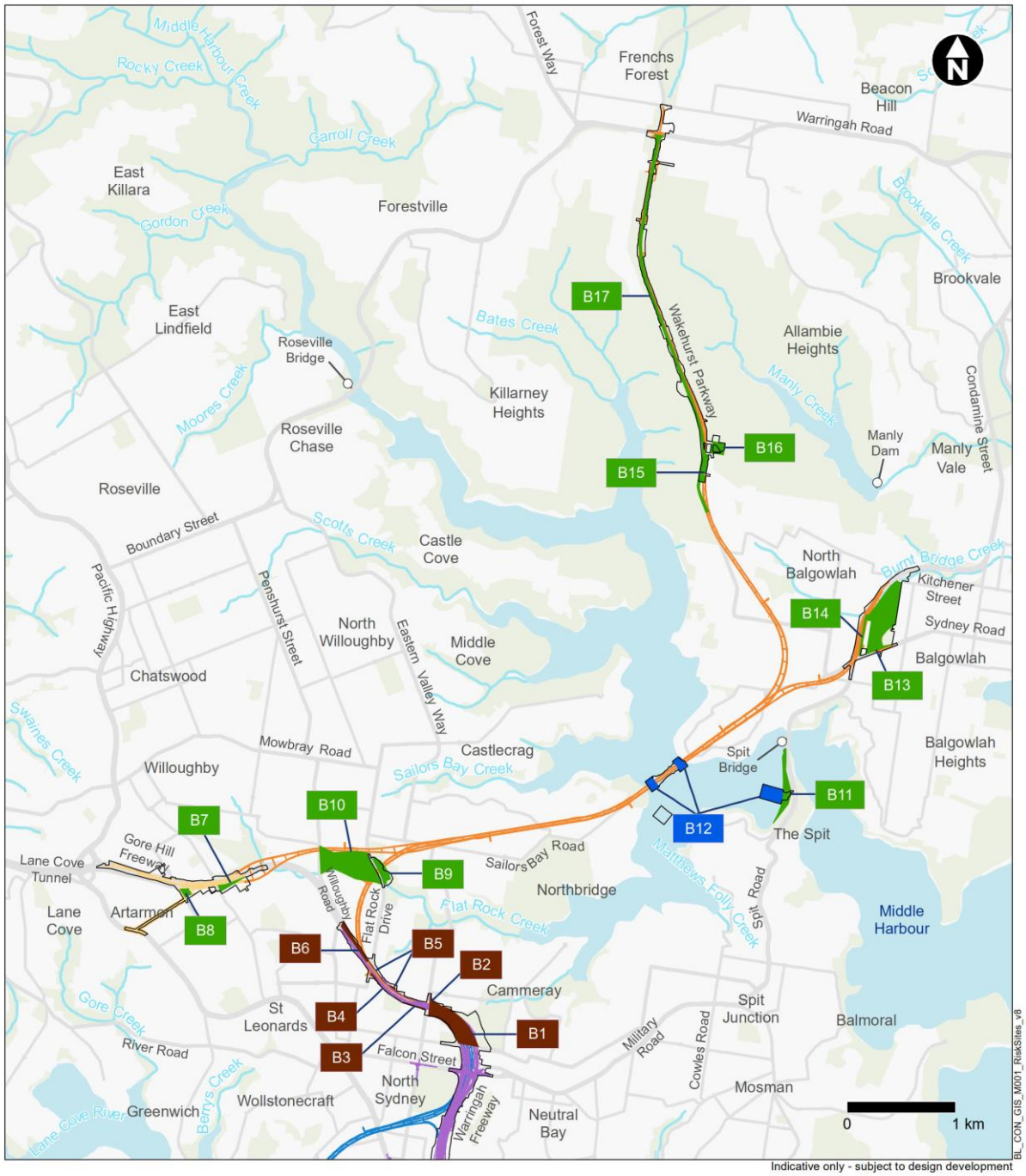


Figure 1 *Overview of the construction support sites (TfNSW, 2020b)*



Legend

- Beaches Link
- Gore Hill Freeway Connection
- Western Harbour Tunnel
- Warringah Freeway Upgrade
- Construction footprint
- Waterways
- Terrestrial AEIs (T-AEIs)
- Crossover terrestrial AEIs (Crossover T-AEIs)
- Marine AEIs (M-AEIs)
- Additional AEIs (A-AEIs) – refer to decision making process for site-specific SAQPs

Figure 2 AEIs with moderate to high risk of contamination (TfNSW, 2020b)[1]

[1] As stated further in Section 1.3, moderate risk sites AEI B1 to AEI B6 are not considered in this Framework SAQP as they are part of the Warringah Freeway Upgrade. High risk site AEI B12 is also not considered as it is an overwater construction site as in outside the agreed scope of works for this Framework SAQP.

1.3 Objectives

The overarching objective of this Framework SAQP is:

– To provide Transport and the Department with the context, justification and scope of contamination sampling and analysis required across the BLGHFC project; and
– To outline the decision making processes and the minimum requirements for contractor(s), in order for them to develop site-specific SAQP(s).

This Framework SAQP documents the generic assessment criteria, the sampling and analysis strategy, methodology and data quality indicators to be referenced by contractor(s) when developing the site-specific SAQP(s) and reporting requirements. This allows a consistent approach to be applied across the different stages of the project.

1.4 Framework SAQP scope of work

The scope of this Framework SAQP is as follows:

– The objectives and scope of work (see Section 1.3);
– The change management process (see Section 1.8);
– The AEIs and the decision making process for site-specific SAQPs (see Section 2 and Section 3);
– The BLGHFC project identification and environmental setting (see Section 2); and
– Reporting requirements for the awarded contractor(s) (see Section 4.8).
– For Project Specific T-AEIs (see Appendix B)
    - The preliminary CSM, identifying potential sources, associated contaminants of concern (COPC), exposure pathways and receptors (See Appendix B Section 1.2);
    - The basis of the assessment, including details of the guidelines, policies and legislation that the investigation has been developed for (see Appendix B Section 1.3);
    - The data quality objectives which have been prepared in accordance with the National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM) (National Environment Protection Council (NEPC, 2013) to ensure future field investigations and analyses are undertaken in a way that enables the collection and reporting of reliable data (see Section 4.6.1);
    - The proposed sampling and analytical program, including rationale for sampling (see Appendix B)
    - The proposed sampling and analytical methodology (see Appendix B Section 1.5); and
    - Data quality indicators, including quality assurance and quality control protocols (see Appendix B Section 1.6).

1.5 Guidelines and References

This Framework SAQP has been prepared with reference to the following standards and/or guidelines. The implementation of the decision making processes and preparation of the site-specific SAQP(s) must be completed in accordance with this Framework SAQP and the guidelines and/or standards outlined below.

1.5.1 Statutory guidelines made by the NSW EPA

NSW EPA, 1995. Contaminated Sites: Sampling Design Guidelines, September 1995;

DEC, 2007. Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination, March 2007;

NSW EPA, 2015. Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997, September 2015;

NSW EPA, 2020a. Assessment and management of hazardous ground gases, Contaminated Land Guidelines, amended May 2020; and

NSW EPA, 2020b. Consultants reporting on contaminated land – Contaminated Land Guidelines, updated 5 May 2020.

1.5.2 Statutory guidelines approved by the NSW EPA

ANZECC & ARMCANZ, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000;

enHealth, 2012. Environmental health risk assessment: Guidelines for assessing human health risks from environmental hazards, June 2012;

NEPC, 2013. National Environment Protection (Assessment of Site Contamination) Amended Measure 2013 (No. 1), May 2013; and

ANZG, 2018. Australian & New Zealand: Guidelines for fresh & Marine Water Quality, August 2018.

1.5.3 Non-statutory guidance documents prepared by NSW EPA

NSW EPA, 2014. Waste Classification Guidelines - Part 1 Classifying Waste, November 2014;

NSW EPA, 2016. Environmental Guidelines: Solid Waste Landfills Second edition, April 2016; and

NSW EPA, 2022. Preparing environmental management plans for contaminated land, Practice Note, January 2022 (in consultation).

1.5.4 Other publications

ASSMAC, 1998. Acid Sulfate Soil Manual, August 2018;

NHMRC, 2008. Guidelines for Managing Risks in Recreational Water. Canberra: National Health and Medical Research Council, Australian Government;

Commonwealth of Australia, 2009. National Assessment Guidelines for Dredging 2009;

Australian Government Department of Agriculture and Water Resources, 2018. National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual, June 2018;

Commonwealth of Australia, 2018. National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual;

WA DoH, 2019. Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia, May 2019;

HEPA, 2020. PFAS National Environmental Management Plan Version 2.0, January 2020; and

CRC CARE Technical Reports (www.crccare.com/publications/technical-reports).

NSW EPA (2022). Position statement — WA guidelines for asbestos contaminated sites, April 2022. This position statement has been prepared in response to the publication of the revised Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia (the WA Asbestos Guidelines) by the West Australian Department of Health on 24 August 2021.

1.5.5 Australian standards

Standards Australia. (1998). Australian Standard AS/NZS 5667.6:1998 Water Quality – Sampling, Guidance on sampling of rivers and streams;

Standards Australia. (1998). Australian Standard AS/NZS 5667.9:1998 Water Quality – Sampling, Guidance on sampling from marine waters;

Standards Australia. (1998). Australian/New Zealand (AS/NZ) Standard 1998, Water Quality – Sampling Part 11: Guidance on Sampling of Groundwaters;

Standards Australia. (1998). Australian/New Zealand Standard AS/NZS 5667.1:1998: Water quality - Sampling - Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples;

Standards Australia. (1999). Australian Standard 4482.2-1999: Guide to the sampling and investigation of potentially contaminated soil guidance, Parts 2: Volatile Substances; and

Standards Australia. (2005). Australian Standard 44821.1-2005: Guide to the sampling and investigation of potentially contaminated soil guidance, Part 1: Non-volatile and semi-volatile compounds.

It is noted that within this Framework SAQP direct reference is made to specific guidelines, regulations and legislation that were in force at the time of preparation of this document. In applying this Framework SAQP those responsible must ensure that the relevant guidelines, regulations and legislation that are applied are those that are in force at that time.

1.6 Persons referred to in the Framework SAQP

In this Framework SAQP the following persons are referred to:

– Transport – Transport for NSW is the Proponent for the BLGHFC project;
– Principal Contractor(s) – The construction company engaged by Transport to deliver various stages of the BLGHFC project;
– Contractor(s) – consultant certified under either the Environment Institute of Australia and New Zealand's Certified Environmental Practitioner (Site Contamination) scheme (CEnvP(SC)) or the Soil Science Australia Certified Professional Soil Scientist Contaminated Site Assessment and Management (CPSS CSAM) scheme to complete the works set out in this Framework SAQP as engaged by the Principal Contractor;
– Site Auditor – The NSW EPA Accredited Site Auditor engaged by Transport to review this Framework SAQP and prepare a Section B Site Audit Statement and Site Audit Report that certifies that the Framework SAQP is appropriate for its purpose and, where relevant, has been prepared in general accordance with the guidelines made or endorsed by the NSW EPA; and
– Future Site Auditor - Once project approval has been obtained, Transport will engage a NSW EPA Accredited Site Auditor to complete a site audit on all future contamination works. The scope of any future site audit(s) will include review of the outcomes of the implementation of this Framework SAQP and subsequent stages of works through the delivery of the BLGHFC project.

1.7 Project staging

Once project approval has been obtained, the BLGHFC project will be delivered over a number of stages. Whilst the final staging will be confirmed in the Staging Report, post project approval, the anticipated project staging is as follows:

– Stage 1 – Enabling and early works;
  - Balgowlah Golf Course construction site (B13/14 Balgowlah Golf Course & Dudley Street); and
  - Flat Rock Drive construction support site (B9 Flat Rock Reserve).
– Stage 2 – Gore Hill Freeway Connection project; and
– Stage 3 – Beaches Link project .

Given the size and complexity of each stage, it is likely that multiple contractors will be involved in the delivery of each stage across the various sites.

Due to the staged approach to the delivery of the BLGHFC project, the works required to ensure that contamination is assessed, remediated and / or appropriately managed will also be completed in stages as part of each package of works. This will include a staged approach to the preparation and

implementation of the site-specific SAQPs for the DSIs or other investigation works on the AEIs of moderate to high risk, and also for any subsequent remediation and/or management works required. Each contractor will be required to implement this Framework SAQP as relevant to their scope of works and specific to the land occupied by the contractor and the extent of disturbance, e.g., surface excavation, deep excavation and groundwater disturbance.

A NSW EPA Accredited Site Auditor will be engaged to complete a Statutory Site Audit on each AEI, in accordance with the project approval.

1.8 Change management

This Framework SAQP has been developed based on information available at the time of preparation which includes, but was not limited to, the BLGHFC concept design, identified AEI sites, construction and final land uses, as detailed in the EIS (TfNSW, 2020a). As with any project of the nature and scale of the BLGHFC project, the concept design will continue to be refined during future stages of detailed planning for design and delivery, which will not commence until project approval has been obtained. This will include resolution of a number of project uncertainties identified in Table 28-2 of the EIS (TfNSW, 2020a). It is expected that the outcomes of these future stages of work could result in changes to the extents of the AEIs, construction activities or intended final land use as set out in this Framework SAQP.

If additional areas are identified, the contractors will be required to investigate these areas in accordance with the process outlined in Section 3.

Any changes or inconsistencies between the information presented in this Framework SAQP and that of the site-specific SAQPs developed by the future contractor(s) will be required to be appropriately documented and justified in the site-specific SAQPs.

1.9 Limitations

This report: has been prepared by GHD for Transport for NSW and may only be used and relied on by Transport for NSW for the purpose agreed between GHD and Transport for NSW as set out in Section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Transport for NSW arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Transport for NSW, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report, which were caused by errors or omissions in that information.

2. Summary of BLGHFC Project area

2.1 Project area identification

The BLGHFC project area spans approximately seven kilometres from the North Shore suburbs of Cammeray, Naremburn and Artarmon to North Balgowlah and Frenchs Forest. It includes the local government areas (LGA) of North Sydney, Willoughby, Mosman, Lane Cove and Northern Beaches. The location and lateral extent of the BLGHFC project is shown on Figures 1 to 10 in Appendix A.

The construction footprint for the BLGHFC project includes the total area required to facilitate the construction of the project, and includes construction support sites which are defined as temporary facilities required for construction of the project where a compound will be established.

2.2 AEIs

As discussed in Section 1.2 and Section 3, this Framework SAQP applies to sites assessed in Appendix M of the EIS (TfNSW, 2020b) and which were identified to have a moderate or high risk of contamination being present, described as AEIs, as well as any additional AEIs that maybe identified as part of the post approval detailed planning phase of the BLGHFC project.

Project Specific T-AEIs, Crossover T-AEIs and M-AEIs are listed in Table 1 using the nomenclature provided in the EIS (TfNSW, 2020a). It is noted that the numbering of construction support sites and identified AEIs differs between the same sites in the EIS (TfNSW, 2020a) and Appendix M of the EIS (TfNSW, 2020b).

Table 1 outlines the construction support site number and location as referenced in the EIS (TfNSW, 2020a), and the AEI number as referenced in Appendix M of the EIS (TfNSW, 2020b).

Table 1 Construction support site and AEI site summary

Construction support site	AEI	Location	AEI Categorisation
BL1 Cammeray Golf Course	B1/B2 Cammeray Golf Course	Cammeray Golf Course – Park Avenue, Cremorne	Crossover T-AEI
Not applicable (construction footprint interface)	B3/B4/B4/B5/B6 Unsealed areas next to Warringah Freeway	Warringah Freeway – Miller Street to Willoughby Road	Crossover T-AEI
BL3 Punch Street	B7 Punch Street	Punch Street, Artarmon	Project specific T-AEI
BL4 Dickson Avenue	B8 Dickson Avenue	Freeway Hotel, Reserve Road, Artarmon	Project specific T-AEI
BL2 Flat Rock Drive	B9 Flat Rock Reserve	Flat Rock Drive, Northbridge	Project specific T-AEI
Not applicable (construction footprint interface)	B10 Bicentennial Reserve	Willoughby Leisure Centre and Bicentennial Reserve, Willoughby	Project specific T-AEI
BL9 Spit West Reserve	B11 Spit West Reserve	Reclamation of land – Spit West Reserve, Mosman	Project specific T-AEI
BL7/BL8 Middle harbour cofferdams and dredging	B12 Middle Harbour marine works	Middle Harbour – Mosman and Northern Beaches LGAs	M-AEI
BL10 Balgowlah Golf Course	B13/14 Balgowlah Golf Course & Dudley Street	Balgowlah Golf Course at Balgowlah/Residential properties, Dudley Street, Balgowlah	Project specific T-AEI

Construction support site	AEI	Location	AEI Categorisation
BL12 Wakehurst Parkway South	B15 Residential properties, Wakehurst Parkway	Residential properties – Judith Street/Kirkwood Street and Wakehurst Parkway, Seaforth	Project specific T-AEI
BL13 Wakehurst Parkway East	B16 Sydney Water Reservoir	Sydney Water Reservoir site (and surrounds) – Kirkwood Street, Seaforth	Project specific T-AEI
Not applicable (construction footprint interface)	B17 Wakehurst Parkway, Seaforth to Frenchs Forest	Wakehurst Parkway - Seaforth to Frenchs Forest	Project specific T-AEI

For clarity, only the AEI site number will be referenced throughout this report. Detailed figures of each AEI addressed in this Framework SAQP are provided in Appendix A.

Information on the Project Specific T-AEIs and the intended future land use for each Project Specific T-AEI, as provided by Transport is set out in Appendix B. Based on this information, the Preliminary Conceptual Site Models for each Project Specific T-AEIs have also been developed in Appendix B Section 1.2 and indicative sampling and analytical programs are then provided in Appendix B Section 1.4.

3. Decision making process for site-specific SAQPs

The decision making processes that must be applied to each category of AEI to determine the requirement for the development and implementation of site-specific SAQPs for further investigation is discussed in further detail below. Location references and AEI categorisations are listed in Table 1.

Contractors must ensure that all information available at the time of preparation of the site-specific SAQPs is considered and assessed in the development of the site-specific SAQPs. Any previous environmental investigations conducted for AEIs, and reviewed as part of the decision making process, must consider compliance with NSW EPA made or endorsed guidelines for contaminated sites.

In applying the decision making processes set out below, contractors will be required to consider the risk of contamination rankings and any land use changes for all AEIs in order to develop site-specific SAQPs that encompass any changes to contamination risk and land use subsequent to the development of this Framework SAQP.

3.1 Project Specific T-AEIs

The decision for the Project Specific T-AEIs is that site-specific SAQPs must be prepared and implemented on each of these AEIs with the objective of the investigations to be to provide an assessment of site suitability for final intended land use. Where suitability cannot be achieved, the investigations must identify the requirement for remediation or management to make the AEI suitable for its final intended land use.

In order to guide the preparation of the site-specific SAQPs for the Project Specific T-AIEs, the information available on these AEIs, as provided in the EIS (TfNSW, 2020a), has been summarised in Appendix B. This information has been used to set out a preliminary CSM and provide the basis of the requirements for the site-specific SAQPs and is to be utilised by contractor(s) to develop the site-specific SAQPs for the Project Specific T-AEIs in accordance with Section 4.

3.2 Crossover T-AEIs

These AEIs are located across an area of Cammeray and North Sydney where the WHTWFU project will ultimately interface and connect with the BLGHFC project. Transport included these AEIs in the EIS's for both projects to allow for flexibility in staging of the works required to deliver the integration and connectivity between the projects. It was anticipated that works relating to contamination and land use suitability assessment required on these AEIs would be completed by the project that first accessed the AEIs for construction.

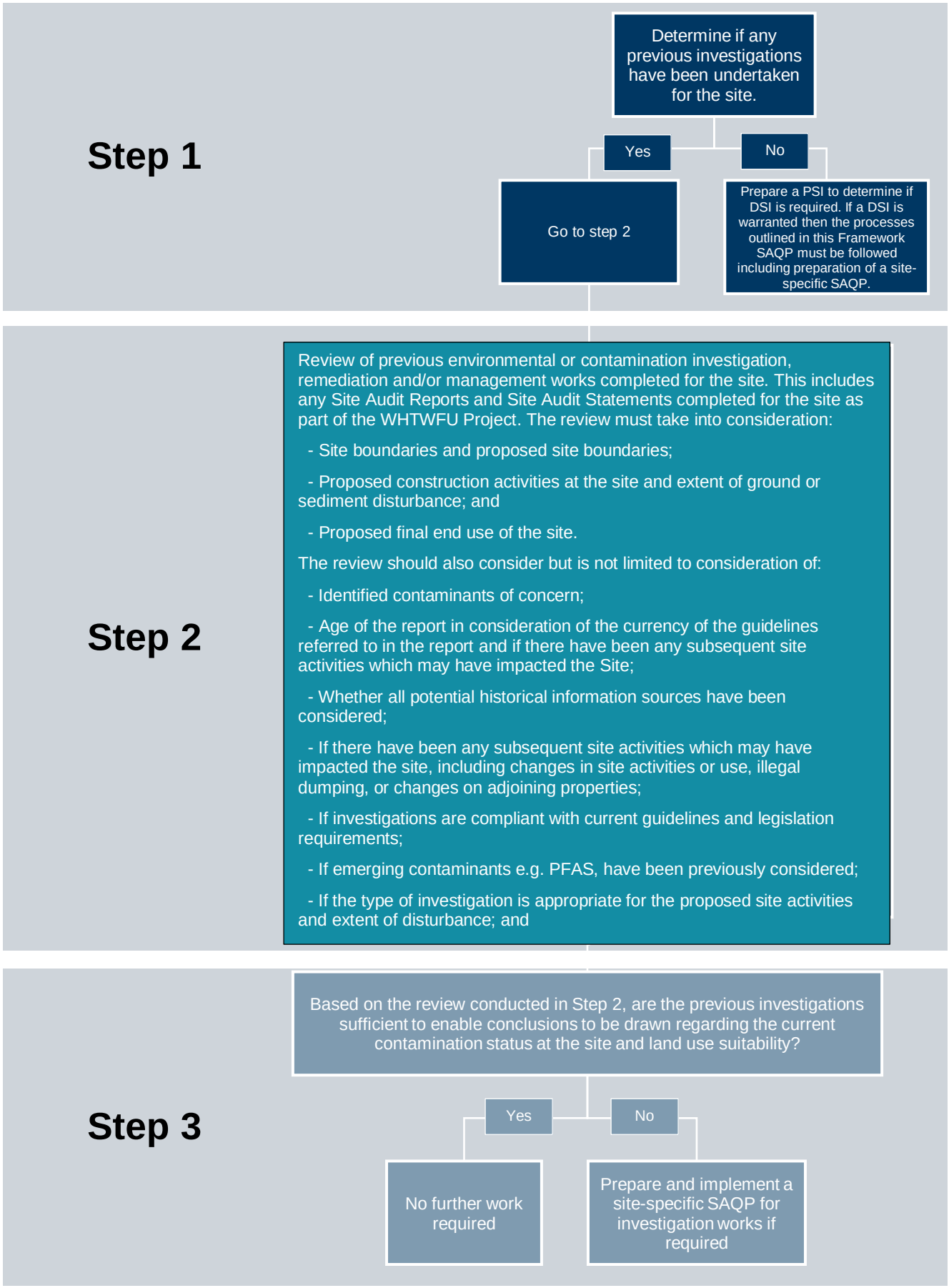
At the time of preparation of this Framework SAQP, progress on the WHTWFU project was well advanced of the BLGHFC project, with early works already underway, main construction activities due to commence in mid-2022 and many of the Crossover T-AEIs already subject to DSIs. Consequently, prior to the commencement of the construction of the BLGHFC project, all investigation works and remediation works on the Crossover T-AEIs, undertaken to comply with SSI-8863 will likely be completed, and construction works either completed or nearing completion.

Given that the timing and nature of the works that may be required by the BLGHFC project on these Crossover T-AEIs is not yet known, a decision making process has been prepared to ensure that any works completed by the WHTWFU project are subject to review and, where possible, relied upon as part of the BLGHFC project. This is to ensure no unnecessary replication of works or further contamination assessment are required where final intended land use suitability has already been assessed and is appropriate to the BLGHFC project,

The decision making process to be applied by contractors to determine whether site-specific SAQPs are required for the Crossover T-AEIs is provided as ***Decision flow chart 1.*** The objective of the review is to determine whether the works completed on the site can:

- be relied upon for the purpose of the BLGHFC project; and
- provide a robust basis for site assessment decisions.

***Decision** flow chart 1 - Crossover T-AEIs*



3.3 M-AEIs

The M-AEIs are those AEIs that were identified in Appendix M of the EIS (TfNSW, 2020b) as marine sites with moderate to high risk of contaminated sediments being present. These M-AEIs have been subject to intrusive investigative works as part of preparation of the EIS, the submissions report and to inform the other approvals. The objective of these investigations comprised assessments of the condition of the sediments to be dredged to determine the requirements for their disposal, both for off-shore disposal under *Commonwealth Environment Protection (Sea Dumping) Act 1981* and also to NSW EPA licenced waste facilities, and additionally to assess the potential impacts to sensitive receptors and mitigation measures during future dredging and sediment disturbance works.

Given the above, the contractor will be required to review the existing information and provide consideration as to whether further investigations into the environmental condition of sediments are required to inform their design and delivery of the marine works, including their compliance with relevant project approvals. The contractor will also be required to continue to engage with the federal Department of Agriculture, Water and Environment (DAWE) and any other relevant federal government agencies as required. A decision making process has been prepared to ensure that site-specific SAQPs are prepared to inform the investigation works where further investigations are deemed to be required.

For clarity, it is noted that the M-AEIs are not required to be assessed for suitability as the trigger for the investigation works relates only to the impacts that construction activities may have to sensitive receptors, and the requirements for disposal of any removed sediments as part of those construction activities.

The decision making process to be applied by contractors to determine whether site-specific SAQPs are required for the M-AEIs is provided as ***Decision flow chart 2.***

Decision flow chart** 2 **- Marine AEIs

Step 1

Review of previous investigations completed in relation to sediments within the M-AEI to determine if works completed are sufficient to meet the relevant requirements in relation to either project approvals, disposal requirements and/or impacts to sensitive receptors. The review must take into consideration:

- Proposed dredging or other construction activities that will disturb sediments;
- Proposed extent of sediment disturbance;
- Requirements for disposal of sediments that are dredged or otherwise removed as part of construction activities;
- Requirements for further assessment of impacts to sensitive receptors;
- Proposed construction activities at the site and extent of ground or sediment disturbance; and
- Potential risk of sediments disturbance to the environment or human health during construction.

The review should also consider but is not limited to consideration of:

- Identified and potential contaminants of potential concern (COPC), including dioxins, and potential bioavailability of COPC
- The potential presence of acid sulfate soils, and handling and disposal options if required;
- Age of the report (in consideration of the currency of the guidellines referred to in the report);
- Whether all potential historical information sources have been considered;
- If there have been any subsequent site activities which may have impacted the site;
- If investigations are compliant with current guidelines and legislation requirements;
- If emerging contaminants e.g. PFAS, have been previously considered;
- If the type of investigation is appropriate for the proposed site activities and extent of disturbance;
- Options to manage sediment to be disturbed during construction, including consideration of on-shore disposal; off-shore disposal; sea dumping and in-shore disposal (in-harbour location);
- Bioavailability of COPCs; and
- The extent of the previous investigation boundaries, including vertical and lateral extents.

Step 2

Based on the review conducted in Step 1, are the previous investigations sufficient to enable conclusions to be drawn regarding potential impacts to sensitive receptors during construction, and sediment disposal requirements?

Yes

No further work required

No

Prepare and implement a site-specific SAQP if required

The guidance framework which must be considered in the development of the M-AEI site-specific SAQPs is provided in Table 2.

Table 2 Marine AEIs – sediment guidance framework

Objective	Scenario	Guidance framework / reference
To determine sediment risk during construction	Environmental / health risk during construction	– Environmental risk: Australian & New Zealand Guidelines for Fresh & Marine Water Quality (Sediment Quality Guidelines) – Health risk: site specific risk assessment, with construction methodology, possible exposure pathways and receptors incorporated – *The Role of Toxicity Testing in Identifying Toxic Substances in Water* (enHealth, 2012) – Schedule B4 of (NEPC, 2013)
To determine options to manage sediment to be disturbed during construction	On shore disposal	– NSW EPA *Waste Classification Guidelines 2014 and PFAS Addendum 2016* and/or Specific NSW EPA resource recovery exemption / orders (follow EPA guidance on applying specific exemption / orders – NSW EPA Control Orders created under Part 3, Division 5 of the Environmentally Hazardous Chemicals Act 1985 (e.g. for dioxin-contaminated waste materials and organotin waste materials)
	Sea dumping (offshore disposal)	– National Assessment Guidelines for Dredging 2009

3.4 A-AEIs

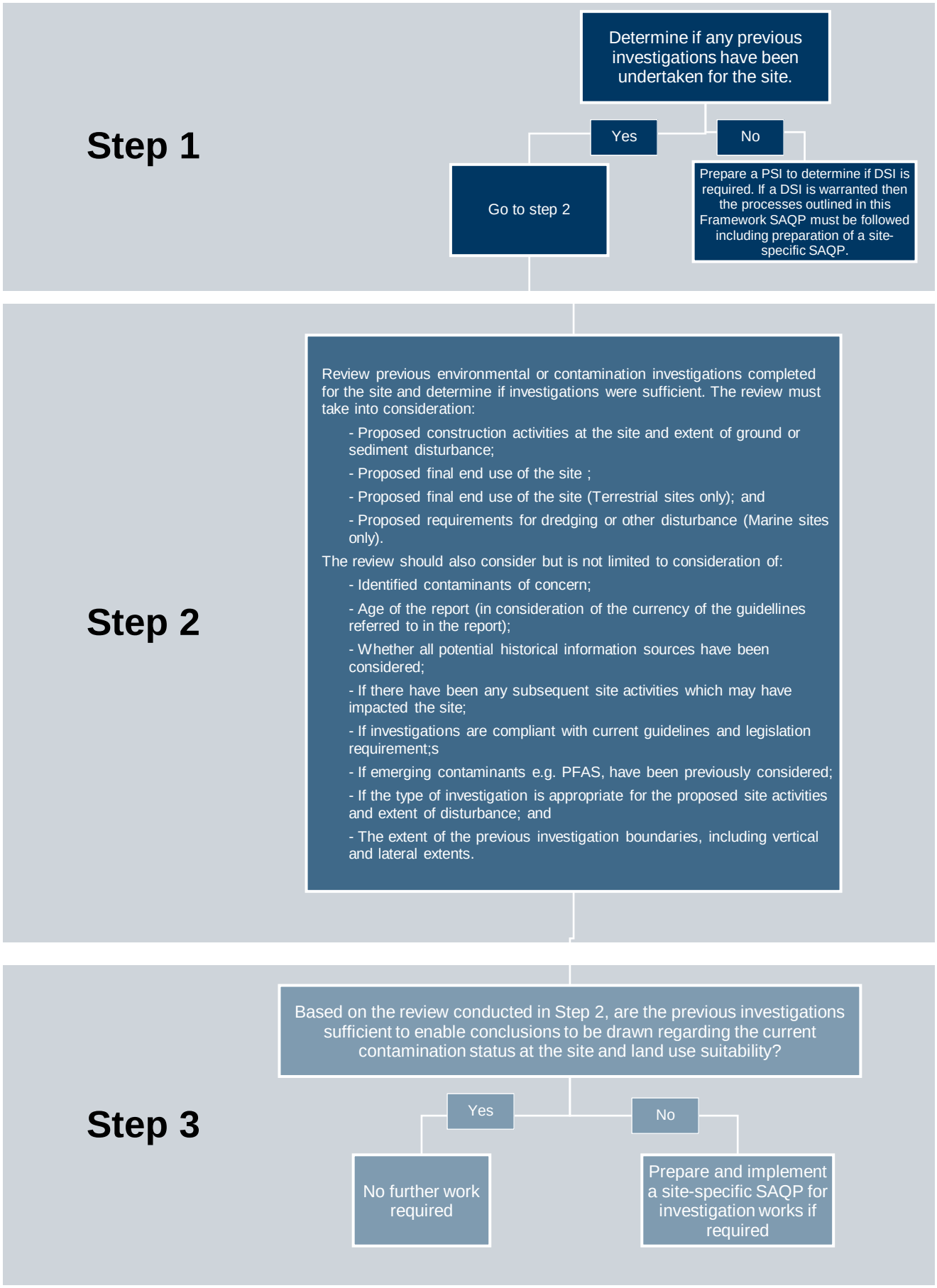
A-AEIs are those AEIs which may arise as a result of the following circumstances:

– Amendments to the boundaries of the AEIs within or adjacent to the current project footprint that were identified in Appendix M of the EIS (TfNSW, 2020b) where the amendments result in the land not previously assessed in the EIS now being within the project footprint;
– Identification of new AEIs within or adjacent to the current project footprint as having a moderate to high risk of contamination being present that had not been identified as an AEI in in Appendix M of the EIS. A change in the boundary to the current project footprint will trigger the need for a PSI for the new portion of land; and
– Any other areas that are located within the project footprint, including those that were identified in Appendix M of the EIS (TfNSW, 2020b) as areas of low risk of contamination being present, where conditions have changed or where review of existing information indicates a potential of contamination being present that otherwise was not previously identified. This includes any changes to surrounding land conditions that could affect the risk of contamination being present on an AEI.

If any of the circumstances listed above arises, consideration must be provided to the risk assessment matrix set out in Section 5 of Appendix M of the EIS (TfNSW, 2020b) and a decision making process has been prepared that ensures that consideration of the potential for contamination to be present is made for such sites and then, if required, subsequent works are completed including the preparation of site-specific SAQPs in accordance with the processes set out in this Framework SAQP.

The decision making process to be applied by contractors to determine whether site-specific SAQPs are required for any site that meets the above circumstances or similar circumstances is shown in ***Decision flow chart 3.***

Decision flow chart 3 - Additional AEIs



3.5 Documentation

The results of the decision-making processes undertaken by the contractor must be documented prior to the preparation of any site-specific SAQPS or undertaking any further investigations or construction activities at the site. The report must detail:

- Attempts made to locate existing reports;
- Outline of proposed construction activities and end use of the site ;
- Summary of findings of the review of the existing reports, including the provision of a reliability assessment (including but not limited to consideration of the appropriateness of previous sampling investigations and an assessment of the quality and reliability of the data), and relevance to the proposed construction activities and end use; and
- Justification for whether additional investigations are / are not required with consideration of relevant guidelines and final intended land use for the BLGHFC project.

4. Site-specific SAQP requirements

The detailed planning and design for the BLGHFC project will commence once planning approval is determined. Contractor(s) must then implement the requirements of this Framework SAQP and apply the decision making processes set out in Section 3 to determine the requirement for preparation and implementation of site-specific SAQPs. The site-specific SAQPs have a critical role in ensuring that the data collected is representative and provides a robust basis for site assessment decisions.

Site-specific SAQPs must be prepared prior to the commencement of the investigation works that they describe, and must consider the significance of the lateral tunnel position and depth relative to AEIs.

The site-specific SAQPs must detail the data quality objectives, sampling design, analytical program, sampling and analytical methodologies to be applied and the data quality indicators and how the works will be reported. These requirements for the site-specific SAQPs are detailed below and have been prepared to be consistent with the relevant guidelines made and endorsed by NSW EPA, including the *Consultants Reporting on Contaminated Land – Contaminated land guidelines* (NSW EPA, 2020) and the Appendix B of the National Environment Protection Measures (ASC NEPM) Schedule B2 Guideline on Site Characterisation (NEPC, 2013).

4.1 Document control

As required by the *Consultants Reporting on Contaminated Land – Contaminated land guidelines* (NSW EPA, 2020) checklist a document control section containing the following information must be presented in the site-specific SAQPs:

– Date;
– Version number;
– Author and reviewer, including certification details; and
– The person that commissioned the report.

4.2 Objectives

The objectives of a sampling and analysis quality plan is to provide the context, justification, methodologies and details of the selected sampling and analysis approach.

The site-specific SAQPs must set out the objectives of the sampling and analytical program to be completed.

4.3 Scope of works

The proposed scope of work must be included in the site-specific SAQPs as required by the *Consultants Reporting on Contaminated Land – Contaminated land guidelines* (NSW EPA, 2020) checklist.

4.4 Site setting and environment

The description of the site setting in the site-specific SAQP must meet the requirements set out in Appendix B of the ASC NEPM Schedule B2 Guideline on Site Characterisation (NEPC, 2013) and the *Consultants Reporting on Contaminated Land – Contaminated land guidelines* (NSW EPA, 2020).

The site-specific SAQPs must detail the following information:

– Site identification in accordance with the ASC NEPM Field Checklist 'Site information' sheet
– Current and future intended land use;
– Site history, including a review of historical aerial photographs;
– Environmental setting;

– Local geology and hydrogeology; and
– Condition of site, including any built structures, vegetation cover and similar that must be based on the results of an inspection of the site;

4.5 Conceptual site model

A CSM provides the framework for identifying sources of contamination, contaminant migration pathways, receptors and exposure mechanisms. The complexity of the CSM should correspond to the scale and complexity of the known or potential contamination impacts. The site-specific SAQP must provide a conceptual site model that details the following:

– Known and potential sources of contamination and contaminants of concern including the mechanism(s) of contamination;
– List of potentially affected media including biota if applicable;
– List of human and ecological receptors (both on- and off-site);
– potential and complete exposure pathways (both on- and off-site, including preferential pathways which are of particular relevance to the assessment of vapour); and
– Data gap and uncertainty assessment; and
– Assumptions underlying the model including:
    - How representative the available data is likely to be;
    - The potential sources of variability and uncertainty; and
    - Importance of identified data gaps are to the objectives of the assessment works.

The conceptual site model developed for the site-specific SAQPs must meet the requirements set out in Appendix B of the ASC NEPM ((NEPC, 2013).

4.6 Sampling, analytical and quality plan

Based on the above information a sampling and analysis quality plan must be developed and included in the site-specific SAQP that sets out the works to be undertaken obtain the necessary representative data for the site.

4.6.1 Data quality objectives

The purpose of establishing data quality objectives (DQOs) is to ensure that the field investigations and subsequent analyses are undertaken in a way that enables the collection and reporting of reliable data on which to base the assessment.

A process for establishing DQOs for a site investigation is defined in Appendix B of the ASC NEPM, Schedule B2 Guideline on Site Characterisation (NEPC, 2013).

The DQO process must be applied to any investigation into the presence of contamination as part of the BLGHFC project to ensure that data collection activities are appropriate and achieve the BLGHFC project objectives. The DQO process involves the following seven steps:

– Step 1: State the problem
– Step 2: Identify the decision
– Step 3: Identify inputs to the decision
– Step 4: Define the study boundaries
– Step 5: Develop a decision rule
– Step 6: Specify limits on decision errors
– Step 7: Optimise the design for obtaining data

The site-specific SAQPs must clearly set out the DQOs for the investigation works to be completed and clearly document the completion of each of the seven step process set out above. It is critical to ensure that the DQOs reference plans, drawings or similar that provide surveyed boundaries of the site to which the investigation is to be completed.

4.6.2 Assessment criteria

The site-specific SAQPs must clearly set out the assessment criteria that is to be applied to the results of the sampling and analytical works and provide the decision making process applied to determine the applicable criteria and demonstrate that it will meet the objectives of the investigation works. The assessment criteria must be provided for each environmental media that is being subject to sampling and analysis and must be utilised and applied in accordance with the ASC NEPM and the guidelines made or endorsed by the NSW EPA.

The assessment criteria section for the site-specific SAQPs must present the rationale for the selection of assessment criteria, including assumptions and limitations of the criteria (relevant to the assessment and current or proposed land use) and any deviations from approved guidelines. Tables listing all selected assessment criteria and references adopted must be included in the site-specific SAQPs.

4.6.3 Sampling plan

An appropriate sampling design must be provided in the site-specific SAQPs. This sampling design must be based on based on accurate and reliable site-specific information (as integrated in the CSM) as far as practicable to obtain sufficient representative data to address the DQOs. The sampling design must detail the sampling locations, density, depth (or similar) and the number of samples to be collected and any other information (such as temporal variations) relevant to achieving the objectives of the assessment. The sampling design and plan selected must be prepared in accordance with the relevant guidelines made or approved by NSW EPA and be appropriately justified as required by Appendix B of the ASC NEPM Schedule B2 Guideline on Site Characterisation (NEPC, 2013). All relevant approvals required to enable intrusive works must be obtained prior to implementing the sampling plan.

4.6.4 Field methodology

The field methodologies to be implemented must be detailed in the site-specific SAQPs. The selection of the most appropriate investigation methodologies must be undertaken with respect to the site setting, each environmental media being subject to investigation, the stage of the investigation, the depth of investigations required and the type of potential contamination being investigated. Consideration should also be provided to temporal variations that may affect methodologies being applied.

The field methods selected must be appropriately justified as required by Appendix B of the ASC NEPM Schedule B2 Guideline on Site Characterisation (NEPC, 2013).

4.6.5 Analytical plan

The analytical plan to be implemented must be detailed in the site-specific SAQPs. The selected schedule of analytes, frequency of analysis, type of analysis and analytical methods to be applied must be detailed and appropriately justified.

The analytical plan selected must be appropriately justified as required by Appendix B of the ASC NEPM Schedule B2 Guideline on Site Characterisation (NEPC, 2013).

4.7 Quality assurance and quality control

Quality assurance (QA) and quality control (QC) are essential elements of the site-specific SAQP. The field QA and QC procedures and laboratory QA and QC procedures must be prepared to comply with the requirements for QA and QC that is set out in Appendix B of the ASC NEPM Schedule B2 Guideline on Site Characterisation (NEPC, 2013).

4.8 Reporting

The site-specific SAQP must be prepared, or reviewed and approved by consultants certified under either the Environment Institute of Australia and New Zealand's Certified Environmental Practitioner (Site Contamination) scheme (CEnvP(SC)) or the Soil Science Australia Certified Professional Soil Scientist Contaminated Site Assessment and Management (CPSS CSAM) scheme.

All phases of sampling and analysis will be subject to a statutory site audit by a NSW EPA- accredited Site Auditor.

The site-specific SAQPs must address all the requirements set out in this Framework SAQP and must include the SAQP checklist provided as Table 2.2 of the Consultants Reporting on Contaminated Land – Contaminated land guidelines (NSW EPA, 2020) and references to the sections of the SAQP which satisfy the requirements of this checklist.

Site-specific SAQPs must include presentation of the environmental data from pre-EIS and post-EIS investigations.

The site-specific SAQPs must also set out the requirements for the reporting to be prepared as an outcome of the implementation of the SAQP which must be stated to include the following at a minimum:

- Data quality objectives for the investigations works;
- Description of the investigation works undertaken;
- Comparison of soil, sediment, water and gas analytical results to adopted assessment criteria;
- Determination of the reliability of the field and laboratory programs, by reference to the site-specific SAQP DQOs and DQIs;
- Identify any "non-conformances" and how they were addressed or how they affect the reliance on the data;
- Any variations to the site-specific SAQP during implementation and detailed justification for the variation;
- Results of fieldworks and laboratory analytical results;
- Provision of data tables and records and other supporting information, including presentation of all sampling points (and groundwater wells) on a site plan where the consultant will rely on that information;
- A refined conceptual site model, including sources, pathways, receptors and a linkage assessment to determine risks to identified receptors during construction and post-construction
- Information demonstrating that the objectives of the assessment works have been achieved, in particular the results and assessment of the data against both the pre-defined data quality objectives and the site assessment criteria;
- Information demonstrating compliance with appropriate regulations and guidelines, identification of any data gaps to be addressed;
- Information demonstrating how the results of the works will be utilised as part of planning for the control or management measures to be required during construction activities;
- Where required, assessment on the suitability of the AEI for final intended land use and recommendations on the requirements, if any, for remediation and/or management in order to make the AEI suitable; and
- Other information as appropriate, that will apply to the AEI.

5. Summary

Transport has committed to the development of this Framework SAQP to set out the general context, justification and general sampling and analytical framework that will be adopted post-determination in subsequent site-specific SAQPs.

It is noted that the Framework SAQP was prepared in consideration of the *Guidelines for Consultants Reporting on Contaminated Sites* (NSW EPA, 2020) and it provides guidance for the future development of site-specific SAQPs required for contamination investigation to be conducted post-determination.

The Framework SAQP has been developed to ensure that, across the different stages of the BLGHFC project, consistent decision making processes are implemented for determining whether site-specific SAQPs are required, and also the context, justification and scope of contamination sampling and analysis where site-specific SAQPs are required.

The requirements of the Framework SAQP will be implemented by contractors, post contract award. The development of site-specific SAQPs will inform the investigation requirements for detailed site investigations (DSIs) or other investigation works for each AEI identified in Appendix M of the EIS as well as for any additional AEIs. The results of the DSIs or other investigation works will determine the requirements, if any, for remediation and/or management.

The preparation and subsequent implementation of the site-specific SAQPs form the second stage of contamination investigation works for the BLGHFC project. The results from the implementation of the site-specific SAQPs will then be relied upon to determine the requirements, if any, for remediation and/or management to ensure that Transport's obligations with respect to contaminated land (including achieving land suitability), for the BLGHFC project are met.

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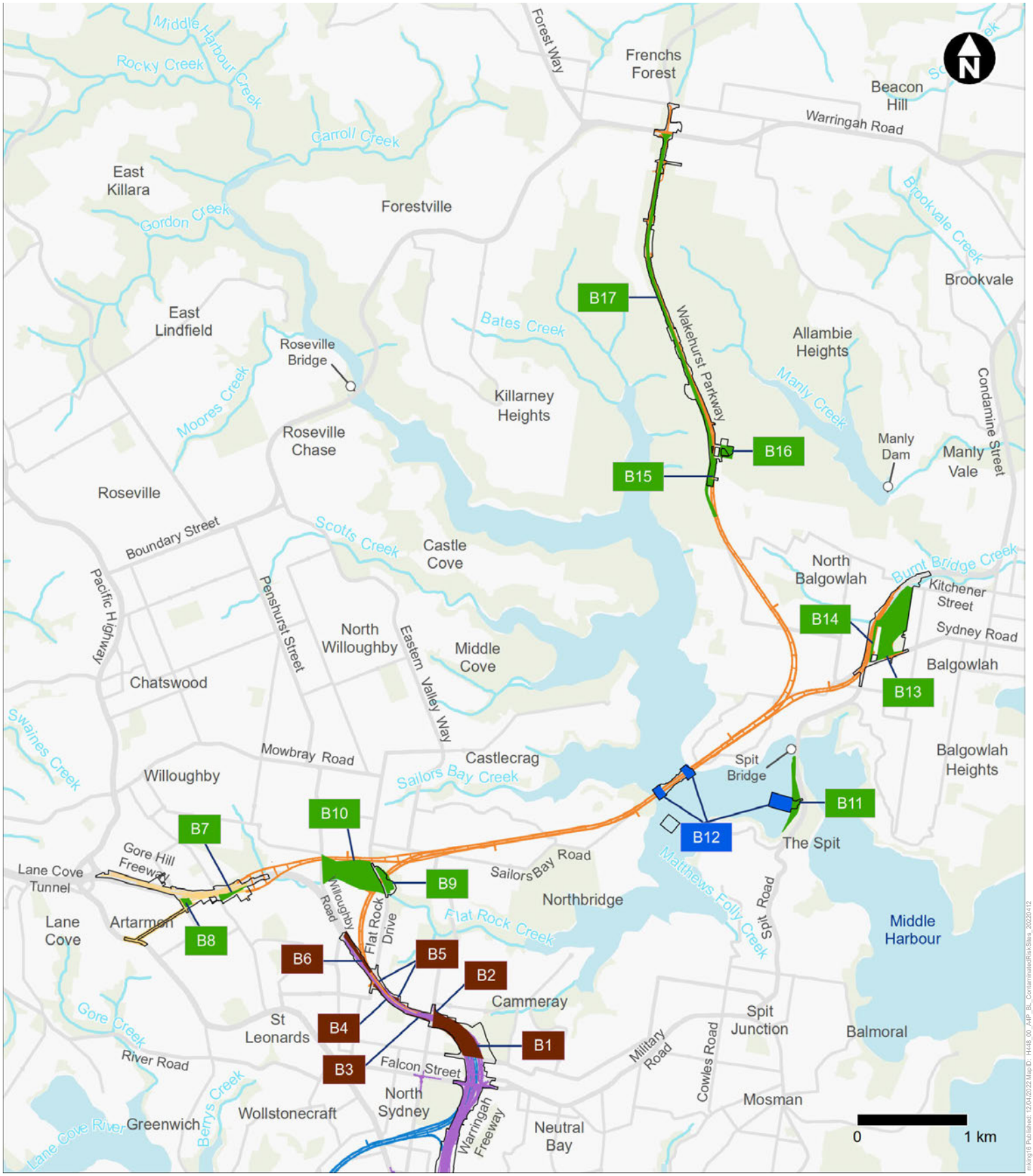
Appendices

Appendix A

Figures



BEACHES LINK
FIGURE 1
KEY

- Beaches Link
- Gore Hill Freeway Connection
- Western Harbour Tunnel
- Warringah Freeway Upgrade
- Construction footprint
- Waterways
- Terrestrial AEIs (T-AEIs)
- Crossover terrestrial AEIs (Crossover T-AEIs)
- Marine AEIs (M-AEIs)
- Additional AEIs (A-AEIs) – refer to decision making process for site-specific SAQPs

NSW GOVERNMENT

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BEACHES LINK
FIGURE 2 - AREAS OF ENVIRONMENTAL INTEREST - B1, B2 AND B3

KEY

- Crossover T-AEIs
- Construction footprint
- Road design boundary
- Suburbs

0 35 70 140 Metres

N

NSW GOVERNMENT

BEACHES LINK
FIGURE 3 - AREAS OF ENVIRONMENTAL INTEREST - B3, B4, B5 AND B6

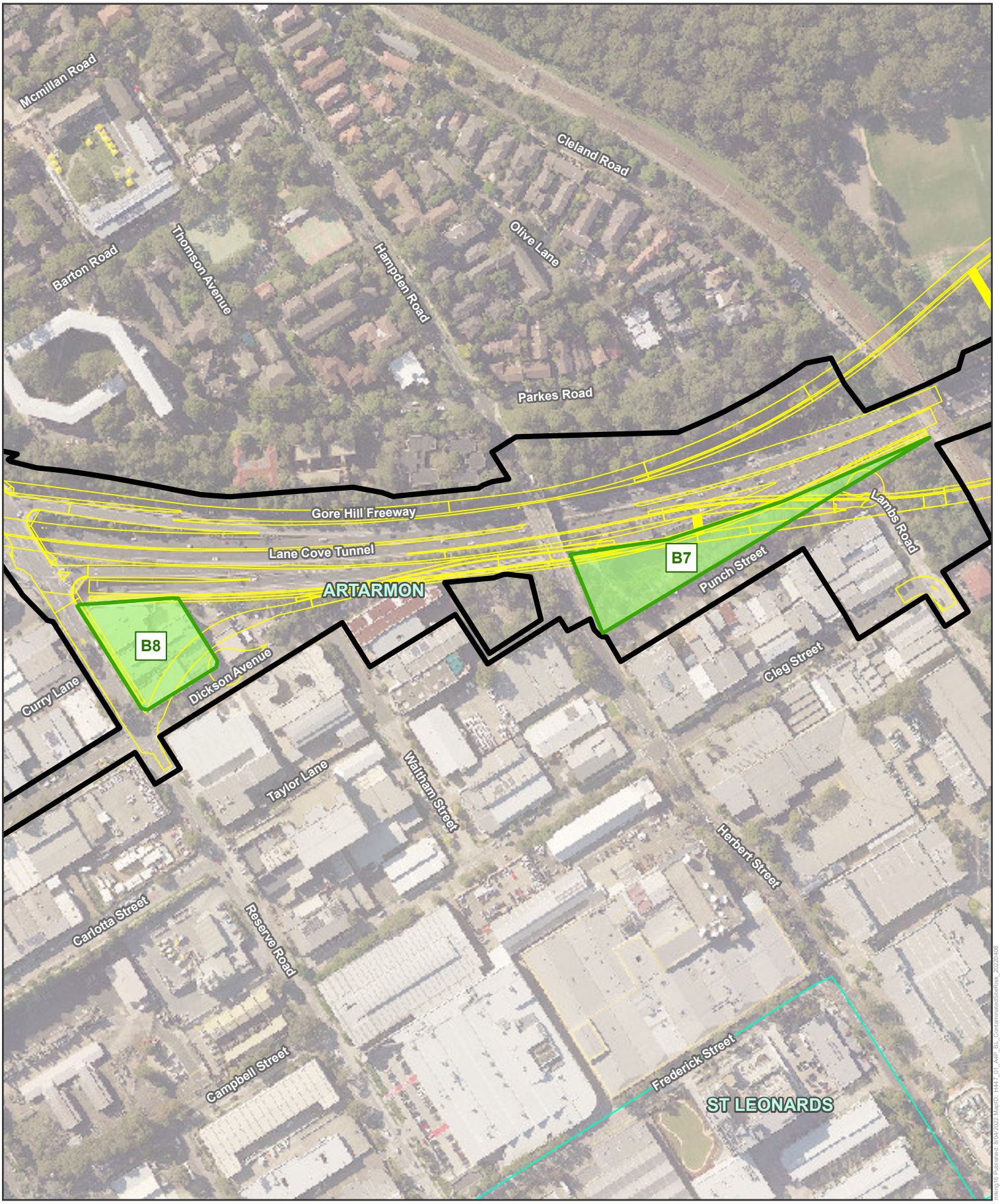
KEY

- Crossover T-AEIs
- Construction footprint
- Road design boundary
- Suburbs

0 35 70 140 Metres

N

NSW GOVERNMENT



BEACHES LINK
FIGURE 4 - AREAS OF ENVIRONMENTAL INTEREST - B7 AND B8

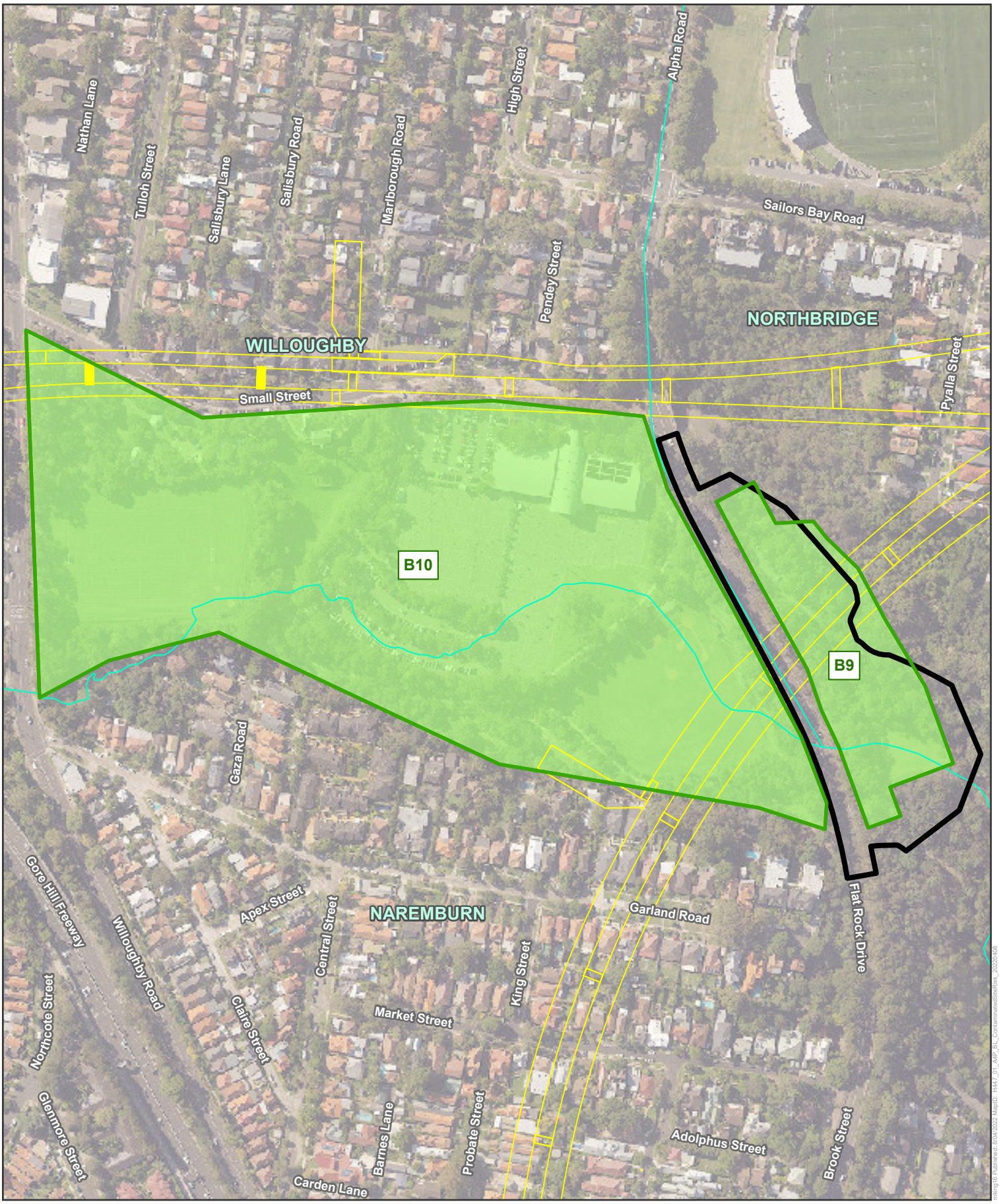
KEY

- T-AEIs
- Construction footprint
- Road design boundary
- Suburbs

0 35 70 140 Metres

N

NSW GOVERNMENT



BEACHES LINK
FIGURE 5 - AREAS OF ENVIRONMENTAL INTEREST - B9 AND B10

KEY

- T-AEIs
- Construction footprint
- Road design boundary
- Suburbs

0 35 70 140 Metres

N

NSW GOVERNMENT

BEACHES LINK
FIGURE 6 - AREAS OF ENVIRONMENTAL INTEREST - B11 AND B12

KEY

- T-AEIs
- M-AEIs
- Construction footprint
- Suburbs

0 35 70 140 Metres

N

NSW GOVERNMENT

BEACHES LINK
FIGURE 7 - AREAS OF ENVIRONMENTAL INTEREST - B12

KEY

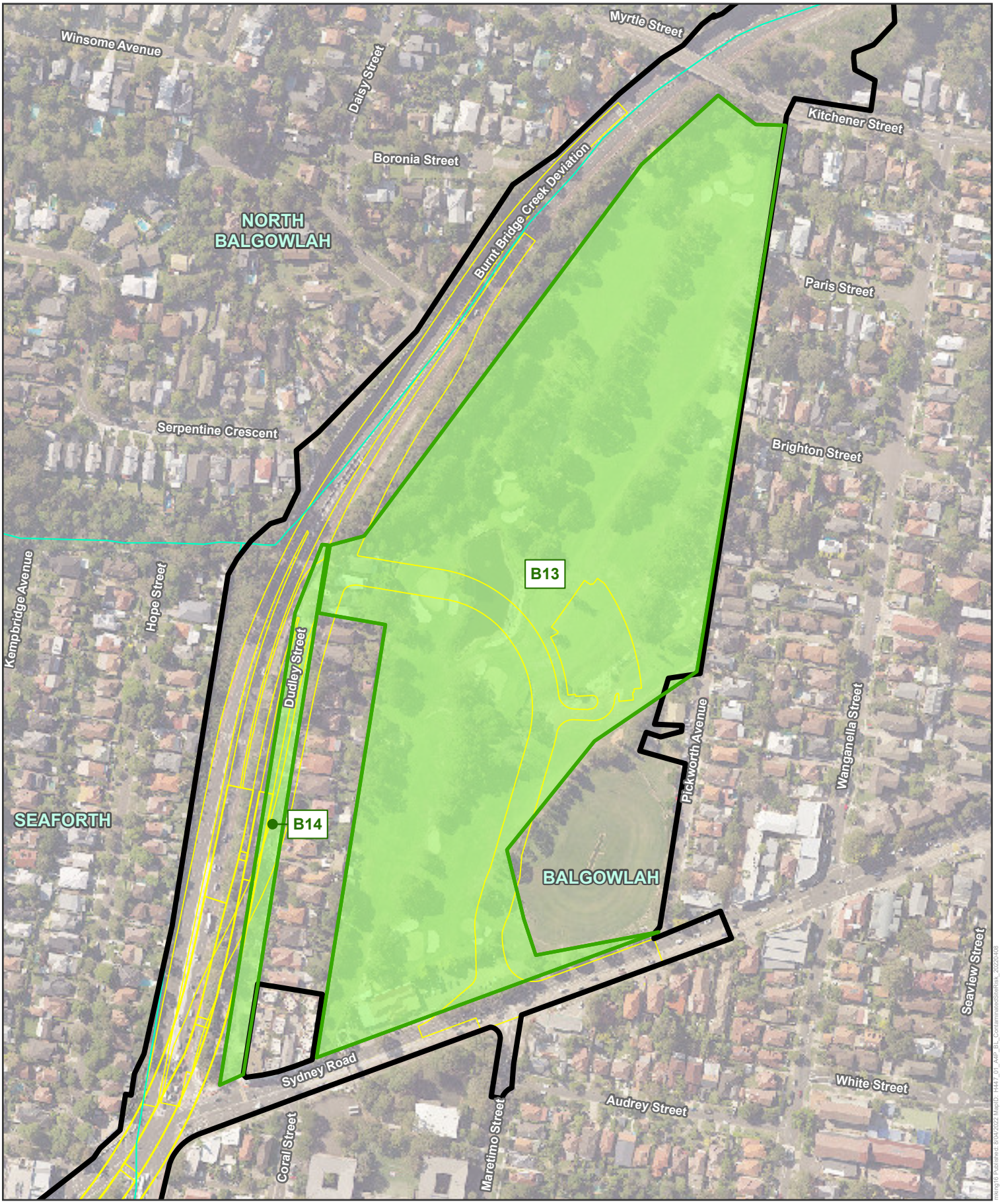
- M-AEIs
- Construction footprint
- Road design boundary
- Suburbs

0 35 70 140 Metres

N

NSW GOVERNMENT

map16 Published: 8/04/2022 MapID: HM17_01_AIP_BL_ContaminatedSiteRisk_20220408



BEACHES LINK
FIGURE 8 - AREAS OF ENVIRONMENTAL INTEREST - B13 AND B14

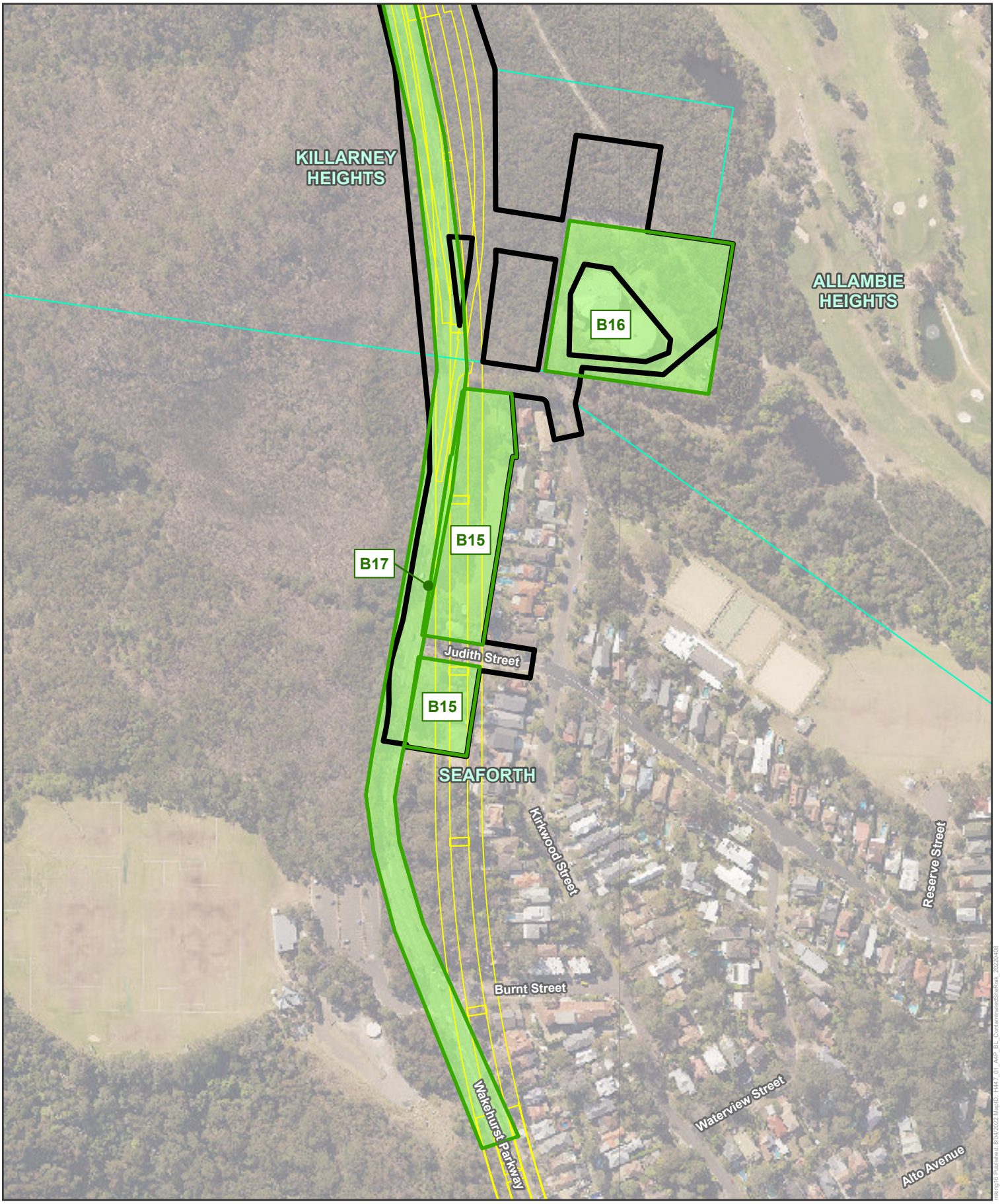
KEY

- T-AEIs
- Construction footprint
- Road design boundary
- Suburbs

0 35 70 140 Metres

N

NSW GOVERNMENT



BEACHES LINK
FIGURE 9 - AREAS OF ENVIRONMENTAL INTEREST - B15, B16 AND B17

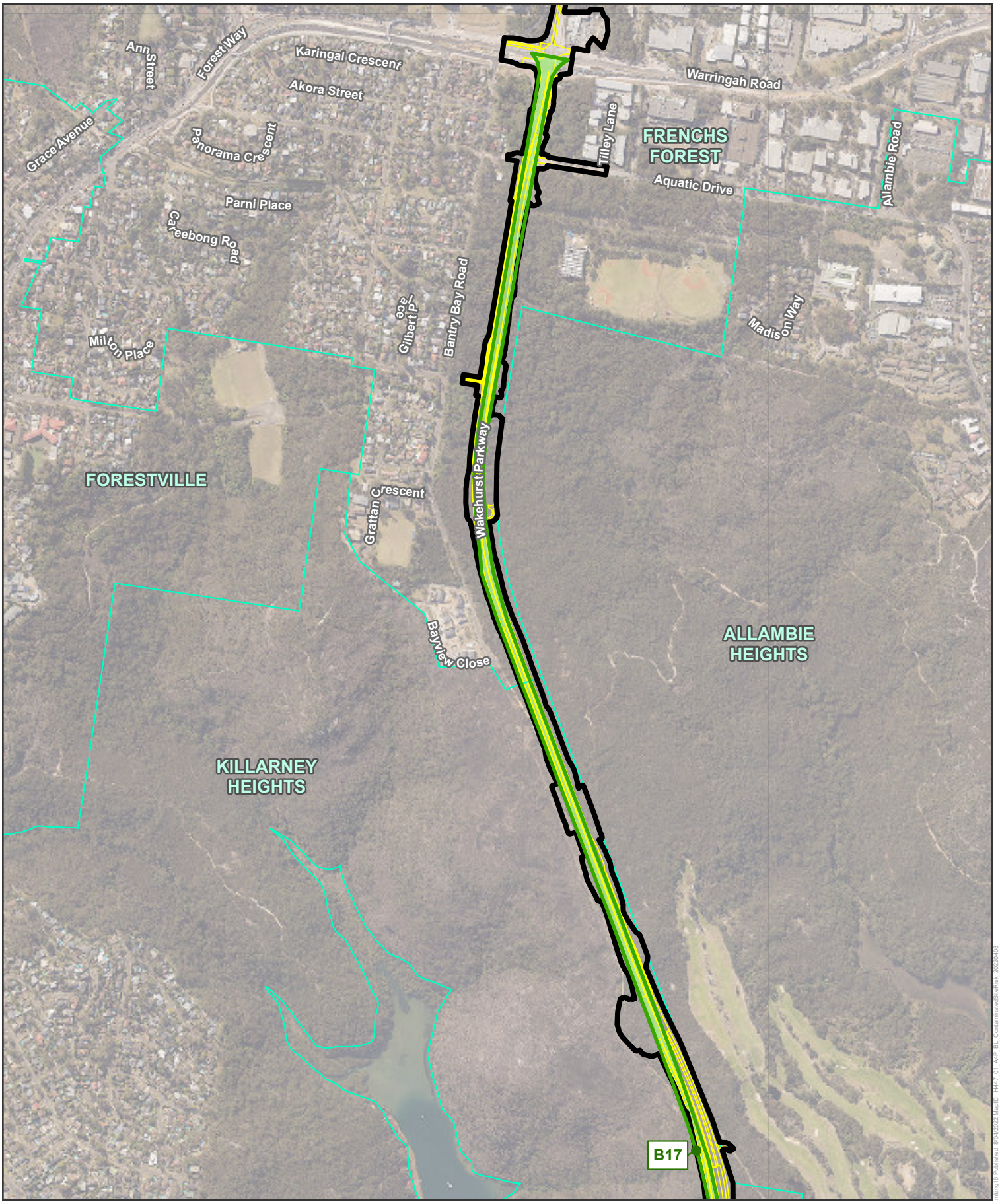
KEY

- T-AEIs
- Construction footprint
- Road design boundary
- Suburbs

0 35 70 140 Metres

N

NSW GOVERNMENT



BEACHES LINK
FIGURE 10 - AREAS OF ENVIRONMENTAL INTEREST - B17

KEY

- T-AEIs
- Construction footprint
- Road design boundary
- Suburbs

0 125 250 500 Metres

N

NSW GOVERNMENT

Appendix B

Project Specific T-AEIs – Basis for site-specific SAQPs

Project Specific T-AEIs - Basis for site-specific SAQPs

Beaches Link Project

Transport for NSW

16 May 2022

→ The Power of Commitment

GHD Pty Ltd | ABN 39 008 488 373| ABN 39 008 488 373
133 Castlereagh Street , Level 15
Sydney, NSW 2000, Australia
T [redacted] | **F** [redacted] | **E** [redacted] | **ghd.com**

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Draft	C	[redacted]	[redacted]		H. Milne (CEnvP SC)		
Final	0	[redacted]	[redacted]		H. Milne (CEnvP SC)		

Contents

Table index

1. Project Specific T-AEIs- Basis for site-specific SAQPs

At the time of preparation of the Framework SAQP, it had been determined that the Project Specific T-AEIs will require the preparation and implementation of site-specific SAQPs for DSIs. In order to guide the preparation of the site-specific SAQPs for the Project Specific T-AIEs, the information available on these AEIs, as provided in the EIS (TfNSW, 2020a), has been detailed below. This information has been set out to reflect the requirements for site-specific SAQPs as detailed in Section 4 of the Framework SAQP, and is to be utilised by contractor(s) to develop the site-specific SAQPs for the Project Specific T-AEIs.

Contractors must ensure that all information available at the time of preparation of the site site-specific SAQPs is considered and assessed in the development of the site-specific SAQPs.

1.1 Project Specific T-AEIs condition and environmental setting

1.1.1 Project Specific T-AEIs identification

A summary of the identification details of each AEI for the BLGHFC project is provided in Table 1 to Table 8. The site locality and setting of each AEI site is presented in Figures 4 to 6 and Figures 8 to 10, Appendix A of the Framework SAQP. As noted above the construction works anticipated to be completed on each AEI and the likely future land use are based on information provided within the EIS (TfNSW, 2020d) and as provided to GHD by Transport. It is noted the construction and final land use may change in the future as the project design is finalised.

Table 1 Site identification summary – B7 Punch Street

Site Information	Details
Site area	The B7 site is located at Punch Street, Artarmon, comprising an area of approximately 5,900 m^2.
LGA	The site is located in Willoughby City Council.
Current land use zoning	Public Recreation (RE1).
Current land use	The site is currently used as a public park and includes a public pathway adjacent the Gore Hill Freeway.
Construction Works	Demolition of existing structures; excavation of tunnel features; construction and operation of temporary site facilities.
Future land use	Commercial/industrial – including commercial / industrial properties and road/motorway operations.
Surrounding land Use	North – Gore Hill Freeway, Artarmon Park and residential properties; South – Punch Street, followed by various commercial/industrial premises; East – A railway line, followed by residential properties; and West – Herbert Street, followed by various commercial/industrial premises.
Site inspection	Key information noted during the GHD inspection conducted on 16 July 2021 of site B7 is as follows: - The site is well vegetated with mature trees, shrubs and long grasses. A pedestrian / cycleway path transects the site from east to west, and is adjacent to and overlooking an open gully / stormwater drain and retention pond; and - The site is separated from Punch Street by a high barbed wire topped fence. Public car parking is provided along the northern side of Punch Street, adjacent to the site.

Site Information	Details
	- Immediately north of the site is the Gore Hill Freeway; and - A telecommunications facility is located at the eastern end of the site.

Table 2 Site identification summary – B8 Dickson Avenue

Site Information	Details
Site area	The B8 site is located on the corner of Reserve Road and Dickson Avenue and comprises an area of approximately 5,500 m^2.
LGA	The site is located in Willoughby City Council.
Current land use zoning	General Industrial (IN1).
Current land Use	The site is currently occupied by a hotel, media company and automotive shop.
Construction land use	Demolition of existing structures; construction and operation of temporary site facilities.
Future land use	Commercial/industrial – including commercial / industrial properties and road/motorway operations.
Surrounding land Use	North – Gore Hill Freeway, followed by public recreation areas and residential properties; South – Dickson Avenue, followed by various commercial/industrial premises; East – Various commercial/industrial premises; and West – Reserve Road, followed by various commercial/industrial premises.
Site inspection	Key information noted during the GHD inspection conducted on 16 July 2021 of site B8 is as follows: - The site consists of two storey commercial buildings housing a tyre fitter, mechanical workshop and repairer, car wash, television production studios, and the Freeway Hotel; and - The site surface is fully sealed.

Table 3 Site identification summary – B9 Flat Rock Reserve & B10 Bicentennial Reserve

Site Information	Details
Site area	The B9 site is located at Flat Rock Drive, Flat Rock Reserve, Northbridge, comprising an area of approximately 10,400 m^2. The B10 site is located at Willoughby Leisure Centre and Bicentennial Reserve (between Flat Rock Drive and Willoughby Road), Willoughby, comprising an area of approximately 109,200 m^2.
LGA	The sites are located in Willoughby City Council.
Current land use zoning	Environmental Conservation (E2) and Infrastructure (SP2) (B9) and Public Recreation (RE1) (B10).
Current land Use	The B9 site is currently used as a bushland Reserve and the B10 site is used as a Leisure Centre and recreational park.
Construction land use	B9: Excavation of tunnel access decline and main tunnel alignment; construction and operation of temporary site facilities . B10: Tunnel excavation (no surface works planned).
Future land use	B9: Open space – public recreation parkland. B10: Will remain in its current state (Public Recreation and open space), with an underground tunnel running below the site
Surrounding land Use	North – Residential properties and recreational oval; South – Residential properties; East – Public open space and residential properties; and West - Residential properties.
Site inspection	Key information noted during the GHD inspection conducted on 16 July 2021 of site B9 is as follows:

Site Information	Details
	- The site is comprised of an historical municipal rubbish tip which has been subject to major earthworks and clay capping and revegetation to re-establish the site as a nature reserve; - The site is heavily vegetated with mature trees, bushes and grasses. A network of unsealed gravel pathways and sealed bitumen pathways wind throughout the reserve. A grassed playing field is located at the southern end of the site; and - Stormwater channels and gullies drain runoff from the site southwards into Flat Rock Creek. Key information noted during the GHD inspection conducted on 16 July 2021 of site B10 is as follows: - The site is comprised of an historical municipal rubbish tip which has been infilled and converted to a sporting facility including a baseball diamond, netball and basketball courts, soccer fields, a leisure centre and a children's playground; - The former municipal waste incinerator has been preserved and converted into the Incinerator Café; - The depth of the Flat Rock Creek gully across this site is understood to be 30 metres or more deep; and - Two box culverts drain stormwater underneath the site from west and north towards the eastern outlet at Flat Rock Creek south of site B9.

Table 4 Site identification summary – B11 Spit West Reserve

Site Information	Details
Site area	The B11 site is located at Spit West Reserve, Mosman, comprising an area of approximately 26,500 m^2.
LGA	The site is located in Mosman Municipal Council.
Current land use zoning	Public Recreation (RE1).
Current land Use	The site is currently used as a public reserve.
Construction land use	Construction and operation of temporary site facilities.
Future land use	Open space – recreational parkland.
Surrounding land Use	North – Middle Harbour, followed by residential properties; South – Environmental conservation area, followed by residential properties; East – Spit Road, followed by commercial properties; and West - Middle Harbour.
Site inspection	A site inspection was not conducted by GHD for this site. Key information noted during a desktop review on 27 October 2021 offsite B11 is as follows: - The site comprises publicly accessible reclaimed land which is grassed area to the southern half and is covered with mature trees to the north; - The D'Albora Marinas are located at the northern end of the site, with boat moorings in the harbour immediately west of the site; and - Commercial shops and a restaurant are located within the marina buildings.

Table 5 Site identification summary – B13/14 Balgowlah Golf Course & Dudley Street

Site Information	Details
Site area	The B13/14 site is located at Balgowlah Golf Course and Dudley Street, Balgowlah, comprising an area of approximately 113,000 m^2.
LGA	The site is located in Northern Beaches Council.
Current land use zoning	General Residential (R1) and Public Recreation (RE1).
Current land Use	The site is occupied by Dudley Street, residential properties on Dudley Street and by a Golf Course for the remainder of the site.

Site Information	Details
Construction land use	Demolition of existing structures; excavation of tunnel features and access decline; construction and operation of temporary and permanent site facilities.
Future land use	Balgowlah Golf Course - commercial/industrial and open space land - including road and motorway operations and public recreational space. Dudley Street – commercial / industrial – including road and motorway operations .
Surrounding land Use	Residential in all directions: – North – Kitchener Street and residential beyond; – South – Sydney Road and residential and Balgowlah Boys Campus school beyond; – East – residential; and – West – residential, Burnt Bridge Creek and Burnt Bridge Creek Deviation.
Site inspection	Key information noted during the GHD inspection conducted on 3 August 2021 of site B13/14 is as follows: - The main site is comprised of the Balgowlah Golf Course with access from Sydney Road. The golf course is operational; and - The westernmost site boundary includes a row of houses which front onto Dudley Street, and then Burnt Bridge Creek further to the north.

Table 6 Site identification summary – B15 Residential properties, Wakehurst Parkway

Site Information	Details
Site area	The B15 site is located at Judith Street, Kirkwood Street and Wakehurst Parkway, Seaforth. The site comprises an area of approximately 10,200 m^2.
LGA	The site is located in Northern Beaches Council.
Current land use zoning	Low Density Residential (R2) and Infrastructure (SP2).
Current land Use	The site is occupied by residential properties, cleared, grassed blocks of land and bushland and Wakehurst Parkway.
Construction land use	Demolition of residential properties, construction and operation of temporary site facilities.
Future land use	Residential – including residential land use and private gardens.
Surrounding land Use	North – Sydney Water reservoir followed by bushland; South – Environmental Conservation area, residential properties and public sports field; East – Residential properties, followed by Wakehurst Golf Club; and West – Garigal National Park.
Site inspection	Key information noted during the GHD inspection conducted on 3 August 2021 of site B15 is as follows: - The site is comprised of residential properties and two cleared, grassed blocks along the eastern side of Wakehurst Parkway. The northern half of B15 has a densely vegetated tract of land separating the road from the longest of the two grassed blocks.

Table 7 Site identification summary – B16 Sydney Water Reservoir

Site Information	Details
Site area	The B16 site is located at the Sydney Water Reservoir, Seaforth, comprising an area of approximately 12,300 m^2.
LGA	The site is located in Northern Beaches Council.
Current land use zoning	Low Density Residential (R2).
Current land Use	The site is currently used as a reservoir.
Construction land use	Excavation of tunnel features and access decline; construction and operation of temporary site facilities.

Site Information	Details
Future land use	Commercial/industrial – Sydney Water reservoir.
Surrounding land Use	North – Bushland; South – Residential properties; East – Wakehurst Golf Club; and West – Wakehurst Parkway, followed by Garigal National Park.
Site inspection	Key information noted during the GHD inspection conducted on 3 August 2021 of site B16 is as follows: - The site is the Sydney Water Reservoir for Seaforth and consists of two large tanks and site building infrastructure. The land has been cleared, with sparse mature trees; - The site is fully fenced with barbed wire topped fencing and bound on all sides by dense, mature vegetation; and - Access to the site is via Kirkwood Street.

Table 8 Site identification summary – B17 Wakehurst Parkway, Seaforth to Frenchs Forest

Site Information	Details
Site area	The B17 site is situated on Wakehurst Parkway, extending from Seaforth to Frenchs Forest. The site comprises an area of approximately 82,700 m^2.
LGA	The site is located in Northern Beaches Council.
Current land use zoning	Infrastructure (SP2).
Current land Use	The site is located on Wakehurst Parkway.
Future land use	Commercial / industrial – including road/motorway operations.
Construction land use	Excavation of tunnel features and cut and cover; widening of Wakehurst Parkway.
Surrounding land Use	North – Frenchs Forest, consisting of residential and recreational areas; South – Residential properties; East – Public bushland; and West – Public recreation, Garigal National Park and residential areas.
Site inspection	Key information noted during the GHD inspection conducted on 10 August 2021 of site B17 is as follows: - The site is comprised of the Wakehurst Parkway from Seaforth Oval in the south, to Warringah Road in the north; - Wakehurst Parkway is a busy two way road (single lane in each direction), which is bound on both sides by dense, mature vegetation; and - Fragments of asbestos containing material were noted along the western side of the parkway within bushland and on walking tracks during the site inspection.

1.1.2 Project Specific T-AEIs environmental setting

A summary of the environmental setting of T-AEIs for the BLGHFC project area, as detailed in the EIS (TfNSW, 2020a), Appendix M (Contamination) (TfNSW, 2020b) and Appendix N (Groundwater) (TfNSW, 2020c), is presented in Table 9.

Table 9 Existing environmental setting for Project Specific AEIs

Information	B7 Punch Street	B8 Dickson Avenue	B9 Flat Rock Reserve & B10 Bicentennial Reserve	B11 Spit West Reserve	B13/14 Balgowlah Golf Course & Dudley Street	B15 Residential properties Wakehurst Parkway	B16 Sydney Water Reservoir	B17 Wakehurst Parkway, Seaforth to Frenchs Forest
Ecology (Further detailed in Chapter 19 (Biodiversity) of the EIS).	Threatened flora species are present 200 m north of the site.	No ecologically significant areas within 500 m of site.	The site is zoned as an Environmental conservation area with a number of threatened flora and fauna species present on the site.	No ecologically significant areas within 500 m of site .	Threatened flora species are present on the site and 200 m to the west. Threatened fauna species are present 100 m north east of the site.	Garigal National Park is adjacent west of the site and an Environmental Conservation area is adjacent south of the site. Threatened fauna habitat is present in the northern portion of the site and adjacent west of the site.	Threatened fauna habitat is present 200 m south-west of site.	Garigal National Park is adjacent west of the site boundary and Reserve area is adjacent east of the site. Threatened fauna habitat and threatened flora species are present on the site.
Aboriginal heritage (Further detailed in Chapter 15 (Aboriginal heritage) of the EIS).	Potential Aboriginal Archaeological Deposits are located north of the northern site boundary.	No Aboriginal heritage areas identified within 50 m of the site.	Potential Aboriginal Archaeological Deposits are located in the south-eastern portion of Flat Rock Baseball Field and in the south-western portion of Flat Rock Reserve.	No Aboriginal heritage areas identified within 50 m of the site.	Potential Aboriginal Archaeological Deposits are located in the western portion of the Balgowlah Golf Course.	No Aboriginal heritage areas identified within 50 m of the site.	Multiple Aboriginal engraving sites are located within 50 m of the site.	Multiple Aboriginal engraving sites are located along and within 50 m of the proposed alignment.
Climate (Further detailed in Chapter 26 (Climate change risk & adaptation) of the EIS)	Climate data was obtained from Bureau of Meteorology (BOM) website, from the Observatory Hill (BoM Station 66062) to depict long-term climate statistics across the BLGHFC project area. The annual mean maximum temperature at the Observatory Hill weather station is 21.8ºC and an annual mean minimum temperature of 13.8 ºC. Majority of rainfall occurs in the first half of the year, peaking in June. There is then an abrupt seasonal change with the lowest rainfalls occurring in September. Average annual rainfall is approximately 1215 millimetres (mm) per year.							

Information	B7 Punch Street	B8 Dickson Avenue	B9 Flat Rock Reserve & B10 Bicentennial Reserve	B11 Spit West Reserve	B13/14 Balgowlah Golf Course & Dudley Street	B15 Residential properties Wakehurst Parkway	B16 Sydney Water Reservoir	B17 Wakehurst Parkway, Seaforth to Frenchs Forest
Surface cover (based on GHD site inspection)	Buildings, roads, vegetated land and hardstand areas for car parking and shared user paths.	Buildings, roads, and concrete hardstand.	Grassed and vegetated land, concrete hardstand and buildings.	Grassed and vegetated land, buildings.	Grassed land and buildings.	Grassed land, concrete hardstand and buildings.	Buildings, concrete hardstand cleared ground and vegetated land.	Roads, road base, vegetated land.
Topography and drainage (Further detailed in Chapter 16 (Geology soils and groundwater) and 18 (Flooding) of the EIS)	The terrain along the BLGHFC project rises from an elevation of around 65 metres Australian Height Datum (AHD) at the southern extent of the BLGHFC project at Cammeray and undulates towards Middle Harbour. Between Middle Harbour and the Warringah Freeway, the BLGHFC project crosses beneath Flat Rock Creek and the upper Willoughby Creek catchment. Both Flat Rock Creek and Willoughby Creek drain to Middle Harbour.				To the north of Middle Harbour the topography has a steep incline up to the ridge line at North Balgowlah, before resuming a moderate incline towards Frenchs Forest, reaching an elevation of around 150 metres AHD at Warringah Road at the northern extent of the BLGHFC project area. The main surface drainage feature in the northern area of the BLGHFC project is Burnt Bridge Creek at North Balgowlah.			
Soil landscapes (Further detailed in Chapter 16 (Geology soils and groundwater) of the EIS)	Gymea/ Lambert[1].	Glenorie[2].	Majority disturbed terrain[3] Hawkesbury[4] in eastern portion and Gymea/ Lambert[2] in southern portion.	Hawkesbury[5].	Lambert[2].	Somersby[5].	Lambert[2].	Majority Lambert[2] with Lucas Heights[6].

[1] Gymea/Lambert Soil Landscape is found on undulating to rolling low hills on Hawkesbury Sandstone. Soils are shallow to moderately deep yellow earths and earthy sands on crests and inside of benches.
[2] Glenorie Soil Landscape is found on low rolling and steep hills. Soils are shallow to moderately deep (less than 100 cm) red, brown and yellow podzolic soils on crests and slopes. Siliceous sands, leached sands and humic gleys on shale lenses and along drainage lines.
[3] Disturbed Terrain occurs within other landscapes and is mapped as “xx”. Topography varies from level plains to undulating terrain and has been disturbed by human activity to a depth of at least 100 cm. Original soil has been removed, greatly disturbed or buried
[4] Hawkesbury Soil Landscape is found on rugged, rolling to very steep hills on Hawkesbury Sandstone. Soils are shallow (less than 50 cm), discontinuous lithosols/siliceous sands associated with rock outcrops, earthy sands, yellow earths on the inside of benches and along joints and fractures.
[5] Somersby Soil Landscape is found on gently undulating to rolling rises on deeply weathered Hawkesbury Sandstone plateau. Soils are moderately deep to deep (100–300 cm) red earths and yellow earths overlying laterite gravels and clays on crests and upper slopes; yellow earths and earthy sands on mid slope; grey earths, leached sands and siliceous sands on lower slopes and drainage lines; gleyed podzolic soils in low lying poorly drained areas
[6] Lucas Heights Soil Landscape is found on gently undulating crests and ridges on plateau surfaces. Soils are moderately deep (50– cm), hard setting yellow podzolic soils and yellow soloths, yellow earths on outer edges

Information	B7 Punch Street	B8 Dickson Avenue	B9 Flat Rock Reserve & B10 Bicentennial Reserve	B11 Spit West Reserve	B13/14 Balgowlah Golf Course & Dudley Street	B15 Residential properties Wakehurst Parkway	B16 Sydney Water Reservoir	B17 Wakehurst Parkway, Seaforth to Frenchs Forest
Acid sulphate soil (Further detailed in Chapter 16 (Geology soils and groundwater) of the EIS).	No probable risk of ASS occurrence.			Low probability of ASS occurrence.	No probable risk of ASS occurrence.			
Hydrology (Further detailed in Chapter 17 (Hydrodynamics and water quality) of the EIS).	Flat Rock Creek located 200 m north-east of the site.	Flat Rock Creek located 750 m north-east of the site	Flat Rock Creek adjacent south to southern site boundary (including underground culvert which runs along the southern boundary of the site)	Middle Harbour is adjacent to the site	Burnt Bridge Creek intersects the north-western portion of the site.	Bantry bay located 200 m west of the site. Manly dam located 600 m east of the site.		Manly Creek located 250 m east of the site at its closest point.
Geology (Further detailed in Chapter 16 (Geology soils and groundwater) of the EIS).	Permo-Triassic Hawkesbury sandstone[7].	Permo-Triassic Wianamatta Group[8].	Permo-Triassic Hawkesbury Sandstone Historical records indicate up to 40 m of fill has been placed along Flat Rock Creek.	Anthropogenic reclaimed estuarine land[9]. The Luna Park Fault Zone spans the entire project area, intersecting the BLGHFC project at Middle Harbour.	Permo-Triassic Hawkesbury Sandstone.	Permo-Triassic Hawkesbury Sandstone. Jurassic basaltic dykes intruding the shale and sandstone are known to be present at Seaforth. It is likely numerous other dykes are present.		Permo-Triassic Hawkesbury Sandstone.
Hydro-geology (Further detailed	Groundwater flow inferred to	Groundwater flow inferred to	Groundwater flow inferred to	Groundwater flow inferred to	Groundwater flow inferred to	Groundwater flow inferred to	Groundwater flow inferred to	Groundwater flow inferred to

[7] Permo-Triassic Hawkesbury Sandstone is comprised of medium- to coarse-grained quartz sandstone with minor shale and laminite lenses.
[8] Permo-Triassic Wianamatta Group is comprised of sandstone, siltstone and shale; common bioturbation.
[9] Anthropogenic reclaimed estuarine land includes a natural surface elevation raised by placement of fill over former estuarine swamps and subaqueous estuarine margins.

Information	B7 Punch Street	B8 Dickson Avenue	B9 Flat Rock Reserve & B10 Bicentennial Reserve	B11 Spit West Reserve	B13/14 Balgowlah Golf Course & Dudley Street	B15 Residential properties Wakehurst Parkway	B16 Sydney Water Reservoir	B17 Wakehurst Parkway, Seaforth to Frenchs Forest
in Chapter 16 (Geology soils and groundwater) of the EIS)	flow easterly towards Northbridge. No registered groundwater bores within 500 m of this site.	flow easterly towards Northbridge. No registered groundwater bores within 500 m of this site.	flow easterly towards Northbridge. One groundwater bore (GW108224.1.1) approx. 500 m south-west of Flat Rock Reserve (water supply) installed 132 metres deep. Standing water level is unknown.	flow south and/or east towards Middle Harbour. No registered groundwater bores within 500 m of this site.	flow southerly and/or westerly towards Middle Harbour. No registered groundwater bores within 500 m of this site.	flow southerly and/or south-easterly towards Burnt Bridge Creek. No registered groundwater bores within 500 m of this site.	flow southerly and/or south-easterly towards Burnt Bridge Creek. No registered groundwater bores within 500 m of this site.	flow east and/or west towards Manly Dam and Bantry Bay. No registered groundwater bores within 500 m of this site.

1.1.3 Project Specific T-AEIs historical aerial photograph review

A selection of aerial photographs were reviewed to identify past activities and land uses within the BLGHFC project boundaries was reviewed. These aerial photographs were sourced by Jacobs from Land and Property Information Division and are provided in Appendix M of the EIS (TfNSW, 2020b) for all years with available imagery. These years included 1930, 1955, 1961, 1970, 1975, 1983/84, 1986, 1991, 1994, 1998, 2002, and 2005. A summary of key observations and developments at each of the Project Specific T-AEI sites has been provided in Table 10**.**

Future Project Specific T-AEIs must include a review of the site history, including the available historical aerial photographs.

Table 10 Review of aerial photographs for Project Specific AEIs

Site	Site and surrounds description
B7 Punch Street	The site is vacant land prior to 1998, with a railway line, residential properties and commercial/industrial properties present in the surrounding area. Vegetation appears to have been established at the site in approximately 1998. Hampden Road/Herbert Street bridge is observed at the site in 1955 imagery. Demolition of residential and commercial premises and clearing of bushland is evident between 1991 – 1994 to allow for construction of Gore Hill Freeway adjacent north of the site.
B8 Reserve Road	Residential properties occupy the site prior to 1975 imagery, in which these are replaced by commercial/industrial properties. The surrounding area comprises residential and commercial/industrial premises in all imagery, however demolition of some properties is evident in 1991 to allow for construction of the Gore Hill Freeway.
B9 Flat Rock Reserve & B10 Bicentennial Reserve	Bushland occupies the site, with vacant land, residential and various commercial properties in the surrounding area in 1930. A building, understood to be an incinerator, is present in the northern portion of the site in 1955, with infilling of Flat Rock Drive observed. Further infilling and construction of commercial properties are also observed in the surrounding area. Large scale filling and removal of bushland is observed at the site between 1970 – 1975. Gore Hill Freeway was observed to be constructed south-west of the site between 1986 – 1991.
B11 Spit West Reserve	The site is vacant land undergoing reclamation works on the southern side of the Spit Bridge and west of Spit Road in 1930. The site is unchanged following completed of reclamation works pictured in the 1955 image. The surrounding area includes residential properties, bushland and the Spit Bridge to 2005. A marina is constructed on the eastern side of the Spit circa 1970.
B13/14 Balgowlah Golf Course & Dudley Street	The site is occupied by vacant land and Burnt Bridge Creek in 1930, with the surrounding area comprised of residential, vacant land and bushland. The Burnt Bridge Creek Deviation is evident in 1983/84 imagery, with demolition of residential premises and clearing of bushland occurring in the surrounding region.
B15 Residential properties Wakehurst Parkway	The site is comprised of bushland prior to 1955 imagery, following 1955 the site is comprised of bushland and residential properties. The surrounding area is predominantly bushland and residential premises to 1961, in which extensive bushland clearing is evident. Construction of a bowling club and golf course is evident in 1970 imagery east of the site.
B16 Sydney Water Reservoir	The site is comprised of bushland and a reservoir in the central portion in 1930, with some clearing of bushland evident in 1955, 1991 and 1994 imagery. A second reservoir appears to have been constructed circa 1970 at the site. The surrounding area is predominantly bushland and residential premises to 1961, in which extensive bushland clearing is evident. Construction of a bowling club and golf course is evident in 1970 imagery east of the site.
B17 Wakehurst Parkway - Seaforth to Frenchs Forest	Wakehurst Parkway is present in 1930 imagery to present day imagery, with residential premises and bushland present in the surrounding area. It is noted a former landfill was present approximately 100 m east of Wakehurst Parkway north, currently occupied by Aquatic Reserve Baseball Park. The exact operational dates of the landfill are not provided.

1.1.4 Project Specific T-AEIs contaminated site register review

A search conducted on 17 January 2022 of NSW EPA Contaminated Sites Record of Notices (under Section 58 of the *Contaminated Land Management Act 1997* (CLM Act)) and the list of contaminated sites notified to NSW EPA (under section 60 of the CLM Act) indicated that there were six notified sites registered with NSW EPA within 1 km of the BLGHFC project. These sites are summarised in Table 11.

Table 11 Regulated/notified sites with 500 m of the BLGHFC project

Suburb	Address	Activity	Contamination status	Distance from project / nearest AEI site
Artarmon	477 Pacific Highway.	Service station	Regulation under CLM Act not required	1 km north-west of B8 Dickson Avenue.
Balgowlah	Corner Sydney Road and Maretimo Street.	Service station	Regulation under CLM Act not required	Adjacent south of southern boundary of B13/14 Balgowlah Golf Course & Dudley Street.
Balgowlah	8-10 Roseberry Street.	Other petroleum	Regulation under CLM Act not required	1 km north-east of B13/14 Balgowlah Golf Course & Dudley Street.
Land Cove North	432 Pacific Highway.	Service station	Currently regulated under the CLM Act	1 km north-west of B8 Dickson Avenue.
Willoughby	616-626 Willoughby Road.	Service station	Regulation under CLM Act not required	500 m north-west of B10 Bicentennial Reserve.
Willoughby	498 Willoughby Road.	Service station	Currently regulated under the POEO Act	200 m north-west of B10 Bicentennial Reserve.
Willoughby	Bicentennial Reserve, Flat Rock Gully, Willoughby Leisure Centre.	Other industry	Under assessment	On-site B9 Flat Rock Reserve & B10 Bicentennial Reserve.

1.1.5 Project Specific T-AEIs contamination summary

1.1.5.1 Project Specific T-AEIs sub-surface conditions

The EIS references a number of intrusive investigations undertaken to assess the soil and/or groundwater conditions across various locations within the BLGHFC project area that were completed by Douglas Partners and Golder Associates (DPGA), AECOM and Coffey between 2018 and 2019. The sub-surface conditions encountered during these investigations, relevant to the Project Specific T-AEIs and as presented in the EIS, are summarised are in Table 12.

Table 12 Historical subsurface conditions

AEI site	Lithology	Groundwater
B7 Punch Street & B8 Dickson Avenue	FILL: Gravelly sand and cobbles from surface to 4.5 m bgl. NATURAL: Clayey silt from 3.0 to 8.5 m bgl. BEDROCK: Natural Sandstone underlying clayey silt.	Groundwater encountered at approximately 5.0 m bgl.

AEI site	Lithology	Groundwater
B9 Flat Rock Reserve & B10 Bicentennial Reserve	FILL: Clay and sand fill from surface to 31 m bgl. Inclusions of bricks, concrete and building rubble. BEDROCK: Sandstone underlying fill.	Groundwater encountered between 19 and 25 m bgl.
B11 Spit West Reserve	No previous investigations completed	No previous investigations completed
B13/14 Balgowlah Golf Course & Dudley Street	FILL: Silty and clayey sand and gravels from surface to 1.0 m bgl. NATURAL: Clayey sand from 1.0 to 2.4 m bgl. BEDROCK: Natural Sandstone underlying natural clayey sands.	Groundwater not encountered in most locations, however observed at 1.3 m bgl in shallow sandstone at one location.
B15 Residential properties Wakehurst Parkway & B16 Sydney Water Reservoir	FILL: Clayey sand and gravels from surface to 1.0 m bgl. BEDROCK: Natural sandstone underlying fill.	Groundwater not encountered.
B17 Wakehurst Parkway, Seaforth to Frenchs Forest	FILL: Gravelly clays and sands from surface to 3.7 m bgl. BEDROCK: Natural sandstone encountered at 1.2 to 3.7 m bgl.	Groundwater encountered at 2.5 m bgl.

1.1.5.2 Soil Analytical Results

As stated in the EIS (TfNSW, 2020b), AECOM and Coffey undertook a soil investigation in 2019. The following boreholes and depths were drilled within the Project Specific T-AEIs:

– B128, drilled from surface to 19 m, located at Balgowlah Golf Course;
– B173 to B175, B362 to B368, B371 and B372, drilled to a maximum depth of 56 m, located along Wakehurst Parkway;
– B176 and B177, drilled to a maximum depth of 93 m, located at Flat Rock Drive;
– B354 and B358, drilled to a maximum depth of 14 m, located along Gore Hill Freeway; and
– B382 and B386, drilled to a maximum depth of 27 m, located at Balgowlah.

Soil samples were analysed for heavy metals, polycyclic aromatic hydrocarbons (PAH), total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene and xylenes (BTEX), organochlorine pesticides (OCP), organochlorine pesticides (OPP), and selected samples for phenols, volatile organic compounds (VOCs), cyanide, polychlorinated biphenyls (PCB) and asbestos. Analytical results were assessed against open space and commercial/industrial criteria, with the exceedances and field observations of contamination summarised in Table 13.

Table 13 Summary of soil results

Bore ID and depth (bgl)	Location and distance from project	Contaminants above guideline criteria	Guideline exceedance
B175_0.25-0.35 m	Within Wakehurst Parkway (B17).	Nickel.	NEPM (2013) EIL (open space).
B371_0.08-0.10 m		Benzo(a)Pyrene Toxic Equivalence Quotient (BaP TEQ).	NEPM (2013) HIL C (open space).
		Benzo(a)pyrene.	NEPM (2013) ESL (open space and commercial/industrial).
		TRH C_{16}-C_{34}.	NEPM (2013) ESL (open space).
B354_0.55-0.75 m	Gore Hill Freeway – 50 m north of Punch Street (B7).	Nickel.	NEPM (2013) EIL (open space).
B176	South-eastern corner of the baseball diamond (B10).	30 m of fill material (noted as sand, sandstone, shale, gravel and cobbles, some building rubble (bricks and concrete).	

Bore ID and depth (bgl)	Location and distance from project	Contaminants above guideline criteria	Guideline exceedance
B177	Southern portion of Flat Rock Reserve (B9).	11 m of fill material (noted a sandstone cobbles and gravels, building debris, wood, bricks and concrete fragments).	

1.1.5.3 Groundwater Analytical Results

Various groundwater monitoring events were completed by DPGA in 2017 and 2018 and AECOM and Coffey in 2019. These have occurred in up to 10 groundwater wells over 15 sampling events. Further detail is provided in the EIS (TfNSW, 2020b) and a summary of analytical results from these sampled groundwater wells is provided in Table 14. Groundwater samples were analysed for heavy metals, nutrients, PAH, TRH, and BTEX.

Table 14 Summary of groundwater exceedances - across all sampling events

Bore ID	Location and distance from project	Contaminants above guideline criteria	Guideline exceedance
B114A	Artarmon – within Punch Street (B7)	Cobalt, zinc and total phosphorous.	ANZECC (2000) 95% marine water.
		Zinc.	ANZECC (2000) 95% freshwater.
		Manganese and nickel	NHMRC (2011) drinking water.
B127A	North Balgowlah – 400 m west of Balgowlah Golf Course (B13/14).	Cobalt, copper, zinc and total phosphorous.	ANZECC (2000) 95% marine water.
		Cobalt, copper, and zinc .	ANZECC (2000) 95% freshwater.
		Lead, manganese and nickel.	NHMRC (2011) drinking water.
B134A	Bicentennial Reserve and Baseball Diamond, Willoughby – within the south-eastern corner of the baseball diamond (B10).	Cobalt, copper, manganese, nickel, zinc, ammonia and total phosphorous.	ANZECC (2000) 95% marine water
		Boron, cadmium, cobalt, copper, manganese, nickel, zinc and ammonia.	ANZECC (2000) 95% freshwater.
		Arsenic, chromium, lead, manganese, nickel and sulphate.	NHMRC (2011) drinking water.
		Lead and manganese.	NHMRC (2008) recreational.
B238A	Northbridge – 1.5 km west of Spit West Reserve (B11).	Ammonia and total phosphorous.	ANZECC (2000) 95% marine water.
		Ammonia .	ANZECC (2000) 95% freshwater.
B128	Balgowlah – within Balgowlah Golf Course (B13/14).	Cobalt, copper, zinc, reactive phosphorous, total phosphorous.	ANZECC (2000) 95% marine water.
		Copper, manganese and zinc.	ANZECC (2000) 95% freshwater.
		Manganese.	NHMRC (2011) drinking water.
B138	Seaforth – 800 m north-west of Spit West Reserve (B11).	Cobalt, nickel, total phosphorous	ANZECC (2000) 95% marine water.
		Manganese and nickel.	ANZECC (2000) 95% freshwater.
		Manganese .	NHMRC (2011) drinking water.
B155	Northbridge– 1 km north-east of Flat Rock Reserve (B9).	Cobalt, nitrate, reactive phosphorous, total phosphorous.	ANZECC (2000) 95% marine water.
		Chromium and nitrate.	ANZECC (2000) 95% freshwater.
B173	Killarney Heights – within Wakehurst Parkway (B17).	Cobalt, copper and zinc.	ANZECC (2000) 95% marine water.
		Chromium, copper and zinc.	ANZECC (2000) 95% freshwater.
B174		Cobalt, copper, nickel, zinc and total phosphorous .	ANZECC (2000) 95% marine water.

Bore ID	Location and distance from project	Contaminants above guideline criteria	Guideline exceedance
		Boron, copper, manganese, nickel and zinc.	ANZECC (2000) 95% freshwater.
		Manganese.	NHMRC (2011) drinking water.
B175	Frenchs Forest–within Wakehurst Parkway (B17).	Copper, nickel, zinc, nitrate and total phosphorous.	ANZECC (2000) 95% marine water.
		Cobalt, copper, manganese, nickel, zinc and nitrate.	ANZECC (2000) 95% freshwater.
		Manganese.	NHMRC (2011) drinking water.

The EIS (TfNSW, 2020c) noted that heavy metal exceedances of adopted criteria for B238A may be unreliable due to high pH results and have not been considered in the assessment. Exceedances at B134A (Bicentennial Reserve and Baseball Diamond, Willoughby) are likely associated with historical landfilling.

1.2 Preliminary conceptual site model for Project Specific T-AEIs

Appendix M of the EIS (TfNSW, 2020b) presented a Technical Working Paper for contamination and did not include a preliminary conceptual site model (CSM) section, however, discussion of the relevant elements of a preliminary CSM, such as potential sources, were provided. This information has been used as the basis of the preliminary conceptual site model that will need to be further developed and refined in the site-specific SAQPs for each Project Specific T-AEI.

1.2.1 Potential sources of contamination

The sections below detail sources and contaminants of potential concern (COPC) for each Project Specific T-AEI as detailed in Appendix M of the EIS (TfNSW, 2020b). Refined COPC are detailed in Section 1.4.2 associated with the proposed sampling and analytical plan for each Project Specific T-AEI site.

On-site

On-site sources of contamination and associated COPC, as described in Appendix M of the EIS (TfNSW, 2020b) based on historical and current land uses, and GHD's site inspections, are summarised is Table 15. As stated above, COPC are further refined in Section 1.4.2 based on the proposed sampling design and analytical plan for each Project Specific T-AEI.

Table 15 Potential on-site contamination sources and COPC

Construction support site	AEI	Source	COPC
Demolition of existing structures; excavation of tunnel features; construction and operation of temporary site facilities.	B7 Punch Street.	Historical hazardous building materials (bridge) and filling. Mixed commercial/industrial use of site and surrounds, including a mechanical workshop and repairer, swim school, veterinarian and a paint supplier.	Anions and cations, heavy metals*, TRH, BTEX, PAH, PCB, nutrients, perfluoroalkyl and polyfluoroalkyl substances (PFAS), OCP, OPP and asbestos (soil only), cyanide, volatile organic compounds (VOC).
Demolition of existing structures; construction and operation of temporary site facilities.	B8 Dickson Avenue.	Mixed commercial/industrial use of site and surrounds, including a tyre fitter, mechanical workshop and repairer, car wash, television production studios, and the Freeway Hotel.	
B9: Excavation of tunnel access decline and main tunnel alignment; construction and operation of temporary site facilities B10: Tunnel excavation (no surface works planned).	B9 Flat Rock Reserve.	Infilling / waste and incinerator operations.	Anions and cations, heavy metals*, TRH, BTEX, PAH, PCB, VOCs, semi volatile organic compounds (SVOCs), phenols, nutrients, dissolved methane, cyanide, ammonia, PFAS, OCP, OPP and asbestos (soil only), landfill gases including methane, carbon dioxide, oxygen and carbon monoxide.
Construction and operation of temporary site facilities.	B11 Spit West Reserve.	Reclamation of land with material of unknown quality, possible boat repairs and maintenance.	Heavy metals*, CrVI, TRH, BTEX, PAH, PCB, nutrients, PFAS, OCP, OPP and asbestos (soil only), VOC, organotins.
Demolition of existing structures;	B13/14 Balgowlah Golf Course	Inappropriate handling and disposal of building materials during demolition of	Anions and cations, heavy metals*, TRH, BTEX, PAH, PCB, nutrients,

Construction support site	AEI	Source	COPC
excavation of tunnel features and access decline; construction and operation of temporary and permanent site facilities.	& Dudley Street.	buildings for construction of Burnt Bridge Creek Deviation. Filling with material of unknown quality during Burnt Bridge Creek Deviation construction. Degradation of hazardous building materials from structures currently present on the site. Chemicals use and storage at the golf course.	PFAS, OCP, OPP and asbestos (soil only).
Construction and operation of temporary site facilities.	B15 Residential properties, Wakehurst Parkway.	Potential for illegal dumping of hazardous building materials. Degradation of hazardous building materials from structures currently present on the site.	Heavy metals*, TRH, BTEX, PAH, PCB, PFAS, OCP, OPP and asbestos (soil only).
Excavation of tunnel features and access decline; construction and operation of temporary site facilities.	B16 Sydney Water Reservoir	Reservoirs coated with lead paint which may flake as a result of degradation. Potential for hazardous building material fragments to be present at site.	
Excavation of tunnel features and cut and cover; widening of Wakehurst Parkway.	B17 Wakehurst Parkway, Seaforth to Frenchs Forest.	Illegal dumping of waste. Potential historical use of site for fuel storage. Degradation of asphalt road surface.	

Note:

* Heavy metals: Including, but not limited to, arsenic, barium, boron, cadmium, chromium, cobalt, copper, cyanide, iron, lead, manganese, mercury, nickel, zinc.

Off-site

Potential current off-site sources of contamination within 500 m of the BLGHFC project, as described in Appendix M of the EIS based on a review of the current business directory, are summarised in Table 16 relevant to the Project Specific T-AEIs. The address of each potential off-site source is not provided in the EIS.

Table 16 Potential off-site sources of contamination

Suburb and associated AEI	Source	Contamination potential
Artarmon - B7 Punch Street and B8 Dickson Avenue	Multiple mechanical engineering premises adjacent to B7 and B8 and 36 mechanical engineering premises within 500 m of the BLGHFC project.	Low – likely premises are covered in concrete hardstand and spills would be surficial
Balgowlah - B13/14 Balgowlah Golf Course & Dudley Street	Two mechanical engineering premises 300 m east of B13/14. One service station adjacent south of southern boundary of B13/14.	Low – groundwater flow is inferred southerly or westerly. Potential impacts from these premises are unlikely to be impacting the site.
Naremburn - B10 Bicentennial Reserve	One dry cleaner 500 m south of B10.	Low – Likely too far from the BLGHFC project to cause impacts.
Northbridge - B9 Flat Rock Reserve	One dry cleaner 500 m east of B9.	
Seaforth - B15 Residential properties, Wakehurst Parkway	One plant nursery 300 m east of B15.	Low – Likely too far from the BLGHFC project to cause impacts.
Willoughby - B10 Bicentennial Reserve	One mechanical engineering 500 m north-west of B10. One service station 200 m north-west of B10.	Low – groundwater flow inferred east. Potential impacts from these premises are unlikely to be impacting the site.
Frenchs Forest - B17 Wakehurst Parkway, Seaforth to Frenchs Forest	Former landfill 100 m east of B17 (Currently Aquatic Reserve Baseball Park)	Moderate – Fill, including PFAS impacts, may be migrating towards the proposed tunnel alignment. It is unlikely landfill gas impacts present a risk due to the distance from the site.

1.2.2 Preliminary conceptual site model assessment

Based on the information presented in the EIS (TfNSW, 2020a) and as provided by Transport, the following elements of the preliminary CSMs have been developed for each Project Specific T-AEI and are summarised in Table 17 below:

– Potential exposure pathways; and
– Human and ecological receptors at and beyond the BLGHFC project area, both for the construction works proposed and intended future land use.

It is understood that receptors may change in the future following the refinement of the project design and confirmation of end uses.

It is noted that in preparing this preliminary CSM, groundwater extraction and associated human receptors were not considered as a potential pathway due to the presence of a reticulated water supply in the BLGHFC project area and surrounding regions. While there is one registered water supply bore 500 m from the BLGHFC project alignment, located at St Leonards, this is drilled to a depth of 132 metres and is considered unlikely be impacted by potentially contaminated groundwater.

Table 17 Preliminary conceptual site model for each site and construction type

AEI	Proposed construction type	Exposure pathways	Construction phase	Operational / end use phase
			Receptors	Receptors
B7, B8, B13/14, B15	Demolition of existing structures	**Human** - Inhalation of dust particulates from atmospheric dispersion of potential contaminated surficial soil and asbestos fibres (if present); and - Dermal contact and/or ingestion with soil and/or sediment. **Ecological** - Migration of contamination via surface water run-off and groundwater movement to nearby creeks; and - Direct contact and ingestion of contaminated media.	**Human** - On-site construction workers; - Off-site commercial/ industrial receptors (B7 (Punch Street) and B8 (Dickson Avenue) only); - Off-site residential receptors (B13/14 only (Balgowlah Oval)); and - Off-site open space/recreational receptors (B13/14 only (Balgowlah Oval)). **Ecological** - Flat Rock Creek (200 m north-east of B7 (Punch Street) and 750 m north-east of B8 (Dickson Avenue)); and - Burnt Bridge Creek (intersecting B13/14 (Balgowlah Oval)).	Commercial/ industrial (B7, B8, and southern half of B13/14 (Punch Street, Dickson Avenue, and Balgowlah Golf Course, respectively)). Open space/recreational (southern and northern half of B13/14 (Balgowlah Golf Course)).
B7, B9, B13/14, B16, B17	Excavation of tunnel access decline, tunnel excavation, tunnel features and/or cut and cover Construction and operation of temporary site facilities, and/or permanent facilities	Human - Dermal contact and/or ingestion with soil, sediment, surface water, groundwater, leachate and seepage; - Inhalation of dust particulates from atmospheric dispersion of potential contaminated surficial soil and asbestos fibres (if present); - Inhalation of volatile emissions emanating from contaminated soil, sediment, groundwater, surface water, leachate and seepage; - Asphyxiation and explosion hazards from accumulation of landfill gas (B9 only - Flat Rock Reserve); and - Preferential pathways for landfill gases to accumulate in enclosed spaces, including service trenches (B9 only - Flat Rock Reserve).	Human - On-site construction workers; - On-site intrusive maintenance workers; - Off-site intrusive maintenance workers; - Off-site commercial/ industrial receptors (B7 only (Punch Street)); - Off-site residential receptors (B9, B13/14 only (Flat Rock Reserve and Balgowlah Golf Course, respectively)); - Off-site open space/recreational receptors (B13/14 and B16 only (Balgowlah Oval and Wakehurst Golf Course, respectively)); and - Off-site residential and recreational (B17 only (Wakehurst Parkway between Seaforth and Frenchs Forest)). Ecological - Groundwater underlying the BLGHFC project.	Commercial/ industrial (B7, B16, B17, and southern half of B13/14) (Punch Street, Wakehurst Parkway east, Wakehurst Parkway between Seaforth and Frenchs Forest, and Balgowlah Golf Course, respectively)). Open space/recreational (B9, and southern and northern half of B13/14 (Flat Rock Reserve and Balgowlah Golf Course, respectively)).

AEI	Proposed construction type	Exposure pathways	Construction phase	Operational / end use phase
			Receptors	**Receptors**
		Ecological - Migration of contamination via surface water run-off and groundwater movement to nearby creeks; - Direct contact and ingestion of contaminated media - Plant uptake of contaminants present in root zones (typically top two metres of soils) (B16 only - Wakehurst Parkway east); and - Downward migration of contamination from soil and surface water to groundwater.	- Flat Rock Creek (200 m north-east of B7 (Punch Street)); - Flat Rock Creek (adjacent to B9 -Flat Rock Reserve); - Burnt Bridge Creek (intersecting B13/14 (Balgowlah Golf Course)); - Bantry Bay and Manly Dam (200 m west and 600 m east of B16, respectively (Wakehurst Parkway east)); - Adjacent Flat Rock Drive flora and fauna (B9 -Flat Rock Reserve); and - Adjacent Garigal Reserve and Manly Dam Reserve flora and fauna (B16 and B17 (Wakehurst Parkway east and Wakehurst Parkway Seaforth to Frenchs Forest, respectively)).	
B8, B11, B15	Construction and operation of temporary site facilities	**Human:** - Dermal contact and/or ingestion with soil and/or sediment; - Ingestion of contaminated plants for human consumption (vegetable garden) (B15 only - Wakehurst Parkway south); and - Inhalation of volatile emissions emanating from contaminated soil, sediment, groundwater, surface water, leachate and seepage. **Ecological** - Migration of contamination via surface water run-off and groundwater movement to nearby creeks; - Direct contact and ingestion of contaminated media; and - Plant uptake of contaminants present in root zones (typically top two metres of	**Human** - On-site construction workers - Off-site commercial/ industrial receptors (B8 only (Dickson Avenue)); - Off-site open space/recreational receptors (B11 only (Spit West Reserve)); and - Off-site residential receptors (B15 only (Wakehurst Parkway south)). **Ecological** - Flat Rock Creek (750 m north-east of B8 (Dickson Avenue)); - Adjacent Middle Harbour (B11 - Spit West Reserve); - Adjacent Garigal National Park (B15 - Wakehurst Parkway south).	Commercial/ industrial (B8 – Dickson Avenue); Open space/recreational (B11 - Spit West Reserve); and Residential with private gardens (B15 - Wakehurst Parkway south).

AEI	Proposed construction type	Exposure pathways	Construction phase	Operational / end use phase
			Receptors	Receptors
		soils) (B15 only - Wakehurst Parkway south).		
B10	Tunnel excavation (no surface works planned)	**Human** - Dermal contact and/or ingestion with soil, sediment, surface water, groundwater, leachate and seepage; - Inhalation of dust particulates from atmospheric dispersion of potential contaminated surficial soil and asbestos fibres (if present); - Inhalation of volatile emissions emanating from contaminated soil, sediment, groundwater, surface water, leachate and seepage; - Asphyxiation and explosion hazards from accumulation of landfill gas; and - Preferential pathways for landfill gases to accumulate in enclosed spaces, including service trenches. **Ecological** - Migration of contamination via surface water run-off and groundwater movement to nearby creeks; - Direct contact and ingestion of contaminated media; - Plant uptake of contaminants present in root zones (typically top two metres of soils); and - Downward migration of contamination from soil and surface water to groundwater.	**Human** - On-site open space/recreational receptors; - On-site construction workers; - On-site intrusive maintenance workers; - Off-site intrusive maintenance workers; and - Off-site residential receptors. **Ecological** - Groundwater underlying the BLGHFC project; - Adjacent Flat Rock Creek; and - Adjacent Flat Rock Reserve flora and fauna.	No change (open space/ recreation)

1.3 Project specific T-AEIs - basis for assessment

The guidelines and assessment criteria provided in the sections below are based on the current understanding of the Project Specific T-AEI sites, including intended construction works and future end use of each Project Specific T-AEI provided at the time of writing by Transport and in the EIS (TfNSW, 2020b). Nominated criteria is for relevant generic site use scenarios and should be refined during development of future site-specific SAQP(s) by the contractor(s) when the BLGHFC project design and end use is finalised.

1.3.1 Relevant guidelines and standards

The primary guidelines and Australian Standards that outline the sampling methodologies for the investigation are described in Sections 1.3.2 to Section 1.3.5, however additionally include the following standards:

- Australian Standards 44821.1-2005 (2005) and 4482.2-1999 (1999) guidance (*Guide to the sampling and investigation of potentially contaminated soil guidance*, Parts 1 and 2).
- Australian/New Zealand Standard AS/NZS 5667.12-1999 (1999): *Water quality - Sampling, Part 12: Guidance on sampling of bottom sediments*;
- Australian/New Zealand Standard AS/NZS 5667.1 (1998) *Water quality - Sampling - Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples;*
- Australian/New Zealand Standard AS/NZ 5667.11 (1998), *Water Quality – Sampling Part 11: Guidance on Sampling of Groundwaters*;
- Australian/New Zealand Standard AS/NZS 5667.6 (1998) *Water Quality – Sampling, Guidance on sampling of rivers and streams; and*
- Australian/New Zealand Standard AS/NZS 5667.9 (1998) *Water Quality – Sampling, Guidance on sampling from marine waters.*

1.3.2 Soil and sediment assessment criteria

Soil and sediment investigation levels have been adopted from assessment criteria presented in CRC Care (2011), NEPM (2013), NEMP (2020) and NSW EPA (2014) as discussed in Table 18 below.

Given the various receptors identified above in Table 15 during construction activities and at completion of construction for end use receptors, screening criteria for commercial / industrial, open space and/or residential land uses should be applied to the relevant Project Specific T-AEI site once the BLGHFC project design and end uses are finalised.

Table 18 Summary of nominated soil and sediment contamination assessment criteria

Criteria	Guideline name	Site	Details
Health screening levels (HSL) for petroleum hydrocarbons	ASC NEPM	All soils and sediments where hydrocarbons are analysed	The NEPM (2013) presents HSLs for fuel derived petroleum hydrocarbons, which are generic criteria based on a series of reasonably conservative assumptions in order to be protective of human health for a variety of land use types. For the purposes of selecting health-based investigation levels for the project sites, commercial/industrial, open space and/or residential land uses are considered depending on the AEI site as per receptors identified in Table 15.
	CRC Care	All soils and sediments where hydrocarbons are analysed	The CRC Care (Friebel & Nadebaum, 2011) HSLs for petroleum hydrocarbons, for intrusive maintenance workers have been considered. Where HSL values are non-limiting for the protection of human receptors, direct contact values should be adopted as per CRC Care guidelines.
Health investigation levels (HILs) for other contaminants	ASC NEPM	All soils and sediments where metals, PAHs, phenols and pesticides are analysed	For non-petroleum hydrocarbons, the NEPM 2013 HILs have been adopted for commercial/industrial, open space and/or residential land uses (as per receptors identified in Table 15). The HILs take into account direct contact pathways, including incidental ingestion and dermal contact.
Ecological investigation levels (EILs) and ecological screening levels (ESLs)	ASC NEPM	Applicable soil and sediment locations	The NEPM (2013) includes EILs for heavy metals and naphthalene and ESLs for petroleum hydrocarbons. The applicability of ESLs and EILs to the BLGHFC project area should be evaluated by the awarded contractor when developing site-specific SAQP/s. Given that large scale earthworks will occur during the construction, most of the existing ecosystems at the BLGHFC project area will be disturbed. Therefore, it is unlikely EILs and ESLs would be included in the assessment, however they may be considered at sites in which parks and reserves are directly adjacent (B9, B15, B16 and B17) or where open space areas are not proposed to be disturbed during construction works (B10).
Management limits	ASC NEPM	All soils and sediments where hydrocarbons are analysed	The NEPM (2013) includes “management limits” for total petroleum hydrocarbons (TPH). Management limits are applied after consideration of relevant HSLs. Where TPH concentrations are less than the adopted HSL, consideration will be given to management limits for commercial/industrial, open space and/or residential land uses (as per receptors identified in Table 15). The soil texture used will be determined during intrusive activities, however, will most likely utilise a coarse soil texture as a conversative measure.
Asbestos screening criteria	ASC NEPM	Selected soils and sediment samples where asbestos is analysed	Analysis must be completed in the field and laboratory for: – Non-friable (also known as bonded) asbestos using the NEPM gravimetric procedure where the sample volume must be a minimum of 10 L per sample; and Asbestos fines/ fibrous asbestos ('AF/FA') where the sample(s) collected must be a minimum of 500 mL or 1 kg. Please note that the laboratory LOR for presence/absence (0.01%) is higher than the AF/FA HSL criteria (0.001%) (WA DoH, 2009).

Criteria	Guideline name	Site	Details
PFAS screening criteria	PFAS NEMP 2.0	Selected soils and sediment samples where PFAS is analysed	For assessment of PFAS in soil and sediment, human health screening values in the NEMP (2020) for commercial/industrial, open space and/or residential land uses (as per receptors identified in Table 15) will be adopted for screening against PFAS results. This will likely be considered at AEI sites B9 and B10 in the former landfill area.
Waste classification	NSW EPA (2014)	Selected soils and sediment samples	For waste classification purposes, the concentrations of the chemicals in samples analysed will be compared to the criteria in NSW EPA (2014) Waste Classification Guidelines to provide preliminary indications of the classification of waste and material requiring offsite disposal. Waste classification for off-site disposal is required in accordance with the *Protection of the Environment Operations Act* (POEO Act) 1997 and its associated regulations. The classification process for non–liquid wastes (i.e., soil) focuses on the potential for waste to release chemical contaminants into the environment through contact with liquids (leachates). The first test used to chemically assess waste is the Contaminant Threshold (CT) test, which determines the total concentration of each contaminant in the waste sample. The guidelines set different maximum levels for the total concentration of each contaminant in order for waste to be classified as either general solid waste, restricted solid waste or hazardous waste. The toxicity characteristics leaching procedure (TCLP) test estimates the potential for waste to release chemical contaminants into a leaching liquid. The guidelines set different maximum levels of the leachable concentration of each contaminant in order for waste to be classified as general solid waste, restricted solid waste or hazardous waste.

1.3.3 Water assessment criteria

The nominated assessment criteria outlined below for groundwater, surface water, leachate and seepage (if tested) may be used to compare analytical results following field investigations by the appointed BLGHFC contractor(s). Assessment criteria should be further refined by the contractor as part of the site-specific SAQPs. Nominated assessment criteria includes the following:

– NEPC (2013) Health Screening Levels for petroleum hydrocarbons
– CRC Care (2011) Health Screening Levels for petroleum hydrocarbons, for intrusive maintenance workers;
– National Health and Medical Research Council (NHMRC) Recreational waters (2008);
– HEPA (2020) PFAS National Environmental Management Plan (NEMP), Version 2.0
– Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000);
– Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality (2018); and
– Kjeldsen et al (2002) Present and Long-term Composition of MSW Landfill Leachate: A Review.

As surrounding suburbs to the BLGHFC project are supplied by a reticulated water supply and only one groundwater abstraction bore is located 500 m from the BLGHFC project, drilled to a depth of 132 m, it is unlikely human groundwater users will be impacted by potentially contaminated groundwater. As such, drinking water criteria has not been considered. Recreational criteria (NHMRC, 2008) has been selected as a conservative measure to assess the potential health risk in relation to direct contact with surface water and groundwater during the construction phase. While groundwater and surface water around the BLGHFC project area is not considered to be used for recreational purposes, this guideline has been adopted as a conservative approach to determine if there is any risk to construction workers that may come in contact with groundwater and surface water.

The assessment of PFAS will likely occur in selected water samples, primarily from AEI sites B9 and B10 in the former landfill area. Criteria from Kjeldsen et al (2002) should also be adopted in this former landfill area to compare to analyte concentrations, particularly in leachate and/or seepage samples.

1.3.4 Landfill gas contamination assessment

AEI sites B9 and B10 are located in the Flat Rock Drive area, known historically to be used as a landfill. This presents potential landfill gas impacts in this area and is subject to gas management criteria listed in the NSW EPA (2016) guidelines. These gas assessment criteria are also referred to in Section 3.6.2 of the NSW EPA (2020) guidelines. Surface gas monitoring and well monitoring would be subject to guidance below, or similar.

Surface transects

– Methane criterion of 500 ppm for intermediate and final capped surfaces.
– In addition to the above criterion, surface monitoring should be performed on calm days with winds below 10 km/hr as per NSW EPA (2016) guidance; and
– Rainfall in the 48 hours preceding surface monitoring should also not exceed circa 28 mm, which is the cut-off level for landfill gas monitoring at the site, calculated using the Department of the Environment and Energy (2017) technical guidelines.

Sub-surface wells

– Methane criterion of 1% (v/v). If methane is detected at concentrations above the threshold level, the occupier must notify the EPA promptly. The subsurface criteria the subsurface criteria 1%v/v also represents the gas accumulation criterion for enclosed structures which triggers further investigation and corrective action; and
– Carbon dioxide criterion of 1.5% (v/v).

1.3.5 Acid sulfate soil assessment

Appendix N of the EIS reports that there is no probable risk of acid sulfate soil (ASS) occurrence across the BLGHFC project, with the exception of AEI site B11, located at Spit West Reserve which comprises a low risk of ASS occurrence. As there is the potential for ASS to be present at this site, analysis of pH and pHfox for soil samples may be required.

The Acid Sulfate Soils Management Advisory Committee (ASSMAC) manual (1998) provides procedures for field screening (pH_F and pH_{FOX}) for actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS). ASS must be assessed with due consideration of the National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual ((Commonwealth of Australia, 2018), noting the requirements for chromium reducible sulfur testing.

Field pH measurements

– pH readings of pH <4, indicate that AASS are possibly present; and

– pH readings of pH >4, indicate the absence of AASS, however does not give any indication of the PASS.

Field Peroxide measurements

– A positive peroxide test indicating one of more of the following may indicate the presence of PASS:
  - Change in colour of the soil from grey to brown tones;
  - Effervescence;
  - Release of sulfur smelling gases such as sulfur dioxide and hydrogen sulphide;
  - A lowering of the soil pH by at least one unit; and
  - A final pH<3.5.

Laboratory analysis

The assessment criteria for ASS adopted for the site includes the acid sulfate action guidelines as stated in the Acid Sulfate Soil Manual (ASSMAC, 1998). The guidelines assess results for ASS testing and determine whether disturbed soils at the site need to be treated or managed. The guidelines for soils with fine to coarse texture are summarised in Table 19.

Table 19 Action criteria for acid sulfate soils

Soil Texture	Description	Action Criteria		
		S_{POS} (%S)	TPA (mole H+/tonne)	TSA (mole H+/tonne)
Soil disturbance < 1000 tonnes				
Coarse	Sands to loamy sands	0.3	18	18
Medium	Sandy loams to light clays	0.6	36	36
Fine	Heavy clays to silty clays	0.1	62	62
Soil disturbance > 1000 tonnes				
Coarse	Sands to loamy sands	0.3	18	18
Medium	Sandy loams to light clays	0.3	18	18
Fine	Heavy clays to silty clays	0.3	18	18

Notes to table:

TPA – Titratable peroxide acidity

TSA – Titratable sulfidic acidity

S_{POS} - Peroxide Oxidisable Sulfur

Given the unknown quantity of soil disturbance at the site, the more stringent action criteria for > 1000 tonnes of disturbance is suggested to be applied, however this should be reviewed as part of the site-specific SAQP.

1.4 Project Specific T-AEIs - sampling and analysis strategy

1.4.1 Data Quality Objectives for Project Specific T-AEIs

The basis for the data quality objectives developed for the Project Specific T-AEIs are defined in and are based on the seven step process set out in the ASC NEPM. The Framework SAQP applies only to the moderate and high risk sites identified in the EIS.

Table 20 Data quality objectives

Steps		Description
1	State the problem	There are a number of potential sources of contamination that have been identified in the EIS and during the preparation of this Framework SAQP (as outlined in Section 1.2). These sources and associated AEIs may have the potential to impact human health and/or the environment during construction and operation of the BLGHFC project and potential future land use receptors.
2	Identify the decision	The key decisions to be made include: – Determine the potential contamination impact at AEIs across the BLGHFC project, as defined in the EIS; and – Determine the sampling and analysis required for AEIs across the BLGHFC project to inform future site-specific SAQP(s) to be developed by the appointed contractor(s) and understand potential risks to receptors during construction and following completion of construction works.
3	Identify inputs to the decision	The information needed to support the decisions identified above at this time includes the EIS, including but not limited to, Appendix M (Contamination, (TfNSW, 2020b)) and Appendix N (Groundwater, (TfNSW, 2020c)).
4	Define the study boundaries	The study boundary comprises the boundaries of each AEI site as shown in Figures 4 to 6 and Figures 8 to 10, (Appendix A of the Framework SAQP)
5	Develop a decision rule	The decision rules to be applied are as follows: – If reported chemical concentrations are above the soil and/or water and/or landfill gas adopted assessment criteria, then soil and/or water and/or landfill gas assessment will be undertaken to review if these constitute an unacceptable risk to potential receptors. In that occurrence, further investigation would be undertaken; and – If concentration(s) of chemical contaminant(s) exceed the adopted assessment criteria, then further assessment of the soil, and/or water and/or landfill gas may be required to evaluate the need for additional investigation.
6	Specify limits on decision errors	Two primary decision error-types may occur due to uncertainties or limitations in the BLGHFC Project data set. This may include: – A sample/site may be deemed to pass the nominated criteria, when in fact it does not. This may occur if contamination is 'missed' due to limitations in the sampling plan, or if the BLGHFC project analytical data set is unreliable; and – A sample/site may be deemed to fail the nominated criteria, in actuality, it may not. This may occur if the BLGHFC project analytical data set is unreliable, due to inappropriate sampling, sample handling, or analytical procedures. The following tasks would be undertaken: – An assessment to understand the likelihood of a decision error being made based on the results of a quality assurance / quality control (QA/QC) assessment and the closeness of the data to the assessment criteria; and – A QA/QC assessment, evaluating the reliability and useability of data, which are expressed as five data quality indicators (DQI).
7	Optimise the design for obtaining data	Achieved by developing this Framework SAQP, which will be refined in the future by the appointed contractor(s) who will create their own by evaluating field observations and analytical results.

1.4.2 Sampling and laboratory analysis program for Project Specific T-AEIs

Based on the summary information presented in Section 4 of this Framework SAQP, consideration has been provided to the likely sampling locations and rationale, laboratory analysis and frequency of sampling that maybe required for each Project Specific T-AEI. The proposed sampling design was developed in accordance with the NSW EPA Sampling Design Guidelines (1995). Sample frequencies stated in the table below consider the area of each Project Specific T- AEI site at the time of reporting and as presented in Figures 4 to 6 and Figures 8 to 10, Appendix A of the Framework SAQP. Sampling required at the exit phase will be dependent on the outcome of any remediation work or management requirements at the completion of construction, with a preliminary estimate provided in Table 21 based on the site area.

Table 21 presents a summary of the required sampling and analytical program, however, these sampling and analytical frequencies may be subject to change following the completion of this Framework SAQP and any change in the program must be justified in the site-specific SAQPs. It is noted the frequency is designed to assess site characterisation and not support waste classification purposes. Additional sampling may be required for the purposes of waste classification (see Section 1.5.9).

Table 21 Sampling design overview

AEI	Surface area of site (m2)	Proposed construction details	Future land use / operational phase	Proposed minimum soil sampling points based on the site area		Investigations to include (Yes/No)			Rationale	
				Construction phase	Exit phase	Groundwater	Surface water / sediment	Landfill gas / Ground gases	COPC	Contamination considerations
B7 Punch Street	5,900	Demolition of existing structures; excavation of tunnel features; construction and operation of temporary site facilities.	Commercial/ industrial	15	15	Yes	Yes	No	**Groundwater** Anions and cations, heavy metals[10], TRH, BTEX, PAH, nutrients, TDS, OCP and OPP. **Surface water** Anions and cations, heavy metals, TRH, BTEX, PAH, nutrients, TDS, OCP and OPP, biochemical oxygen demand (BOD) and chemical oxygen demand (COD). **Soil and sediment** pH, asbestos (presence/absence), TRH, BTEX, PAH, heavy metals, OCP and OPP, PCB, TCLP (PAH and metals).	It is likely that contamination (if present) is located throughout the soil profile due to historical filling, demolition and construction activities (including construction of the Gore Hill Freeway), and commercial/industrial use of the adjacent area. This may be impacting groundwater underlying the site and/or Flat Rock Creek, located 200 m north-east of the site.
B8 Dickson Avenue	5,500			14	14	Yes	Yes	No		It is likely that contamination (if present) is located throughout the soil profile due to historical demolition and construction activities (including construction of the Gore Hill Freeway), and commercial/industrial use of the site and adjacent area. This may be impacting groundwater underlying the site and/or Flat Rock Creek, located 750 m north-east of the site.
B9 Flat Rock Reserve	10,400	Excavation of tunnel access decline and main tunnel alignment; construction and operation of temporary site facilities.	Open space	24	24	Yes	Yes	Yes	**Groundwater** Anions and cations, heavy metals, TRH, BTEX, PAH, nutrients, TDS, VOCs, SVOCs, phenols, PFAS, OCP and OPP, dissolved methane, BOD and COD. **Surface water** Anions and cations, heavy metals, TRH, BTEX, PAH, nutrients, TDS, VOCs, SVOCs, phenols, PFAS, OCP and OPP, dissolved methane, BOD and COD. **Soil and sediment** pH, asbestos (presence/absence), TRH, BTEX, PAH, heavy metals, OCP and OPP, PCB, VOCs, SVOCs, phenols, PFAS, cyanide, ammonia,	It is likely that contamination (if present) is located throughout the soil profile due to historical infilling, associated with the former landfill, and incinerator operations at the sites. Commercial/industrial has also occurred in the adjacent area. This may be impacting groundwater underlying the sites and/or Flat Rock Creek adjacent to the sites.

[10] Heavy metals: Including, but not limited to, arsenic, boron, cadmium, chromium, cobalt, copper, cyanide, iron, lead, manganese, mercury, nickel and zinc

AEI	Surface area of site (m2)	Proposed construction details	Future land use / operational phase	Proposed minimum soil sampling points based on the site area		Investigations to include (Yes/No)			Rationale	
				Construction phase	Exit phase	Groundwater	Surface water / sediment	Landfill gas / Ground gases	COPC	Contamination considerations
									TCLP (PFAS, PAH and metals). **Landfill gas** Field test (concentration, pressure gradient and flow), carbon dioxide, methane, oxygen, hydrogen sulphide	
B10 Bicentennial Reserve	109,200	Tunnel excavation (no surface works planned).	Public recreation	Targeted for design and waste classification purposes for tunnel route and material that comes from the road header excavation. No requirements for site characterisation.	None, as no surface works proposed	Yes	No	Yes		
B11 Spit West Reserve	26,500	Construction and operation of temporary site facilities.	Open space	37	37	Yes	Yes	No	**Groundwater** Anions and cations, heavy metals, TRH, BTEX, PAH, nutrients, TDS, OCP and OPP **Soil** pH, asbestos (presence/absence), TRH, BTEX, PAH, heavy metals, OCP and OPP, PCB, TCLP (PAH and metals), ASS	It is likely that contamination (if present) would be present in surficial soil as the site is reclaimed land, with no known potentially contaminating activities occurring. It is adjacent to Middle Harbour which is considered to be impacted by various sources, prior to construction of the BLGHFC project.
B13/14 Balgowlah Golf Course & Dudley Street	113,000	Demolition of existing structures; excavation of tunnel features and access decline; construction and operation of temporary and permanent site facilities.	Both sites will be used for commercial/ industrial and open space land. The northern half of the site will only comprise of open space land.	Likely required to be separated into smaller sites. Based on size - 135 sampling points.	Likely required to be separated into smaller sites. Based on size - 135 sampling points.	Yes	Yes	Yes	**Groundwater** Anions and cations, heavy metals, TRH, BTEX, PAH, nutrients, TDS **Surface water** Anions and cations, heavy metals, TRH, BTEX, PAH, nutrients, OCP and OPP, BOD and COD, TDS **Soil and sediment** pH, asbestos (presence/absence), TRH, BTEX, PAH, heavy metals, OCP and OPP, PCB, TCLP (PAH and metals) **Landfill gas** Field test (concentration, pressure gradient and flow)	It is likely that contamination (if present) is located throughout the soil profile due to historical filling and demolition and construction activities associated with the Burnt Bridge Creek Deviation, and current potential chemicals stored at the Golf Course. This may be impacting groundwater underlying the sites and/or Burnt Bridge Creek which intersects the north-western portion of the site.
	10,200			21	21		No	No	**Groundwater**	

AEI	Surface area of site (m2)	Proposed construction details	Future land use / operational phase	Proposed minimum soil sampling points based on the site area		Investigations to include (Yes/No)			Rationale	
				Construction phase	Exit phase	Groundwater	Surface water / sediment	Landfill gas / Ground gases	COPC	Contamination considerations
B15 Residential properties, Wakehurst Parkway		Construction and operation of temporary site facilities.	Residential land use including private gardens.			Yes (subject to soil investigation results)			Anions and cations, heavy metals, TRH, BTEX, PAH, nutrients, TDS, OCP and OPP **Surface water** Anions and cations, heavy metals, TRH, BTEX, PAH, nutrients, TDS, OCP and OPP, BOD and COD **Soil** pH, asbestos (presence/absence), TRH, BTEX, PAH, heavy metals, OCP and OPP, PCB, TCLP (PAH and metals)	It is likely that contamination (if present) would be present in surficial soils as the site has been relatively unchanged from 1955 comprising bushland and residential properties. Some degradation of these properties may have occurred. It is unlikely that contamination (if present) would be received by underlying groundwater and/or off-site surface water receptors. Should the soils investigation return results below the selected criteria, groundwater investigation is not considered to be necessary.
B16 Sydney Water Reservoir	12,300	Excavation of tunnel features and access decline; construction and operation of temporary site facilities.	Commercial/ industrial	23	23	Yes (subject to soil investigation results)	Yes	No		It is likely that contamination (if present) would be present in surficial soils as the site has been relatively unchanged since 1930. Some degradation of reservoirs on-site. It is unlikely that contamination (if present) would be received by underlying groundwater and/or off-site surface water receptors. Should the soils investigation return results below the selected criteria, groundwater investigation is not considered to be necessary.
B17 Wakehurst Parkway, Seaforth to Frenchs Forest	82,700	Excavation of tunnel features and cut and cover; widening of Wakehurst Parkway.	Public road	Likely required to be separated into smaller sites. Based on size - 100 sampling points.	None as public road	Yes (subject to soil investigation results)	No - unless excavation interact with groundwater in northern most portion of alignment	No	**Soil** pH, asbestos (presence/absence), TRH, BTEX, PAH, heavy metals, OCP and OPP, PCB, TCLP (PAH and metals)	It is likely that contamination (if present) would be present in surficial soils due to clearing and use of the site for storage and parking in the 1970s and further development possibly including fuel storage in the early 2000s. Fly tipping known to have occurred adjacent to the site bringing potential asbestos containing materials (ACM) waste. It is unlikely that contamination (if present) would be received by underlying groundwater and/or off-site surface water receptors. Should the soils investigation return results below the selected criteria, groundwater investigation is not considered to be necessary.

1.5 Field and analytical methodology

The site-specific SAQPs must detail the field and analytical methodologies to be applied and justify the selection of those methods. The sections below provide some further guidance and requirements for the methodologies that must be detailed within the site-specific SAQPs.

1.5.1 Field work preparations

For each site-specific SAQP, the following activities must be undertaken prior to mobilising to site for the investigation and/or monitoring (where relevant):

- Develop a health, safety and environmental management plan tailored to the BLGHFC project area and proposed scope of work, including Job Safety and Environmental Analysis (JSEA) and/or Construction Environmental Management Plan (CEMP) or similar;
- Obtain all other relevant approvals required to enable intrusive works will be obtained prior to implementing the sampling plan (e.g. for work on sites with ecologically sensitive communities or heritage items);
- Investigation of drilling additives and core boxes as a potential contamination source, specifically relating to PFAS;
- Obtain and review dial before you dig (DBYD) services drawings;
- Engage the services of the following contractors:
    - Service locator to aid in identifying underground services prior to commencement of works at all proposed intrusive locations;
    - Labour – to advance hand augers / test pits into soil and drillers for advancement of boreholes and installation of monitoring wells and gas wells;
    - Licensed Asbestos Assessor (LAA) to undertake emu-picking and asbestos mapping along Wakehurst Parkway;
    - National Association of Testing Authority (NATA) accredited laboratories – to analyse samples; and
- Preparation and order of laboratory consumables (gloves, jars, bottles) and equipment for sampling.

1.5.2 Soil and sediment sampling

Various methods may be utilised to advance into the ground to collect soil samples, including drill rig, excavator bucket, hand auger and grab samples, where relevant. Soil and sediment sampling methods set out in site-specific SAQPs must include the application of the relevant following methodologies:

- Soil samples should be collected directly off of auger flights, bits, push-tubes, tow of excavator bucket or hand auger where relevant. Grab samples should be collected using disposable nitrile gloves. Care should be taken during sampling to ensure no cross contamination occurs between different layers of soil;
- All soil and sediment samples should be visually inspected, and all field observations and subsurface conditions recorded on field lithological logs, including presence of fill materials and any visual or olfactory indications of contamination;
- Where asbestos is visually identified, quantitative asbestos sampling in accordance with NEPM 2013 is required to confirm site suitability;
- Should asbestos be identified in soils, a sampling and analysis regime must be included in the site-specific SAQPs, and must be completed in the field and laboratory for:
    - Non-friable (also known as bonded) asbestos using the NEPM gravimetric procedure where the sample volume must be a minimum of 10 L per sample; and
- Asbestos fines/ fibrous asbestos ('AF/FA') where the sample(s) collected must be a minimum of 500 mL or 1 kg. Please note that the laboratory LOR for presence/absence (0.01%) is higher than the AF/FA HSL criteria (0.001%). (WA DoH, 2009);
- Soil samples should not be collected across changes in soil strata or soil horizons. Additional samples should be taken where there is a change in soil strata / horizon;.

– Soil samples should be screened for the presence of volatile contamination using a calibrated photo-ionisation detector (PID) where relevant volatile COPCs are to be analysed;
– The extent and depth of soil sampling locations will be determined by the appointed contractor(s);
– In general, soil sampling should be conducted at the surface, 0.2 m bgl, 0.5 m bgl, at 1 m bgl and approximate 1 m intervals thereafter until reaching termination depth. Sediment samples should be collected just below surface level;
– The appointed contractor(s) is to decide how many samples are to be collected from each borehole, test pit and/or hand auger;
– Leachate testing should be considered as required in the site-specific SAQPs for the assessment of soils and sediments;
– Unanalysed samples should be retained on hold in case additional laboratory analysis is required; and
– Photographs should be taken of the soil cores and sampling locations.

General sample collection and handling procedures are further detailed in Section 1.6.1.1.

Rock sampling

Core drilling may be used for combined geotechnical and contamination investigation locations. Rock samples should be collected from the recovered and cored rock column. Where practical, field staff should use laboratory provided rinsate water or deionised water to rinse the rock samples prior to submission to the laboratory. Given the recovered rock column may be used for geotechnical assessment purpose, field staff should select rock samples from corebox for analysis of non-volatile COPCs.

1.5.3 Groundwater and leachate well installation

Groundwater wells should be installed in general accordance with the Minimum Construction Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee, 2020). It is noted that the construction of groundwater wells may differ between consultants and will be specified by the appointed contractor(s).

Construction of groundwater wells should take into account the following general considerations:

– Wells will be constructed using 50 mm polyvinyl chloride (PVC) class 18 blank and screened casings, or similar;
– Screened casing slots (commercial factory manufactured) should be no greater than 1 mm in width and be screened across the encountered water strike. Leachate monitoring wells should be screened in landfill waste;
– Blank and screened PVC casing will be attached to each other using flush mounted factory-threaded joints;
– Primary filter pack material should be uniformly graded clean, coarse, sub-rounded to rounded silica sand or similar material, with a high coefficient of uniformity and will extend at least 0.5 m above the screened PVC casing;
– Bentonite pellets, or similar, should be used as annular sealant extending at least 0.5 m above the filter pack;
– Wells should be grouted from the top of the bentonite to the surface;
– Monitoring wells should be finished with a stainless steel monument cover or a flush mounted gatic cover and cemented (depending on land owner requirements);
– Wells should be developed following completion using Teflon-free equipment by purging at least three well volumes (where possible) or until dry. Well development should include removal of sediment from wells and reconnection back to the water bearing sequence; and
– Following installation, the monitoring wells should be accurately surveyed for location and elevation.

It is noted that due to topographic differences across the BLGHFC project, the length of the screen will differ between locations.

The monitoring wells installed are considered to be valuable as long-term infrastructure and should be retained for future proposed monitoring events where possible. Monitoring wells may also be installed in the same locations as geotechnical boreholes if appropriate.

1.5.4 Landfill gas well installation

Landfill gas wells should be installed in general accordance with NSW EPA. (2020). Assessment and management of hazardous ground gases (NSW EPA, 2020) and EPA Victoria (2015) Best Practice Environmental Management for the siting, design, operation and rehabilitation of landfills: Publication 788.3. The following aspects must be taken into consideration when designing the wells:

– A well screen interval that intercepts as much of the unsaturated (vadose) zone as possible whilst still allowing an adequate gas tight seal to be present/ constructed at the ground's surface;
– Where vertical stratification of gas concentrations or multiple pathways have been identified, or where these are otherwise deemed likely, multiple wells screened at different depths or multi-port wells should be installed;
– Sealing of the well so that any gas accumulating will be retained for sampling;
– Fitted with a cap tapped to take a quick-connect nipple (or a manual valve and nipple) that seals the well and allows easy connection to a measuring instrument; and
– Robustness, durability and accessibility of the well to ensure its suitability for ongoing use.

1.5.5 Groundwater and leachate sampling

Groundwater sampling should be conducted by considering the following:

– Wells should be left to recharge for at least one week following development and prior to sampling;
– Wells should be gauged to determine the standing water levels and depth of well using a water level probe. Depth measurements should be referenced to the top of well casing as an established datum and recorded to the nearest millimetre;
– Wells should be purged and sampled using Teflon-free dedicated and disposable high-density polyethylene (HDPE), or low-density polyethylene (LDPE) when not analysing for PFAS, using low-flow sampling techniques. Using this approach, only dedicated disposal equipment will come into contact with the sample, to reduce the risk of cross contamination between sampling locations;
– Field parameters measured during purging on a calibrated water quality meter should include at a minimum: Temperature, pH, electrical conductivity (EC), dissolved oxygen (DO) and oxidation reduction potential (ORP). Field parameters should be recorded on field data sheets;
– Wells should be purged until stabilisation of parameters, after which the sample should be collected in laboratory supplied bottles. Following sampling, the sample containers should be placed into a chilled cooler box for transport to a NATA accredited laboratory for analysis; and
– If the well is low yielding and is purged dry, it should be left to recover. Following recovery of groundwater levels in the well, grab samples should be collected on the assumption that the groundwater represents inflow from the hydrostratigraphic unit screened by the well. In this instance, measurement of one round of field water quality parameters at the time of sampling would be adopted to provide a cross check and confirm representative formation water is being collected.

Where PFAS is proposed within the analytical schedule, reusable components of the pump should be decontaminated with PFAS-free detergent (e.g., Liquinox) and laboratory supplied PFAS-free rinsate water. The collection point should be placed within the screen interval and the flow rate reduced to achieve a low flow sampling effect whereby water is preferentially drawn in through the well screen. This should be verified through monitoring of the water level during sampling and by avoiding to the extent practicable the drawdown of the water in the well due to pumping.

The appointed contractor(s) is to consider whether ongoing groundwater monitoring is required based on initial investigations.

1.5.6 Groundwater level and surface water gauging

It is understood that water level logging of groundwater and/or surface water may be required, particularly to understand seasonal variation and the impact of construction on the groundwater table and surrounding surface water receptors. A site inspection should be undertaken by the awarded contractor to identify suitable locations for monitoring of the surface water levels if deemed required.

Groundwater level loggers, if required, should be installed within the existing well casing approximately 1 m from the base of the well. A barometric logger should also be installed at a selected groundwater monitoring well to compensate for atmospheric pressure fluctuations and correction of the data (if this data is not available from the nearest weather station).

Timing intervals for data collection will be determined by the appointed contractor(s), however may include collection of data every 15 minutes throughout the duration of project construction.

The data should be validated and calibrated with manual measurements to assess accuracy of the loggers.

1.5.7 Surface water sampling

Where the embankment of the water body is stable and the water body can be safely accessed, surface water samples should be collected by hand, directly into the laboratory supplied sample containers. Where depth permits, the sample container should be positioned at least 10 cm below the surface water level, above the sediment bed and oriented with the capped opening facing downwards to avoid the collection of surface films. Once in position, the container cap should be removed to allow sample collection.

Where sampling points cannot be safely accessed, surface water samples should be collected using a long-handled sampler and decanted into the laboratory supplied sample containers.

Field parameters including temperature, pH, EC, DO and ORP are to be measured at the time of sampling using a pre-calibrated water quality meter and recorded on field sampling sheets. Field observations such as odours or sheen presence should also be recorded on field sampling sheets.

These procedures should likewise be followed if seepage samples are to be obtained following the identification of seepage locations at the time of sampling.

Rainfall events

To understand the impact of wet weather events on contaminant concentrations in surface water locations, surface water sampling events may occur during construction following rainfall events. To determine the trigger for wet weather sampling events, the appointed contractor(s) may choose to adopt the Department of the Environment and Energy (2017) *National Greenhouse and Energy Reporting Scheme Measurement Technical Guidelines for the Estimation of Emissions by Facilities in Australia* definition of a 'heavy rainfall event'. This is a defined as a volume of rainfall recorded within a day that exceeds the 'heavy rainfall benchmark' (HRF) as defined by the following formula:

$$HRF = 2 \times \frac{RF}{MRD}$$

Where:

HRF = heavy rainfall benchmark

RF = the mean monthly rainfall for the month at the nearest Bureau of Meteorology weather station (in this case, Mosman Council (BoM Station 66184) or Observatory Hill (BoM Station 66062).

MRD = the mean number of rainfall days for the month at the nearest Bureau of Meteorology weather station (in this case, Mosman Council (BoM Station 66184) or Observatory Hill (BoM Station 66062).

The timing and frequency of these sampling events should be determined based upon review of BoM rainfall data from the nearest weather station by the awarded contractor.

1.5.8 Landfill gas monitoring

Landfill gas (LFG) monitoring will likely include LFG surface emission monitoring and LFG sub-surface well monitoring as presented below, and should be conducted in general accordance with (NSW EPA, 2020).

LFG surface emission monitoring

Methane should be measured using a calibrated surface gas analyser (e.g., Huberg Laser One) approximately 50 mm above the ground level along grid lines spaced 25 metres apart across the inferred surface of the landfilled waste mass. A calibrated wind vane anemometer must also be used to measure wind speeds at the site during the LFG surface emission monitoring.

Where observations (including LFG odours or bubbling through ponded water) indicate that significant LFG emissions may occur offset from the gridlines being monitored, the monitoring personnel should divert from the gridlines to investigate these possible point sources.

LFG sub-surface well monitoring

LFG related parameters are to be measured in installed landfill gas sub-surface wells using a calibrated gas analyser (e.g., GA5000). Furthermore, a water level probe should be used to measure standing water levels and the depth to the base of the monitoring wells.

LFG related parameters to be measured and recorded on field sheets are to include at a minimum:

– Methane
– Carbon dioxide
– Oxygen
– Gas balance (the volume of the gas monitored that is not methane, carbon dioxide, oxygen, hydrogen sulphide, or carbon monoxide)
– Hydrogen sulphide
– Carbon monoxide
– Atmospheric pressure
– Relative (bore) pressure
– Gas flow

Observations such as the weather conditions and well condition should also be recorded on field sheets. Frequency of events should be determined by the awarded contractor.

1.5.9 Waste management

Spoil generated during intrusive investigations should be used to reinstate test pits and boreholes, in the reverse order of extraction. Spoil from the installation, development and sampling of groundwater wells should be characterised and transported off-site if required to an appropriately licenced waste facility. Further analysis will be used for characterising spoil generated from sampling.

Stockpile sampling should be undertaken in accordance with Schedule B2 (NEPC, 2013) with sampling requirements informed by the site history, the composition of the stockpile and the contaminant(s). The external composition of the stockpile must be documented, along with any excavations into the stockpile. An assessment of the age and surface condition must be undertaken, and the stockpile dimensions determined. Sample numbers, point distribution and collection methodology must be in accordance with Schedule B2 (NEPC, 2013).

Excess spoils comprising waste materials are to be classified in accordance with (NSW EPA, 2014) Waste Classification Guidelines, and where required, removed for off-site disposal by a licensed contractor. Excess spoils comprising natural soil / rock should be placed at surface near the drilled boreholes or test pits, away from areas prone to erosion and nominally compacted to minimise risk of run-off.

Further details on the storage procedure and waste handling should be directed by the appointed contractor(s).

1.5.10 Contingency plan

The site-specific SAQPs must require that control measures to be implemented during the intrusive investigations to protect the surrounding environment and community are appropriately documented by the contractor(s) prior to the commencement of any intrusive investigations. A contingency plan is outlined below, listing potential unexpected events that may arise during the fieldwork and actions that are to be undertaken if unexpected conditions occur:

– Environmental controls are to be implemented at all sites to prevent migration of potentially impacted material to the surrounding environment; and
– If evidence of contamination other than that expected is encountered, additional samples should be collected for assessment by the appointed contractor(s).

1.6 Data quality indicators

The site-specific SAQPs must detail the data quality indicators to be applied during an investigation. The sections below provide some further guidance and requirements for the data quality indicators that must be detailed within the site-specific SAQPs.

1.6.1 Field quality assurance and quality control

1.6.1.1 General sample collection and handling

All fieldwork is to be conducted with reference to the relevant guidelines and standards outlined in Section 1.3.

An experienced environmental scientist is to undertake the fieldwork and sampling program. Borelogs, field sheets and photographs should be prepared for each sampling location and included in the report. A hand-held GPS should be used to record coordinates of sampling locations.

Soil, sediment and water samples should be collected using new disposable nitrile gloves and placed directly into dedicated, laboratory supplied sample jars and bottles. These should then be placed into chilled insulated containers for transport to a NATA accredited laboratory. A label should be attached to each sampling container showing job number, date, sample location, depth and sampler initials. Sample details are to be entered onto a chain of custody (COC) form that will accompany the samples to the laboratory. A COC form should be used for every batch of samples submitted to the laboratory, including the scheduled analysis for each sample to be undertaken. Delivery of samples to the laboratory will need to comply with sample holding times.

When handling samples dedicated for PFAS analysis, as per the NEMP (2020), no Teflon coated materials or aluminium foil are to be used. All re-usable sampling equipment is to be made from HDPE or stainless steel and decontaminated prior to use. For samples where PFAS is not analysed, LDPE materials are able to be used.

Where PFAS is included in the analytical suite, during field sampling of PFAS, the sampling personnel are to adhere to the sampling recommendations as specified in the NEMP (2020), including the following:

– No brand-new field clothing to be worn;
– No waterproof clothing (e.g. GoreTex, Teflon or Tyvek clothing);
– No fast-food wrappers/containers or pre-wrapped foods or snacks; and
– No use of self-sticking notes or similar office products.

Soil samples for ASS screening test should be placed in ziplock plastic bags immediately from the ground and then placed into ice filled insulated containers for transport to the laboratory. Samples scheduled for asbestos analysis and potential asbestos containing materials (ACM) are to likewise be placed into ziplock bags.

Calibration certificates for field instruments are to be retained for record of correct calibration.

1.6.1.2 Decontamination of sampling equipment

To avoid cross-contamination between samples and sampling locations all reusable sampling equipment must be decontaminated prior to and at completion of sampling at each sample location, and where PFAS is proposed in the analytical schedule decontamination should be undertaken in accordance with the NEMP (HEPA , 2020). The decontamination process should not comprise a decontamination solution or detergent containing PFAS (e.g., Decon 90).

The decontamination process should comprise the following:

– Drilling equipment brushed to remove soil on the equipment and washed by high pressure water prior to first time use in the field and between sampling locations;
– Sampling equipment and tools washed and scrubbed in tap water; followed by rinsing with PFAS-free decontamination solution (e.g., Liquinox) and deionised water;
– Prior to sampling, a rinsate sample should be collected from all new equipment brought onto site using laboratory supplied PFAS free water. The primary laboratory will certify the rinsate water; and

– In addition, all samples must be handled by field staff in accordance with HEPA (2020) requirements and using clean disposable nitrile gloves, replaced between each sample.

1.6.1.3 Quality assurance assessment for cross contamination

1.6.1.3.1 Drilling additives

Drilling additives may be used during the investigation to enable drilling to reach the tunnel depth and collection of rock samples. To avoid the potential false concentrations of COPC, i.e., PFAS and hydrocarbons (TRH) in rock and groundwater samples, the awarded contractor should analyse drilling additives for PFAS and hydrocarbon (TRH) and provide the analytical data to Transport prior to using the drilling additives in the field.

An experienced environmental scientist/engineer should collect samples from the drilling contractor's materials for the following drilling additives, or similar, for every batch delivered to the drilling contractor during the investigation program prior to use:

– Clay breaker or similar thinner and dispersing agent;
– Poly Vis 2000 or similar synthetic polymer;
– AMC Det Xtra or similar surfactants;
– AMC Floc Blocks or similar anionic flocculant; and
– LUBRIPLATE or similar PFPE-based grease.

In addition, the tap water used in the field to make the drilling mud and the prepared drilling mud should be sampled on a daily basis. These samples should be submitted to the BLGHFC project laboratory for analysis of benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN), TRH and PFAS.

No drilling works should be undertaken until the quality control (QC) sampling and analysis has been completed and the analytical results received.

1.6.1.4 Summary

An example of analyses of drilling additives and plastic core boxes are summarised in Table 22.

Table 22 Pre-start quality control sampling and analysis

Matrix	Details	Drilling contractor yard		In the field	
Drilling additive	Clay breaker or similar thinner and dispersing agent.	One sample per batch	Analysis of PFAS, BTEXN and TRH	-	-
	Poly Vis 2000 or similar synthetic polymer.	One sample per batch	Analysis of PFAS, BTEXN and TRH	-	-
	AMC Det Xtra or similar surfactants.	One sample per batch	Analysis of PFAS, BTEXN and TRH	-	-
	AMC Floc Blocks or similar anionic flocculant.	One sample per batch	Analysis of PFAS, BTEXN and TRH	-	-
	LUBRIPLATE or similar PFPE-based grease.	One sample per batch	Analysis of PFAS, BTEXN and TRH	-	-
	Potable water used for preparation of drilling mud.	-	-	One sample per water supply source	Analysis of PFAS
	Mixed drilling mud.	-	-	One sample per cored borehole	Analysis of PFA, BTEXN and TRH
Rinsate	Plastic core box rinsate	One sample	Analysis of PFAS	One sample per plastic core box if used in the field	Analysis of PFAS
	Drilling equipment	-	-	One sample per key drilling equipment	Analysis of PFAS

1.6.1.5 Field quality control sampling and analysis – soil, sediment and water

All fieldwork is to be conducted with reference to the relevant NEPM and PFAS NEMP guidelines which allow all samples to be collected by a set of uniform and systematic methods. The field QC sampling and analysis program is summarised in Table 23.

Table 23 Field QC sampling program

Field QC samples	Purpose	Rate of collection
Blind (intra-laboratory) duplicates	Used to identify variation in the analyte concentration between samples from the same sampling point.	1 in every 20 samples for primary analytes 1 in every 10 samples for PFAS analytes
Split (inter-laboratory) duplicates	Provide an indication of the repeatability of the results between laboratories.	1 in every 20 samples for primary analytes 1 in every 10 samples for PFAS analytes
Rinsate blank	Used to estimate the amount of contamination introduced during the re-use of sampling equipment. Rinsate blank samples are obtained by pouring laboratory supplied deionised water over decontaminated sampling equipment (e.g. drill bit, hand auger, groundwater probe) into laboratory supplied bottles.	1 taken for every day of sampling where reusable equipment is used. Rinsate blanks are typically analysed for metals, TRH, BTEXN and PFAS.
Trip blank / trip spikes	Used to estimate contamination introduced into samples during transport of samples from the field to the laboratory.	1 for every batch of samples sent to the laboratory. Trip blank samples are typically analysed for TRH (C6-C9 fraction), BTEXN and PFAS.
Trip spike	Used to estimate loss of volatile compounds during transport of samples from the field to the laboratory.	1 for every batch of samples sent to the laboratory. Trip spike samples are typically analysed for BTEXN

Blind and split duplicate samples are to be assessed by calculating the relative percentage difference (RPD) between the primary, blind and split samples. RPD values are calculated using the following equation.

$$RPD(\%) = \frac{(C_o - C_s)}{\left(\frac{C_o + C_s}{2}\right)} \times 100¤$$

Where:

Co = reported from primary sample

Cs = reported concentration from duplicate sample

According to AS 4482.1 – 2005 (Standards Australia, 2005), typical RPDs are expected to range between 30% and 50%; however, this may be higher for concentrations which are close to the laboratory limit of reporting (LOR). The following acceptable RPD limits may be adopted based on standard industry practice and the inherent variability associated with PFAS analysis:

– 200% for concentrations within one to ten times the analyte LOR;
– 50% for concentrations within ten to 30 times the analyte LOR; and
– 30% for concentrations greater than 30 times the analyte LOR.

It is noted that these limits may not always be achieved, particularly in heterogeneous soils.

1.6.1.6 Field QA/QC sampling and analysis – Landfill gas

LFG monitoring QA/QC typically consists of the application and completion of appropriate QC measures in the field, with laboratory-based quality assurance usually only completed where further confirmation of data obtained using portable field equipment is required. The following measures (as outlined in *Assessment and management of hazardous ground gases* (NSW EPA, 2020)) are to be applied as far as reasonably practicable:

- Personal competence of monitoring personnel;
- Selection of appropriate instrumentation;
- Monitoring personnel suitably trained in use of the instruments;
- Review of operations manuals for the selected instruments;
- Review of *Appendix 4, Further guidance on site assessment methodology* in *Assessment and management of hazardous ground gases* (NSW EPA, 2020);
- Review of the landfill gas section of EPA Victoria (2015) Siting, design, operation and rehabilitation of landfills Publication 788.3 August, 2015;
- Instruments are to be appropriately calibrated over a suitable range in accordance with manufacturer's recommendations;
- Instruments will be used and maintained as per the manufacturer's recommendations;
- The relevant monitoring methods outlined in *Assessment and management of hazardous ground gases* (NSW EPA, 2020) are to be followed;
- Monitoring tasks are to be completed under appropriate meteorological/environmental conditions (as far as is practicable);
- Only adequately designed, installed and maintained monitoring locations are to be used (sub-surface geology) this will be confirmed on the review of existing well network report being prepared by the Environmental Consultant; and
- Data is to continuously be assessed during monitoring.

1.6.2 Laboratory QA/QC procedures

Soil and groundwater samples are required to be submitted to a NATA accredited project laboratory for the proposed analytical suite. Samples not selected for analysis should be placed on hold should further testing be required.

1.6.2.1 Laboratory quality control

Laboratory quality control procedures used during the BLGHFC project should include:

- **Laboratory duplicate samples**:
  The analytical laboratory collects duplicate sub samples from one sample submitted for analytical testing at a rate equivalent to one in twenty samples per analytical batch, or one sample per batch if less than twenty samples are analysed in a batch. A laboratory duplicate provides data on the analytical precision and reproducibility of the test result.
- **Spiked Samples**:
  An authentic field sample is 'spiked' by adding an aliquot of known concentration of the target analyte(s) prior to sample extraction and analysis. A spike documents the effect of the sample matrix on the extraction and analytical techniques. Spiked samples are analysed for each batch where samples are analysed for organic chemicals of concern.
- **Certified Reference Standards**:
  A reference standard of known (certified) concentration is analysed along with a batch of samples. The Certified Reference Standard (CRS) or Laboratory Control Spike provides an indication of the analytical accuracy and the precision of the test method and is used for inorganic analyses.
- **Surrogate Standard / Spikes**:
  These are organic compounds which are similar to the analyte of interest in terms of chemical composition, extractability, and chromatographic conditions (retention time), but which are not normally found in environmental samples. These surrogate compounds are 'spiked' into blanks, standards and samples submitted for organic analyses by gas-chromatographic techniques prior to sample extraction. Surrogate Standard/Spikes provide a means of checking that no gross errors have occurred during any stage of the test method leading to significant analyte loss.
- **Method Blank**:
  Usually an organic or aqueous solution that is as free as possible of analytes of interest to which is added all

the reagents, in the same volume, as used in the preparation and subsequent analysis of the samples. The reagent blank is carried through the complete sample preparation procedure and contains the same reagent concentrations in the final solution as in the sample solution used for analysis. The reagent blank is used to correct for possible contamination resulting from the preparation or processing of the sample.

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