A meeting of the
City Planning & Environment Committee
will be held in the Committee Room, Botany Town Hall
Corner of Edward Street and Botany Road, Botany
on Wednesday, 13 April 2022 at 6:30 pm

UNDER SEPARATE COVER ATTACHMENTS PART ONE

PLANNING INGENUITY

Our Ref: M170091/LT1

7 April 2020

The General Manager
Bayside Council
444-446 Princes Highway,
ROCKDALE NSW 2216

Attention: Mr John McNally

Dear John,

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
187 SLADE ROAD, BEXLEY NORTH

We act as town planning consultants to the owner of the above property. Specifically, we have been instructed to make representation to Council in response to the email request for additional information on 27 February 2020. In summary, we have prepared scaled plans for consideration of Council but consider that the provision of a Draft Development Control Plan (DCP) is unnecessary at this stage given Council has not indicated its support, or otherwise, of the planning proposal and its indicative concept scheme. In any case, the Urban Design Study by GMU makes clear the style of envelope controls that would ultimately be included in a DCP which in our experience is often drafted post Gateway determination.

We address the issues raised by Council individually.

1. **If possible, please provided scale drawings at a commonly-used scale of the site plan, indicative concept layouts, indicative basements and indicative sectional studies;**

   GMU have provided scaled drawings of 1:500 at A3 for the indicative concept scheme, including the basements. These documents are submitted under a separate attachment.

   It is noted that the indicative sections are detailed on Page 27 of the Urban Design Report (UDR) prepared by GMU which, whilst not to scale, have indicative RLs. The provision of scale sections is beyond the scope of the indicative concept plans as the design will require detailed structural, geotechnical and traffic input that will be provided at the development application stage. The provision of indicative sections with RLs is considered appropriate at this stage of the planning proposal.

2. **Please provide a level-by-level breakdown of the proposed GFA through an area schedule and measured area plans of all levels as described below, as well as a short description of how the GFA/FSR was measured/calculated;**

   GMU have provided a level by level breakdown of the Gross Buildable Area (GBA) and the Gross Floor Area (GFA) which are submitted under a separate attachment.

   GMU have provided the following description with regards to how the GBA and GFA were considered:

"In arriving at the estimated GBA as indicated in drawings SK-013 to SK-021, GMU has calculated the GBA shown in the blue hatched lines in the drawings. GMU has arrived on an efficiency of 75% based on Part 2B of the Apartment Design Guide (ADG) which states that *a building envelope should be 25-30% greater than the achievable floor area to allow for building components that do not count as floor space but contribute to building design and articulation such as balconies, lifts, stairs and open circulation*. However, we are aware that a 75% efficiency is a conservative estimate, especially for commercial uses but it will allow for architectural detailing and building articulation. Subject to detailed design, the GFA will be in accordance with the LEP definition."

3. **Please provide measured area plans: GBA overlays of the existing "Indicative Concept Design" layouts that were provided in the UDR. Plans should be provided at a commonly used drawing scale. For each level, please highlight each separate measured area of non-residential, residential and/or non-GFA (services/parking) use;**

As discussed above, the scaled GBA and GFA calculations are submitted under a separate attachment.

The indicative concept plans have not detailed the floor areas by use. As the plans are to scale, calculations on the floor areas for each use can be undertaken by Council if required. However, it should be noted that the detailed areas of the residential and non-residential uses have not been determined and will be subject to detailed design at the development application stage.

If the intention of Council is to impose an FSR for non-residential floor space, this can be discussed and the indicative concept design can be altered (if required) at later stages in the planning proposal.

4. **Please provide an area schedule: A table summary of the measured areas of each use on each level including basements, all efficiency assumptions (separated by use) that were used to derive a GFA from the measured areas, and the subsequent GFA by level by use; and**

As discussed in Part 3 above.

5. **Please provide HOB and FSR maps that have been notated with dimensions sufficient to accurately identify the division of the site into the two separate sections that delineate where the various heights are apportioned and the areas upon the FSR calculations have been based.**

GMU have provided dimensioned Height of Buildings (HOB) and Floor Space Ratio (FSR) maps to identify the division between the height limits. These plans are submitted under a separate attachment.

In addition, paragraph 3.2 of the Planning Proposal Report states that a 'site-specific Development Control Plan (DCP) will be prepared post-Gateway' for public exhibition…' A draft version of the DCP needs to be provided as part of the current document submission so that it can be shown to the Bayside Local Planning Panel and Council to assist with the assessment of whether the Planning Proposal has merit.

It is envisaged that the draft Site Specific DCP will be prepared post gateway determination for public exhibition. We consider that the provision of a draft Site Specific DCP is premature at this stage as there has been no indication from Council for support, or otherwise, of the planning proposal. For example, if the indicative concept design evolves after discussions with Council or the BLPP, all the work on the draft Site Specific DCP would be redundant.

The document *Planning Proposals: A Guide to Preparing Planning Proposals* states:

> *A planning proposal which is submitted for a Gateway determination must provide enough information to determine whether there is merit in the proposed amendment proceeding to the next stage of the plan making process. The level of detail required in a planning proposal should be proportionate to the complexity of the proposed amendment.*
>
> *A planning proposal relates only to a LEP amendment. It is not a development application nor does it consider specific detailed matters that should form part of a development application.*
>
> *The planning proposal should contain enough information to identify relevant environmental, social, economic and other site-specific considerations. The scope for investigating any key issues should be identified in the initial planning proposal that is submitted for a Gateway determination. This would include listing what additional studies the PPA considers necessary to justify the suitability of the proposed LEP amendment. The actual information/investigation may be undertaken after a Gateway determination has been issued and if required by the Gateway determination.*

As such, we would say that the scaled indicative concept plans (attached) and information submitted within the UDR and PP Report are sufficient to determine whether there is merit in the planning proposal application. Furthermore, as the Planning Proposal only seeks to modify the height and FSR development standards, the planning proposal is not of a sufficient complexity to warrant detailed analysis (Site Specific DCP) prior to Gateway.

We thank Council for their time and consideration of the above matters and hope the additional information submitted will permit the continued assessment of the planning proposal application.

We look forward to continuing to work with Council on this planning proposal application.

Yours faithfully,
Planning Ingenuity Pty Ltd

David Waghorn
ASSOCIATE DIRECTOR

EIS
ENVIRONMENTAL INVESTIGATION SERVICES

REPORT

TO

TUNBORN PTY LTD

ON

STAGE 2 ENVIRONMENTAL SITE ASSESSMENT

FOR

PROPOSED HOTEL REDEVELOPMENT

AT

187 SLADE ROAD, BEXLEY NORTH

19 MARCH 2018 **REF: E30293KHrpt2**

Postal Address: PO Box 976, North Ryde BC NSW 1670
Tel: 02 9888 5000 • Fax: 9888 5004
EIS is a division of Jeffery and Katauskas Pty Ltd • ABN 17 003 550 801

Document Distribution Record

Report Reference	Distribution	Report Date
E30293KHrpt	Client via email	19 March 2018

Report prepared by:

Todd Hore
Associate | Environmental Engineer

Report reviewed by:

Adrian Kingswell
Principal | Environmental Scientist

This Report (which includes all attachments and annexures) has been prepared by EIS for the Client, and is intended for the use only by that Client.

This Report has been prepared pursuant to a contract between EIS and the Client and is therefore subject to:

a) EIS proposal in respect of the work covered by the Report;
b) The limitations defined in the client's brief to EIS; and
c) The terms of contract between EIS and the Client, including terms limiting the liability of EIS.

If the Client, or any person, provides a copy of this Report to any third party, such third party must not rely on this Report, except with the express written consent of EIS which, if given, will be deemed to be upon the same terms, conditions, restrictions and limitations as apply by virtue of (a), (b), and (c) above.

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EIS

EXECUTIVE SUMMARY

Nexus Project Delivery, on behalf of Tunborn Pty Ltd ('the client'), commissioned Environmental Investigation Services (EIS) to undertake a Stage 2 Environmental Site Assessment (ESA) for the proposed hotel redevelopment at 187 Slade Road, Bexley North ('the site').

The ESA included a review of a previous Stage 1 ESA, walkover site inspection, soil sampling from six locations and groundwater sampling from two locations.

At the time of the inspection, the majority of site was occupied by a hotel building, with a semi-detached motel style accommodation building and a drive-thru bottle shop.

The historical assessment indicated the following potential site uses:

- Pre-1953 - Vacant with possible poultry farming;
- 1950's - Development of the site occurred; and
- At least 1961 to present the site has been occupied by the existing Hotel.

Based on the scope of work undertaken for this assessment, EIS identified the following potential contamination sources/AEC:

- Fill material;
- Historical agricultural use (poultry farm);
- Use of pesticides;
- Hazardous Building Material;
- Two service stations were located approximately 75m and 150m up-gradient (south-west) of the site; and
- A former dry cleaners was located less than 50m to the south of the site.

Fill was encountered at the surface or beneath the pavement in all boreholes and extended to depths of approximately 0.3m to 6.5m. Fill was typically shallower than 1.6m, with the exception of BH102. A fibre-cement sheeting fragment was encountered in the fill material in BH101.

The fill was underlain by natural soil and sandstone bedrock.

Asbestos was encountered in the form of a FCF in the fill material in BH101. The source of the asbestos is considered likely to be the fill material, which may have been imported onto the site. In the present site configuration, the asbestos contamination presents a very low risk to site occupants as it is beneath a concrete pavement. The risk would increase if the pavement was removed and especially during excavation works.

Based on the results of the assessment, and at the time of reporting, the fill material in the vicinity of BH101 is classified as General Solid Waste (non-putrescible) containing Special Waste (asbestos). The fill material across the remainder of the site may be classified as General Solid Waste (non-putrescible) subject to further assessment to better assess the extent of the asbestos impacted material.

EIS are of the opinion that the natural soil and bedrock at the site meets the definition of VENM for off-site disposal or re-use purposes.

Asbestos was encountered in fill material in the north-west section of the site. At this stage further investigation, to better assess the extent of the contamination, is not possible due to the physical constraints of the site. It may be possible to undertake further investigation following demolition of the buildings at the site, however, this would likely result in significant delays to the project. Based on our experience, where asbestos is encountered in a discrete location in fill material by drilling boreholes, further, asbestos is usually encountered during excavation works. EIS consider that the most cost and time effective approach would be to take a conservative view of the contamination and assume that all fill material at the site is impacted by asbestos.

Based on the above, EIS make the following recommendations:

- A Remedial Action Plan (RAP) should be prepared outlining procedures to be undertaken during each stage of development/excavation, with respect to the asbestos contamination;
- A validation assessment should be undertaken on completion of remediation at each development stage; and
- An unexpected finds protocol should be implemented during excavation works at the site.

The conclusions and recommendations should be read in conjunction with the limitations presented in the body of the report.

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ABBREVIATIONS

Asbestos Fines/Fibrous Asbestos	**AF/FA**
Ambient Background Concentrations	**ABC**
Added Contaminant Limits	**ACL**
Asbestos Containing Material	**ACM**
Australian Drinking Water Guidelines	**ADWG**
Area of Environmental Concern	**AEC**
Australian Height Datum	**AHD**
Acid Sulfate Soil	**ASS**
Above-Ground Storage Tank	**AST**
Below Ground Level	**BGL**
Benzo(a)pyrene Toxicity Equivalent Factor	**BaP TEQ**
Bureau of Meteorology	**BOM**
Benzene, Toluene, Ethylbenzene, Xylene	**BTEX**
Cation Exchange Capacity	**CEC**
Contaminated Land Management	**CLM**
Contaminant(s) of Potential Concern	**CoPC**
Chain of Custody	**COC**
Conceptual Site Model	**CSM**
Development Application	**DA**
Data Quality Indicator	**DQI**
Data Quality Objective	**DQO**
Detailed Site Investigation	**DSI**
Ecological Investigation Level	**EIL**
Environmental Investigation Services	**EIS**
Ecological Screening Level	**ESL**
Environmental Management Plan	**EMP**
Excavated Natural Material	**ENM**
Environment Protection Authority	**EPA**
Environmental Site Assessment	**ESA**
Ecological Screening Level	**ESL**
Fibre Cement Fragment(s)	**FCF**
General Approval of Immobilisation	**GAI**
Health Investigation Level	**HILs**
Hardness Modified Trigger Values	**HMTV**
Health Screening Level	**HSLs**
International Organisation of Standardisation	**ISO**
Lab Control Spike	**LCS**
Light Non-Aqueous Phase Liquid	**LNAPL**
Map Grid of Australia	**MGA**
National Association of Testing Authorities	**NATA**
National Environmental Protection Measure	**NEPM**
Organochlorine Pesticides	**OCP**
Organophosphate Pesticides	**OPP**
Polycyclic Aromatic Hydrocarbons	**PAH**
Potential ASS	**PASS**
Polychlorinated Biphenyls	**PCBs**

ABBREVIATIONS

Photo-ionisation Detector	**PID**
Protection of the Environment Operations	**POEO**
Practical Quantitation Limit	**PQL**
Quality Assurance	**QA**
Quality Control	**QC**
Remediation Action Plan	**RAP**
Relative Percentage Difference	**RPD**
Site Assessment Criteria	**SAC**
Sampling, Analysis and Quality Plan	**SAQP**
Site Audit Statement	**SAS**
Site Audit Report	**SAR**
Site Specific Assessment	**SSA**
Source, Pathway, Receptor	**SPR**
Specific Contamination Concentration	**SCC**
Standard Penetration Test	**SPT**
Standard Sampling Procedure	**SSP**
Standing Water Level	**SWL**
Trip Blank	**TB**
Toxicity Characteristic Leaching Procedure	**TCLP**
Total Recoverable Hydrocarbons	**TRH**
Trip Spike	**TS**
Upper Confidence Limit	**UCL**
United States Environmental Protection Agency	**USEPA**
Underground Storage Tank	**UST**
Virgin Excavated Natural Material	**VENM**
Volatile Organic Compounds	**VOC**
World Health Organisation	**WHO**
Work Health and Safety	**WHS**
Units	
Litres	**L**
Metres BGL	**mBGL**
Metres	**m**
Millivolts	**mV**
Millilitres	**ml or mL**
Milliequivalents	**meq**
micro Siemens per Centimetre	**µS/cm**
Micrograms per Litre	**µg/L**
Milligrams per Kilogram	**mg/kg**
Milligrams per Litre	**mg/L**
Parts Per Million	**ppm**
Percentage	**%**

1 INTRODUCTION

Nexus Project Delivery, on behalf of Tunborn Pty Ltd ('the client'), commissioned Environmental Investigation Services (EIS)[1] to undertake a Stage 2 Environmental Site Assessment (ESA) for the proposed hotel redevelopment at 187 Slade Road, Bexley North ('the site'). The site location is shown on Figure 1 and the assessment was confined to the site boundaries as shown on Figure 2.

A geotechnical investigation was undertaken previously to with this assessment by JK Geotechnics[2]. The results of the investigation are presented in a separate report (Ref. 30293ZRrpt2-rev1, dated 25 September 2017[3]). This report should be read in conjunction with the JK report.

EIS have previously undertaken a Stage 1 (desktop) assessment at the site. A summary of this information has been included in Section 2.

1.1 Proposed Development Details

Based on a review of the provided information, we understand that a staged mixed use development is proposed, including:

- Stage 1: retention of existing pub and bottle store, and demolition of the southern portion of the existing hotel and existing motel over the eastern side of the site. New construction of a new six level hotel over the southern portion of the site and a new eight level residential apartment block over the eastern side of the site. The new hotel and apartment block will also include retail ground floor levels. The new buildings will be constructed over two and three levels of basement car park with a finished floor reduced level (RL) for the lower car park levels B2 and B3 at RL7.76m and RL4.46m, respectively. Excavations to depths between about 4.5m and 8.5m will be required to achieve design subgrade levels;
- Stage 2: demolish the existing pub and construction of a two storey pub and two storey apartment building over two basement car park levels. No further details have been provided at the time of preparing this report;
- The basement retention system will comprise an anchored or propped secant pile wall formed using 0.6m diameter piles; and
- The proposed twin Westconnex Tunnels will extend below the northern portion of the site in an east-west direction. The tunnel invert levels will be at approximately RL -16.6m and the upper limit of the Westconnex Tunnels acquisition zone will be 16m below existing ground level.

1.2 Aims and Objectives

The primary aims of the assessment were to identify any past or present potentially contaminating activities at the site, identify the potential for site contamination, and make a preliminary assessment of the soil and groundwater contamination conditions. The assessment objectives were to:

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[1] Environmental consulting division of Jeffery & Katauskas Pty Ltd (J&K)
[2] Geotechnical consulting division of J&K
[3] Referred to as JK Geotechnics (2017)

- Provide an appraisal of the past site use(s) based on a review of historical records;
- Assess the current site conditions and use(s) via a site walkover inspection;
- Identify potential contamination sources/areas of environmental concern (AEC) and contaminants of potential concern (CoPC);
- Assess the soil and groundwater contamination conditions via implementation of a preliminary sampling and analysis program;
- Prepare a conceptual site model (CSM);
- Assess the potential risks posed by contamination to the receptors identified in the CSM (Tier 1 assessment);
- Provide a preliminary waste classification for off-site disposal of soil;
- Assess whether the site is suitable or can be made suitable for the proposed development (from a contamination viewpoint); and
- Assess whether further intrusive investigation and/or remediation is required.

1.3 Scope of Work

The assessment was undertaken generally in accordance with an EIS proposal (Ref: EP46436KH) of 16 January 2018 and written acceptance from Nexus Project Delivery, on behalf of the client, of 18 January 2018. The scope of work included the following:

- Review of site information, including background and site history information from a Lotsearch Pty Ltd *Environmental Risk and Planning Report* and other sources;
- Preparation of a CSM;
- Design and implementation of a sampling, analysis and quality plan (SAQP);
- Interpretation of the analytical results against the adopted Site Assessment Criteria (SAC);
- Data Quality Assessment; and
- Preparation of a report including a Tier 1 risk assessment.

The scope of work was undertaken with reference to the National Environmental Protection (Assessment of Site Contamination) Measure 1999 as amended (2013)[4], other guidelines made under or with regards to the Contaminated Land Management Act (1997)[5] and State Environmental Planning Policy No.55 – Remediation of Land (1998)[6]. A list of reference documents/guidelines is included in the appendices.

[4] National Environment Protection Council (NEPC), (2013). *National Environmental Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013).* (referred to as NEPM 2013)
[5] Contaminated Land Management Act 1997 (NSW) (referred to as CLM Act 1997)
[6] *State Environmental Planning Policy No. 55 – Remediation of Land 1998* (NSW) (referred to as SEPP55)

2 SITE INFORMATION

2.1 Background

2.1.1 Stage 1 Preliminary Environmental Site Assessment

The Stage 1 Preliminary ESA (ref: E30293KHrpt) included a walkover site inspection and review of historical information.

At the time of the inspection, the majority of site was occupied by a hotel building, with a semi-detached motel style accommodation building and a drive-thru bottle shop.

The historical assessment indicated the following potential site uses:

- Pre-1953 - Vacant with possible poultry farming;
- 1950's - Development of the site occurred; and
- At least 1961 to present the site has been occupied by the existing Hotel.

Based on the scope of work undertaken for this assessment, EIS identified the following potential contamination sources/AEC:

- Fill material;
- Historical agricultural use (poultry farm);
- Use of pesticides;
- Hazardous Building Material;
- Two service stations were located approximately 75m and 150m up-gradient (south-west) of the site; and
- A former dry cleaners was located less than 50m to the south of the site.

Considering the above, and based on a qualitative assessment of various lines of evidence as discussed throughout this report, EIS were of the opinion that there is a moderate potential for site contamination.

Based on the potential contamination sources/AEC identified, and the perceived potential for contamination, further investigation of the contamination conditions was considered to be required.

Based on the scope of work undertaken for the assessment, EIS were of the opinion that the historical land uses and potential sources of contamination identified would not preclude the proposed development. However, the following was recommended to better assess the risks associated with the CoPC:

- A preliminary intrusive investigation should be undertaken to make an assessment of the soil and groundwater contamination conditions; and
- A hazardous building materials survey should be undertaken prior to demolition/alteration of the buildings. Following any demolition/removal works (and preferably prior to removal of the hardstand), an asbestos clearance certificate should be provided.

2.1.2 JK Geotechnical Investigation

The geotechnical investigation included drilling of five boreholes and installation of three groundwater wells. The boreholes encountered fill material to depths of approximately 0.2m to 4.75m, overlying natural clays and sandstone bedrock. The deep fill was encountered in the central-north section of the site.

2.2 Site Identification

Table 2-1: Site Identification

Current Site Owner:	Tunborn Pty Ltd
Site Address:	187 Slade Road, Bexley North
Lot & Deposited Plan:	Lot 30 DP 1222252
Current Land Use:	Commercial
Proposed Land Use:	Commercial/Residential
Local Government Authority:	Bayside Council
Current Zoning:	B4 Mixed Use
Site Area (m^2):	4,300
RL (AHD in m) (approx.):	10
Geographical Location (decimal degrees) (approx.):	Latitude: -33.9381 Longitude: 151.1152
Site Location Plan:	Figure 1
Sample Location Plan:	Figure 2

2.3 Site Location and Regional Setting

The site is located in a mixed residential and commercial area of Bexley North. The site is located in a depression and the regional topography generally falls to the north, north-east and north-west at approximately 2-3°. The area north of the site falls to the east and west towards a gully feature at approximately 1-2°.

The site itself generally falls to the north at approximately 2-3°, however steeper areas were observed in the south-east section of the site. Parts of the site appear to have been levelled to account for the slope and accommodate the existing development.

2.4 Site Inspection

A walkover inspection of the site was undertaken by EIS on 3 April 2017. The inspection was limited to accessible areas of the site and immediate surrounds. An internal inspection of buildings was not undertaken

At the time of the inspection, the majority of site was occupied by a hotel building, with a semi-detached motel style accommodation building and a drive-thru bottle shop.

A summary of the other inspection findings are outlined in the following subsections:

2.4.1 Buildings, Structures and Roads

The majority of the site was occupied by a single storey concrete hotel building with a basement cellar. A concrete clad bottle shop building extended from the north end of the hotel building.

A split level, brick accommodation building was located in the east section of the site. The building included a reception area at the south end with a possible laundry beneath. An undercroft car park extended beneath the majority of the building.

2.4.2 Boundary Conditions, Soil Stability and Erosion

Brick retaining walls up to approximately 1.2m high, were observed in the east section of the site. The walls retained a grass embankment in the south-east section of the site and extended parallel with the east site boundary. An additional wall retained the hotel level above the undercroft car park.

2.4.3 Visible or Olfactory Indicators of Contamination

No obvious visual indicators of contamination were observed at the site.

2.4.4 Presence of Drums/Chemicals, Waste and Fill Material

No chemicals or waste were observed stored on the site.

The most obvious signs of potential fill was the presence of the retaining walls in the east section of the site. It is not clear if these were created from cut or fill works.

2.4.5 Drainage and Services

Stormwater pits were observed in the undercroft car park and in the driveway for the bottle shop. The remainder of the site was either covered by buildings or grassed.

2.4.6 Sensitive Environments

Sensitive environments such as wetlands, ponds, creeks or extensive areas of natural vegetation were not identified on site or in the immediate surrounds.

2.4.7 Landscaped Areas and Visible Signs of Plant Stress

Some small trees were observed adjacent to the motel building and a grassed area was observed in the south-east section of the site. No visible signs of vegetation stress were observed.

2.5 Surrounding Land Use

During the site inspection, EIS observed the following land uses in the immediate surrounds:

- North – Multi-storey residential buildings, with the railway corridor beyond.
- South – retail areas including commercial office space, restaurants, a bakery and TAB. A medical centre was located to the south-west of the retail area and included residential apartments above it.
- East – A residential area that included houses to the east and multi-storey apartment buildings to the south-east.
- West – an on-grade asphaltic concrete paved car park that extended to Bexley Road. A retail area was located west of Bexley Road that included restaurants, fast food and a massage parlour.

EIS did not observe any land uses in the immediate surrounds that were identified as potential contamination sources for the site.

2.6 Underground Services

The 'Dial Before You Dig' (DBYD) plans were reviewed for the assessment in order to establish whether any major underground services exist at the site or in the immediate vicinity that could act as a preferential pathway for contamination migration. No major services were identified that would be expected to act as preferential pathways for contamination migration.

2.7 Section 149 Planning Certificate

The s149 (2 and 5) planning certificates were reviewed for the assessment. Copies of the certificates are attached in the appendices. A summary of the relevant information is outlined below:

- The site is not located in an area of ecological significance;

- The site is not deemed to be: significantly contaminated; subject to a management order; subject of an approved voluntary management proposal; or subject to an on-going management order under the provisions of the CLM Act 1997;
- The site is not subject to a Site Audit Statement (SAS);
- The site is not located within an ASS risk area; and
- The site is not located in a heritage conservation area.

3 GEOLOGY AND HYDROGEOLOGY

3.1 Regional Geology

Regional geological information presented in the Lotsearch report (attached in the appendices) indicated that the site is underlain by Hawkesbury Sandstone, which typically consists of medium to coarse grained quartz sandstone with minor shale and laminite lenses.

3.2 Acid Sulfate Soil Risk and Planning

The site is not located in an acid sulfate soil (ASS) risk area according to the risk maps prepared by the Department of Land and Water Conservation.

3.3 Hydrogeology

Hydrogeological information presented in the Lotsearch report (attached in the appendices) indicated that the regional aquifer on-site and in the areas immediately surrounding the site includes porous, extensive aquifers of low to moderate productivity. There were a total of 15 registered bores within the report buffer of 2,000m. In summary:

- The nearest registered bore was located approximately 516m from the site. This was utilised for recreation purposes;
- The majority of the bores were registered for monitoring purposes;
- There were no nearby bores (i.e. within 500m) registered for domestic or irrigation uses; and
- The drillers log information from the closest registered bore identified fill and/or clay soil to depths of 4m, underlain by sandstone bedrock. The Standing Water Level (SWL) in the closest bore was 93mBGL.

The information reviewed for this assessment indicated that the subsurface conditions at the site are likely to consist of residual soils overlying relatively shallow bedrock. The potential for viable groundwater abstraction and use of groundwater under these conditions is considered to be low. Use of groundwater is not proposed as part of the development.

Considering the local topography and surrounding land features, EIS would generally expect groundwater to flow towards the north.

3.4 Receiving Water Bodies

Surface water bodies were not identified in the immediate vicinity of the site. The closest surface water body is Wolli Creek located approximately 150m to the north of the site. This may be a potential receptor, however the railway corridor located to the north of the site is in a cutting. This may restrict groundwater flow to the north.

5 CONCEPTUAL SITE MODEL

NEPM (2013) defines a CSM as a representation of site related information regarding contamination sources, receptors and exposure pathways between those sources and receptors. The CSM for the site is presented in the following sub-sections and is based on the site information (including the site inspection information) and the review of site history information. Reference should also be made to the figures attached in the appendices.

A review of the CSM in relation to source, pathway and receptor (SPR) linkages has been undertaken as part of the Tier 1 risk assessment process, as outlined in Section 10.

5.1 Potential Contamination Sources/AEC and CoPC

The potential contamination sources/AEC and CoPC are presented in the following table:

Table 5-1: Potential (and/or known) Contamination Sources/AEC and Contaminants of Potential Concern

Source / AEC	CoPC
Fill material - The site appears to have been historically filled to achieve the existing levels. The fill may have been imported from various sources and could be contaminated.	Heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), petroleum hydrocarbons (referred to as total recoverable hydrocarbons – TRHs), benzene, toluene, ethylbenzene and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs), organophosphate pesticides (OPPs), polychlorinated biphenyls (PCBs) and asbestos.
Historical agricultural use – The site may have been used as a poultry farm This could have resulted in contamination across the site via use of machinery, application of pesticides and building/demolition of various structures. Asbestos pipes may also be present for irrigation purposes.	Heavy metals, TRH, PAHs, OCPs, PCBs and asbestos
Use of pesticides – Pesticides may have been used beneath the buildings and/or around the site.	Heavy metals, OCPs and OPPs
Hazardous Building Material – Hazardous building materials may be present in the existing buildings/ structures on site.	Asbestos, lead and PCBs
Off-site area 1 – Two service stations were located approximately 75m and 150m up-gradient of the site and are considered to be a potential source of contamination.	Heavy metals (lead), TRH and BTEX

Source / AEC	CoPC
Dry Cleaners – a former dry cleaners was located less than 50m to the south of the site	TRHs and VOCs, including tetrachloroethene (also known as perchloroethylene - PCE) and the breakdown products trichloroethene (TCE), cis-1,2-dichloroethene (cis-DCE) and vinyl chloride (VC).

5.2 Mechanism for Contamination, Affected Media, Receptors and Exposure Pathways

The mechanisms for contamination, affected media, receptors and exposure pathways relevant to the potential contamination sources/AEC are outlined in the following CSM table:

Table 5-2: CSM

Potential mechanism for contamination	Potential mechanisms for contamination include: • Fill material – importation of impacted material, 'top-down' impacts (e.g. leaching from surficial material), or sub-surface release (e.g. impacts from buried material); • Historical agricultural use – 'top-down' and spills (e.g. application of pesticides, refuelling or repairing machinery, and other activities at the ground surface level); • Use of pesticides – 'top-down' and spills (e.g. during normal use, application and/or improper storage); • Hazardous building materials – 'top-down' (e.g. demolition resulting in surficial impacts in unpaved areas); and • Off-site land uses – 'top-down', spill or sub-surface release. Impacts to the site could occur via migration of contaminated groundwater.
Affected media	Soil/soil vapour and groundwater have been identified as potentially affected media.
Receptor identification	Human receptors include site occupants/users, construction workers and intrusive maintenance workers. Off-site human receptors include adjacent land users, groundwater users and recreational water users within Wolli Creek. Ecological receptors include terrestrial organisms and plants within unpaved areas (including the proposed landscaped areas), and freshwater ecology in Wolli Creek (low risk).
Potential exposure pathways	Potential exposure pathways relevant to the human receptors include ingestion, dermal absorption and inhalation of dust (all contaminants) and vapours (volatile TRH, naphthalene and BTEX). The potential for exposure would typically be associated with the construction and excavation works, and use of unpaved areas (i.e. the gardens) and basement (i.e. vapour inhalation or incidental contact with groundwater seepage).

	Potential exposure pathways for ecological receptors include primary contact and ingestion. Exposure to groundwater is unlikely to occur in Wolli Creek through direct migration, however groundwater has the potential to enter the creek via the stormwater system (which may discharge into the creek) in a drained basement scenario.
Potential exposure mechanisms	The following have been identified as potential exposure mechanisms for site contamination: • Vapour intrusion into the proposed basement and/or building (either from soil contamination or volatilisation of contaminants from groundwater); • Contact (dermal, ingestion or inhalation) with exposed soils in landscaped areas and/or unpaved areas; • Migration of groundwater off-site and into nearby water bodies, including aquatic ecosystems and those being used for recreation; and • Migration of groundwater off-site into areas where groundwater is being utilised as a resource (i.e. for irrigation).
Presence of preferential pathways for contaminant movement	No obvious preferential pathways for contamination for observed at the site. The deep fill encountered in the central-north section of the site during the geotechnical investigation may represent a preferential pathway.

6 SAMPLING, ANALYSIS AND QUALITY PLAN

6.1 Data Quality Objectives (DQO)

Data Quality Objectives (DQOs) were developed to define the type and quality of data required to achieve the project objectives outlined in Section 1.2. The DQOs were prepared with reference to the process outlined in Schedule B2 of NEPM (2013) and the Guidelines for the NSW Site Auditor Scheme, 3rd Edition (2017)[7]. The seven-step DQO approach for this project is outlined in the following sub-sections.

The DQO process is validated in part by the Data Quality Assurance/Quality Control (QA/QC) Evaluation. The Data (QA/QC) Evaluation is summarised in Section 8.1 and the detailed evaluation is provided in the appendices.

6.1.1 Step 1 - State the Problem

The CSM identified potential sources of contamination/AEC at the site that may pose a risk to human health and the environment. Investigation data is required to assess the contamination status of the site, assess the risks posed by the contaminants in the context of the proposed development/intended land use, and assess whether remediation is required. This information will be considered by the consent authority in exercising its planning functions in relation to the development proposal.

A waste classification is required prior to off-site disposal of excavated soil/bedrock.

The investigation was subject to access constraints associated with the existing hotel buildings at the site.

6.1.2 Step 2 - Identify the Decisions of the Study

The objectives of the assessment are outlined in Section 1.2. The decisions to be made reflect these objectives and are as follows:

- Did the site inspection, or does the historical information identify potential contamination sources/AEC at the site?
- Are any results above the SAC?
- Do potential risks associated with contamination exist, and if so, what are they?
- Is remediation required?
- Is the site characterisation sufficient to provide adequate confidence in the above decisions?
- Is the site suitable for the proposed development, or can the site be made suitable subject to further characterisation and/or remediation?

[7] NSW EPA (2017). *Guidelines for the NSW Site Auditor Scheme, 3rd ed.* (referred to as Site Auditor Guidelines 2017)

6.1.3 Step 3 - Identify Information Inputs

The primary information inputs required to address the decisions outlined in Step 2 include the following:

- Existing relevant environmental data from previous reports;
- Site information, including site observations and site history documentation;
- Sampling of potentially affected media, including soil and groundwater;
- Observations of sub-surface variables such as soil type, photo-ionisation detector (PID) concentrations, odours and staining, and groundwater physiochemical parameters;
- Laboratory analysis of soils, fibre-cement and groundwater for the CoPC identified in the CSM; and
- Field and laboratory QA/QC data.

6.1.4 Step 4 - Define the Study Boundary

The sampling will be confined to the site boundaries as shown in Figure 2 (spatial boundary). The sampling was completed on 7 and 15 February 2018 (temporal boundary). The assessment of potential risk to adjacent land users has been made based on data collected within the site boundary.

Sampling was not undertaken within the existing building footprint due to access constraints.

6.1.5 Step 5 - Develop an Analytical Approach (or Decision Rule)

6.1.5.1 Tier 1 Screening Criteria

The laboratory data will be assessed against relevant Tier 1 screening criteria (referred to as SAC), as outlined in Section 7. Exceedances of the SAC do not necessarily indicate a requirement for remediation or a risk to human health and/or the environment. Exceedances are considered in the context of the CSM and valid SPR-linkages.

For this assessment, the individual results have been assessed as either above or below the SAC. Statistical evaluation of the dataset via calculation of mean values and/or 95% upper confidence limit (UCL) values has not been undertaken due to the spatial distribution of the data and the number of samples submitted for analysis.

6.1.5.2 Field and Laboratory QA/QC

Field QA/QC included analysis of intra-laboratory duplicates, trip spike and trip blank samples. Further details regarding the sampling and analysis undertaken, and the acceptable limits adopted, is provided in the Data Quality (QA/QC) Evaluation in the appendices.

The suitability of the laboratory data is assessed against the laboratory QA/QC criteria which is outlined in the attached laboratory reports. These criteria were developed and implemented in accordance with the laboratory's National Association of Testing Authorities, Australia (NATA) accreditation and align with the acceptable limits for QA/QC samples as outlined in NEPM (2013) and other relevant guidelines.

In the event that acceptable limits are not met by the laboratory analysis, other lines of evidence are reviewed (e.g. field observations of samples, preservation, handling etc) and, where required, consultation with the laboratory is undertaken in an effort to establish the cause of the non-conformance. Where uncertainty exists, EIS typically adopt the most conservative concentration reported (or in some cases, consider the data from the affected sample as an estimate).

6.1.5.3 Appropriateness of Practical Quantitation Limits (PQLs)

The PQLs of the analytical methods are considered in relation to the SAC to confirm that the PQLs are less than the SAC. In cases where the PQLs are greater than the SAC, a discussion of this is provided.

6.1.6 Step 6 – Specify Limits on Decision Errors

To limit the potential for decision errors, a range of quality assurance processes are adopted. A quantitative assessment of the potential for false positives and false negatives in the analytical results is undertaken with reference to Schedule B(3) of NEPM (2013) using the data quality assurance information collected.

Decision errors can be controlled through the use of hypothesis testing. The test can be used to show either that the baseline condition is false or that there is insufficient evidence to indicate that the baseline condition is false. The null hypothesis is an assumption that is assumed to be true in the absence of contrary evidence. For this assessment, the null hypothesis has been adopted which is that, there is considered to be a complete SPR linkage for the CoPC identified in the CSM unless this linkage can be proven not to (or unlikely to) exist. The null hypothesis has been adopted for this assessment.

6.1.7 Step 7 - Optimise the Design for Obtaining Data

The most resource-effective design will be used in an optimum manner to achieve the assessment objectives. Adjustment of the assessment design can occur following consultation or feedback from project stakeholders. For this investigation, the design was optimised via consideration of the various lines of evidence used to select the sample locations, the media being sampled, and also by the way in which the data were collected.

The sampling plan and methodology are outlined in the following sub-sections.

6.2 Soil Sampling Plan and Methodology

The soil sampling plan and methodology adopted for this assessment is outlined in the table below:

Table 6-1: Soil Sampling Plan and Methodology

Aspect	Input
Sampling Density	Samples were collected from six locations as shown on the attached Figure 2. Based on the site area (4,300m²), this number of locations corresponded to a sampling density of approximately one sample per 700m². The sampling plan was not designed to meet the minimum sampling density for hotspot identification, as outlined in the NSW EPA Contaminated Sites Sampling Design Guidelines (1995)[8].
Sampling Plan	The sampling locations were placed on a judgemental sampling plan and were broadly positioned for site coverage, taking into consideration areas that were not easily accessible. This sampling plan was considered suitable to make a preliminary assessment of potential risks associated with the AEC and CoPC identified in the CSM, and assess whether further investigation is warranted.
Set-out and Sampling Equipment	Sampling locations were set out using a tape measure. In-situ sampling locations were cleared for underground services by an external contractor prior to sampling as outlined in the SSP. Samples were collected using a drill rig equipped with spiral flight augers. Soil samples were obtained from a Standard Penetration Test (SPT) split-spoon sampler, or directly from the auger when conditions did not allow use of the SPT sampler.
Sample Collection and Field QA/QC	Soil samples were obtained on 7 February 2018 in accordance with the standard sampling procedure (SSP) attached in the appendices. Soil samples were collected from the fill and natural profiles based on field observations. The sample depths are shown on the logs attached in the appendices. Samples were placed in glass jars with plastic caps and teflon seals with minimal headspace. Samples for asbestos analysis were placed in zip-lock plastic bags. During sampling, soil at selected depths was split into primary and duplicate samples for field QA/QC analysis.
Field Screening	A portable Photoionisation Detector (PID) fitted with a 10.6mV lamp was used to screen the samples for the presence of volatile organic compounds (VOCs). PID screening for VOCs was undertaken on soil samples using the soil sample headspace method. VOC data was obtained from partly filled zip-lock plastic bags following equilibration of the headspace gases. PID calibration records are maintained on file by EIS. Fill/spoil at the sampling locations was visually inspected during the works for the presence of fibre cement fragments.
Decontamination and Sample Preservation	Sampling personnel used disposable nitrile gloves during sampling activities. Re-usable sampling equipment was decontaminated as outlined in the SSP. Soil samples were preserved by immediate storage in an insulated sample container with ice in accordance with the SSP. On completion of the fieldwork, the samples were stored

[8] NSW EPA, (1995), *Contaminated Sites Sampling Design Guidelines.* (referred to as EPA Sampling Design Guidelines 1995)

Aspect	Input
	temporarily in fridges in the EIS warehouse before being delivered in the insulated sample container to a NATA registered laboratory for analysis under standard chain of custody (COC) procedures.

6.3 Groundwater Sampling Plan and Methodology

The groundwater sampling plan and methodology is outlined in the table below:

Table 6-2: Groundwater Sampling Plan and Methodology

Aspect	Input
Sampling Plan	Groundwater monitoring wells were installed in BH102 (MW102) and BH106 (MW106). The wells were positioned to assess groundwater conditions coming onto the site (MW106) and groundwater conditions leaving the site via the deep fill area (MW102).
Monitoring Well Installation Procedure	The monitoring well construction details are documented on the appropriate borehole logs attached in the appendices. The monitoring wells were installed to a depth of approximately 6m below ground level. The wells were generally constructed as follows: • 50mm diameter Class 18 PVC (machine slotted screen) was installed in the lower section of the well to intersect groundwater; • 50mm diameter Class 18 PVC casing was installed in the upper section of the well (screw fixed); • A 2mm sand filter pack was used around the screen section for groundwater infiltration; • A hydrated bentonite seal/plug was used on top of the sand pack to seal the well; and • A gatic cover was installed at the surface with a concrete plug to limit the inflow of surface water.
Monitoring Well Development	The monitoring wells were developed on 8 February 2018 using a submersible electrical pump in accordance with the SSP. Due to the hydrogeological conditions, groundwater inflow into the wells was relatively low, therefore the wells were pumped until they were effectively dry. The field monitoring records and calibration data are attached in the appendices.
Groundwater Sampling	The monitoring wells were allowed to recharge for approximately five to seven days after development. Groundwater samples were obtained on 15 February 2018. Prior to sampling, the monitoring wells were checked for the presence of Light Non-Aqueous Phase Liquids (LNAPLs) using an inter-phase probe electronic dip meter. The monitoring well head space was checked for VOCs using a calibrated PID unit. The samples were obtained using a peristaltic pump. During sampling, the following parameters were monitored using calibrated field instruments (see SSP): • Standing water level (SWL) using an electronic dip meter; and

Aspect	Input
	• pH, temperature, electrical conductivity (EC), dissolved oxygen (DO) and redox potential (Eh) using a YSI Multi-probe water quality meter. Due to silty conditions, steady state conditions were not achieved prior to sampling. Groundwater samples were obtained directly from the single use PVC tubing and placed in the sample containers. Duplicate samples were obtained by alternate filling of sample containers. This technique was adopted to minimise disturbance of the samples and loss of volatile contaminants associated with mixing of liquids in secondary containers, etc. Groundwater removed from the wells during development and sampling was transported to EIS in jerry cans and stored in holding drums prior to collection by a licensed waste water contractor for off-site disposal. The field monitoring record and calibration data are attached in the appendices.
Decontaminant and Sample Preservation	The decontamination procedure adopted during sampling is outlined in the SSP attached in the appendices. During development, the pump was flushed between monitoring wells with potable water (single-use tubing was used for each well). The pump tubing was discarded after each sampling event and replaced therefore no decontamination procedure was considered necessary. The samples were preserved with reference to the analytical requirements and placed in an insulated container with ice in accordance with the SSP. On completion of the fieldwork, the samples were temporarily stored in a fridge at the EIS office, before being delivered in the insulated sample container to a NATA registered laboratory for analysis under standard COC procedures.

6.4 Analytical Schedule

The analytical schedule is outlined in the following table:

Table 6-3: Analytical Schedule

Analyte/CoPC	Fill Samples	Natural Soil Samples	Fibre Cement Material Samples	Groundwater Samples
Heavy Metals	10	2	-	2
TRH/BTEX	10	2	-	2
PAHs	10	2	-	2
OCPs/OPPs	6	-	-	-

Analyte/CoPC	Fill Samples	Natural Soil Samples	Fibre Cement Material Samples	Groundwater Samples
PCBs	6	-	-	-
Asbestos	10	2	1	-
pH/EC/hardness	-	-	-	2

6.4.1 Laboratory Analysis

Samples were analysed by an appropriate, NATA Accredited laboratory using the analytical methods detailed in Schedule B(3) of NEPM 2013. Reference should be made to the laboratory reports attached in the appendices for further details.

Table 6-4: Laboratory Details

Samples	Laboratory	Report Reference
All primary samples and field QA/QC samples including (intra-laboratory duplicates, trip blanks, trip spikes and field rinsate samples)	Envirolab Services Pty Ltd NSW, NATA Accreditation Number – 2901 (ISO/IEC 17025 compliance)	184710 and 185317

7 SITE ASSESSMENT CRITERIA (SAC)

The SAC were derived from the NEPM 2013 and other guidelines as discussed in the following sub-sections. The guideline values for individual contaminants are presented in the attached report tables and further explanation of the various criteria adopted is provided in the appendices.

7.1 Soil

Soil data were compared to relevant Tier 1 screening criteria in accordance with NEPM (2013) as outlined below.

7.1.1 Human Health

- Health Investigation Levels (HILs) for a 'residential with minimal opportunities for access to soil' exposure scenario (HIL-B);
- Health Screening Levels (HSLs) for a 'low-high density residential' exposure scenario (HSL-A & HSL-B). HSLs were calculated based on the soil type and the most conservative depth interval of 0m to 1m as the proposed development included excavation;
- Where exceedances of the HSLs were reported for hydrocarbons (TRH/BTEX and naphthalene), the soil health screening levels for direct contact presented in the CRC Care Technical Report No. 10 – Heath screening levels for hydrocarbons in soil and groundwater Part 1: Technical development document (2011)[9] were considered; and
- Asbestos was assessed on the basis of presence/absence. Asbestos HSLs were not adopted as detailed asbestos quantification was not undertaken

7.1.2 Environment (Ecological – terrestrial ecosystems)

- Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs) for an 'urban residential and public open space' (URPOS) exposure scenario. These have only been applied to the top 2m of soil as outlined in NEPM (2013). The criteria for benzo(a)pyrene has been increased from the value presented in NEPM (2013) based on the information presented in the CRC Care Technical Report No. 39 – Risk-based management and guidance for benzo(a)pyrene (2017)[10];
- ESLs were calculated based on the soil type. EILs for selected metals were calculated based on the most conservative added contaminant limit (ACL) values presented in Schedule B(1) of NEPM (2013) and published ambient background concentration (ABC) values presented in the

[9] Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC Care), (2011). Technical Report No. 10 - *Health screening levels for hydrocarbons in soil and groundwater Part 1: Technical development document*

[10] CRC Care, (2011). *Technical Report No. 39 - Risk-based management and guidance for benzo(a)pyrene*

document titled Trace Element Concentrations in Soils from Rural and Urban Areas of Australia (1995)[11]. This method is considered to be adequate for the Tier 1 screening.

7.1.3 Management Limits for Petroleum Hydrocarbons

Management limits for petroleum hydrocarbons (as presented in Schedule B1 of NEPM 2013) were considered (if required) following evaluation of human health and ecological risks, and risks to groundwater.

7.1.4 Waste Classification

Data for the waste classification assessment were assessed in accordance with the Waste Classification Guidelines, Part 1: Classifying Waste (2014)[12] as outlined in the following table:

Table 7-1: Waste Categories

Category	Description
General Solid Waste (non-putrescible)	• If Specific Contaminant Concentration (SCC) ≤ Contaminant Threshold (CT1) then Toxicity Characteristics Leaching Procedure (TCLP) not needed to classify the soil as general solid waste; and • If TCLP ≤ TCLP1 and SCC ≤ SCC1 then treat as general solid waste.
Restricted Solid Waste (non-putrescible)	• If SCC ≤ CT2 then TCLP not needed to classify the soil as restricted solid waste; and • If TCLP ≤ TCLP2 and SCC ≤ SCC2 then treat as restricted solid waste.
Hazardous Waste	• If SCC > CT2 then TCLP not needed to classify the soil as hazardous waste; and • If TCLP > TCLP2 and/or SCC > SCC2 then treat as hazardous waste.
Virgin Excavated Natural Material (VENM)	Natural material (such as clay, gravel, sand, soil or rock fines) that meet the following: • That has been excavated or quarried from areas that are not contaminated with manufactured chemicals, or with process residues, as a result of industrial, commercial mining or agricultural activities; • That does not contain sulfidic ores or other waste; and • Includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved from time to time by a notice published in the NSW Government Gazette.

[11] Olszowy, H., Torr, P., and Imray, P., (1995), *Trace Element Concentrations in Soils from Rural and Urban Areas of Australia. Contaminated Sites Monograph Series No. 4*. Department of Human Services and Health, Environment Protection Agency, and South Australian Health Commission.
[12] NSW EPA, (2014). *Waste Classification Guidelines, Part 1: Classifying Waste.* (referred to as Waste Classification Guidelines 2014)

7.2 Groundwater

Groundwater data were compared to relevant Tier 1 screening criteria in accordance with NEPM (2013), following an assessment of environmental values in accordance with the Guidelines for the Assessment and Management of Groundwater Contamination (2007)[13]. Environmental values for this assessment include aquatic ecosystems, human uses, and human-health risks in non-use scenarios.

7.2.1 Human Health

- HSLs for a 'low-high density residential' exposure scenario (HSL-A/HSL-B). HSLs were calculated based on the soil type and the observed depth to groundwater;
- The NEPM (2013) HSLs may not be applicable for this project as the proposed basement may intersect groundwater. On this basis, as a conservative measure, EIS have undertaken a site specific assessment (SSA) for the Tier 1 screening of human health risks posed by volatile contaminants in groundwater. The assessment included selection of alternative Tier 1 criteria that were considered suitably protective of human health. These criteria are based on drinking water guidelines and have been referred to as HSL-SSA. The criteria were based on the following (as shown in the attached report tables):
    - Australian Drinking Water Guidelines (2011)[14] for BTEX compounds and selected VOCs;
    - World Health Organisation (WHO) document titled Petroleum Products in Drinking-water, Background document for the development of WHO Guidelines for Drinking Water Quality (2008)[15] for petroleum hydrocarbons;
    - USEPA Region 9 screening levels for naphthalene (threshold value for tap water); and
    - The use of the laboratory PQLs for other contaminants where there were no Australian guidelines.
- The Australian Drinking Water Guidelines (2011)[16] were adopted as screening criteria for consumption of groundwater; and
- The guidelines for recreational water quality (primary and secondary contact) presented in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)[17] were adopted as screening criteria to assess risks associated with incidental contact with groundwater in the proposed basement.

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[13] NSW Department of Environment and Conservation, (2007). *Guidelines for the Assessment and Management of Groundwater Contamination*

[14] National Health and Medical Research Council (NHMRC), (2011). *National Water Quality Management Strategy, Australian Drinking Water Guidelines* (referred to as ADWG 2011)

[15] World Health Organisation (WHO), (2008). *Petroleum Products in Drinking-water, Background document for the development of WHO Guidelines for Drinking Water Quality* (referred to as WHO 2008)

[16] National Health and Medical Research Council (NHMRC), (2011). *National Water Quality Management Strategy, Australian Drinking Water Guidelines* (referred to as ADWG 2011)

[17] ANZECC, (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* (referred to as ANZECC 2000)

7.2.2 Environment (Ecological - aquatic ecosystems)

- Groundwater Investigation Levels (GILs) for 95% trigger values for protection of freshwater/marine species presented in Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000). The 99% trigger values were adopted where required to account for bioaccumulation. Low and moderate reliability trigger values were also adopted for some contaminants where high-reliability trigger values don't exist.

8 RESULTS

8.1 Summary of Data (QA/QC) Evaluation

The data evaluation is presented in the appendices. In summary, EIS are of the opinion that the data are adequately precise, accurate, representative, comparable and complete to serve as a basis for interpretation to achieve the investigation objectives.

8.2 Subsurface Conditions

A summary of the subsurface conditions encountered during the investigation is presented in the table below. Reference should be made to the borehole logs attached in the appendices for further details.

Table 8-1: Summary of Subsurface Conditions

Profile	Description
Pavement	Asphaltic Concrete (AC) or Concrete pavement, approximately 30mm to 190mm thick, was encountered at the surface in BH101, BH103 and BH104.
Fill	Fill was encountered at the surface or beneath the pavement in all boreholes and extended to depths of approximately 0.3m to 6.5m. Fill was typically shallower than 1.6m, with the exception of BH102 . The fill typically comprised silty sand, silty clay and sandy clay with inclusions of ash, igneous and sandstone gravel. A fibre-cement sheeting fragment was encountered in the fill material in BH101.
Natural Soil	Natural silty clay, clayey sand or sandy clay soil was encountered beneath the fill in all boreholes and extended to the termination of BH101 to BH105 at a maximum depth of approximately 7.5m. Natural soil in BH106 extended to a depth of approximately 5.2m. The natural soil was typically grey or red-brown and contained traces of ironstone gravel.
Bedrock	Sandstone bedrock was encountered beneath the natural soil in BH106 and extended to the termination of the borehole at a depth of approximately 6m.
Groundwater	Groundwater seepage was encountered in BH102 at a depth of approximately 5m during drilling. All boreholes remained dry on completion of drilling and a short time after.

8.3 Field Screening

A summary of the field screening results are presented in the table below.

Table 8-2: Summary of Field Screening

Aspect	Details
PID Screening of Soil Samples for VOCs	PID soil sample headspace readings are presented in attached report tables and the COC documents attached in the appendices. All results were 0ppm isobutylene equivalents which indicates a lack of PID detectable VOCs.
Groundwater Depth & Flow	Groundwater monitoring wells were installed in BH102 and BH106. SWLs measured in the monitoring wells installed at the site were 4.75m and 4.09m, respectively. Excavation for the proposed basement may intercept groundwater. Groundwater would generally be expected to flow to the north towards the depression in the central-north section of the site and beyond to the north.
Groundwater Field Parameters	Field measurements recorded during sampling were as follows: - pH ranged from 6 to 6.19; - EC ranged from 992µS/cm to 1008µS/cm; - Eh ranged from 45.4mV to 56.9mV; and - DO ranged from 1.1ppm to 1.2ppm.
LNAPLs petroleum hydrocarbons	Phase separated product (i.e. LNAPL) were not detected using the interphase probe during groundwater sampling.

8.4 Soil Laboratory Results

The soil laboratory results are compared to the relevant SAC in the attached report tables. A summary of the results assessed against the SAC is presented below:

8.4.1 Human Health and Environmental (Ecological) Assessment

Table 8-3: Summary of Soil Laboratory Results – Human Health and Environmental (Ecological)

Analyte	Results Compared to SAC
Heavy Metals	All heavy metals results were below the SAC.
TRH	All TRH results were below the SAC.
BTEX	All BTEX results were below the SAC.
PAHs	All PAH results were below the SAC.
OCPs and OPPs	All OCP and OPP results were below the SAC. All pesticide concentrations were below the laboratory PQLs.
PCBs	All PCB results were below the SAC. All PCB concentrations were below the laboratory PQLs.

Analyte	Results Compared to SAC
Asbestos	The fibre-cement fragment (FCF) encountered in the fill material in BH101 contained asbestos. The remaining asbestos results were below the SAC (i.e. asbestos was absent in the remaining samples analysed for the investigation).

8.4.2 Waste Classification Assessment

The laboratory results were assessed against the criteria presented in Part 1 of the Waste Classification Guidelines, as summarised previously in this report. The results are presented in the report tables attached in the appendices. A summary of the results is presented below.

Table 8-4: Summary of Soil Laboratory Results Compared to CT and SCC Criteria

Analyte	No. of Samples Analysed	No. of Results > CT Criteria	No. of Results > SCC Criteria	Comments
Heavy Metals	12	0	0	-
TRH	12	0	0	-
BTEX	12	0	0	-
Total PAHs	12	0	0	-
Benzo(a)pyrene	12	0	0	-
OCPs & OPPs	6	0	0	-
PCBs	6	0	0	-
Asbestos	13	1	-	Asbestos was detected in the FCF sample from BH101.

8.5 Groundwater Laboratory Results

The groundwater laboratory results are compared to the relevant SAC in the attached report tables. A summary of the results assessed against the SAC is presented below:

Table 8-5: Summary of Groundwater Laboratory Results – Human Health and Environmental (Ecological)

Analyte	Results Compared to SAC
Heavy Metals	The zinc results ranged from 9µg/L to 77µg/L and exceeded the ecological criterion of 8µg/L. The remaining heavy metals results were below the SAC.
TRH	All TRH results were below the SAC.
BTEX	All BTEX results were below the SAC.
Other VOCs	All VOC results were below the SAC.
PAHs	All PAH results were below the SAC. It should be noted that the PQL for benzo(a)pyrene was above the SAC for recreational use of groundwater.
Other Parameters	The results for pH, EC and hardness are summarised below: • pH ranged from 6.2 to 6.3; • EC ranged from 730µS/cm to 850µS/cm; and • Hardness values for both samples were 130mg$CaCO_3$/L.

9 WASTE CLASSIFICATION ASSESSMENT

9.1 Waste Classification of Fill

Based on the results of the assessment, and at the time of reporting, the fill material in the vicinity of BH101 is classified as **General Solid Waste (non-putrescible) containing Special Waste (asbestos)**. Surplus fill should be disposed of to a facility that is appropriately licensed to receive this waste stream. The facility should be contacted to obtain the required approvals prior to commencement of excavation.

The fill material across the remainder of the site may be classified as **General Solid Waste (non-putrescible)** subject to further assessment to better assess the extent of the asbestos impacted material.

9.2 Classification of Natural Soil and Bedrock

Based on the scope of work undertaken for this assessment/screening, and at the time of reporting, EIS are of the opinion that the natural soil and bedrock at the site meets the definition of **VENM** for off-site disposal or re-use purposes. VENM is considered suitable for re-use on-site, or alternatively, the information included in this report may be used to assess whether the material is suitable for beneficial reuse at another site as fill material. In accordance with Part 1 of the Waste Classification Guidelines, the VENM is pre-classified as general solid waste and can also be disposed of accordingly to a facility that is licensed to accept it.

10 DISCUSSION AND CONCLUSIONS

10.1 Tier 1 Risk Assessment and Review of CSM

For a contaminant to represent a risk to a receptor, the following three conditions must be present:

1. Source – The presence of a contaminant;
2. Pathway – A mechanism or action by which a receptor can become exposed to the contaminant; and
3. Receptor – The human or ecological entity which may be adversely impacted following exposure to contamination.

If one of the above components is missing, the potential for adverse risks is relatively low.

10.1.1 Soil

Asbestos was encountered in the form of a FCF in the fill material in BH101. The source of the asbestos is considered likely to be the fill material, which may have been imported onto the site.

In the present site configuration, the asbestos contamination presents a very low risk to site occupants as it is beneath a concrete pavement. The risk would increase if the pavement was removed and especially during excavation works.

Further investigation will be required to better assess the vertical and horizontal extent of the asbestos contamination. Ideally this would include a detailed site investigation for asbestos, however, we note that this would not be possible due to the existing structures on the site. As a conservative measure, the assumption could be made that all fill material at the site is impacted by asbestos and will required remediation and/or management.

10.1.2 Groundwater

The zinc results in the groundwater samples exceeded the ecological SAC. These results are considered likely to be indicative of regional condition rather than site specific contamination based on the following:

- The zinc concentrations in the soil samples analysed were typically low; and
- The zinc concentrations in the groundwater are typically of urban Sydney aquifers and may the result of leaking water infrastructure.

10.2 Decision Statements

The decision statements are addressed below:

Did the site inspection, or does the historical information identify potential contamination sources/AEC at the site?

Yes, the main potential contamination sources were fill material, historical agricultural use (poultry farm), use of pesticides, hazardous Building Materials, two service stations located approximately 75m and 150m up-gradient (south-west) of the site and a former dry cleaners was located less than 50m to the south of the site.

Are any results above the SAC?

Yes, asbestos was encountered in the form of FCF in the fill in BH101. Zinc was encountered above the ecological SAC in groundwater.

Do potential risks associated with contamination exist, and if so, what are they?

Yes, the extent of the asbestos contamination is unknown and disturbance of the fill material may create a risk to site occupants and workers.

Is remediation required?

Remediation and/or management of the asbestos contamination may be required.

Is the site characterisation sufficient to provide adequate confidence in the above decisions?

No, a detailed site investigation for asbestos would be required to sufficiently characterise the site.

Is the site suitable for the proposed development, or can the site be made suitable subject to further characterisation and/or remediation?

The site can be made suitable for the proposed development provided that further investigation and subsequent remediation and/or management is undertaken.

10.3 Data Gaps

The assessment has identified the following data gaps:

- The minimum recommended sampling density was not met as much of the site was inaccessible due to the existing buildings;
- The extent of the asbestos contamination remains unknown, however, the contamination would be expected to be confined to the fill material; and
- The asbestos investigation to date has only included a preliminary assessment for the presence/absence of asbestos.

11 CONCLUSIONS AND RECOMMENDATIONS

EIS consider that the report objectives outlined in Section 1.2 have been addressed.

Asbestos was encountered in fill material in the north-west section of the site. At this stage further investigation, to better assess the extent of the contamination, is not possible due to the physical constraints of the site. It may be possible to undertake further investigation following demolition of the buildings at the site, however, this would likely result in significant delays to the project. Based on our experience, where asbestos is encountered in a discrete location in fill material by drilling boreholes, further, asbestos is usually encountered during excavation works. EIS consider that the most cost and time effective approach would be to take a conservative view of the contamination and assume that all fill material at the site is impacted by asbestos.

Based on the above, EIS make the following recommendations:

- A Remedial Action Plan (RAP) should be prepared outlining procedures to be undertaken during each stage of development/excavation, with respect to the asbestos contamination;
- A validation assessment should be undertaken on completion of remediation at each development stage; and
- The following unexpected finds protocol should be implemented during excavation works at the site.

11.1 Unexpected Finds Protocol

There is considered to be a relatively low potential for contamination-related unexpected finds (other than asbestos) to occur at the site during the proposed development works. Unexpected finds would typically be able to be identified by visual or olfactory indicators and could include:

- Waste materials in fill, including building and demolition waste;
- Friable asbestos;
- Stained fill/soil;
- Odorous soils (e.g. hydrocarbon odours); and/or
- Ash, slag and/or coal wash.

The following should be implemented in the event of an unexpected find:

- All work in the immediate vicinity should cease and temporary barricades should be erected to isolate the area;
- A suitably qualified contaminated land consultant[18] should be engaged to inspect the find and provide advice on the appropriate course of action; and
- Any actions should be implemented and validated to demonstrate that there are no unacceptable risks to the receptors.

[18] EIS recommend that the consultancy engaged for the work be a member of the Australian Contaminated Land Consultants Associated (ACLCA), and/or the individual undertaking the works be certified under one of the NSW EPA endorsed certified practitioner schemes

The requirement to notify the NSW EPA of the site contamination under then NSW EPA Guidelines on the Duty to Report Contamination under Section 60 of the CLM Act 1997 (2015)[19] should be reviewed on completion of the remediation and validation works.

[19] NSW EPA, (2015). *Guidelines on the Duty to Report Contamination under Section 60 of the CLM Act 1997* (referred to as Duty to Report Contamination)

12 LIMITATIONS

The report limitations are outlined below:

- EIS accepts no responsibility for any unidentified contamination issues at the site. Any unexpected problems/subsurface features that may be encountered during development works should be inspected by an environmental consultant as soon as possible;
- Previous use of this site may have involved excavation for the foundations of buildings, services, and similar facilities. In addition, unrecorded excavation and burial of material may have occurred on the site. Backfilling of excavations could have been undertaken with potentially contaminated material that may be discovered in discrete, isolated locations across the site during construction work;
- This report has been prepared based on site conditions which existed at the time of the investigation; scope of work and limitation outlined in the EIS proposal; and terms of contract between EIS and the client (as applicable);
- The conclusions presented in this report are based on investigation of conditions at specific locations, chosen to be as representative as possible under the given circumstances, visual observations of the site and immediate surrounds and documents reviewed as described in the report;
- Subsurface soil and rock conditions encountered between investigation locations may be found to be different from those expected. Groundwater conditions may also vary, especially after climatic changes;
- The investigation and preparation of this report have been undertaken in accordance with accepted practice for environmental consultants, with reference to applicable environmental regulatory authority and industry standards, guidelines and the assessment criteria outlined in the report;
- Where information has been provided by third parties, EIS has not undertaken any verification process, except where specifically stated in the report;
- EIS has not undertaken any assessment of off-site areas that may be potential contamination sources or may have been impacted by site contamination, except where specifically stated in the report;
- EIS accept no responsibility for potentially asbestos containing materials that may exist at the site. These materials may be associated with demolition of pre-1990 constructed buildings or fill material at the site;
- EIS have not and will not make any determination regarding finances associated with the site;
- Additional investigation work may be required in the event of changes to the proposed development or landuse. EIS should be contacted immediately in such circumstances;
- Material considered to be suitable from a geotechnical point of view may be unsatisfactory from a soil contamination viewpoint, and vice versa; and
- This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose.

LIST OF IN-TEXT TABLES

IMPORTANT INFORMATION ABOUT THIS REPORT

These notes have been prepared by EIS to assist with the assessment and interpretation of this report.

The Report is based on a Unique Set of Project Specific Factors
This report has been prepared in response to specific project requirements as stated in the EIS proposal document which may have been limited by instructions from the client. This report should be reviewed, and if necessary, revised if any of the following occur:

- The proposed land use is altered;
- The defined subject site is increased or sub-divided;
- The proposed development details including size, configuration, location, orientation of the structures or landscaped areas are modified;
- The proposed development levels are altered, eg addition of basement levels; or
- Ownership of the site changes.

EIS/J&K will not accept any responsibility whatsoever for situations where one or more of the above factors have changed since completion of the assessment. If the subject site is sold, ownership of the assessment report should be transferred by EIS to the new site owners who will be informed of the conditions and limitations under which the assessment was undertaken. No person should apply an assessment for any purpose other than that originally intended without first conferring with the consultant.

Changes in Subsurface Conditions
Subsurface conditions are influenced by natural geological and hydrogeological process and human activities. Groundwater conditions are likely to vary over time with changes in climatic conditions and human activities within the catchment (e.g. water extraction for irrigation or industrial uses, subsurface waste water disposal, construction related dewatering). Soil and groundwater contaminant concentrations may also vary over time through contaminant migration, natural attenuation of organic contaminants, ongoing contaminating activities and placement or removal of fill material. The conclusions of an assessment report may have been affected by the above factors if a significant period of time has elapsed prior to commencement of the proposed development.

This Report is based on Professional Interpretations of Factual Data
Site assessments identify actual subsurface conditions at the actual sampling locations at the time of the investigation. Data obtained from the sampling and subsequent laboratory analyses, available site history information and published regional information is interpreted by geologists, engineers or environmental scientists and opinions are drawn about the overall subsurface conditions, the nature and extent of contamination, the likely impact on the proposed development and appropriate remediation measures.

Actual conditions may differ from those inferred, because no professional, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from predictions. Nothing can be done to prevent the unanticipated, but steps can be taken to help minimise the impact. For this reason, site owners should retain the services of their consultants throughout the development stage of the project, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

Assessment Limitations
Although information provided by a site assessment can reduce exposure to the risk of the presence of contamination, no environmental site assessment can eliminate the risk. Even a rigorous professional assessment may not detect all contamination on a site. Contaminants may be present in areas that were not surveyed or sampled, or may migrate to areas which showed no signs of contamination when sampled. Contaminant analysis cannot possibly cover every type of contaminant which may occur; only the most likely contaminants are screened.

Misinterpretation of Site Assessments by Design Professionals

Costly problems can occur when other design professionals develop plans based on misinterpretation of an assessment report. To minimise problems associated with misinterpretations, the environmental consultant should be retained to work with appropriate professionals to explain relevant findings and to review the adequacy of plans and specifications relevant to contamination issues.

Logs Should not be Separated from the Assessment Report

Borehole and test pit logs are prepared by environmental scientists, engineers or geologists based upon interpretation of field conditions and laboratory evaluation of field samples. Logs are normally provided in our reports and these should not be re-drawn for inclusion in site remediation or other design drawings, as subtle but significant drafting errors or omissions may occur in the transfer process. Photographic reproduction can eliminate this problem, however contractors can still misinterpret the logs during bid preparation if separated from the text of the assessment. If this occurs, delays, disputes and unanticipated costs may result. In all cases it is necessary to refer to the rest of the report to obtain a proper understanding of the assessment. Please note that logs with the 'Environmental Log' header are not suitable for geotechnical purposes as they have not been peer reviewed by a Senior Geotechnical Engineer.

To reduce the likelihood of borehole and test pit log misinterpretation, the complete assessment should be available to persons or organisations involved in the project, such as contractors, for their use. Denial of such access and disclaiming responsibility for the accuracy of subsurface information does not insulate an owner from the attendant liability. It is critical that the site owner provides all available site information to persons and organisations such as contractors.

Read Responsibility Clauses Closely

Because an environmental site assessment is based extensively on judgement and opinion, it is necessarily less exact than other disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, model clauses have been developed for use in written transmittals. These are definitive clauses designed to indicate consultant responsibility. Their use helps all parties involved recognise individual responsibilities and formulate appropriate action. Some of these definitive clauses are likely to appear in the environmental site assessment, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to any questions.

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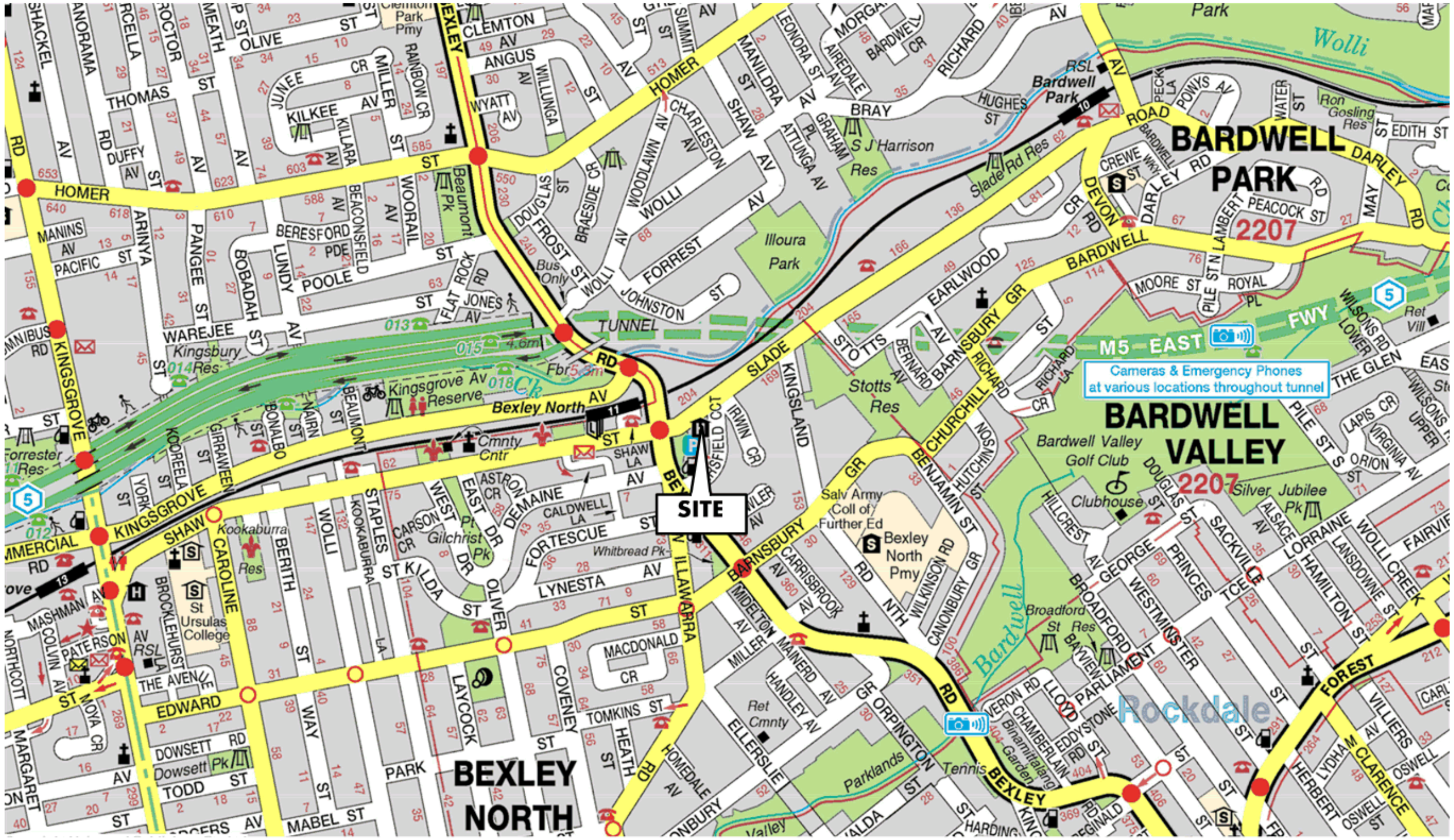
REPORT FIGURES



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NOTES:
Figure has been recreated from UBD on disc (version 7.1)

Figure is not to scale. UBD Map ref: 273 Q9

This plan should be read in conjunction with the EIS report.

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SITE LOCATION PLAN
187 SLADE ROAD,
BEXLEY, NSW

PROJECT ID: E30293KH

F1

N

This plan should be read in conjunction with the EIS report.

- - - - Approximate site boundary

BH (Fill Depth) Borehole location, number and depth of fill (m) (EIS 2015)

BH/MW Groundwater monitoring well location

SCALE (m) @ A3: 0 5 10 15 20 25

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BOREHOLE LOCATION PLAN

187 SLADE ROAD,
BEXLEY NORTH, NSW

PROJECT ID: E30293KH **F2**

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LABORATORY SUMMARY TABLES

Stage 2 Environmental Site Assessment
187 Slade Road, Bexley North
E30293KH

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TABLE A

SOIL LABORATORY RESULTS COMPARED TO HIL-B: 'Residential with minimal opportunities for soil access; including dwellings with fully/permanently paved yards like high-rise buildings'

All data in mg/kg unless stated otherwise

			HEAVY METALS								PAHs		ORGANOCHLORINE PESTICIDES (OCPs)							OP PESTICIDES (OPPs)		
			Arsenic	Cadmium	Chromium VI 1	Copper	Lead	Mercury	Nickel	Zinc	Total PAHs	Carcinogenic PAHs	HCB	Endosulfan	Methoxychlor	Aldrin & Dieldrin	Chlordane	DDT, DDD & DDE	Heptachlor	Chlorpyrifos	TOTAL PCBs	ASBESTOS FIBRES
PQL - Envirolab Services			4	0.4	1	1	1	0.1	1	1	-	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	100
Site Assessment Criteria (SAC)			500	150	500	30000	1200	120	1200	60000	400	4	15	400	500	10	90	600	10	340	1	Detected/Not Detected
Sample Reference	**Sample Depth**	**Sample Description**																				
BH101	0.2-0.4	Fill: silty sand	LPQL	LPQL	4	5	64	LPQL	2	29	1.1	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	No asbestos detected
BH101	0.5-0.95	Fill: sandy clay	10	LPQL	11	2	27	LPQL	2	25	0.52	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	No asbestos detected
BH102	0-0.2	Fill: silty sand	LPQL	LPQL	19	19	27	LPQL	8	50	2	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	No asbestos detected
BH102	1.5-1.95	Fill: sandy clay	LPQL	LPQL	9	17	38	LPQL	2	31	0.06	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	No asbestos detected
BH103	0.03-0.2	Fill: silty clay	LPQL	LPQL	11	20	15	LPQL	5	23	0.08	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	No asbestos detected
BH103	0.9-1.1	Fill: sandy clay	LPQL	LPQL	14	LPQL	9	LPQL	1	5	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	No asbestos detected
BH104	0.03-0.2	Fill: silty clay	4	LPQL	15	3	18	LPQL	2	11	0.2	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	No asbestos detected
BH104	0.5-0.95	Silty clay	LPQL	LPQL	9	2	9	LPQL	1	7	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	No asbestos detected
BH105	0-0.2	Fill: silty sand	LPQL	LPQL	11	11	56	LPQL	2	110	0.06	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	No asbestos detected
BH105	1.1-1.3	Clayey sand	LPQL	LPQL	10	1	6	LPQL	1	13	LPQL	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	No asbestos detected
BH106	0-0.2	Fill: silty sand	5	LPQL	13	31	40	LPQL	5	54	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	LPQL	No asbestos detected
BH106	0.5-0.8	Fill: silty sand	5	LPQL	17	9	22	LPQL	4	31	0.3	LPQL	NA	NA	NA	NA	NA	NA	NA	NA	NA	No asbestos detected
AMF1	-	Fibre-cement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Detected
Total Number of Samples			12	12	12	12	12	12	12	12	12	12	6	6	6	6	6	6	6	6	6	1
Maximum Value			10	<PQL	19	31	64	<PQL	8	110	2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	NC

Concentration above the SAC **VALUE**

Stage 2 Environmental Site Assessment
187 Slade Road, Bexley North
E30293KH

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TABLE B
SOIL LABORATORY RESULTS COMPARED TO HSLs
All data in mg/kg unless stated otherwise

					C_6-C_{10} (F1)	>C_{10}-C_{16} (F2)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene	Field PID Measurement
PQL - Envirolab Services					25	50	0.2	0.5	1	3	1	ppm
NEPM 2013 HSL Land Use Category					**HSL-A/B:LOW/HIGH DENSITY RESIDENTIAL**							
Sample Reference	**Sample Depth**	**Sample Description**	**Depth Category**	**Soil Category**								
BH101	0.2-0.4	Fill: silty sand	0m to < 1m	Sand	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH101	0.5-0.95	Fill: sandy clay	0m to < 1m	Clay	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH102	0-0.2	Fill: silty sand	0m to < 1m	Sand	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH102	1.5-1.95	Fill: sandy clay	0m to < 1m	Clay	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH103	0.03-0.2	Fill: silty clay	0m to < 1m	Clay	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH103	0.9-1.1	Fill: sandy clay	0m to < 1m	Clay	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH104	0.03-0.2	Fill: silty clay	0m to < 1m	Clay	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH104	0.5-0.95	Silty clay	0m to < 1m	Clay	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH105	0-0.2	Fill: silty sand	0m to < 1m	Sand	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH105	1.1-1.3	Clayey sand	0m to < 1m	Sand	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH106	0-0.2	Fill: silty sand	0m to < 1m	Sand	<25	<50	<0.2	<0.5	<1	<3	<1	0
BH106	0.5-0.8	Fill: silty sand	0m to < 1m	Sand	<25	<50	<0.2	<0.5	<1	<3	<1	0
Total Number of Samples					12	12	12	12	12	12	12	12
Maximum Value					<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL

Concentration above the SAC **VALUE**

The guideline corresponding to the elevated value is highlighted in grey in the Site Assessment Criteria Table below

SITE ASSESSMENT CRITERIA

					C_6-C_{10} (F1)	>C_{10}-C_{16} (F2)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene
PQL - Envirolab Services					25	50	0.2	0.5	1	3	1
NEPM 2013 HSL Land Use Category					**HSL-A/B:LOW/HIGH DENSITY RESIDENTIAL**						
Sample Reference	**Sample Depth**	**Sample Description**	**Depth Category**	**Soil Category**							
BH101	0.2-0.4	Fill: silty sand	0m to < 1m	Sand	45	110	0.5	160	55	40	3
BH101	0.5-0.95	Fill: sandy clay	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
BH102	0-0.2	Fill: silty sand	0m to < 1m	Sand	45	110	0.5	160	55	40	3
BH102	1.5-1.95	Fill: sandy clay	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
BH103	0.03-0.2	Fill: silty clay	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
BH103	0.9-1.1	Fill: sandy clay	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
BH104	0.03-0.2	Fill: silty clay	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
BH104	0.5-0.95	Silty clay	0m to < 1m	Clay	50	280	0.7	480	NL	110	5
BH105	0-0.2	Fill: silty sand	0m to < 1m	Sand	45	110	0.5	160	55	40	3
BH105	1.1-1.3	Clayey sand	0m to < 1m	Sand	45	110	0.5	160	55	40	3
BH106	0-0.2	Fill: silty sand	0m to < 1m	Sand	45	110	0.5	160	55	40	3
BH106	0.5-0.8	Fill: silty sand	0m to < 1m	Sand	45	110	0.5	160	55	40	3

Stage 2 Environmental Site Assessment
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TABLE C
SOIL LABORATORY RESULTS COMPARED TO NEPM 2013 EILs AND ESLs
All data in mg/kg unless stated otherwise

Land Use Category				URBAN RESIDENTIAL AND PUBLIC OPEN SPACE																			
							AGED HEAVY METALS-EILs						EILs		ESLs								
				pH	CEC ($cmol_c/kg$)	Clay Content (% clay)	Arsenic	Chromium	Copper	Lead	Nickel	Zinc	Naphthalene	DDT	C_6-C_{10} (F1)	>C_{10}-C_{16} (F2)	>C_{16}-C_{34} (F3)	>C_{34}-C_{40} (F4)	Benzene	Toluene	Ethylbenzene	Total Xylenes	B(a)P
PQL - Envirolab Services				-	1	-	4	1	1	1	1	1	0.1	0.1	25	50	100	100	0.2	0.5	1	2	0.05
Ambient Background Concentration (ABC)				-	-	-	NSL	13	28	163	5	122	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Sample Reference	**Sample Depth**	**Sample Description**	**Soil Texture**																				
BH101	0.2-0.4	Fill: silty sand	Coarse	NA	NA	NA	<4	4	5	64	2	29	<0.1	<0.1	<25	<50	<100	<100	<0.2	<0.5	<1	<2	0.2
BH101	0.5-0.95	Fill: sandy clay	Fine	NA	NA	NA	10	11	2	27	2	25	<0.1	NA	<25	<50	<100	<100	<0.2	<0.5	<1	<2	0.09
BH102	0-0.2	Fill: silty sand	Coarse	NA	NA	NA	<4	19	19	27	8	50	<0.1	NA	<25	<50	<100	<100	<0.2	<0.5	<1	<2	0.3
BH102	1.5-1.95	Fill: sandy clay	Fine	NA	NA	NA	<4	9	17	38	2	31	<0.1	<0.1	<25	<50	<100	<100	<0.2	<0.5	<1	<2	0.06
BH103	0.03-0.2	Fill: silty clay	Fine	NA	NA	NA	<4	11	20	15	5	23	<0.1	<0.1	<25	<50	620	750	<0.2	<0.5	<1	<2	0.08
BH103	0.9-1.1	Silty clay	Fine	NA	NA	NA	<4	14	<1	9	1	5	<0.1	NA	<25	<50	<100	<100	<0.2	<0.5	<1	<2	<0.05
BH104	0.03-0.2	Fill: silty clay	Fine	NA	NA	NA	4	15	3	18	2	11	<0.1	<0.1	<25	<50	<100	<100	<0.2	<0.5	<1	<2	0.06
BH104	0.5-0.95	Silty clay	Fine	NA	NA	NA	<4	9	2	9	1	7	<0.1	NA	<25	<50	<100	<100	<0.2	<0.5	<1	<2	<0.05
BH105	0-0.2	Fill: silty sand	Coarse	NA	NA	NA	<4	11	11	56	2	110	<0.1	<0.1	<25	<50	<100	<100	<0.2	<0.5	<1	<2	0.06
BH105	1.1-1.3	Clayey sand	Coarse	NA	NA	NA	<4	10	1	6	1	13	<0.1	NA	<25	<50	<100	<100	<0.2	<0.5	<1	<2	<0.05
BH106	0-0.2	Fill: silty sand	Coarse	NA	NA	NA	5	13	31	40	5	54	<0.1	<0.1	<25	<50	<100	<100	<0.2	<0.5	<1	<2	<0.05
BH106	0.5-0.8	Fill: silty sand	Coarse	NA	NA	NA	5	17	9	22	4	31	<0.1	NA	<25	<50	<100	<100	<0.2	<0.5	<1	<2	0.06
Total Number of Samples				0	0	0	12	12	12	12	12	12	12	6	12	12	12	12	12	12	12	12	12
Maximum Value				<PQL	<PQL	<PQL	10	19	31	64	8	110	<PQL	<PQL	<PQL	<PQL	620	750	<PQL	<PQL	<PQL	<PQL	0.3

Concentration above the SAC VALUE

The guideline corresponding to the elevated value is highlighted in grey in the EIL and ESL Assessment Criteria Table below

EIL AND ESL ASSESSMENT CRITERIA

Land Use Category				URBAN RESIDENTIAL AND PUBLIC OPEN SPACE																			
							AGED HEAVY METALS-EILs						EILs		ESLs								
				pH	CEC ($cmol_c/kg$)	Clay Content (% clay)	Arsenic	Chromium	Copper	Lead	Nickel	Zinc	Naphthalene	DDT	C_6-C_{10} (F1)	>C_{10}-C_{16} (F2)	>C_{16}-C_{34} (F3)	>C_{34}-C_{40} (F4)	Benzene	Toluene	Ethylbenzene	Total Xylenes	B(a)P
PQL - Envirolab Services				-	1	-	4	1	1	1	1	1	0.1	0.1	25	50	100	100	0.2	0.5	1	2	0.05
Ambient Background Concentration (ABC)				-	-	-	NSL	13	28	163	5	122	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Sample Reference	**Sample Depth**	**Sample Description**	**Soil Texture**																				
BH101	0.2-0.4	Fill: silty sand	Coarse	NA	NA	NA	100	203	88	1263	35	192	170	180	180	120	300	2800	50	85	70	105	33
BH101	0.5-0.95	Fill: sandy clay	Fine	NA	NA	NA	100	203	88	1263	35	192	170	--	180	120	1300	5600	60	105	125	45	33
BH102	0-0.2	Fill: silty sand	Coarse	NA	NA	NA	100	203	88	1263	35	192	170	--	180	120	300	2800	50	85	70	105	33
BH102	1.5-1.95	Fill: sandy clay	Fine	NA	NA	NA	100	203	88	1263	35	192	170	180	180	120	1300	5600	60	105	125	45	33
BH103	0.03-0.2	Fill: silty clay	Fine	NA	NA	NA	100	203	88	1263	35	192	170	180	180	120	1300	5600	60	105	125	45	33
BH103	0.9-1.1	Silty clay	Fine	NA	NA	NA	100	203	88	1263	35	192	170	--	180	120	1300	5600	60	105	125	45	33
BH104	0.03-0.2	Fill: silty clay	Fine	NA	NA	NA	100	203	88	1263	35	192	170	180	180	120	1300	5600	60	105	125	45	33
BH104	0.5-0.95	Silty clay	Fine	NA	NA	NA	100	203	88	1263	35	192	170	--	180	120	1300	5600	60	105	125	45	33
BH105	0-0.2	Fill: silty sand	Coarse	NA	NA	NA	100	203	88	1263	35	192	170	180	180	120	300	2800	50	85	70	105	33
BH105	1.1-1.3	Clayey sand	Coarse	NA	NA	NA	100	203	88	1263	35	192	170	--	180	120	300	2800	50	85	70	105	33
BH106	0-0.2	Fill: silty sand	Coarse	NA	NA	NA	100	203	88	1263	35	192	170	180	180	120	300	2800	50	85	70	105	33
BH106	0.5-0.8	Fill: silty sand	Coarse	NA	NA	NA	100	203	88	1263	35	192	170	--	180	120	300	2800	50	85	70	105	33

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TABLE D
SOIL LABORATORY RESULTS COMPARED TO WASTE CLASSIFICATION GUIDELINES
All data in mg/kg unless stated otherwise

			HEAVY METALS								PAHs		OC/OP PESTICIDES				Total PCBs	TRH					BTEX COMPOUNDS				ASBESTOS FIBRES
			Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Total PAHs	B(a)P	Total Endosulfans	Chloropyrifos	Total Moderately Harmful	Total Scheduled		C_6-C_9	C_{10}-C_{14}	C_{15}-C_{28}	C_{29}-C_{36}	Total C_{10}-C_{36}	Benzene	Toluene	Ethyl benzene	Total Xylenes	
PQL - Envirolab Services			4	0.4	1	1	1	0.1	1	1	-	0.05	0.1	0.1	0.1	0.1	0.1	25	50	100	100	250	0.2	0.5	1	3	100
General Solid Waste CT1			100	20	100	NSL	100	4	40	NSL	200	0.8	60	4	250	<50	<50	650		NSL		10,000	10	288	600	1,000	-
General Solid Waste SCC1			500	100	1900	NSL	1500	50	1050	NSL	200	10	108	7.5	250	<50	<50	650		NSL		10,000	18	518	1,080	1,800	-
Restricted Solid Waste CT2			400	80	400	NSL	400	16	160	NSL	800	3.2	240	16	1000	<50	<50	2600		NSL		40,000	40	1,152	2,400	4,000	-
Restricted Solid Waste SCC2			2000	400	7600	NSL	6000	200	4200	NSL	800	23	432	30	1000	<50	<50	2600		NSL		40,000	72	2,073	4,320	7,200	-
Sample Reference	**Sample Depth**	**Sample Description**																									
BH101	0.2-0.4	Fill: silty sand	<4	<0.4	4	5	64	<0.1	2	29	1.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
BH101	0.5-0.95	Fill: sandy clay	10	<0.4	11	2	27	<0.1	2	25	0.52	0.09	NA	NA	NA	NA	NA	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
BH102	0-0.2	Fill: silty sand	<4	<0.4	19	19	27	<0.1	8	50	2	0.3	NA	NA	NA	NA	NA	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
BH102	1.5-1.95	Fill: sandy clay	<4	<0.4	9	17	38	<0.1	2	31	0.06	0.06	<0.1	<0.1	<0.1	<0.1	<0.1	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
BH103	0.03-0.2	Fill: silty clay	<4	<0.4	11	20	15	<0.1	5	23	0.08	0.08	<0.1	<0.1	<0.1	<0.1	<0.1	<25	<50	180	670	850	<0.2	<0.5	<1	<3	Not Detected
BH103	0.9-1.1	Fill: sandy clay	<4	<0.4	14	<1	9	<0.1	1	5	<0.05	<0.05	NA	NA	NA	NA	NA	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
BH104	0.03-0.2	Fill: silty clay	4	<0.4	15	3	18	<0.1	2	11	0.2	0.06	<0.1	<0.1	<0.1	<0.1	<0.1	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
BH104	0.5-0.95	Silty clay	<4	<0.4	9	2	9	<0.1	1	7	<0.05	<0.05	NA	NA	NA	NA	NA	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
BH105	0-0.2	Fill: silty sand	<4	<0.4	11	11	56	<0.1	2	110	0.06	0.06	<0.1	<0.1	<0.1	<0.1	<0.1	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
BH105	1.1-1.3	Clayey sand	<4	<0.4	10	1	6	<0.1	1	13	<0.05	<0.05	NA	NA	NA	NA	NA	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
BH106	0-0.2	Fill: silty sand	5	<0.4	13	31	40	<0.1	5	54	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
BH106	0.5-0.8	Fill: silty sand	5	<0.4	17	9	22	<0.1	4	31	0.3	0.06	NA	NA	NA	NA	NA	<25	<50	<100	<100	<PQL	<0.2	<0.5	<1	<3	Not Detected
AMF1	-	Fibre-cement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Detected
Total Number of samples			12	12	12	12	12	12	12	12	12	12	6	6	6	6	6	12	12	12	12	12	12	12	12	12	13
Maximum Value			10	<PQL	19	31	64	<PQL	8	110	2	0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	180	670	850	<PQL	<PQL	<PQL	<PQL	NC

Concentration above the CT1 VALUE
Concentration above SCC1 VALUE
Concentration above the SCC2 VALUE

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TABLE E
GROUNDWATER LABORATORY RESULTS COMPARED TO HSLs
All data in µg/L unless stated otherwise

				C_6-C_{10} (F1)	>C_{10}-C_{16} (F2)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene	PID
PQL - Envirolab Services				10	50	1	1	1	3	1	
NEPM 2013 - Land Use Category				**HSL-A/B: LOW/HIGH DENSITY RESIDENTIAL**							
Sample Reference	**Water Depth**	**Depth Category**	**Soil Category**								
MW102	4.75	4m to <8m	Clay	<10	<50	<1	<1	<1	<3	<1	0
MW106	4.09	4m to <8m	Clay	<10	<50	<1	<1	<1	<3	<1	0
Total Number of Samples				2	2	2	2	2	2	2	2
Maximum Value				<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL

Concentration above the SAC	VALUE
Site specific assesment (SSA) required	VALUE

The guideline corresponding to the elevated value is highlighted in grey in the Site Assessment Criteria Table below

HSL GROUNDWATER ASSESSMENT CRITERIA

				C_6-C_{10} (F1)	>C_{10}-C_{16} (F2)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene
PQL - Envirolab Services				10	50	1	1	1	3	1
NEPM 2013 - Land Use Category				**HSL-A/B: LOW/HIGH DENSITY RESIDENTIAL**						
Sample Reference	**Water Depth**	**Depth Category**	**Soil Category**							
MW2	4.75	4m to <8m	Clay	NL	NL	5000	NL	NL	NL	NL
MW6	4.09	4m to <8m	Clay	NL	NL	5000	NL	NL	NL	NL

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TABLE F

GROUNDWATER LABORATORY RESULTS COMPARED TO SITE SPECIFIC HSLs - RISK ASSESSMENT

All results in µg/L unless stated otherwise.

	PQL Envirolab Services	NHMRC ADWG 2011	WHO 2008	USEPA RSL Tapwater 2017	SAMPLES	
					MW102	MW106
Total Recoverable Hydrocarbons (TRH)						
C_6-C_9 Aliphatics (assessed using F1)	10	NSL	15000	-	<10	<10
>C_9-C_{14} Aliphatics (assessed using F2)	50	NSL	100	-	<50	<50
Monocyclic Aromatic Hydrocarbons (BTEX Compounds)						
Benzene	1	1	-	-	<1	<1
Toluene	1	800	-	-	<1	<1
Ethylbenzene	1	300	-	-	<1	<1
Total xylenes	2	600	-	-	<3	<3
Polycyclic Aromatic Hydrocarbons (PAHs)						
Naphthalene	0.2	-	-	6.1	<1	<1
Volatile Organic Compounds (VOCs), including chlorinated VOCs						
Vinyl Chloride	10	0.3	-	-	<10	<10
1,1-Dichloroethene	1	30	-	-	<1	<1
Chloroform	1	250	-	-	<1	<1
Bromodichloromethane	1		-	-	<1	<1
1,2-dichloroethane	1	3	-	-	<1	<1
Chlorobenzene	1	300	-	-	<1	<1
1,3-dichlorobenzene	1	300	-	-	<1	<1
1,4-dichlorobenzene	1	40	-	-	<1	<1
1,2-dichlorobenzene	1	1500	-	-	<1	<1

Concentration above the HSL -SSA	VALUE
PQL exceeds HSL-SSA	**BOLD/RED**

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TABLE G

SUMMARY OF GROUNDAWATER LABORATORY RESULTS COMPARED TO ECOLOGICAL GILs SAC

All results in µg/L unless stated otherwise.

	PQL Envirolab Services	ANZECC 2000 Fresh Waters	SAMPLES	
			MW102	MW106
Inorganic Compounds and Parameters				
pH	0.1	6.5 - 8.5	6.2	6.3
Electrical Conductivity (µS/cm)	1	NSL	730	850
Hardness (mgCaCO$_3$/L)	3	NSL	130	130
Metals and Metalloids				
Arsenic (As III)	1	24	<1	<1
Cadmium	0.1	0.2	<0.1	0.1
Chromium (VI)	1	1	<1	<1
Copper	1	1.4	<1	<1
Lead	1	3.4	<1	<1
Total Mercury (inorganic)	0.05	0.06	<0.05	<0.05
Nickel	1	11	<1	13
Zinc	1	8	9	77
Monocyclic Aromatic Hydrocarbons (BTEX Compounds)				
Benzene	1	950	<1	<1
Toluene	1	180	<1	<1
Ethylbenzene	1	80	<1	<1
m+p-xylene	2	75	<2	<2
o-xylene	1	350	<1	<1
Total xylenes	2	NSL	<3	<3
Volatile Organic Compounds (VOCs), including chlorinated VOCs				
Dichlorodifluoromethane	10	NSL	<10	<10
Chloromethane	10	NSL	<10	<10
Vinyl Chloride	10	100	<10	<10
Bromomethane	10	NSL	<10	<10
Chloroethane	10	NSL	<10	<10
Trichlorofluoromethane	10	NSL	<10	<10
1,1-Dichloroethene	1	700	<1	<1
Trans-1,2-dichloroethene	1	NSL	<1	<1
1,1-dichloroethane	1	90	<1	<1
Cis-1,2-dichloroethene	1	NSL	<1	<1
Bromochloromethane	1	NSL	<1	<1
Chloroform	1	370	<1	<1
2,2-dichloropropane	1	NSL	<1	<1
1,2-dichloroethane	1	1900	<1	<1
1,1,1-trichloroethane	1	270	<1	<1
1,1-dichloropropene	1	NSL	<1	<1
Cyclohexane	1	NSL	<1	<1
Carbon tetrachloride	1	240	<1	<1
Benzene	1	see BTEX	<1	<1
Dibromomethane	1	NSL	<1	<1
1,2-dichloropropane	1	900	<1	<1
Trichloroethene	1	NSL	<1	<1
Bromodichloromethane	1	NSL	<1	<1
trans-1,3-dichloropropene	1	NSL	<1	<1
cis-1,3-dichloropropene	1	NSL	<1	<1
1,1,2-trichloroethane	1	6500	<1	<1
Toluene	1	see BTEX	<1	<1
1,3-dichloropropane	1	1100	<1	<1
Dibromochloromethane	1	NSL	<1	<1
1,2-dibromoethane	1	NSL	<1	<1
Tetrachloroethene	1	70	<1	<1
1,1,1,2-tetrachloroethane	1	NSL	<1	<1
Chlorobenzene	1	55	<1	<1
Ethylbenzene	1	see BTEX	<1	<1
Bromoform	1	NSL	<1	<1
m+p-xylene	2	see BTEX	<2	<2
Styrene	1	NSL	<1	<1
1,1,2,2-tetrachloroethane	1	400	<1	<1
o-xylene	1	see BTEX	<1	<1
1,2,3-trichloropropane	1	NSL	<1	<1
Isopropylbenzene	1	30	<1	<1
Bromobenzene	1	NSL	<1	<1
n-propyl benzene	1	NSL	<1	<1
2-chlorotoluene	1	NSL	<1	<1
4-chlorotoluene	1	NSL	<1	<1
1,3,5-trimethyl benzene	1	NSL	<1	<1
Tert-butyl benzene	1	NSL	<1	<1
1,2,4-trimethyl benzene	1	NSL	<1	<1
1,3-dichlorobenzene	1	260	<1	<1
Sec-butyl benzene	1	NSL	<1	<1
1,4-dichlorobenzene	1	60	<1	<1
4-isopropyl toluene	1	NSL	<1	<1
1,2-dichlorobenzene	1	160	<1	<1
n-butyl benzene	1	NSL	<1	<1
1,2-dibromo-3-chloropropane	1	NSL	<1	<1
1,2,4-trichlorobenzene	1	85	<1	<1
Hexachlorobutadiene	1	NSL	<1	<1
1,2,3-trichlorobenzene	1	3	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)				
Naphthalene	0.2	16	<0.2	<0.2
Acenaphthylene	0.1	NSL	<0.1	<0.1
Acenaphthene	0.1	NSL	<0.1	<0.1
Fluorene	0.1	NSL	<0.1	<0.1
Phenanthrene	0.1	0.6	<0.1	<0.1
Anthracene	0.1	0.01	<0.1	<0.1
Fluoranthene	0.1	1	<0.1	<0.1
Pyrene	0.1	NSL	<0.1	<0.1
Benzo(a)anthracene	0.1	NSL	<0.1	<0.1
Chrysene	0.1	NSL	<0.1	<0.1
Benzo(b,j+k)fluoranthene	0.2	NSL	<0.2	<0.2
Benzo(a)pyrene	0.1	0.1	<0.1	<0.1
Indeno(1,2,3-c,d)pyrene	0.1	NSL	<0.1	<0.1
Dibenzo(a,h)anthracene	0.1	NSL	<0.1	<0.1
Benzo(g,h,i)perylene	0.1	NSL	<0.1	<0.1

Concentration above the GIL	VALUE
PQL exceeds GIL	**BOLD/RED**

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TABLE H

SUMMARY OF GROUNDAWATER LABORATORY RESULTS COMPARED TO HUMAN CONTACT GILs

All results in µg/L unless stated otherwise.

	PQL Envirolab Services	ANZECC 2000 Recreational	SAMPLES MW102	SAMPLES MW106
Inorganic Compounds and Parameters				
pH	0.1	6.5 - 8.5	6.2	6.3
Electrical Conductivity (µS/cm)	1	NSL	730	850
Hardness (mgCaCo3/L)	3	500	130	130
Metals and Metalloids				
Arsenic (As III)	1	50	<1	<1
Cadmium	0.1	5	<0.1	0.1
Chromium (total)	1	50	<1	<1
Copper	1	1000	<1	<1
Lead	1	50	<1	<1
Total Mercury (inorganic)	0.05	1	<0.05	<0.05
Nickel	1	100	<1	13
Zinc	1	5000	9	77
Monocyclic Aromatic Hydrocarbons (BTEX Compounds)				
Benzene	1	10	<1	<1
Toluene	1	NSL	<1	<1
Ethylbenzene	1	NSL	<1	<1
m+p-xylene	2	NSL	<2	<2
o-xylene	1	NSL	<1	<1
Total xylenes	2	NSL	<3	<3
Volatile Organic Compounds (VOCs), including chlorinated VOCs				
Dichlorodifluoromethane	10	NSL	<10	<10
Chloromethane	10	NSL	<10	<10
Vinyl Chloride	10	NSL	<10	<10
Bromomethane	10	NSL	<10	<10
Chloroethane	10	NSL	<10	<10
Trichlorofluoromethane	10	NSL	<10	<10
1,1-Dichloroethene	1	0.3	<1	<1
Trans-1,2-dichloroethene	1	NSL	<1	<1
1,1-dichloroethane	1	NSL	<1	<1
Cis-1,2-dichloroethene	1	NSL	<1	<1
Bromochloromethane	1	NSL	<1	<1
Chloroform	1	NSL	<1	<1
2,2-dichloropropane	1	NSL	<1	<1
1,2-dichloroethane	1	10	<1	<1
1,1,1-trichloroethane	1	NSL	<1	<1
1,1-dichloropropene	1	NSL	<1	<1
Cyclohexane	1	NSL	<1	<1
Carbon tetrachloride	1	3	<1	<1
Benzene	1	NSL	<1	<1
Dibromomethane	1	NSL	<1	<1
1,2-dichloropropane	1	NSL	<1	<1
Trichloroethene	1	30	<1	<1
Bromodichloromethane	1	NSL	<1	<1
trans-1,3-dichloropropene	1	NSL	<1	<1
cis-1,3-dichloropropene	1	NSL	<1	<1
1,1,2-trichloroethane	1	NSL	<1	<1
Toluene	1	NSL	<1	<1
1,3-dichloropropane	1	NSL	<1	<1
Dibromochloromethane	1	NSL	<1	<1
1,2-dibromoethane	1	NSL	<1	<1
Tetrachloroethene	1	10	<1	<1
1,1,1,2-tetrachloroethane	1	NSL	<1	<1
Chlorobenzene	1	NSL	<1	<1
Ethylbenzene	1	NSL	<1	<1
Bromoform	1	NSL	<1	<1
m+p-xylene	2	NSL	<2	<2
Styrene	1	NSL	<1	<1
1,1,2,2-tetrachloroethane	1	NSL	<1	<1
o-xylene	1	NSL	<1	<1
1,2,3-trichloropropane	1	NSL	<1	<1
Isopropylbenzene	1	NSL	<1	<1
Bromobenzene	1	NSL	<1	<1
n-propyl benzene	1	NSL	<1	<1
2-chlorotoluene	1	NSL	<1	<1
4-chlorotoluene	1	NSL	<1	<1
1,3,5-trimethyl benzene	1	NSL	<1	<1
Tert-butyl benzene	1	NSL	<1	<1
1,2,4-trimethyl benzene	1	NSL	<1	<1
1,3-dichlorobenzene	1	NSL	<1	<1
Sec-butyl benzene	1	NSL	<1	<1
1,4-dichlorobenzene	1	NSL	<1	<1
4-isopropyl toluene	1	NSL	<1	<1
1,2-dichlorobenzene	1	NSL	<1	<1
n-butyl benzene	1	NSL	<1	<1
1,2-dibromo-3-chloropropane	1	NSL	<1	<1
1,2,4-trichlorobenzene	1	NSL	<1	<1
Hexachlorobutadiene	1	NSL	<1	<1
1,2,3-trichlorobenzene	1	NSL	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)				
Naphthalene	0.2	NSL	<0.2	<0.2
Acenaphthylene	0.1	NSL	<0.1	<0.1
Acenaphthene	0.1	NSL	<0.1	<0.1
Fluorene	0.1	NSL	<0.1	<0.1
Phenanthrene	0.1	NSL	<0.1	<0.1
Anthracene	0.1	NSL	<0.1	<0.1
Fluoranthene	0.1	NSL	<0.1	<0.1
Pyrene	0.1	NSL	<0.1	<0.1
Benzo[a]anthracene	0.1	NSL	<0.1	<0.1
Chrysene	0.1	NSL	<0.1	<0.1
Benzo[b,j+k]fluoranthene	0.2	NSL	<0.2	<0.2
Benzo[a]pyrene	0.1	**0.01**	<0.1	<0.1
Indeno[1,2,3-c,d]pyrene	0.1	NSL	<0.1	<0.1
Dibenzo[a,h]anthracene	0.1	NSL	<0.1	<0.1
Benzo[g,h,i]perylene	0.1	NSL	<0.1	<0.1

Concentration above the GIL	VALUE
PQL exceeds GIL	**BOLD/RED**

Stage 2 Environmental Site Assessment
187 Slade Road, Bexley North
E30293KH

TABLE I
SOIL INTRA-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in mg/kg unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	INITIAL	REPEAT	MEAN	RPD %
Sample Ref = BH103 (0.03-0.2m)	Arsenic	4	<4	<4	NC	NC
Dup Ref = Dup HL1	Cadmium	0.4	<0.4	<0.4	NC	NC
	Chromium	1	11	12	11.5	9
Envirolab Report: 184710	Copper	1	20	15	17.5	29
	Lead	1	15	23	19.0	42
	Mercury	0.1	<0.1	<0.1	NC	NC
	Nickel	1	5	3	4.0	50
	Zinc	1	23	26	24.5	12
	Naphthalene	0.1	<0.1	<0.1	NC	NC
	Acenaphthylene	0.1	<0.1	<0.1	NC	NC
	Acenaphthene	0.1	<0.1	<0.1	NC	NC
	Fluorene	0.1	<0.1	<0.1	NC	NC
	Phenanthrene	0.1	<0.1	0.1	0.1	67
	Anthracene	0.1	<0.1	<0.1	NC	NC
	Fluoranthene	0.1	<0.1	0.2	0.1	120
	Pyrene	0.1	<0.1	0.2	0.1	120
	Benzo(a)anthracene	0.1	<0.1	0.1	0.1	67
	Chrysene	0.1	<0.1	0.1	0.1	67
	Benzo(b,j+k)fluoranthene	0.2	<0.2	0.2	0.2	67
	Benzo(a)pyrene	0.05	0.08	0.1	0.1	22
	Indeno(123-cd)pyrene	0.1	<0.1	<0.1	NC	NC
	Dibenzo(ah)anthracene	0.1	<0.1	<0.1	NC	NC
	Benzo(ghi)perylene	0.1	<0.1	<0.1	NC	NC
	TRH C_6-C_{10} (F1)	25	<25	<25	NC	NC
	TRH >C_{10}-C_{16} (F2)	50	<50	<50	NC	NC
	TRH >C_{16}-C_{34} (F3)	100	620	350	485.0	56
	TRH >C_{34}-C_{40} (F4)	100	750	420	585.0	56
	Benzene	0.5	<0.2	<0.2	NC	NC
	Toluene	0.5	<0.5	<0.5	NC	NC
	Ethylbenzene	1	<1	<1	NC	NC
	m+p-xylene	2	<2	<2	NC	NC
	o-xylene	1	<1	<1	NC	NC

Explanation:
The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:
- Results > 10 times PQL = RPD value <= 50% are acceptable
- Results between 5 & 10 times PQL = RPD value <= 75% are acceptable
- Results < 5 times PQL = RPD value <= 100% are acceptable

If result is LPQL then 50% of the PQL is used for the calculation

RPD Results Above the Acceptance Criteria VALUE

Stage 2 Environmental Site Assessment
187 Slade Road, Bexley North
E30293KH

TABLE J
GROUNDWATER INTRA-LABORATORY DUPLICATE RESULTS & RPD CALCULATIONS
All results in µg/L unless stated otherwise

SAMPLE	ANALYSIS	Envirolab PQL	INITIAL	REPEAT	MEAN	RPD %
Sample Ref = MW106	Arsenic	1	<1	<1	NC	NC
Dup Ref = Dup AM1	Cadmium	0.1	0.1	0.1	0	0
	Chromium	1	<1	<1	NC	NC
Envirolab Report: 185317	Copper	1	<1	<1	NC	NC
	Lead	1	<1	<1	NC	NC
	Mercury	0.05	<0.05	<0.05	NC	NC
	Nickel	1	13	13	13	0
	Zinc	1	77	78	78	1
	Naphthalene	0.1	<0.2	<0.2	NC	NC
	Acenaphthylene	0.1	<0.1	<0.1	NC	NC
	Acenaphthene	0.1	<0.1	<0.1	NC	NC
	Fluorene	0.1	<0.1	<0.1	NC	NC
	Phenanthrene	0.1	<0.1	<0.1	NC	NC
	Anthracene	0.1	<0.1	<0.1	NC	NC
	Fluoranthene	0.1	<0.1	<0.1	NC	NC
	Pyrene	0.1	<0.1	<0.1	NC	NC
	Benzo(a)anthracene	0.1	<0.1	<0.1	NC	NC
	Chrysene	0.1	<0.1	<0.1	NC	NC
	Benzo(b,j+k)fluoranthene	0.2	<0.2	<0.2	NC	NC
	Benzo(a)pyrene	0.1	<0.1	<0.1	NC	NC
	Indeno(123-cd)pyrene	0.1	<0.1	<0.1	NC	NC
	Dibenzo(ah)anthracene	0.1	<0.1	<0.1	NC	NC
	Benzo(ghi)perylene	0.1	<0.1	<0.1	NC	NC
	TRH C6-C10 (F1)	10	<10	<10	NC	NC
	TRH >C10-C16 (F2)	50	<50	<50	NC	NC
	TRH >C16-C34 (F3)	100	<100	<100	NC	NC
	TRH >C34-C40 (F4)	100	<100	<100	NC	NC
	Benzene	1	<1	<1	NC	NC
	Toluene	1	<1	<1	NC	NC
	Ethylbenzene	1	<1	<1	NC	NC
	m+p-xylene	2	<2	<2	NC	NC
	o-xylene	1	<1	<1	NC	NC

Explanation:
The RPD value is calculated as the absolute value of the difference between the initial and repeat results divided by the average value expressed as a percentage. The following acceptance criteria will be used to assess the RPD results:
Results > 10 times PQL = RPD value <= 50% are acceptable
Results between 5 & 10 times PQL = RPD value <= 75% are acceptable
Results < 5 times PQL = RPD value <= 100% are acceptable
If result is LPQL then 50% of the PQL is used for the calculation

RPD Results Above the Acceptance Criteria VALUE

Stage 2 Environmental Site Assessment
187 Slade Road, Bexley North
E30293KH

TABLE K
SUMMARY OF FIELD QA/QC RESULTS

ANALYSIS	Envirolab PQL		TB1[s]	TS1[s]
			7/02/2018	7/02/2018
	mg/kg	µg/L	mg/kg	% Recovery
Benzene	1	1	<0.2	92
Toluene	1	1	<0.5	94
Ethylbenzene	1	1	<1	94
m+p-xylene	2	2	<2	94
o-xylene	1	1	<1	94

Explanation:
[s] Sample type (sand)
BTEX concentrations in trip spikes are presented as % recovery

Values above PQLs/Acceptance criteria **VALUE**

EIS

Appendix A: Borehole Logs

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

EIS

ENVIRONMENTAL LOG

Borehole No. **101** 1/1

Environmental logs are not to be used for geotechnical purposes

Client: TUNBORN PTY LTD
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 187 SLADE ROAD, BEXLEY, NSW

Job No. E30293KH **Method:** JK205 **R.L. Surface:** N/A
Date: 7/2/18 **Datum:**
Logged/Checked by: H.L. & A.M./T.H.

Groundwater Record	SAMPLES (ES, ASS, ASB, SAL, DB)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0			CONCRETE: 190mm.t				
					-	FILL: silty sand, fine to medium grained, brown, trace of fine to coarse grained sandstone gravel, and ash.	M			
		N = 4 1,2,2	1			FILL: Sandy clay, low to medium plasticity, light orange brown, trace of fine to coarse grained igneous gravel, and ash.	MC>PL			FCF IN FILL SAMPLE AMF1
		N = 8 3,4,4			CL-CI	SILTY CLAY: low to medium plasticity, grey, with ironstone gravel.	MC≥PL			
			2			END OF BOREHOLE AT 2.0m				
			3							
			4							
			5							
			6							
			7							

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

EIS

ENVIRONMENTAL LOG

Borehole No.
102/MW102
1/2

Environmental logs are not to be used for geotechnical purposes

Client: TUNBORN PTY LTD
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 187 SLADE ROAD, BEXLEY, NSW

Job No. E30293KH **Method:** JK205 **R.L. Surface:** N/A
Date: 7/2/18 **Datum:**
Logged/Checked by: H.L. & A.M./T.H.

Groundwater Record	SAMPLES (ES, ASS, ASB, SAL, DB)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0			FILL: Silty sand, fine to medium grained, brown, with fine to coarse igneous gravel.	D			
		N = 17 3,7,10				FILL: Sandy clay, low to medium plasticity, brown, trace of fine to coarse grained igneous gravel, and ash.	MC>PL			
			1							
		N = 2 0,1,1	2							
		N = 2 1,1,1	3							
			4							
		N = 2 0,1,1	5							
			6							
					CL-CI	SILTY CLAY: low to medium plasticity, brown mottled red brown.	MC≥PL			
			7							

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **102/MW102** 2/2

Environmental logs are not to be used for geotechnical purposes

Client: TUNBORN PTY LTD
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 187 SLADE ROAD, BEXLEY, NSW

Job No. E30293KH **Method:** JK205 **R.L. Surface:** N/A
Date: 7/2/18 **Datum:**
Logged/Checked by: H.L. & A.M./T.H.

Groundwater Record	SAMPLES ES ASS ASB SAL DB	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						END OF BOREHOLE AT 7.5m				GROUNDWATER MONITORING WELL INSTALLED TO 6.0m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 6.0m TO 3.0m. CASING 3.0m TO 0.1m 2mm SAND PACK 6.0m TO 2.2m. BENTONITE SEAL 2.2m TO 1.3m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH CONCRETED GATIC COVER.
			8							
			9							
			10							
			11							
			12							
			13							
			14							

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **103**
1/1
DUPHL1

Environmental logs are not to be used for geotechnical purposes

Client: TUNBORN PTY LTD
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 187 SLADE ROAD, BEXLEY, NSW

Job No. E30293KH **Method:** JK205 **R.L. Surface:** N/A
Date: 7/2/18 **Datum:**
Logged/Checked by: H.L. & A.M./T.H.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION		0	-	ASPHALTIC CONCRETE: 30mm.t	MC≥PL			
	N = 15 5,8,7			FILL: low to medium plasticity, brown, with fine to coarse grained igneous gravel, trace of sandstone gravel, and ash.	MC≥PL			
				FILL: Silty clay, low to medium plasticity, yellow brown, trace of fine to coarse grained gravel, and ash.				
		1	CL-CI	SILTY CLAY: low to medium plasticity, red brown.	MC≥PL			
	N = 19 7,10,9			as above, but grey mottled red brown.	MC≤PL			
		2		END OF BOREHOLE AT 2.0m				
		3						
		4						
		5						
		6						
		7						

Samples columns: ES, ASS, ASB, SAL, DB

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

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ENVIRONMENTAL LOG

Borehole No.
104
1/1

Environmental logs are not to be used for geotechnical purposes

Client: TUNBORN PTY LTD
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 187 SLADE ROAD, BEXLEY, NSW

Job No. E30293KH **Method:** JK205 **R.L. Surface:** N/A
Date: 7/2/18 **Datum:**
Logged/Checked by: H.L. & A.M./T.H.

Groundwater Record	SAMPLES (ES, ASS, ASB, SAL, DB)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0		-	ASPHALTIC CONCRETE: 30mm.t	MC<PL			
		N = 12 4,6,6				FILL: Silty clay, low to medium plasticity, red brown, trace of fine to coarse grained igneous gravel, and ash				
					CI-CH	SILTY CLAY: medium to high plasticity, grey mottled red brown.	MC<PL			
			1			END OF BOREHOLE AT 1.0m				
			2							
			3							
			4							
			5							
			6							
			7							

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. 105
1/1

Environmental logs are not to be used for geotechnical purposes

Client: TUNBORN PTY LTD
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 187 SLADE ROAD, BEXLEY, NSW

Job No. E30293KH **Method:** JK205 **R.L. Surface:** N/A
Date: 7/2/18 **Datum:**
Logged/Checked by: H.L. & A.M./T.H.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	N = 16 6,8,8	0		FILL: Silty sand, fine to medium grained, brown, trace of fine to coarse grained sandstone gravel, and root fibres	D			GRASS COVER
		1	CL-CI	SILTY CLAY: low to medium plasticity, red brown, trace of fine to coarse grained ironstone gravel.	MC≥PL			POTENTIAL IRONSTONE BAND POSSIBLY FILL
			SC	CLAYEY SAND: fine to medium grained, yellow brown, trace of fine to coarse grained ironstone gravel.	D			
	N = 25 7,15,10		-	SANDY CLAY: low to medium plasticity, yellow brown, trace of fine to coarse grained ironstone gravel.	MC≥PL			
		2		END OF BOREHOLE AT 2.0m				
		3						
		4						
		5						
		6						
		7						

SAMPLES: ES, ASS, ASB, SAL, DB

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

EIS

ENVIRONMENTAL LOG

Borehole No.
106/MW106
1/1

Environmental logs are not to be used for geotechnical purposes

Client: TUNBORN PTY LTD
Project: PROPOSED ALTERATIONS AND ADDITIONS
Location: 187 SLADE ROAD, BEXLEY, NSW

Job No. E30293KH **Method:** JK205 **R.L. Surface:** N/A
Date: 7/2/18 **Datum:**
Logged/Checked by: H.L. & A.M./T.H.

Groundwater Record	SAMPLES (ES, ASS, ASB, SAL, DB)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0			FILL: Silty sand, fine to medium grained, brown, trace of root fibres and ash	D			GRASS COVER
		N = 27 18,21,16				FILL: Silty sand, fine to medium grained, brown, trace of fine to coarse grained sandstone gravel.	D			
			1		CL-CI	SILTY CLAY: low to medium plasticity, red brown, trace of fine to coarse grained ironstone gravel.	MC≥PL			GROUNDWATER MONITORING WELL INSTALLED TO 6.0m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 6.0m TO 3.0m. CASING 3.0m TO 0.1m 2mm SAND PACK 6.0m TO 2.5m. BENTONITE SEAL 2.5m TO 1.7m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH CONCRETED GATIC COVER.
			2							
			3							
			4			as above, but light red brown.				
			5			SANDSTONE: red.	SW			
			6			END OF BOREHOLE AT 6.0m				
			7							

EIS

EXPLANATORY NOTES – ENVIRONMENTAL LOGS

INTRODUCTION

These notes have been provided to supplement the environmental report with regards to drilling and field logging. Not all notes are necessarily relevant to all reports. Where geotechnical borehole logs are utilised for environmental purpose, reference should also be made to the explanatory notes included in the geotechnical report. Environmental logs are not suitable for geotechnical purposes.

The ground is a product of continuing natural and manmade processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Environmental studies involve gathering and assimilating limited facts about these characteristics and properties in order to understand the ground on a particular site under certain conditions. These conditions are directly relevant only to the ground at the place where, and time when, the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (e.g. sandy clay) as set out below (note that unless stated in the report, the soil classification is based on a qualitative field assessment, not laboratory testing):

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as shown in the following table:

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

DRILLING OR EXCAVATION METHODS

The following is a brief summary of drilling and excavation methods currently adopted by the Company, and some comments on their use and application. All except test pits and hand auger drilling require the use of a mechanical drilling rig.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descend into the pit. The depth of penetration is limited to approximately 3m for a backhoe and up to 6m for an excavator. Limitations of test pits include problems associated with disturbance and difficulty of reinstatement; and the consequent effects on nearby structures. Care must be taken if construction is to be carried out near test pit locations to either properly re-compact the backfill during construction, or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as fill, hard clay, gravel or ironstone, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (e.g. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The locations of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as: N = 13 (4, 6, 7)
- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as: N>30 (15, 30/40mm)

The results of the test can be related empirically to the engineering properties of the soil. Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60 tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "Nc" on the borehole logs, together with the number of blows per 150mm penetration.

LOGS

The borehole or test pit logs presented herein are an interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment, but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open;
- A localised perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or 'reverted' chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (e.g. bricks, concrete, plastic, slag/ash, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes

LABORATORY TESTING

Laboratory testing has not been undertaken to confirm the soil classifications and rocks strengths indicated on the environmental logs unless noted in the report.

SITE ANOMALIES

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, EIS should be notified immediately.

EIS

GRAPHIC LOG SYMBOLS FOR SOIL AND ROCKS

SOIL

- FILL
- TOPSOIL
- CLAY (CL, CH)
- SILT (ML, MH)
- SAND (SP, SW)
- GRAVEL (GP, GW)
- SANDY CLAY (CL, CH)
- SILTY CLAY (CL, CH)
- CLAYEY SAND (SC)
- SILTY SAND (SM)
- GRAVELLY CLAY (CL, CH)
- CLAYEY GRAVEL (GC)
- SANDY SILT (ML)
- PEAT AND ORGANIC SOILS

ROCK

- CONGLOMERATE
- SANDSTONE
- SHALE
- SILTSTONE, MUDSTONE, CLAYSTONE
- LIMESTONE
- PHYLLITE, SCHIST
- TUFF
- GRANITE, GABBRO
- DOLERITE, DIORITE
- BASALT, ANDESITE
- QUARTZITE

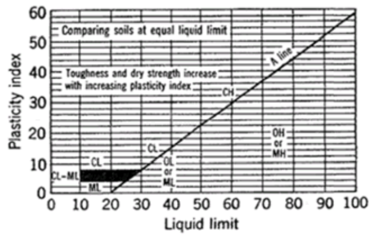
DEFECTS AND INCLUSIONS

- CLAY SEAM
- SHEARED OR CRUSHED SEAM
- BRECCIATED OR SHATTERED SEAM/ZONE
- IRONSTONE GRAVEL
- ORGANIC MATERIAL

OTHER MATERIALS

- CONCRETE
- BITUMINOUS CONCRETE, COAL
- COLLUVIUM

EIS

Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)						Group Symbols a	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils More than half of material is *larger* than 75 μm sieve size b (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	Use grain size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP* More than 12% *GM, GC, SM, SC* 5% to 12% *Borderline* cases requiring use of dual symbols $C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or *PI* less than 4 Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, with *PI* greater than 7
	Sands More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5 Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7
Fine-grained soils More than half of material is *smaller* than 75 μm sieve size	Identification Procedures on Fraction Smaller than 380 μm Sieve Size								
			Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				
	Silts and clays liquid limit less than 50		None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)	 Plasticity chart for laboratory classification of fine grained soils
			Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity		
	Silts and clays liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays		
			Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity		
Highly Organic Soils			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils		

Note: 1 Soils possessing characteristics of two groups are designated by combinations of group symbols (eg. GW-GC, well graded gravel-sand mixture with clay fines).
2 Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown.
	C	Extent of borehole collapse shortly after drilling.
		Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos screening.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3 R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample heads pace test).
Moisture (Cohesive Soils)	MC>PL	Moisture content estimated to be greater than plastic limit.
	MC≈PL	Moisture content estimated to be approximately equal to plastic limit.
	MC<PL	Moisture content estimated to be less than plastic limit.
(Cohesionless)	D	DRY – Runs freely through fingers.
	M	MOIST – Does not run freely but no free water visible on soil surface.
	W	WET – Free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT – Unconfined compressive strength less than 25kPa
	S	SOFT – Unconfined compressive strength 25-5 0kPa
	F	FIRM – Unconfined compressive strength 50-1 00kPa
	St	STIFF – Unconfined compressive strength 100- 200kPa
	VSt	VERY STIFF – Unconfined compressive strength 200- 400kPa
	H	HARD – Unconfined compressive strength greater than 400kPa
	( )	Bracketed symbol indicates estimated consistency based o n tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (ID) Range (%)** — **SPT ' N' Value Range (Blows/300mm)**
	VL	Very Loose <15 — 0-4
	L	Loose 15-35 — 4-10
	MD	Medium Dense 35-65 — 10-30
	D	Dense 65-85 — 30-50
	VD	Very Dense >85 — >50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten carbide wing bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

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EIS

LOG SYMBOLS CONTINUED

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining and Geomechanics Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL		Easily remoulded by hand to a material with soil properties.
		0.03	
Very Low:	VL		May be crumbled in the hand. Sandstone is "sugary" and friable.
		0.1	
Low:	L		A piece of core 150 mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
		0.3	
Medium Strength:	M		A piece of core 150 mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
		1	
High:	H		A piece of core 150 mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
		3	
Very High:	VH		A piece of core 150 mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
		10	
Extremely High:	EH		A piece of core 150 mm long x 50mm dia. is very difficult to break with h and-held hammer . Rings when struck with a hammer.

ROCK STRENGTH

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to (i.e. relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Iron stained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	

EIS

Appendix B: Laboratory Reports & COC Documents

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 184710

Client Details	
Client	Environmental Investigation Services
Attention	Todd Hore
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details	
Your Reference	**E30293KH, Bexley**
Number of Samples	26 soil, 1 MATERIAL
Date samples received	07/02/2018
Date completed instructions received	07/02/2018

Analysis Details
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details	
Date results requested by	14/02/2018
Date of Issue	14/02/2018
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***	

Asbestos Approved By
Analysed by Asbestos Approved Identifier: Lulu Scott, Lucy Zhu
Authorised by Asbestos Approved Signatory: Lulu Scott
Results Approved By
Dragana Tomas, Senior Chemist
Jeremy Faircloth, Organics Supervisor
Long Pham, Team Leader, Metals
Lulu Scott, Asbestos Supervisor
Paul Ching, Senior Analyst
Steven Luong, Senior Chemist

Authorised By

David Springer, General Manager

Client Reference: E30293KH, Bexley

vTRH(C6-C10)/BTEXN in Soil						
Our Reference		184710-1	184710-2	184710-4	184710-6	184710-10
Your Reference	UNITS	BH101	BH101	BH102	BH102	BH103
Depth		0.2-0.4	0.5-0.95	0-0.2	1.5-1.95	0.03-0.2
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
TRH C_6 - C_9	mg/kg	<25	<25	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Total +ve Xylenes	mg/kg	<1	<1	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	111	106	108	111	109

vTRH(C6-C10)/BTEXN in Soil						
Our Reference		184710-12	184710-14	184710-15	184710-16	184710-18
Your Reference	UNITS	BH103	BH104	BH104	BH105	BH105
Depth		0.9-1.1	0.03-0.2	0.5-0.95	0-0.2	1.1-1.3
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
TRH C_6 - C_9	mg/kg	<25	<25	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Total +ve Xylenes	mg/kg	<1	<1	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	109	107	107	111	110

Client Reference: E30293KH, Bexley

vTRH(C6-C10)/BTEXN in Soil						
Our Reference		184710-20	184710-21	184710-24	184710-25	184710-27
Your Reference	UNITS	BH106	BH106	TSAM1	TBAM1	DUPHL1
Depth		0-0.2	0.5-0.8	-	-	-
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
TRH C_6 - C_9	mg/kg	<25	<25	[NA]	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	[NA]	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	[NA]	<25	<25
Benzene	mg/kg	<0.2	<0.2	92%	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	94%	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	94%	<1	<1
m+p-xylene	mg/kg	<2	<2	94%	<2	<2
o-Xylene	mg/kg	<1	<1	94%	<1	<1
naphthalene	mg/kg	<1	<1	[NA]	<1	<1
Total +ve Xylenes	mg/kg	<1	<1	[NA]	<1	<1
Surrogate aaa-Trifluorotoluene	%	111	113	95	111	112

Envirolab Reference: 184710
Revision No: R00

Client Reference: E30293KH, Bexley

svTRH (C10-C40) in Soil						
Our Reference		184710-1	184710-2	184710-4	184710-6	184710-10
Your Reference	UNITS	BH101	BH101	BH102	BH102	BH103
Depth		0.2-0.4	0.5-0.95	0-0.2	1.5-1.95	0.03-0.2
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
TRH C_{10} - C_{14}	mg/kg	<50	<50	<50	<50	<50
TRH C_{15} - C_{28}	mg/kg	<100	<100	<100	<100	180
TRH C_{29} - C_{36}	mg/kg	<100	<100	<100	<100	670
TRH >C_{10} -C_{16}	mg/kg	<50	<50	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50	<50	<50	<50	<50
TRH >C_{16} -C_{34}	mg/kg	<100	<100	<100	<100	620
TRH >C_{34} -C_{40}	mg/kg	<100	<100	<100	<100	750
Total +ve TRH (>C10-C40)	mg/kg	<50	<50	<50	<50	1,400
Surrogate o-Terphenyl	%	82	80	81	79	89

svTRH (C10-C40) in Soil						
Our Reference		184710-12	184710-14	184710-15	184710-16	184710-18
Your Reference	UNITS	BH103	BH104	BH104	BH105	BH105
Depth		0.9-1.1	0.03-0.2	0.5-0.95	0-0.2	1.1-1.3
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
TRH C_{10} - C_{14}	mg/kg	<50	<50	<50	<50	<50
TRH C_{15} - C_{28}	mg/kg	<100	<100	<100	<100	<100
TRH C_{29} - C_{36}	mg/kg	<100	<100	<100	<100	<100
TRH >C_{10} -C_{16}	mg/kg	<50	<50	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50	<50	<50	<50	<50
TRH >C_{16} -C_{34}	mg/kg	<100	<100	<100	<100	<100
TRH >C_{34} -C_{40}	mg/kg	<100	<100	<100	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	<50	<50	<50	<50	<50
Surrogate o-Terphenyl	%	79	80	80	82	80

Client Reference: E30293KH, Bexley

svTRH (C10-C40) in Soil				
Our Reference		184710-20	184710-21	184710-27
Your Reference	UNITS	BH106	BH106	DUPHL1
Depth		0-0.2	0.5-0.8	-
Date Sampled		07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018
TRH C_{10} - C_{14}	mg/kg	<50	<50	<50
TRH C_{15} - C_{28}	mg/kg	<100	<100	110
TRH C_{29} - C_{36}	mg/kg	<100	<100	370
TRH >C_{10} -C_{16}	mg/kg	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50	<50	<50
TRH >C_{16} -C_{34}	mg/kg	<100	<100	350
TRH >C_{34} -C_{40}	mg/kg	<100	<100	420
Total +ve TRH (>C10-C40)	mg/kg	<50	<50	780
Surrogate o-Terphenyl	%	80	80	82

Client Reference: E30293KH, Bexley

PAHs in Soil						
Our Reference		184710-1	184710-2	184710-4	184710-6	184710-10
Your Reference	UNITS	BH101	BH101	BH102	BH102	BH103
Depth		0.2-0.4	0.5-0.95	0-0.2	1.5-1.95	0.03-0.2
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	<0.1	0.1	0.1	<0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	0.2	0.2	0.3	<0.1	<0.1
Pyrene	mg/kg	0.2	0.2	0.3	<0.1	<0.1
Benzo(a)anthracene	mg/kg	0.1	<0.1	0.2	<0.1	<0.1
Chrysene	mg/kg	0.1	<0.1	0.2	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	0.2	<0.2	0.4	<0.2	<0.2
Benzo(a)pyrene	mg/kg	0.2	0.09	0.3	0.06	0.08
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	0.2	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	0.1	<0.1	<0.1
Total +ve PAH's	mg/kg	1.1	0.52	2.0	0.06	0.08
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Surrogate p-Terphenyl-d14	%	94	87	90	90	92

Client Reference: E30293KH, Bexley

PAHs in Soil						
Our Reference		184710-12	184710-14	184710-15	184710-16	184710-18
Your Reference	UNITS	BH103	BH104	BH104	BH105	BH105
Depth		0.9-1.1	0.03-0.2	0.5-0.95	0-0.2	1.1-1.3
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	0.1	<0.1	<0.1	<0.1
Pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	mg/kg	<0.05	0.06	<0.05	0.06	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve PAH's	mg/kg	<0.05	0.2	<0.05	0.06	<0.05
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Surrogate p-Terphenyl-d14	%	96	87	88	97	93

Client Reference: E30293KH, Bexley

PAHs in Soil				
Our Reference		184710-20	184710-21	184710-27
Your Reference	UNITS	BH106	BH106	DUPHL1
Depth		0-0.2	0.5-0.8	-
Date Sampled		07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018
Naphthalene	mg/kg	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	<0.1	<0.1	0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	0.1	0.2
Pyrene	mg/kg	<0.1	0.1	0.2
Benzo(a)anthracene	mg/kg	<0.1	<0.1	0.1
Chrysene	mg/kg	<0.1	<0.1	0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	<0.2	0.2
Benzo(a)pyrene	mg/kg	<0.05	0.06	0.1
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1
Total +ve PAH's	mg/kg	<0.05	0.3	1.0
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5
Surrogate p-Terphenyl-d14	%	90	95	89

Client Reference: E30293KH, Bexley

Organochlorine Pesticides in soil						
Our Reference		184710-1	184710-6	184710-10	184710-14	184710-16
Your Reference	UNITS	BH101	BH102	BH103	BH104	BH105
Depth		0.2-0.4	1.5-1.95	0.03-0.2	0.03-0.2	0-0.2
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
HCB	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	108	105	104	106	106

Client Reference: E30293KH, Bexley

Organochlorine Pesticides in soil		
Our Reference		184710-20
Your Reference	UNITS	BH106
Depth		0-0.2
Date Sampled		07/02/2018
Type of sample		soil
Date extracted	-	08/02/2018
Date analysed	-	09/02/2018
HCB	mg/kg	<0.1
alpha-BHC	mg/kg	<0.1
gamma-BHC	mg/kg	<0.1
beta-BHC	mg/kg	<0.1
Heptachlor	mg/kg	<0.1
delta-BHC	mg/kg	<0.1
Aldrin	mg/kg	<0.1
Heptachlor Epoxide	mg/kg	<0.1
gamma-Chlordane	mg/kg	<0.1
alpha-chlordane	mg/kg	<0.1
Endosulfan I	mg/kg	<0.1
pp-DDE	mg/kg	<0.1
Dieldrin	mg/kg	<0.1
Endrin	mg/kg	<0.1
pp-DDD	mg/kg	<0.1
Endosulfan II	mg/kg	<0.1
pp-DDT	mg/kg	<0.1
Endrin Aldehyde	mg/kg	<0.1
Endosulfan Sulphate	mg/kg	<0.1
Methoxychlor	mg/kg	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1
Surrogate TCMX	%	108

Client Reference: E30293KH, Bexley

Organophosphorus Pesticides						
Our Reference		184710-1	184710-6	184710-10	184710-14	184710-16
Your Reference	UNITS	BH101	BH102	BH103	BH104	BH105
Depth		0.2-0.4	1.5-1.95	0.03-0.2	0.03-0.2	0-0.2
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
Azinphos-methyl (Guthion)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Bromophos-ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyriphos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyriphos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Parathion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ronnel	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	108	105	104	106	106

Organophosphorus Pesticides		
Our Reference		184710-20
Your Reference	UNITS	BH106
Depth		0-0.2
Date Sampled		07/02/2018
Type of sample		soil
Date extracted	-	08/02/2018
Date analysed	-	09/02/2018
Azinphos-methyl (Guthion)	mg/kg	<0.1
Bromophos-ethyl	mg/kg	<0.1
Chlorpyriphos	mg/kg	<0.1
Chlorpyriphos-methyl	mg/kg	<0.1
Diazinon	mg/kg	<0.1
Dichlorvos	mg/kg	<0.1
Dimethoate	mg/kg	<0.1
Ethion	mg/kg	<0.1
Fenitrothion	mg/kg	<0.1
Malathion	mg/kg	<0.1
Parathion	mg/kg	<0.1
Ronnel	mg/kg	<0.1
Surrogate TCMX	%	108

Client Reference: E30293KH, Bexley

PCBs in Soil						
Our Reference		184710-1	184710-6	184710-10	184710-14	184710-16
Your Reference	UNITS	BH101	BH102	BH103	BH104	BH105
Depth		0.2-0.4	1.5-1.95	0.03-0.2	0.03-0.2	0-0.2
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date extracted	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
Aroclor 1016	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCLMX	%	108	105	104	106	106

PCBs in Soil		
Our Reference		184710-20
Your Reference	UNITS	BH106
Depth		0-0.2
Date Sampled		07/02/2018
Type of sample		soil
Date extracted	-	08/02/2018
Date analysed	-	09/02/2018
Aroclor 1016	mg/kg	<0.1
Aroclor 1221	mg/kg	<0.1
Aroclor 1232	mg/kg	<0.1
Aroclor 1242	mg/kg	<0.1
Aroclor 1248	mg/kg	<0.1
Aroclor 1254	mg/kg	<0.1
Aroclor 1260	mg/kg	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1
Surrogate TCLMX	%	108

Client Reference: E30293KH, Bexley

Acid Extractable metals in soil						
Our Reference		184710-1	184710-2	184710-4	184710-6	184710-10
Your Reference	UNITS	BH101	BH101	BH102	BH102	BH103
Depth		0.2-0.4	0.5-0.95	0-0.2	1.5-1.95	0.03-0.2
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date prepared	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Arsenic	mg/kg	<4	10	<4	<4	<4
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	4	11	19	9	11
Copper	mg/kg	5	2	19	17	20
Lead	mg/kg	64	27	27	38	15
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	2	2	8	2	5
Zinc	mg/kg	29	25	50	31	23

Acid Extractable metals in soil						
Our Reference		184710-12	184710-14	184710-15	184710-16	184710-18
Your Reference	UNITS	BH103	BH104	BH104	BH105	BH105
Depth		0.9-1.1	0.03-0.2	0.5-0.95	0-0.2	1.1-1.3
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date prepared	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Arsenic	mg/kg	<4	4	<4	<4	<4
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	14	15	9	11	10
Copper	mg/kg	<1	3	2	11	1
Lead	mg/kg	9	18	9	56	6
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	1	2	1	2	1
Zinc	mg/kg	5	11	7	110	13

Client Reference: E30293KH, Bexley

Acid Extractable metals in soil				
Our Reference		184710-20	184710-21	184710-27
Your Reference	UNITS	BH106	BH106	DUPHL1
Depth		0-0.2	0.5-0.8	-
Date Sampled		07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil
Date prepared	-	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	08/02/2018	08/02/2018	08/02/2018
Arsenic	mg/kg	5	5	<4
Cadmium	mg/kg	<0.4	<0.4	<0.4
Chromium	mg/kg	13	17	12
Copper	mg/kg	31	9	15
Lead	mg/kg	40	22	23
Mercury	mg/kg	<0.1	<0.1	<0.1
Nickel	mg/kg	5	4	3
Zinc	mg/kg	54	31	26

Client Reference: E30293KH, Bexley

Moisture						
Our Reference		184710-1	184710-2	184710-4	184710-6	184710-10
Your Reference	UNITS	BH101	BH101	BH102	BH102	BH103
Depth		0.2-0.4	0.5-0.95	0-0.2	1.5-1.95	0.03-0.2
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date prepared	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
Moisture	%	3.9	13	6.9	12	9.7

Moisture						
Our Reference		184710-12	184710-14	184710-15	184710-16	184710-18
Your Reference	UNITS	BH103	BH104	BH104	BH105	BH105
Depth		0.9-1.1	0.03-0.2	0.5-0.95	0-0.2	1.1-1.3
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date prepared	-	08/02/2018	08/02/2018	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018	09/02/2018	09/02/2018
Moisture	%	11	15	14	5.8	6.3

Moisture				
Our Reference		184710-20	184710-21	184710-27
Your Reference	UNITS	BH106	BH106	DUPHL1
Depth		0-0.2	0.5-0.8	-
Date Sampled		07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil
Date prepared	-	08/02/2018	08/02/2018	08/02/2018
Date analysed	-	09/02/2018	09/02/2018	09/02/2018
Moisture	%	6.1	7.0	9.3

Client Reference: E30293KH, Bexley

Asbestos ID - soils						
Our Reference		184710-1	184710-2	184710-4	184710-6	184710-10
Your Reference	UNITS	BH101	BH101	BH102	BH102	BH103
Depth		0.2-0.4	0.5-0.95	0-0.2	1.5-1.95	0.03-0.2
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date analysed	-	14/02/2018	14/02/2018	14/02/2018	14/02/2018	14/02/2018
Sample mass tested	g	Approx. 30g	Approx. 35g	Approx. 40g	Approx. 30g	Approx. 50g
Sample Description	-	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & bitumen
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected

Client Reference: E30293KH, Bexley

Asbestos ID - soils						
Our Reference		184710-12	184710-14	184710-15	184710-16	184710-18
Your Reference	UNITS	BH103	BH104	BH104	BH105	BH105
Depth		0.9-1.1	0.03-0.2	0.5-0.95	0-0.2	1.1-1.3
Date Sampled		07/02/2018	07/02/2018	07/02/2018	07/02/2018	07/02/2018
Type of sample		soil	soil	soil	soil	soil
Date analysed	-	14/02/2018	14/02/2018	14/02/2018	14/02/2018	14/02/2018
Sample mass tested	g	Approx. 40g	Approx. 40g	Approx. 50g	Approx. 25g	Approx. 40g
Sample Description	-	Red coarse-grained soil & rocks	Red coarse-grained soil & rocks	Grey clayey soil & rocks	Brown coarse-grained soil & rocks	Orange coarse-grained soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected

Asbestos ID - soils			
Our Reference		184710-20	184710-21
Your Reference	UNITS	BH106	BH106
Depth		0-0.2	0.5-0.8
Date Sampled		07/02/2018	07/02/2018
Type of sample		soil	soil
Date analysed	-	14/02/2018	14/02/2018
Sample mass tested	g	Approx. 30g	Approx. 60g
Sample Description	-	Brown fine-grained soil & rocks	Brown coarse-grained soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibre detected
Trace Analysis	-	No asbestos detected	No asbestos detected

Client Reference: E30293KH, Bexley

Asbestos ID - materials		
Our Reference		184710-26
Your Reference	UNITS	AMF1
Depth		-
Date Sampled		07/02/2018
Type of sample		MATERIAL
Date analysed	-	13/02/2018
Mass / Dimension of Sample	-	30x25x5mm
Sample Description	-	Grey compressed fibre cement material
Asbestos ID in materials	-	Chrysotile asbestos detected Amosite asbestos detected

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Method ID	Methodology Summary
ASB-001	Asbestos ID - Qualitative identification of asbestos in bulk samples using Polarised Light Microscopy and Dispersion Staining Techniques including Synthetic Mineral Fibre and Organic Fibre as per Australian Standard 4964-2004.
Inorg-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's. Note, the Total +ve reported DDD+DDE+DDT PQL is reflective of the lowest individual PQL and is therefore simply a sum of the positive individually report DDD+DDE+DDT.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PCBs" is simply a sum of the positive individual PCBs.
Org-008	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.

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Method ID	Methodology Summary
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013. For soil results:- 1. 'EQ PQL'values are assuming all contributing PAHs reported as <PQL are actually at the PQL. This is the most conservative approach and can give false positive TEQs given that PAHs that contribute to the TEQ calculation may not be present. 2. 'EQ zero'values are assuming all contributing PAHs reported as <PQL are zero. This is the least conservative approach and is more susceptible to false negative TEQs when PAHs that contribute to the TEQ calculation are present but below PQL. 3. 'EQ half PQL'values are assuming all contributing PAHs reported as <PQL are half the stipulated PQL. Hence a mid-point between the most and least conservative approaches above. Note, the Total +ve PAHs PQL is reflective of the lowest individual PQL and is therefore "Total +ve PAHs" is simply a sum of the positive individual PAHs.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

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QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-7	184710-6
Date extracted	-			08/02/2018	1	08/02/2018	08/02/2018		08/02/2018	08/02/2018
Date analysed	-			09/02/2018	1	09/02/2018	09/02/2018		09/02/2018	09/02/2018
TRH C_6 - C_9	mg/kg	25	Org-016	<25	1	<25	<25	0	83	87
TRH C_6 - C_{10}	mg/kg	25	Org-016	<25	1	<25	<25	0	83	87
Benzene	mg/kg	0.2	Org-016	<0.2	1	<0.2	<0.2	0	75	66
Toluene	mg/kg	0.5	Org-016	<0.5	1	<0.5	<0.5	0	83	90
Ethylbenzene	mg/kg	1	Org-016	<1	1	<1	<1	0	94	101
m+p-xylene	mg/kg	2	Org-016	<2	1	<2	<2	0	81	88
o-Xylene	mg/kg	1	Org-016	<1	1	<1	<1	0	95	104
naphthalene	mg/kg	1	Org-014	<1	1	<1	<1	0	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-016	112	1	111	110	1	115	105

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	20	08/02/2018	08/02/2018		[NT]	[NT]
Date analysed	-			[NT]	20	09/02/2018	09/02/2018		[NT]	[NT]
TRH C_6 - C_9	mg/kg	25	Org-016	[NT]	20	<25	<25	0	[NT]	[NT]
TRH C_6 - C_{10}	mg/kg	25	Org-016	[NT]	20	<25	<25	0	[NT]	[NT]
Benzene	mg/kg	0.2	Org-016	[NT]	20	<0.2	<0.2	0	[NT]	[NT]
Toluene	mg/kg	0.5	Org-016	[NT]	20	<0.5	<0.5	0	[NT]	[NT]
Ethylbenzene	mg/kg	1	Org-016	[NT]	20	<1	<1	0	[NT]	[NT]
m+p-xylene	mg/kg	2	Org-016	[NT]	20	<2	<2	0	[NT]	[NT]
o-Xylene	mg/kg	1	Org-016	[NT]	20	<1	<1	0	[NT]	[NT]
naphthalene	mg/kg	1	Org-014	[NT]	20	<1	<1	0	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-016	[NT]	20	111	111	0	[NT]	[NT]

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QUALITY CONTROL: svTRH (C10-C40) in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-7	184710-6
Date extracted	-			08/02/2018	1	08/02/2018	08/02/2018		08/02/2018	08/02/2018
Date analysed	-			08/02/2018	1	09/02/2018	09/02/2018		08/02/2018	09/02/2018
TRH C_{10} - C_{14}	mg/kg	50	Org-003	<50	1	<50	<50	0	103	97
TRH C_{15} - C_{28}	mg/kg	100	Org-003	<100	1	<100	<100	0	101	95
TRH C_{29} - C_{36}	mg/kg	100	Org-003	<100	1	<100	<100	0	92	88
TRH >C_{10}-C_{16}	mg/kg	50	Org-003	<50	1	<50	<50	0	103	97
TRH >C_{16}-C_{34}	mg/kg	100	Org-003	<100	1	<100	<100	0	101	95
TRH >C_{34}-C_{40}	mg/kg	100	Org-003	<100	1	<100	<100	0	92	88
Surrogate o-Terphenyl	%		Org-003	83	1	82	83	1	90	91

QUALITY CONTROL: svTRH (C10-C40) in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	20	08/02/2018	08/02/2018		[NT]	[NT]
Date analysed	-			[NT]	20	09/02/2018	09/02/2018		[NT]	[NT]
TRH C_{10} - C_{14}	mg/kg	50	Org-003	[NT]	20	<50	<50	0	[NT]	[NT]
TRH C_{15} - C_{28}	mg/kg	100	Org-003	[NT]	20	<100	<100	0	[NT]	[NT]
TRH C_{29} - C_{36}	mg/kg	100	Org-003	[NT]	20	<100	<100	0	[NT]	[NT]
TRH >C_{10}-C_{16}	mg/kg	50	Org-003	[NT]	20	<50	<50	0	[NT]	[NT]
TRH >C_{16}-C_{34}	mg/kg	100	Org-003	[NT]	20	<100	<100	0	[NT]	[NT]
TRH >C_{34}-C_{40}	mg/kg	100	Org-003	[NT]	20	<100	<100	0	[NT]	[NT]
Surrogate o-Terphenyl	%		Org-003	[NT]	20	80	80	0	[NT]	[NT]

Client Reference: E30293KH, Bexley

QUALITY CONTROL: PAHs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-8	184710-6
Date extracted	-			08/02/2018	1	08/02/2018	08/02/2018		08/02/2018	08/02/2018
Date analysed	-			09/02/2018	1	09/02/2018	09/02/2018		09/02/2018	09/02/2018
Naphthalene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	94	85
Acenaphthylene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Fluorene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	95	89
Phenanthrene	mg/kg	0.1	Org-012	<0.1	1	<0.1	0.2	67	98	99
Anthracene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-012	<0.1	1	0.2	0.3	40	99	106
Pyrene	mg/kg	0.1	Org-012	<0.1	1	0.2	0.3	40	120	120
Benzo(a)anthracene	mg/kg	0.1	Org-012	<0.1	1	0.1	0.2	67	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-012	<0.1	1	0.1	0.2	67	93	99
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-012	<0.2	1	0.2	0.3	40	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-012	<0.05	1	0.2	0.2	0	101	115
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	<0.1	1	<0.1	0.1	0	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	94	1	94	92	2	121	109

QUALITY CONTROL: PAHs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	20	08/02/2018	08/02/2018		[NT]	[NT]
Date analysed	-			[NT]	20	09/02/2018	09/02/2018		[NT]	[NT]
Naphthalene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Acenaphthylene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Fluorene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Phenanthrene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Anthracene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Pyrene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Benzo(a)anthracene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-012	[NT]	20	<0.2	<0.2	0	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-012	[NT]	20	<0.05	<0.05	0	[NT]	[NT]
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	[NT]	20	90	90	0	[NT]	[NT]

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QUALITY CONTROL: Organochlorine Pesticides in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-8	184710-6
Date extracted	-			08/02/2018	1	08/02/2018	08/02/2018		08/02/2018	08/02/2018
Date analysed	-			09/02/2018	1	09/02/2018	09/02/2018		09/02/2018	09/02/2018
HCB	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	92	90
gamma-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
beta-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	89	87
Heptachlor	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	88	86
delta-BHC	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aldrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	84	83
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	89	89
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
pp-DDE	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	88	88
Dieldrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	93	94
Endrin	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	84	86
pp-DDD	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	91	91
Endosulfan II	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
pp-DDT	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	92	92
Methoxychlor	mg/kg	0.1	Org-005	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-005	106	1	108	108	0	124	115

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QUALITY CONTROL: Organophosphorus Pesticides					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-8	184710-6
Date extracted	-			08/02/2018	1	08/02/2018	08/02/2018		08/02/2018	08/02/2018
Date analysed	-			09/02/2018	1	09/02/2018	09/02/2018		09/02/2018	09/02/2018
Azinphos-methyl (Guthion)	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Bromophos-ethyl	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Chlorpyriphos	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	89	89
Chlorpyriphos-methyl	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Diazinon	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Dichlorvos	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	85	82
Dimethoate	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Ethion	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	98	110
Fenitrothion	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	109	101
Malathion	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	75	82
Parathion	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	98	113
Ronnel	mg/kg	0.1	Org-008	<0.1	1	<0.1	<0.1	0	103	98
Surrogate TCMX	%		Org-008	106	1	108	108	0	124	99

Client Reference: E30293KH, Bexley

QUALITY CONTROL: PCBs in Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-8	184710-6
Date extracted	-			08/02/2018	1	08/02/2018	08/02/2018		08/02/2018	08/02/2018
Date analysed	-			09/02/2018	1	09/02/2018	09/02/2018		09/02/2018	09/02/2018
Aroclor 1016	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1221	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1232	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1242	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1248	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1254	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	101	103
Aroclor 1260	mg/kg	0.1	Org-006	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCLMX	%		Org-006	106	1	108	108	0	124	99

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QUALITY CONTROL: Acid Extractable metals in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-7	184710-6
Date prepared	-			08/02/2018	1	08/02/2018	08/02/2018		08/02/2018	08/02/2018
Date analysed	-			08/02/2018	1	08/02/2018	08/02/2018		08/02/2018	08/02/2018
Arsenic	mg/kg	4	Metals-020	<4	1	<4	<4	0	112	96
Cadmium	mg/kg	0.4	Metals-020	<0.4	1	<0.4	<0.4	0	102	100
Chromium	mg/kg	1	Metals-020	<1	1	4	5	22	110	104
Copper	mg/kg	1	Metals-020	<1	1	5	5	0	111	97
Lead	mg/kg	1	Metals-020	<1	1	64	66	3	106	88
Mercury	mg/kg	0.1	Metals-021	<0.1	1	<0.1	<0.1	0	95	101
Nickel	mg/kg	1	Metals-020	<1	1	2	3	40	109	105
Zinc	mg/kg	1	Metals-020	<1	1	29	31	7	103	90

QUALITY CONTROL: Acid Extractable metals in soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	20	08/02/2018	08/02/2018		[NT]	[NT]
Date analysed	-			[NT]	20	08/02/2018	08/02/2018		[NT]	[NT]
Arsenic	mg/kg	4	Metals-020	[NT]	20	5	4	22	[NT]	[NT]
Cadmium	mg/kg	0.4	Metals-020	[NT]	20	<0.4	<0.4	0	[NT]	[NT]
Chromium	mg/kg	1	Metals-020	[NT]	20	13	15	14	[NT]	[NT]
Copper	mg/kg	1	Metals-020	[NT]	20	31	26	18	[NT]	[NT]
Lead	mg/kg	1	Metals-020	[NT]	20	40	33	19	[NT]	[NT]
Mercury	mg/kg	0.1	Metals-021	[NT]	20	<0.1	<0.1	0	[NT]	[NT]
Nickel	mg/kg	1	Metals-020	[NT]	20	5	7	33	[NT]	[NT]
Zinc	mg/kg	1	Metals-020	[NT]	20	54	51	6	[NT]	[NT]

Client Reference: E30293KH, Bexley

Result Definitions	
NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions	
Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	

Client Reference: E30293KH, Bexley

Laboratory Acceptance Criteria
Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.
Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.
In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.
When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.
Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.
Measurement Uncertainty estimates are available for most tests upon request.

Client Reference: E30293KH, Bexley

Report Comments
Asbestos: A portion of the supplied sample was sub-sampled for asbestos analysis according to Envirolab procedures. We cannot guarantee that this sub-sample is indicative of the entire sample. Envirolab recommends supplying 40-50g of sample in its own container. Note: Samples 184710-12, 15, 18 & 21 were sub-sampled from jars provided by the client.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details	
Client	Environmental Investigation Services
Attention	Todd Hore

Sample Login Details	
Your reference	E30293KH, Bexley
Envirolab Reference	184710
Date Sample Received	07/02/2018
Date Instructions Received	07/02/2018
Date Results Expected to be Reported	14/02/2018

Sample Condition	
Samples received in appropriate condition for analysis	YES
No. of Samples Provided	26 soil, 1 MATERIAL
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	13.1
Cooling Method	Ice
Sampling Date Provided	YES

Comments
Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
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Sample ID	VTRH(C6-C10)/BTEXN in Soil	svTRH (C10-C40) in Soil	PAHs in Soil	Organochlorine Pesticidesin soil	Organophosphorus Pesticides	PCBsin Soil	Acid Extractable metalsin soil	Asbestos ID - soils	Asbestos ID - materials	On Hold
BH101-0.2-0.4	✓	✓	✓	✓	✓	✓	✓	✓		
BH101-0.5-0.95	✓	✓	✓				✓	✓		
BH101-1.6-1.95										✓
BH102-0-0.2	✓	✓	✓				✓	✓		
BH102-0.5-0.95										✓
BH102-1.5-1.95	✓	✓	✓	✓	✓	✓	✓	✓		
BH102-3.0-3.45										✓
BH102-4.53-4.95										✓
BH102-6.5-6.7										✓
BH103-0.03-0.2	✓	✓	✓	✓	✓	✓	✓	✓		
BH103-0.5-0.9										✓
BH103-0.9-1.1	✓	✓	✓				✓	✓		
BH103-1.5-1.95										✓
BH104-0.03-0.2	✓	✓	✓	✓	✓	✓	✓	✓		
BH104-0.5-0.95	✓	✓	✓				✓	✓		
BH105-0-0.2	✓	✓	✓	✓	✓	✓	✓	✓		
BH105-0.85-0.95										✓
BH105-1.1-1.3	✓	✓	✓				✓	✓		
BH105-1.5-1.95										✓
BH106-0-0.2	✓	✓	✓	✓	✓	✓	✓	✓		
BH106-0.5-0.8	✓	✓	✓				✓	✓		
BH106-1.3-135										✓
BH106-5.2-5.3										✓
TSAM1	✓									
TBAM1	✓									
AMF1									✓	
DUPHL1	✓	✓	✓				✓			

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info
Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.

SAMPLE AND CHAIN OF CUSTODY FORM

TO:
ENVIROLAB SERVICES PTY LTD
12 ASHLEY STREET
CHATSWOOD NSW 2067
P: (02) 99106200
F: (02) 99106201

Attention: Aileen

EIS Job Number: E30293KH

Date Results Required: STANDARD

Page: 1/2

FROM:
EIS
ENVIRONMENTAL INVESTIGATION SERVICES
REAR OF 115 WICKS ROAD
MACQUARIE PARK, NSW 2113
P: 02-9888 5000 F: 02-9888 5001
Attention: Todd Hore

Location: Bexley

Sampler: AM/HL

Sample Preserved in Esky on Ice

Tests Required

Date Sampled	Lab Ref:	Sample Number	Depth (m)	Sample Container	PID	Sample Description	PH	Combo 3a	Combo 3	Combo 6a	8 Metals	PAHs	TRH/BTEX	BTEX	Asbestos	CEC	Clay content	
7/2/18	1	BH101	0.2-0.4	G, A	0	Fill Soil				X								
	2		0.5-0.95	G,A	0	FS		X										
	3		1.6-1.95	G	0	Nat Soil												
	4	BH102	0-0.2	G,A	0	FS		X										
	5		0.5-0.95		0	FS												
	6		1.5-1.95		0	FS				X								
	7		3.0-3.45		0	FS												
	8		4.5-4.95		0	FS												
	9		6.5-6.7	G	0	NS												
	10	BH103	0.03-0.2	G,A	0	FS				X								
	11		0.5-0.9		0	FS												
	12		0.9-1.1	G	0	NS		X										
	13		1.5-1.95		0	NS												
	14	BH104	0.03-0.2	G,A	0	FS				X								
	15		0.5-0.95	G	0	NS		X										
	16	BH105	0-0.2	G,A	0	FS				X								
	17		0.85-0.95	G	0	NS												
	18		1.1-1.3		0	NS		X										
	19		1.5-1.95		0	NS												
	20	BH106	0-0.2	G,A	0	FS				X								
	21		0.5-0.8	G	0	FS		X										
	22		1.3-1.5		0	NS												
	23		5.2-5.3		0	Nat Rock												
	24	TSAM1	–	G	–	Spike								X				
	25	TBAM1	–	V	–	Blank								X				

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200
Job No: 184710
Date Received: 7/2/18
Time Received: 15:45
Received by: AB
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Remarks (comments/detection limits required):

Sample Containers:
G - 250mg Glass Jar
A - Ziplock Asbestos Bag
P - Plastic Bag

Relinquished By: [signature] Date: 7/2/18 Time: 2.30pm Received By: AB/ELS Date: 7/2/18

SAMPLE AND CHAIN OF CUSTODY FORM

TO: ENVIROLAB SERVICES PTY LTD 12 ASHLEY STREET CHATSWOOD NSW 2067 P: (02) 99106200 F: (02) 99106201 Attention: Aileen	EIS Job Number: E30293KH Date Results Required: STANDARD Page: 2/2	**FROM:** ENVIRONMENTAL INVESTIGATION SERVICES REAR OF 115 WICKS ROAD MACQUARIE PARK, NSW 2113 P: 02-9888 5000 F: 02-9888 5001 Attention: Todd Hore EIS

Location: Bexley
Sampler: AM/HL

Sample Preserved in Esky on Ice

Tests Required

Date Sampled	Lab Ref:	Sample Number	Depth (m)	Sample Container	PID	Sample Description	PH	Combo 3a	Combo 3	Combo 6a	8 Metals	PAHs	TRH/BTEX	BTEX	Asbestos	CEC	Clay content
7/2/18	26	AMF1	–	A	–	Fragment									X		
↓	27	DUPHL1	–	G	–	FS			X								

Remarks (comments/detection limits required):

Sample Containers:
G - 250mg Glass Jar
A - Ziplock Asbestos Bag
P - Plastic Bag

Relinquished By:	Date:	Time:	Received By:	Date:
[signature]	7/2/18	2.30pm	AB / ELS	7/2/18

184710

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 185317

Client Details	
Client	Environmental Investigation Services
Attention	Todd Hore
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details	
Your Reference	**E30293KH, Bexley**
Number of Samples	3 water
Date samples received	15/02/2018
Date completed instructions received	15/02/2018

Analysis Details
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details	
Date results requested by	22/02/2018
Date of Issue	20/02/2018
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***	

Results Approved By
Jaimie Loa-Kum-Cheung, Senior Chemist
Jeremy Faircloth, Organics Supervisor
Leon Ow, Chemist
Priya Samarawickrama, Senior Chemist
Steven Luong, Senior Chemist

Authorised By

David Springer, General Manager

Envirolab Reference: 185317
Revision No: R00

ACCREDITED FOR TECHNICAL COMPETENCE

Page | **1 of 20**

Client Reference: E30293KH, Bexley

VOCs in water			
Our Reference		185317-1	185317-2
Your Reference	UNITS	MW2	MW6
Date Sampled		15/02/2018	15/02/2018
Type of sample		water	water
Date extracted	-	16/02/2018	16/02/2018
Date analysed	-	16/02/2018	16/02/2018
Dichlorodifluoromethane	µg/L	<10	<10
Chloromethane	µg/L	<10	<10
Vinyl Chloride	µg/L	<10	<10
Bromomethane	µg/L	<10	<10
Chloroethane	µg/L	<10	<10
Trichlorofluoromethane	µg/L	<10	<10
1,1-Dichloroethene	µg/L	<1	<1
Trans-1,2-dichloroethene	µg/L	<1	<1
1,1-dichloroethane	µg/L	<1	<1
Cis-1,2-dichloroethene	µg/L	<1	<1
Bromochloromethane	µg/L	<1	<1
Chloroform	µg/L	<1	<1
2,2-dichloropropane	µg/L	<1	<1
1,2-dichloroethane	µg/L	<1	<1
1,1,1-trichloroethane	µg/L	<1	<1
1,1-dichloropropene	µg/L	<1	<1
Cyclohexane	µg/L	<1	<1
Carbon tetrachloride	µg/L	<1	<1
Benzene	µg/L	<1	<1
Dibromomethane	µg/L	<1	<1
1,2-dichloropropane	µg/L	<1	<1
Trichloroethene	µg/L	<1	<1
Bromodichloromethane	µg/L	<1	<1
trans-1,3-dichloropropene	µg/L	<1	<1
cis-1,3-dichloropropene	µg/L	<1	<1
1,1,2-trichloroethane	µg/L	<1	<1
Toluene	µg/L	<1	<1
1,3-dichloropropane	µg/L	<1	<1
Dibromochloromethane	µg/L	<1	<1
1,2-dibromoethane	µg/L	<1	<1
Tetrachloroethene	µg/L	<1	<1
1,1,1,2-tetrachloroethane	µg/L	<1	<1
Chlorobenzene	µg/L	<1	<1
Ethylbenzene	µg/L	<1	<1
Bromoform	µg/L	<1	<1

Client Reference: E30293KH, Bexley

VOCs in water			
Our Reference		185317-1	185317-2
Your Reference	UNITS	MW2	MW6
Date Sampled		15/02/2018	15/02/2018
Type of sample		water	water
m+p-xylene	µg/L	<2	<2
Styrene	µg/L	<1	<1
1,1,2,2-tetrachloroethane	µg/L	<1	<1
o-xylene	µg/L	<1	<1
1,2,3-trichloropropane	µg/L	<1	<1
Isopropylbenzene	µg/L	<1	<1
Bromobenzene	µg/L	<1	<1
n-propyl benzene	µg/L	<1	<1
2-chlorotoluene	µg/L	<1	<1
4-chlorotoluene	µg/L	<1	<1
1,3,5-trimethyl benzene	µg/L	<1	<1
Tert-butyl benzene	µg/L	<1	<1
1,2,4-trimethyl benzene	µg/L	<1	<1
1,3-dichlorobenzene	µg/L	<1	<1
Sec-butyl benzene	µg/L	<1	<1
1,4-dichlorobenzene	µg/L	<1	<1
4-isopropyl toluene	µg/L	<1	<1
1,2-dichlorobenzene	µg/L	<1	<1
n-butyl benzene	µg/L	<1	<1
1,2-dibromo-3-chloropropane	µg/L	<1	<1
1,2,4-trichlorobenzene	µg/L	<1	<1
Hexachlorobutadiene	µg/L	<1	<1
1,2,3-trichlorobenzene	µg/L	<1	<1
Surrogate Dibromofluoromethane	%	95	104
Surrogate toluene-d8	%	97	92
Surrogate 4-BFB	%	91	93

Client Reference: E30293KH, Bexley

vTRH(C6-C10)/BTEXN in Water				
Our Reference		185317-1	185317-2	185317-3
Your Reference	UNITS	MW2	MW6	DUPAM1
Date Sampled		15/02/2018	15/02/2018	15/02/2018
Type of sample		water	water	water
Date extracted	-	16/02/2018	16/02/2018	16/02/2018
Date analysed	-	16/02/2018	16/02/2018	16/02/2018
TRH C_6 - C_9	µg/L	<10	<10	<10
TRH C_6 - C_{10}	µg/L	<10	<10	<10
TRH C_6 - C_{10} less BTEX (F1)	µg/L	<10	<10	<10
Benzene	µg/L	<1	<1	<1
Toluene	µg/L	<1	<1	<1
Ethylbenzene	µg/L	<1	<1	<1
m+p-xylene	µg/L	<2	<2	<2
o-xylene	µg/L	<1	<1	<1
Naphthalene	µg/L	<1	<1	<1
Surrogate Dibromofluoromethane	%	95	104	108
Surrogate toluene-d8	%	97	92	99
Surrogate 4-BFB	%	91	93	118

Client Reference: E30293KH, Bexley

svTRH (C10-C40) in Water				
Our Reference		185317-1	185317-2	185317-3
Your Reference	UNITS	MW2	MW6	DUPAM1
Date Sampled		15/02/2018	15/02/2018	15/02/2018
Type of sample		water	water	water
Date extracted	-	16/02/2018	16/02/2018	16/02/2018
Date analysed	-	17/02/2018	17/02/2018	17/02/2018
TRH C_{10} - C_{14}	µg/L	<50	<50	<50
TRH C_{15} - C_{28}	µg/L	<100	<100	<100
TRH C_{29} - C_{36}	µg/L	<100	<100	<100
TRH >C_{10} - C_{16}	µg/L	<50	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	µg/L	<50	<50	<50
TRH >C_{16} - C_{34}	µg/L	<100	<100	<100
TRH >C_{34} - C_{40}	µg/L	<100	<100	<100
Surrogate o-Terphenyl	%	90	92	94

Client Reference: E30293KH, Bexley

PAHs in Water - Low Level				
Our Reference		185317-1	185317-2	185317-3
Your Reference	UNITS	MW2	MW6	DUPAM1
Date Sampled		15/02/2018	15/02/2018	15/02/2018
Type of sample		water	water	water
Date extracted	-	16/02/2018	16/02/2018	16/02/2018
Date analysed	-	19/02/2018	19/02/2018	19/02/2018
Naphthalene	µg/L	<0.2	<0.2	<0.2
Acenaphthylene	µg/L	<0.1	<0.1	<0.1
Acenaphthene	µg/L	<0.1	<0.1	<0.1
Fluorene	µg/L	<0.1	<0.1	<0.1
Phenanthrene	µg/L	<0.1	<0.1	<0.1
Anthracene	µg/L	<0.1	<0.1	<0.1
Fluoranthene	µg/L	<0.1	<0.1	<0.1
Pyrene	µg/L	<0.1	<0.1	<0.1
Benzo(a)anthracene	µg/L	<0.1	<0.1	<0.1
Chrysene	µg/L	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	µg/L	<0.2	<0.2	<0.2
Benzo(a)pyrene	µg/L	<0.1	<0.1	<0.1
Indeno(1,2,3-c,d)pyrene	µg/L	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	µg/L	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	µg/L	<0.1	<0.1	<0.1
Benzo(a)pyrene TEQ	µg/L	<0.5	<0.5	<0.5
Total +ve PAH's	µg/L	NIL (+)VE	NIL (+)VE	NIL (+)VE
Surrogate p-Terphenyl-d14	%	99	102	98

Client Reference: E30293KH, Bexley

HM in water - dissolved				
Our Reference		185317-1	185317-2	185317-3
Your Reference	UNITS	MW2	MW6	DUPAM1
Date Sampled		15/02/2018	15/02/2018	15/02/2018
Type of sample		water	water	water
Date prepared	-	16/02/2018	16/02/2018	16/02/2018
Date analysed	-	16/02/2018	16/02/2018	16/02/2018
Arsenic-Dissolved	µg/L	<1	<1	<1
Cadmium-Dissolved	µg/L	<0.1	0.1	0.1
Chromium-Dissolved	µg/L	<1	<1	<1
Copper-Dissolved	µg/L	<1	<1	<1
Lead-Dissolved	µg/L	<1	<1	<1
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	<1	13	13
Zinc-Dissolved	µg/L	9	77	78

Client Reference: E30293KH, Bexley

Miscellaneous Inorganics			
Our Reference		185317-1	185317-2
Your Reference	UNITS	MW2	MW6
Date Sampled		15/02/2018	15/02/2018
Type of sample		water	water
Date prepared	-	15/02/2018	15/02/2018
Date analysed	-	15/02/2018	15/02/2018
pH	pH Units	6.2	6.3
Electrical Conductivity	µS/cm	730	850

Client Reference: E30293KH, Bexley

Cations in water Dissolved			
Our Reference		185317-1	185317-2
Your Reference	UNITS	MW2	MW6
Date Sampled		15/02/2018	15/02/2018
Type of sample		water	water
Date digested	-	16/02/2018	16/02/2018
Date analysed	-	16/02/2018	16/02/2018
Calcium - Dissolved	mg/L	43	29
Magnesium - Dissolved	mg/L	6.5	15
Hardness	mgCaCO 3 /L	130	130

Client Reference: E30293KH, Bexley

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.
Org-013	Water samples are analysed directly by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.

Client Reference: E30293KH, Bexley

QUALITY CONTROL: VOCs in water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W3	[NT]
Date extracted	-			16/02/2018	[NT]	[NT]	[NT]	[NT]	16/02/2018	[NT]
Date analysed	-			16/02/2018	[NT]	[NT]	[NT]	[NT]	16/02/2018	[NT]
Dichlorodifluoromethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chloromethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Vinyl Chloride	µg/L	10	Org-013	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Bromomethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chloroethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Trichlorofluoromethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,1-Dichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Trans-1,2-dichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,1-dichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Cis-1,2-dichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Bromochloromethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chloroform	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	87	[NT]
2,2-dichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2-dichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	110	[NT]
1,1,1-trichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	119	[NT]
1,1-dichloropropene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Cyclohexane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Carbon tetrachloride	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Dibromomethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2-dichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Trichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	83	[NT]
Bromodichloromethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	87	[NT]
trans-1,3-dichloropropene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
cis-1,3-dichloropropene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,1,2-trichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Toluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,3-dichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Dibromochloromethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	84	[NT]
1,2-dibromoethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Tetrachloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	83	[NT]
1,1,1,2-tetrachloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Ethylbenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Bromoform	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
m+p-xylene	µg/L	2	Org-013	<2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Styrene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,1,2,2-tetrachloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
o-xylene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Client Reference: E30293KH, Bexley

QUALITY CONTROL: VOCs in water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W3	[NT]
1,2,3-trichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Isopropylbenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Bromobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
n-propyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
2-chlorotoluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
4-chlorotoluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,3,5-trimethyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Tert-butyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2,4-trimethyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,3-dichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Sec-butyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,4-dichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
4-isopropyl toluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2-dichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
n-butyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2-dibromo-3-chloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2,4-trichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Hexachlorobutadiene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
1,2,3-trichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate Dibromofluoromethane	%		Org-013	96	[NT]	[NT]	[NT]	[NT]	108	[NT]
Surrogate toluene-d8	%		Org-013	99	[NT]	[NT]	[NT]	[NT]	98	[NT]
Surrogate 4-BFB	%		Org-013	92	[NT]	[NT]	[NT]	[NT]	94	[NT]

Client Reference: E30293KH, Bexley

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W3	[NT]
Date extracted	-			16/02/2018	[NT]	[NT]	[NT]	[NT]	16/02/2018	[NT]
Date analysed	-			16/02/2018	[NT]	[NT]	[NT]	[NT]	16/02/2018	[NT]
TRH C_6 - C_9	µg/L	10	Org-016	<10	[NT]	[NT]	[NT]	[NT]	84	[NT]
TRH C_6 - C_{10}	µg/L	10	Org-016	<10	[NT]	[NT]	[NT]	[NT]	84	[NT]
Benzene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	92	[NT]
Toluene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	85	[NT]
Ethylbenzene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	81	[NT]
m+p-xylene	µg/L	2	Org-016	<2	[NT]	[NT]	[NT]	[NT]	80	[NT]
o-xylene	µg/L	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	80	[NT]
Naphthalene	µg/L	1	Org-013	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate Dibromofluoromethane	%		Org-016	96	[NT]	[NT]	[NT]	[NT]	108	[NT]
Surrogate toluene-d8	%		Org-016	99	[NT]	[NT]	[NT]	[NT]	98	[NT]
Surrogate 4-BFB	%		Org-016	92	[NT]	[NT]	[NT]	[NT]	94	[NT]

Client Reference: E30293KH, Bexley

QUALITY CONTROL: svTRH (C10-C40) in Water					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	[NT]
Date extracted	-			16/02/2018	[NT]	[NT]	[NT]	[NT]	16/02/2018	[NT]
Date analysed	-			17/02/2018	[NT]	[NT]	[NT]	[NT]	17/02/2018	[NT]
TRH C_{10} - C_{14}	µg/L	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	99	[NT]
TRH C_{15} - C_{28}	µg/L	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	130	[NT]
TRH C_{29} - C_{36}	µg/L	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	120	[NT]
TRH >C_{10} - C_{16}	µg/L	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	99	[NT]
TRH >C_{16} - C_{34}	µg/L	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	130	[NT]
TRH >C_{34} - C_{40}	µg/L	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	120	[NT]
Surrogate o-Terphenyl	%		Org-003	75	[NT]	[NT]	[NT]	[NT]	105	[NT]

Client Reference: E30293KH, Bexley

QUALITY CONTROL: PAHs in Water - Low Level					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W3	[NT]
Date extracted	-			16/02/2018	[NT]	[NT]	[NT]	[NT]	16/02/2018	[NT]
Date analysed	-			19/02/2018	[NT]	[NT]	[NT]	[NT]	19/02/2018	[NT]
Naphthalene	µg/L	0.2	Org-012	<0.2	[NT]	[NT]	[NT]	[NT]	76	[NT]
Acenaphthylene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Acenaphthene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluorene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	83	[NT]
Phenanthrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	89	[NT]
Anthracene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluoranthene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	79	[NT]
Pyrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	95	[NT]
Benzo(a)anthracene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chrysene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	84	[NT]
Benzo(b,j+k)fluoranthene	µg/L	0.2	Org-012	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(a)pyrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	101	[NT]
Indeno(1,2,3-c,d)pyrene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Dibenzo(a,h)anthracene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(g,h,i)perylene	µg/L	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	93	[NT]	[NT]	[NT]	[NT]	92	[NT]

Client Reference: E30293KH, Bexley

QUALITY CONTROL: HM in water - dissolved					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	185317-2
Date prepared	-			16/02/2018	1	16/02/2018	16/02/2018		16/02/2018	16/02/2018
Date analysed	-			16/02/2018	1	16/02/2018	16/02/2018		16/02/2018	16/02/2018
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		103	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	[NT]		104	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		95	[NT]
Copper-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		93	[NT]
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		102	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	98	100
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	<1	[NT]		102	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	9	[NT]		101	[NT]

Client Reference: E30293KH, Bexley

QUALITY CONTROL: Miscellaneous Inorganics					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			15/02/2018	[NT]	[NT]	[NT]	[NT]	15/02/2018	[NT]
Date analysed	-			15/02/2018	[NT]	[NT]	[NT]	[NT]	15/02/2018	[NT]
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	102	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	96	[NT]

Client Reference: E30293KH, Bexley

QUALITY CONTROL: Cations in water Dissolved					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date digested	-			16/02/2018	[NT]	[NT]	[NT]	[NT]	16/02/2018	[NT]
Date analysed	-			16/02/2018	[NT]	[NT]	[NT]	[NT]	16/02/2018	[NT]
Calcium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	102	[NT]
Magnesium - Dissolved	mg/L	0.5	Metals-020	<0.5	[NT]	[NT]	[NT]	[NT]	103	[NT]

Client Reference: E30293KH, Bexley

Result Definitions	
NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions	
Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	

Client Reference: E30293KH, Bexley

Laboratory Acceptance Criteria
Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.
Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.
In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.
When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.
Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.
Measurement Uncertainty estimates are available for most tests upon request.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

SAMPLE RECEIPT ADVICE

Client Details	
Client	Environmental Investigation Services
Attention	Todd Hore

Sample Login Details	
Your reference	E30293KH, Bexley
Envirolab Reference	185317
Date Sample Received	15/02/2018
Date Instructions Received	15/02/2018
Date Results Expected to be Reported	22/02/2018

Sample Condition	
Samples received in appropriate condition for analysis	YES
No. of Samples Provided	3 water
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	11.5
Cooling Method	Ice
Sampling Date Provided	YES

Comments
Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

Sample ID	VOCs in water	vTRH(C6-C10)/BTEXN in Water	svTRH (C10-C40) in Water	PAHs in Water - Low Level	HM in water - dissolved	pH	Electrical Conductivity	Cations in water Dissolved
MW2	✓	✓	✓	✓	✓	✓	✓	✓
MW6	✓	✓	✓	✓	✓	✓	✓	✓
DUPAM1		✓	✓	✓	✓			

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info
Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.

SAMPLE AND CHAIN OF CUSTODY FORM

TO: ENVIROLAB SERVICES PTY LTD 12 ASHLEY STREET CHATSWOOD NSW 2067 P: (02) 99106200 F: (02) 99106201 Attention: Aileen	EIS Job Number: E30293KH Date Results Required: STANDARD Page: 1 of 1	**FROM:** ENVIRONMENTAL INVESTIGATION SERVICES REAR OF 115 WICKS ROAD MACQUARIE PARK, NSW 2113 P: 02-9888 5000 F: 02-9888 5001 Attention: Todd Hore

Location: Bexley

Sampler: HL/AM

Sample Preserved in Esky on Ice

Tests Required

Date Sampled	Lab Ref:	Sample Number	Sample Containers	PID	Sample Description	Combo 3L	VOCs	pH / EC	Hardness
15/02/2018	1	MW2	G1, V, H	0.0	water	X	X	X	X
15/02/2018	2	MW6	G1, V, H	0.0	water	X	X	X	X
15/02/2018	3	DUPAM1	G1, V, H	0.0	water	X			

ENVIROLAB Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 185317

Date Received: 15/2/18
Time Received: 15:30
Received by: AB
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Remarks (comments/detection limits required):

All analysis PQLs to ANZECC (2000) Detection Limits Please

Sample Containers:
G1 - 500mL Amber Glass Bottle G2 - 1L Amber Glass Bottle
V - BTEX Vial H - HNO3 Wash PVC
PVC - HDPE Plastic Bottles

Relinquished By:	Date:	Time:	Received By:	Date:
HL AM	15/2/2018	15:30	AB	15/2/18

EIS

Appendix C: Report Explanatory Notes

EIS

STANDARD SAMPLING PROCEDURE

These protocols specify the basic procedures to be used when sampling soils or groundwater for environmental site assessments undertaken by EIS. The purpose of these protocols is to provide standard methods for: sampling, decontamination procedures for sampling equipment, sample preservation, sample storage and sample handling. Deviations from these procedures must be recorded.

Soil Sampling

- Prepare a borehole/test pit log or made a note of the sample description for stockpiles.
- Layout sampling equipment on clean plastic sheeting to prevent direct contact with ground surface. The work area should be at a distance from the drill rig/excavator such that the machine can operate in a safe manner.
- Ensure all sampling equipment has been decontaminated prior to use.
- Remove any surface debris from the immediate area of the sampling location.
- Collect samples and place in glass jar with a Teflon seal. This should be undertaken as quickly as possible to prevent the loss of any volatiles. If possible, fill the glass jars completely.
- Collect samples for asbestos analysis and place in a zip-lock plastic bag.
- Label the sampling containers with the EIS job number, sample location (eg. BH1), sampling depth interval and date. If more than one sample container is used, this should also be indicated (eg. 2 = Sample jar 1 of 2 jars).
- Photoionisation detector (PID) screening of volatile organic compounds (VOCs) should be undertaken on samples using the soil sample headspace method. Headspace measurements are taken following equilibration of the headspace gasses in partly filled zip-lock plastic bags. PID headspace data is recorded on the borehole/test pit log and the chain of custody forms.
- Record the lithology of the sample and sample depth on the borehole/test pit log generally in accordance with AS1726-1993[20].
- Store the sample in a sample container cooled with ice or chill packs. On completion of the sampling the sample container should be delivered to the lab immediately or stored in the refrigerator prior to delivery to the lab. All samples are preserved in accordance with the standards outlined in the report.
- Check for the presence of groundwater after completion of each borehole using an electronic dip metre or water whistle. Boreholes should be left open until the end of fieldwork where it is safe to do so. All groundwater levels in the boreholes should be rechecked on the completion of the fieldwork.
- Backfill the boreholes/test pits with the excavation cuttings or clean sand prior to leaving the site.

Decontamination Procedures for Soil Sampling Equipment

- All sampling equipment should be decontaminated between every sampling location. This excludes single use PVC tubing used for push tubes etc. Equipment and materials required for the decontamination include:
  - Phosphate free detergent (Decon 90);
  - Potable water;
  - Stiff brushes; and
  - Plastic sheets.
- Ensure the decontamination materials are clean prior to proceeding with the decontamination.
- Fill both buckets with clean potable water and add phosphate free detergent to one bucket.

[20] Standards Australia, (1993), *Geotechnical Site Investigations.* (AS1726-1993)

- In the bucket containing the detergent, scrub the sampling equipment until all the material attached to the equipment has been removed.
- Rinse sampling equipment in the bucket containing potable water.
- Place cleaned equipment on clean plastic sheets.

If all materials are not removed by this procedure, high-pressure water cleaning is recommended. If any equipment is not completely decontaminated by both these processes, then the equipment should not be used until it has been thoroughly cleaned.

Groundwater Sampling

Groundwater samples are more sensitive to contamination than soil samples and therefore adhesion to this protocol is particularly important to obtain reliable, reproducible results. The recommendations detailed in AS/NZS 5667.1:1998 are considered to form a minimum standard.

The basis of this protocol is to maintain the security of the borehole and obtain accurate and representative groundwater samples. The following procedure should be used for collection of groundwater samples from previously installed groundwater monitoring wells.

- After monitoring well installation, at least three bore volumes should be pumped from the monitoring wells (well development) to remove any water introduced during the drilling process and/or the water that is disturbed during installation of the monitoring well. This should be completed prior to purging and sampling.
- Groundwater monitoring wells should then be left to recharge for at least three days before purging and sampling. Prior to purging or sampling, the condition of each well should observed and any anomalies recorded on the field data sheets. The following information should be noted: the condition of the well, noting any signs of damage, tampering or complete destruction; the condition and operation of the well lock; the condition of the protective casing and the cement footing (raised or cracked); and, the presence of water between protective casing and well.
- Measure the groundwater level from the collar of the piezometer/monitoring well using an electronic dip meter. The collar level should be taken (if required) during the site visit using a dumpy level and staff.
- Purging and sampling of piezometers/monitoring wells is done on the same site visit when using micro-purge (or other low flow) techniques.
- Layout and organize all equipment associated with groundwater sampling in a location where they will not interfere with the sampling procedure and will not pose a risk of contaminating samples. Equipment generally required includes:
  - Stericup single-use filters (for heavy metals samples);
  - Bucket with volume increments;
  - Sample containers: teflon bottles with 1 ml nitric acid, 75mL glass vials with 1 mL hydrochloric acid, 1 L amber glass bottles;
  - Bucket with volume increments;
  - Flow cell;
  - pH/EC/Eh/Temperature meters;
  - Plastic drums used for transportation of purged water;
  - Esky and ice;
  - Nitrile gloves;
  - Distilled water (for cleaning);
  - Electronic dip meter;
  - Low flow peristaltic pump and associated tubing; and
  - Groundwater sampling forms.

- Ensure all non-disposable sampling equipment is decontaminated or that new disposable equipment is available prior to any work commencing at a new location. The procedure for decontamination of groundwater equipment is outlined at the end of this section.
- Disposable gloves should be used whenever samples are taken to protect the sampler and to assist in avoidance of contamination.
- Groundwater samples are obtained from the monitoring wells using low flow sampling equipment to reduce the disturbance of the water column and loss of volatiles.
- During pumping to purge the well, the pH, temperature, conductivity, dissolved oxygen, redox potential and groundwater levels are monitored (where possible) using calibrated field instruments to assess the development of steady state conditions. Steady state conditions are generally considered to have been achieved when the difference in the pH measurements was less than 0.2 units and the difference in conductivity was less than 10%.
- All measurements are recorded on specific data sheets.
- Once steady state conditions are considered to have been achieved, groundwater samples are obtained directly from the pump tubing and placed in appropriate glass bottles, BTEX vials or plastic bottles.
- All samples are preserved in accordance with water sampling requirements specified by the laboratory and placed in an insulated container with ice. Groundwater samples are preserved by immediate storage in an insulated sample container with ice.
- At the end of each water sampling complete a chain of custody form for samples being sent to the laboratory.

Decontamination Procedures for Groundwater Sampling Equipment

- All equipment associated with the groundwater sampling procedure (other than single-use items) should be decontaminated between every sampling location.
- The following equipment and materials are required for the decontamination procedure:
  - Phosphate free detergent;
  - Potable water;
  - Distilled water; and
  - Plastic Sheets or bulk bags (plastic bags).
- Fill one bucket with clean potable water and phosphate free detergent, and one bucket with distilled water.
- Flush potable water and detergent through pump head. Wash sampling equipment and pump head using brushes in the bucket containing detergent until all materials attached to the equipment are removed.
- Flush pump head with distilled water.
- Change water and detergent solution after each sampling location.
- Rinse sampling equipment in the bucket containing distilled water.
- Place cleaned equipment on clean plastic sheets.
- If all materials are not removed by this procedure that equipment should not be used until it has been thoroughly cleaned

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QA/QC DEFINITIONS

The QA/QC terms used in this report are defined below. The definitions are in accordance with US EPA publication SW-846, entitled *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (1994)[21] methods and those described in *Environmental Sampling and Analysis, A Practical Guide,* (1991)[22].

Practical Quantitation Limit (PQL), Limit of Reporting (LOR) & Estimated Quantitation Limit (EQL)

These terms all refer to the concentration above which results can be expressed with a minimum 95% confidence level. The laboratory reporting limits are generally set at ten times the standard deviation for the Method Detection Limit for each specific analyte. For the purposes of this report the LOR, PQL, and EQL are considered to be equivalent.

When assessing laboratory data it should be borne in mind that values at or near the PQL have two important limitations: *"The uncertainty of the measurement value can approach, and even equal, the reported value. Secondly, confirmation of the analytes reported is virtually impossible unless identification uses highly selective methods. These issues diminish when reliably measurable amounts of analytes are present. Accordingly, legal and regulatory actions should be limited to data at or above the reliable detection limit"* (Keith, 1991).

Precision

The degree to which data generated from repeated measurements differ from one another due to random errors. Precision is measured using the standard deviation or Relative Percent Difference (RPD).

Accuracy

Accuracy is a measure of the agreement between an experimental result and the true value of the parameter being measured (i.e. the proximity of an averaged result to the true value, where all random errors have been statistically removed). The assessment of accuracy for an analysis can be achieved through the analysis of known reference materials or assessed by the analysis of surrogates, field blanks, trip spikes and matrix spikes. Accuracy is typically reported as percent recovery.

Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is primarily dependent upon the design and implementation of the sampling program. Representativeness of the data is partially ensured by the avoidance of contamination, adherence to sample handing and analysis protocols and use of proper chain-of-custody and documentation procedures.

Completeness

Completeness is a measure of the number of valid measurements in a data set compared to the total number of measurements made and overall performance against DQIs. The following information is assessed for completeness:

- Chain-of-custody forms;
- Sample receipt form;
- All sample results reported;

---

[21] US EPA, (1994). *SW-846: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* (US EPA SW-846)

[22] Keith., H, (1991). *Environmental Sampling and Analysis, A Practical Guide.*

EIS

- All blank data reported;
- All laboratory duplicate and RPDs calculated;
- All surrogate spike data reported;
- All matrix spike and lab control spike (LCS) data reported and RPDs calculated;
- Spike recovery acceptable limits reported; and
- NATA stamp on reports.

Comparability

Comparability is the evaluation of the similarity of conditions (e.g. sample depth, sample homogeneity) under which separate sets of data are produced. Data comparability checks include a bias assessment that may arise from the following sources:

- Collection and analysis of samples by different personnel; Use of different techniques;
- Collection and analysis by the same personnel using the same methods but at different times; and
- Spatial and temporal changes (due to environmental dynamics).

Blanks

The purpose of laboratory and field blanks is to check for artefacts and interferences that may arise during sampling, transport and analysis.

Matrix Spikes

Samples are spiked with laboratory grade standards to detect interactive effects between the sample matrix and the analytes being measured. Matrix Spikes are reported as a percent recovery and are prepared for 1 in every 20 samples. Sample batches that contain less than 20 samples may be reported with a Matrix Spike from another batch. The percent recovery is calculated using the formula below. Acceptable recovery limits are 70% to 130%.

$$\frac{(\text{Spike Sample Result} - \text{Sample Result}) \times 100}{\text{Concentration of Spike Added}}$$

Surrogate Spikes

Samples are spiked with a known concentration of compounds that are chemically related to the analyte being investigated but unlikely to be detected in the environment. The purpose of the Surrogate Spikes is to check the accuracy of the analytical technique. Surrogate Spikes are reported as percent recovery.

Duplicates

Laboratory duplicates measure precision, expressed as Relative Percent Difference. Duplicates are prepared from a single field sample and analysed as two separate extraction procedures in the laboratory. The RPD is calculated using the formula where D1 is the sample concentration and D2 is the duplicate sample concentration:

$$\frac{(D1 - D2) \times 100}{\{(D1 + D2)/2\}}$$

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SCREENING CRITERIA DEFINITIONS

The following definitions have been adopted based on Schedule B(1) of NEPM (2013) and are relevant to Tier 1 screening criteria adopted for contamination assessments.

Health investigation levels (HILs) have been developed for a broad range of metals and organic substances. The HILs are applicable for assessing human health risk via all relevant pathways of exposure. The HILs are generic to all soil types and apply generally to a depth of 3 m below the surface for residential use. Site-specific conditions should determine the depth to which HILs apply for other land uses.

Health screening levels (HSLs) have been developed for selected petroleum compounds and fractions and are applicable to assessing human health risk via the inhalation and direct contact pathways. The HSLs depend on specific soil physicochemical properties, land use scenarios, and the characteristics of building structures. They apply to different soil types, and depths below surface to >4 m. HSLs have also been developed for asbestos and apply to the top 3m of soil.

Ecological investigation levels (EILs) have been developed for selected metals and organic substances and are applicable for assessing risk to terrestrial ecosystems. EILs depend on specific soil physicochemical properties and land use scenarios and generally apply to the top 2 m of soil.

Ecological screening levels (ESLs) have been developed for selected petroleum hydrocarbon compounds and total petroleum/recoverable hydrocarbon (TPH/TRH) fractions and are applicable for assessing risk to terrestrial ecosystems. ESLs broadly apply to coarse- and fine-grained soils and various land uses. They are generally applicable to the top 2 m of soil.

Groundwater investigation levels (GILs) are the concentrations of a contaminant in groundwater above which further investigation (point of extraction) or a response (point of use) is required. GILs are based on Australian water quality guidelines and drinking water guidelines and are applicable for assessing human health risk and ecological risk from direct contact (including consumption) with groundwater.

Management Limits for Petroleum hydrocarbons are applicable to petroleum hydrocarbon compounds only. They are applicable as screening levels following evaluation of human health and ecological risks and risks to groundwater resources. They are relevant for operating sites where significant sub-surface leakage of petroleum compounds has occurred and when decommissioning industrial and commercial sites.

Interim soil vapour health investigation levels (interim HILs) have been developed for selected volatile organic chlorinated compounds (VOCCs) and are applicable to assessing human health risk by the inhalational pathway. They have interim status pending further scientific work on volatile gas modelling from the sub-surface to building interiors for chlorinated compounds.

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Appendix D: Data (QA/QC) Evaluation

DATA (QA/QC) EVALUATION

INTRODUCTION

This Data (QA/QC) Evaluation forms part of the validation process for the DQOs documented in Section 6.1 of this report. Checks were made to assess the data in terms of precision, accuracy, representativeness, comparability and completeness. These 'PARCC' parameters are referred to collectively as DQIs and are defined in the Report Explanatory Notes attached in the report appendices.

Field and Laboratory Considerations

The quality of the analytical data produced for this project has been considered in relation to the following:

- Sample collection, storage, transport and analysis;
- Laboratory PQLs;
- Field QA/QC results; and
- Laboratory QA/QC results.

Field QA/QC Samples and Analysis

A summary of the field QA/QC samples collected and analysed for this assessment is provided in the following table:

Sample Type	Sample Identification	Frequency (of Sample Type)	Analysis Performed
Intra-laboratory duplicate (soil)	Dup HL1 (primary sample BH103 0.03-0.2m)	Approximately 8% of primary samples	Heavy metals, TRH/BTEX and PAHs
Intra-laboratory duplicate (water)	Dup AM1 (primary sample MW106)	Approximately 50% of primary samples	Heavy metals, TRH/BTEX and PAHs
Trip spike (soil)	TS1 (7/2/18)	One per day of soil sampling	BTEX
Trip blank (soil)	TB1 (7/2/18)	One per day of soil sampling	BTEX

The results for the field QA/QC samples are detailed in the laboratory summary tables (Table I to Table K inclusive) attached to the assessment report and are discussed in the subsequent sections of this Data (QA/QC) Evaluation report.

Data Assessment Criteria

EIS adopted the following criteria for assessing the field and laboratory QA/QC analytical results:

Field Duplicates

Acceptable targets for precision of field duplicates in this report will be less than 50% RPD for concentrations greater than 10 times the PQL, less than 75% RPD for concentrations between five and 10 times the PQL and less than 100% RPD for concentrations that are less than five times the PQL. RPD failures will be considered qualitatively on a case-by-case basis taking into account factors such as the sample type, collection methods and the specific analyte where the RPD exceedance was reported.

Field Blanks

Acceptable targets for field blank samples in this report will be less than the PQL for organic analytes. Metals will be considered on a case-by-case basis with regards to typical background concentrations in soils and published drinking water guidelines for waters.

Trip Spikes

Acceptable targets for trip spike samples in this report will be 70% to 130%. This is in line with spike recovery limits adopted by the laboratory for organic analysis.

Laboratory QA/QC

The suitability of the laboratory data is assessed against the laboratory QA/QC criteria which is outlined in the laboratory reports. These criteria were developed and implemented in accordance with the laboratory's NATA accreditation and align with the acceptable limits for QA/QC samples as outlined in NEPM (2013) and other relevant guidelines.

A summary of the acceptable limits adopted by the primary laboratory (Envirolab) is provided below:

RPDs

- Results that are <5 times the PQL, any RPD is acceptable; and
- Results >5 times the PQL, RPDs between 0-50% are acceptable.

Laboratory Control Samples (LCS) and Matrix Spikes

- 70-130% recovery acceptable for metals and inorganics;
- 60-140% recovery acceptable for organics; and
- 10-140% recovery acceptable for VOCs.

Surrogate Spikes

- 60-140% recovery acceptable for general organics; and
- 10-140% recovery acceptable for VOCs.

Method Blanks

- All results less than PQL.

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DATA EVALUATION

Sample Collection, Storage, Transport and Analysis

Samples were collected by trained field staff in accordance with the EIS SSP. The SSP was developed to be consistent with relevant guidelines, including NEPM (2013) and other guidelines made under the CLM Act 1997.

Appropriate sample preservation, handling and storage procedures were adopted. Laboratory analysis was undertaken within specified holding times in accordance with Schedule B(3) of NEPM (2013) and the laboratory NATA accredited methodologies.

Review of the project data also indicated that:

- COC documentation was adequately maintained;
- Sample receipt advice documentation was provided for all sample batches;
- All analytical results were reported; and
- Consistent units were used to report the analysis results.

Laboratory PQLs

Appropriate PQLs were adopted for the analysis and all PQLs were below the SAC.

Field QA/QC Sample Results

Field Duplicates

The results indicated that field precision was acceptable. RPD non-conformances were reported for several PAH compounds in Dup HL1/BH103 (0.03-0.2m).

Values outside the acceptable limits have been attributed to the very low concentrations of compounds present in the sample. As both the primary and duplicate sample results were less than the SAC, the exceedances are not considered to have had an adverse impact on the data set as a whole.

Field Blanks

During the investigation, one soil trip blank was placed in the esky during sampling and transported back to the laboratory. The results were all less than the PQLs, therefore cross contamination between samples that may have significance for data validity did not occur.

Trip Spikes

The results ranged from 92% to 94% and indicated that field preservation methods were appropriate.

Laboratory QA/QC

The analytical methods implemented by the laboratory were performed in accordance with their NATA accreditation and were consistent with Schedule B(3) of NEPM (2013). The frequency of data reported for the laboratory QA/QC (i.e. duplicates, spikes, blanks, LCS) was considered to be acceptable for the purpose of this assessment.

DATA QUALITY SUMMARY

EIS are of the opinion that the data are adequately precise, accurate, representative, comparable and complete to serve as a basis for interpretation to achieve the investigation objectives.

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Appendix E: Field Work Documents

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

EIS

Client:	Tunborn Pty Ltd	**Job No.:**	E30293KH
Project:	Proposed Alterations and Additions	**Well No.:**	MW2
Location:	187 SLADE ROAD, BEXLEY, NSW	**Depth (m):**	6.17m

WELL FINISH DETAILS

Gatic Cover ☒ Standpipe ☐ Other (describe) ☐

WELL DEVELOPMENT DETAILS

Method:	electric pump	**SWL – Before (m):**	4.76m
Date:	8/2/2018	**Time – Before:**	11:03am
Undertaken By:	HL/AM	**SWL – After (m):**	6.17
Total Vol. Removed:	2	**Time – After:**	11:04
PID Reading (ppm):	0.0		

Comments:

DEVELOPMENT MEASUREMENTS

Volume Removed (L)	Temp (°C)	DO (mg/L)	EC (µS/m)	pH	Eh (mV)
1	24.4	6.2	763	6.35	8.1
2	23	3.8	4034	6.28	17.5

Comments: Odours (YES / NO) NAPL/PSH (YES / NO), Sheen (YES / NO), Steady State Achieved (YES / NO)

Pumped dry moderate silt loading

Tested By:	HL/AM	**Remarks:**
Date Tested:	8/2/2018	- All measurements are corrected to ground level - All stated Volumes are in Litres - SWL is an abbreviation for standing water level - Steady state conditions - difference in the pH less than 0.2 units and difference in conductivity less than 10% - Minimum 3 monitoring well volumes are purged
Checked By:		
Date:		

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

EIS

Client:	Tunborn Pty Ltd	**Job No.:**	E30293KH
Project:	Proposed Alterations and Additions	**Well No.:**	MW6.
Location:	187 SLADE ROAD, BEXLEY, NSW	**Depth (m):**	6.2m.

WELL FINISH DETAILS

Gatic Cover ☒ Standpipe ☐ Other (describe) ☐

WELL DEVELOPMENT DETAILS

Method:	electric pump	**SWL – Before (m):**	4.72.
Date:	8/2/2018	**Time – Before:**	10:35.
Undertaken By:	HL/AM.	**SWL – After (m):**	6.2m
Total Vol. Removed:	~~2.5~~ 3.5	**Time – After:**	10:47
PID Reading (ppm):	0.3.		

Comments:

DEVELOPMENT MEASUREMENTS

Volume Removed (L)	Temp (°C)	DO (mg/L)	EC (µS/m)	pH	Eh (mV)
1	27.2	6.6	979	5.94	37.6
2	27.9	4.7	1019	5.98	5.8

Comments:Odours (YES / NO), NAPL/PSH (YES / NO), Sheen (YES / NO) Steady State Achieved (YES / NO)
Pumped dry and slight silt loading

Tested By:	HL/AM	**Remarks:**
Date Tested:	8/2/2018	- All measurements are corrected to ground level - All stated Volumes are in Litres - SWL is an abbreviation for standing water level - Steady state conditions - difference in the pH less than 0.2 units and difference in conductivity less than 10% - Minimum 3 monitoring well volumes are purged
Checked By:	HL/AM	
Date:		

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

EIS

Client:	Tunborn Pty Ltd	Job No.:	E30293KH
Project:	Proposed Alterations and Additions	Well No.:	MW2
Location:	187 SLADE ROAD, BEXLEY, NSW	Depth (m):	6.19

WELL FINISH

✓	Gatic Cover		Standpipe		Other (describe)

WELL PURGE DETAILS:

Method:	peristaltic pump.	SWL – Before:	4.75
Date:	15/2/2018	Time – Before:	12:03
Undertaken By:	HL/AM	Total Vol Removed:	
Pump Program No:	—	PID (ppm):	0

PURGING / SAMPLING MEASUREMENTS

Time (min)	SWL (m)	Vol (L)	Notes	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Eh (mV)
12:12	4.88	1	silty, no odours.	26.1	1.6	1045	6.51	61.8
12:18	4.96	2		25.4	1.4	999	6.22	75.0
12:23	4.99	3		25.3	1.3	994	6.20	65.6
12:28	5.01	4		25.4	1.2	992	6.19	45.4
			Sampling ↓↓↓					

Comments: Odours (YES / NO), NAPL/PSH (YES / NO), Sheen (YES / NO), Steady State Achieved (YES / NO)
Silt loading in groundwater

Sampling Containers Used: 2 x glass amber, 4 x BTEX vials, 1 x H2NO3 plastic, ~~x H2SO4 plastic~~, ~~x unpreserved plastic.~~

Tested By: ~~Todd Hore.~~ HL/AM	**Remarks:**
Date Tested: 15/2/2018	- All measurements are corrected to ground level - SWL is an abbreviation for standing water level
Checked By:	- Steady state conditions - difference in the pH less than 0.2 units and
Date:	difference in conductivity less than 10%

ENVIRONMENTAL INVESTIGATION SERVICES
CONSULTING ENVIRONMENTAL ENGINEERS

EIS

Client:	Tunborn Pty Ltd	Job No.:	E30293KH
Project:	Proposed Alterations and Additions	Well No.:	MW6.
Location:	187 SLADE ROAD, BEXLEY, NSW	Depth (m):	6.15.

WELL FINISH

X	Gatic Cover		Standpipe		Other (describe)

WELL PURGE DETAILS:

Method:	peristaltic pump.	SWL – Before:	4.09.
Date:	15/2/2018.	Time – Before:	10:46.
Undertaken By:	HL/AM.	Total Vol Removed:	8.5L.
Pump Program No:	74287	PID (ppm):	1.9.

PURGING / SAMPLING MEASUREMENTS

Time (min)	SWL (m)	Vol (L)	Notes	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Eh (mV)
10:55	4.21	1		24.6	1.6	1270	5.99	46.9
11:00	4.35	2		24.2	1.3	1232	5.99	39.5
11:05	4.59	3		23	1.1	1143	6.04	41.8
11:10	4.75	4		23.3	1.0	1102	6.00	43.3
11:14	4.90	5		24.1	1.1	1080	5.99	44.2
11:20	5.10	6		24.3	1.1	1008	6.00	56.9
			sampling					

Comments: Odours (YES / NO) NAPL/PSH (YES / NO), Sheen (YES / NO), Steady State Achieved (YES / NO)

Sampling Containers Used: 4 x glass amber, 6 x BTEX vials, 2 x H2NO3 plastic, ~~x H2SO4 plastic,~~ ~~x unpreserved plastic~~

Tested By: ~~Todd Hore~~ HL/AM	**Remarks:**
Date Tested: 15/2/2018.	- All measurements are corrected to ground level - SWL is an abbreviation for standing water level
Checked By:	- Steady state conditions - difference in the pH less than 0.2 units and
Date:	difference in conductivity less than 10%

EIS

Appendix F: Guidelines and Reference Documents

EIS

Acid Sulfate Soils Management Advisory Committee (ASSMAC), (1998). Acid Sulfate Soils Manual

Australian and New Zealand Environment Conservation Council (ANZECC), (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality

CRC Care, (2011). Technical Report No. 10 – Health screening levels for hydrocarbons in soil and groundwater Part 1: Technical development document

CRC Care, (2017). Technical Report No. 39 – Risk-based management and guidance for benzo(a)pyrene

Contaminated Land Management Act 1997 (NSW)

Department of Land and Water Conservation, (1997). 1:25,000 Acid Sulfate Soil Risk Map (Series 9130N3, Ed 2)

Managing Land Contamination, Planning Guidelines SEPP55 – Remediation of Land (1998)

National Health and Medical Research Council (NHMRC), (2011). National Water Quality Management Strategy, Australian Drinking Water Guidelines

NSW Department of Environment and Conservation, (2007). Guidelines for the Assessment and Management of Groundwater Contamination

NSW EPA, (1995). Contaminated Sites Sampling Design Guidelines

NSW EPA, (2014). Waste Classification Guidelines - Part 1: Classifying Waste

NSW EPA, (2015). Guidelines on the Duty to Report Contamination under Section 60 of the CLM Act 1997

NSW EPA, (2017). Guidelines for the NSW Site Auditor Scheme, 3rd Edition

National Environmental Protection (Assessment of Site Contamination) Measure 1999 as amended (2013)

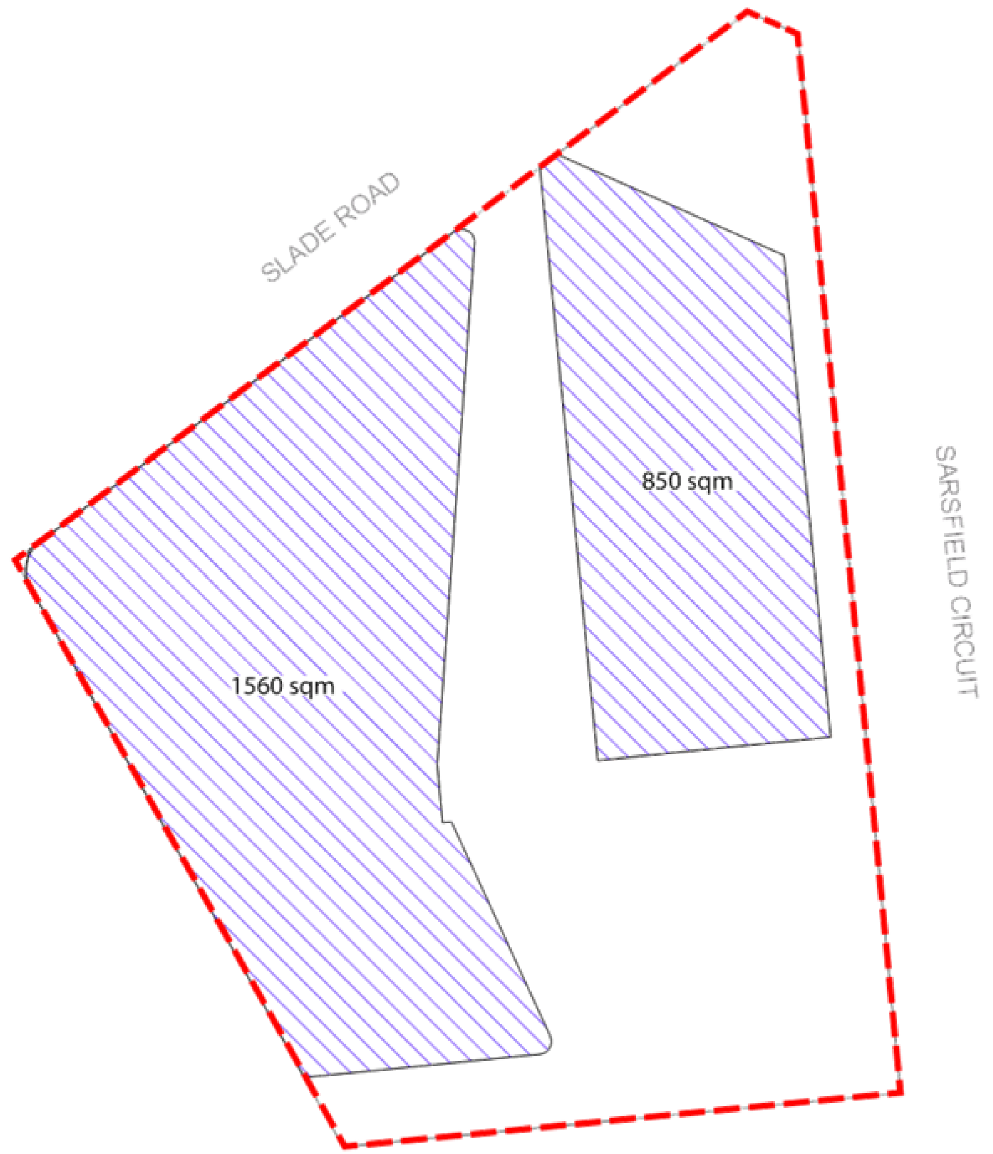
Olszowy, H., Torr, P., and Imray, P., (1995). Trace Element Concentrations in Soils from Rural and Urban Areas of Australia. Contaminated Sites Monograph Series No. 4. Department of Human Services and Health, Environment Protection Agency, and South Australian Health Commission

Protection of the Environment Operations Act 1997 (NSW)

State Environmental Planning Policy No.55 – Remediation of Land 1998 (NSW)

World Health Organisation (WHO), (2008). Petroleum Products in Drinking-water, Background document for the development of WHO Guidelines for Drinking Water Quality

Western Australia Department of Health, (2009). Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia



KEY

Site boundary

GBA

Ground Level

18054 - PP - Bexley North - 187 Slade Road

Area Calculations - Estimated GBA

SK-013
Revision:A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*

0 5 10 15 20 25m

*Please note subject any printing margins

Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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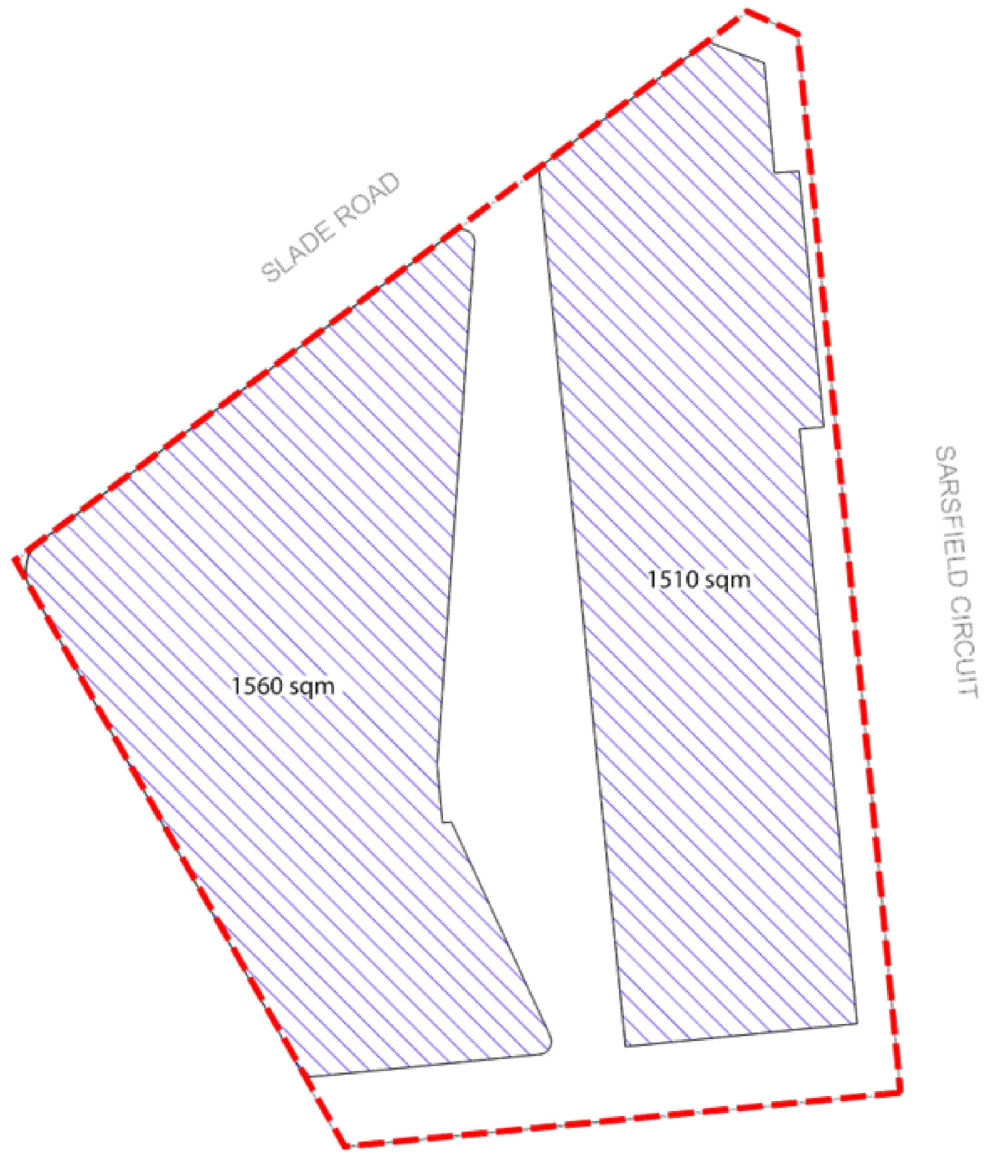

KEY

Site boundary

GBA

Level 01

18054 - PP - Bexley North - 187 Slade Road

Area Calculations - Estimated GBA

SK-014
Revision:A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*

0 5 10 15 20 25m

*Please note subject any printing margins

Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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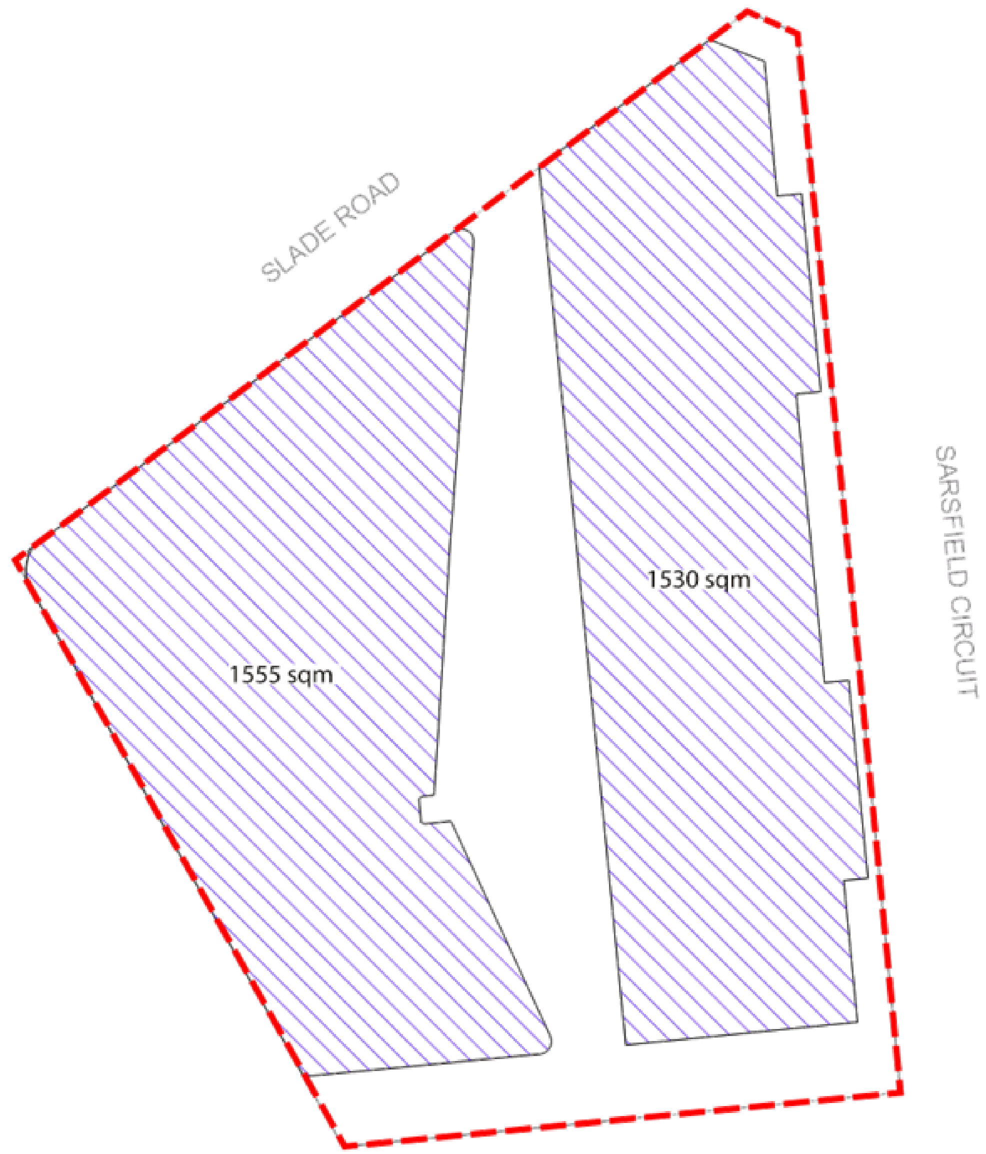

KEY

Site boundary

GBA

Levels 02 - 03

18054 - PP - Bexley North - 187 Slade Road

Area Calculations - Estimated GBA

SK-015
Revision:A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*

0 5 10 15 20 25m

*Please note subject any printing margins

Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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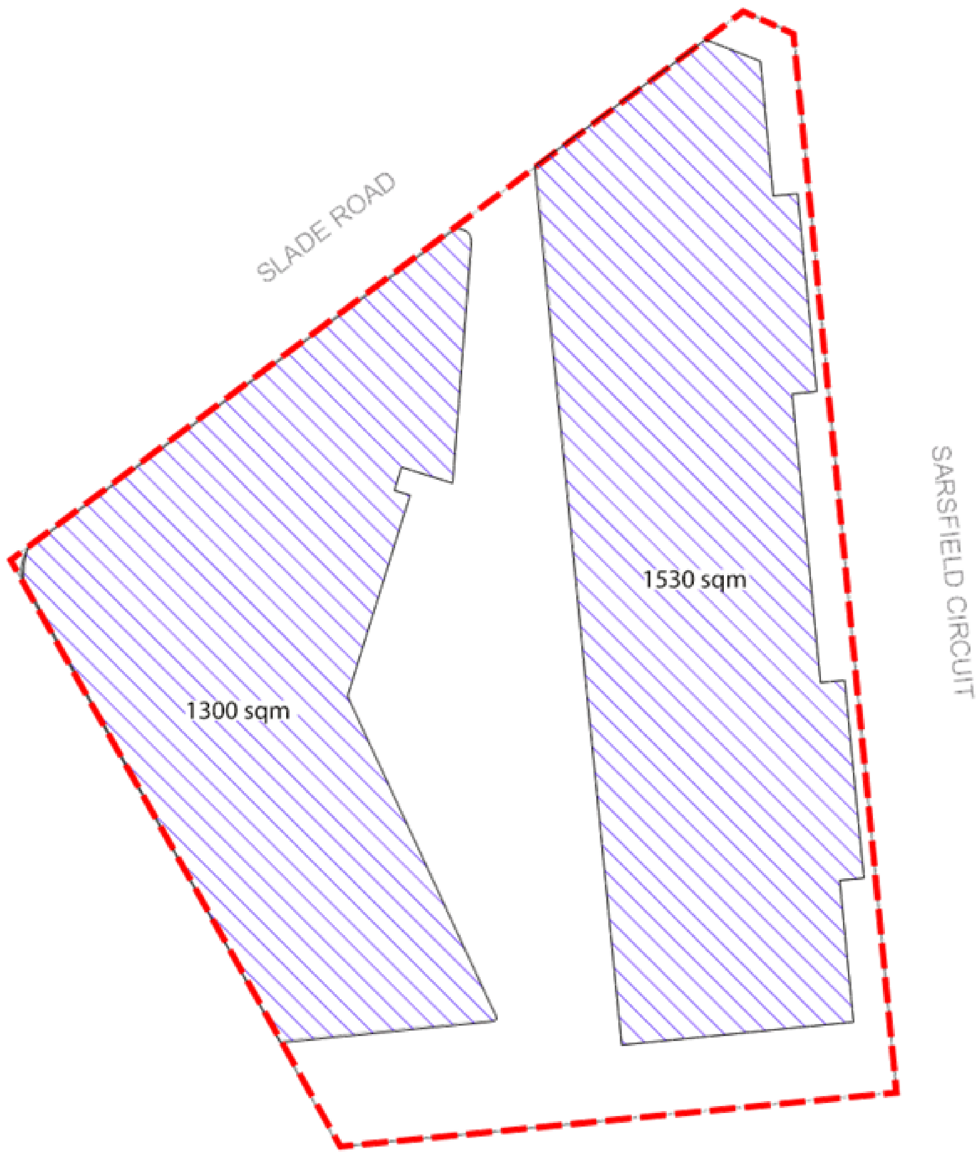

KEY
Site boundary
GBA

Level 04

18054 - PP - Bexley North - 187 Slade Road
Area Calculations - Estimated GBA
Prepared for: TUNBORN PTY LTD

SK-016
Revision:A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*
0 5 10 15 20 25m
*Please note subject any printing margins

Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
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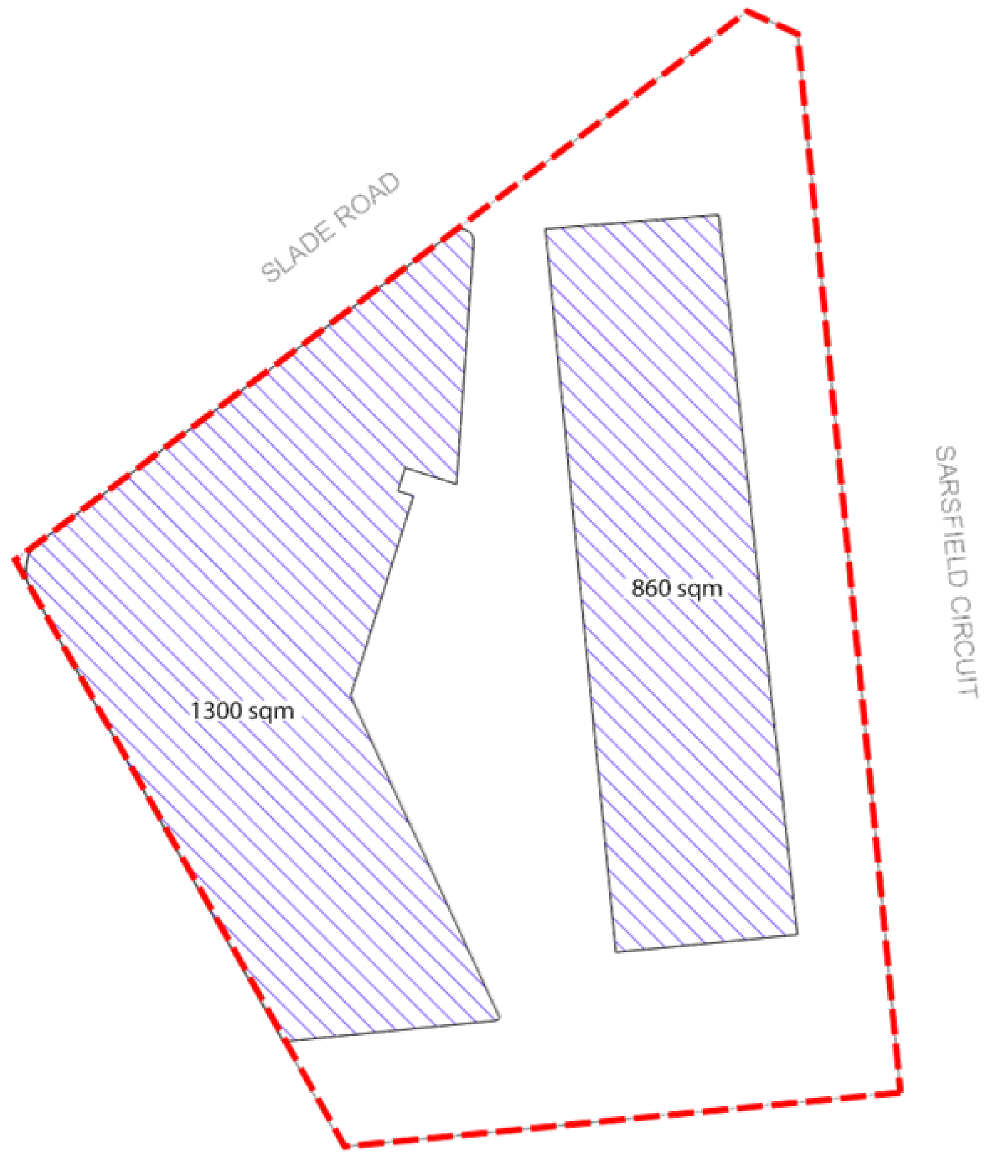

KEY

Site boundary

GBA

Level 05

18054 - PP - Bexley North - 187 Slade Road

Area Calculations - Estimated GBA

Prepared for: TUNBORN PTY LTD

SK-017
Revision:A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*

0 5 10 15 20 25m

*Please note subject any printing margins

Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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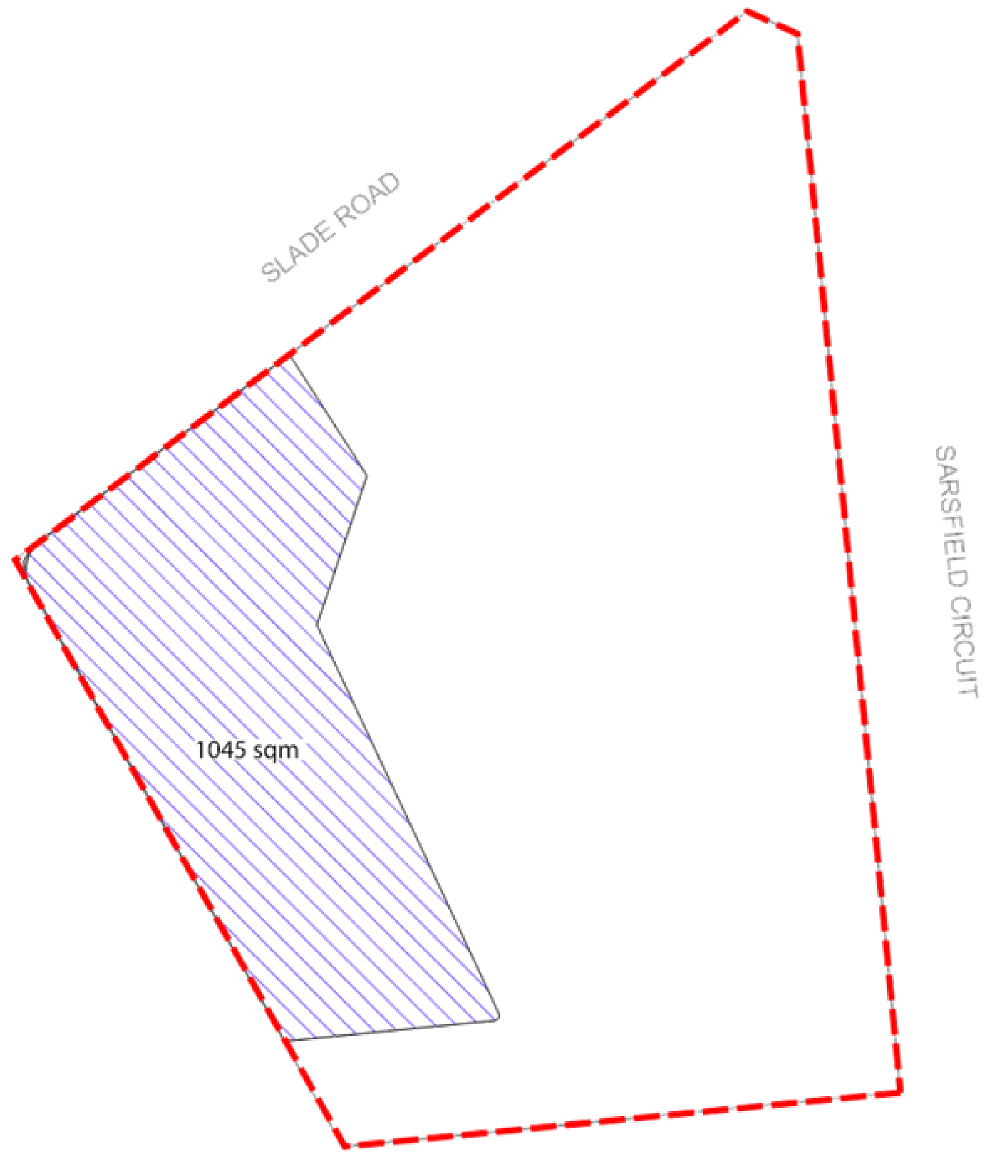

KEY

Site boundary

GBA

Level 06

18054 - PP - Bexley North - 187 Slade Road

Area Calculations - Estimated GBA

Prepared for: TUNBORN PTY LTD

SK-018

Revision:A by DR

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Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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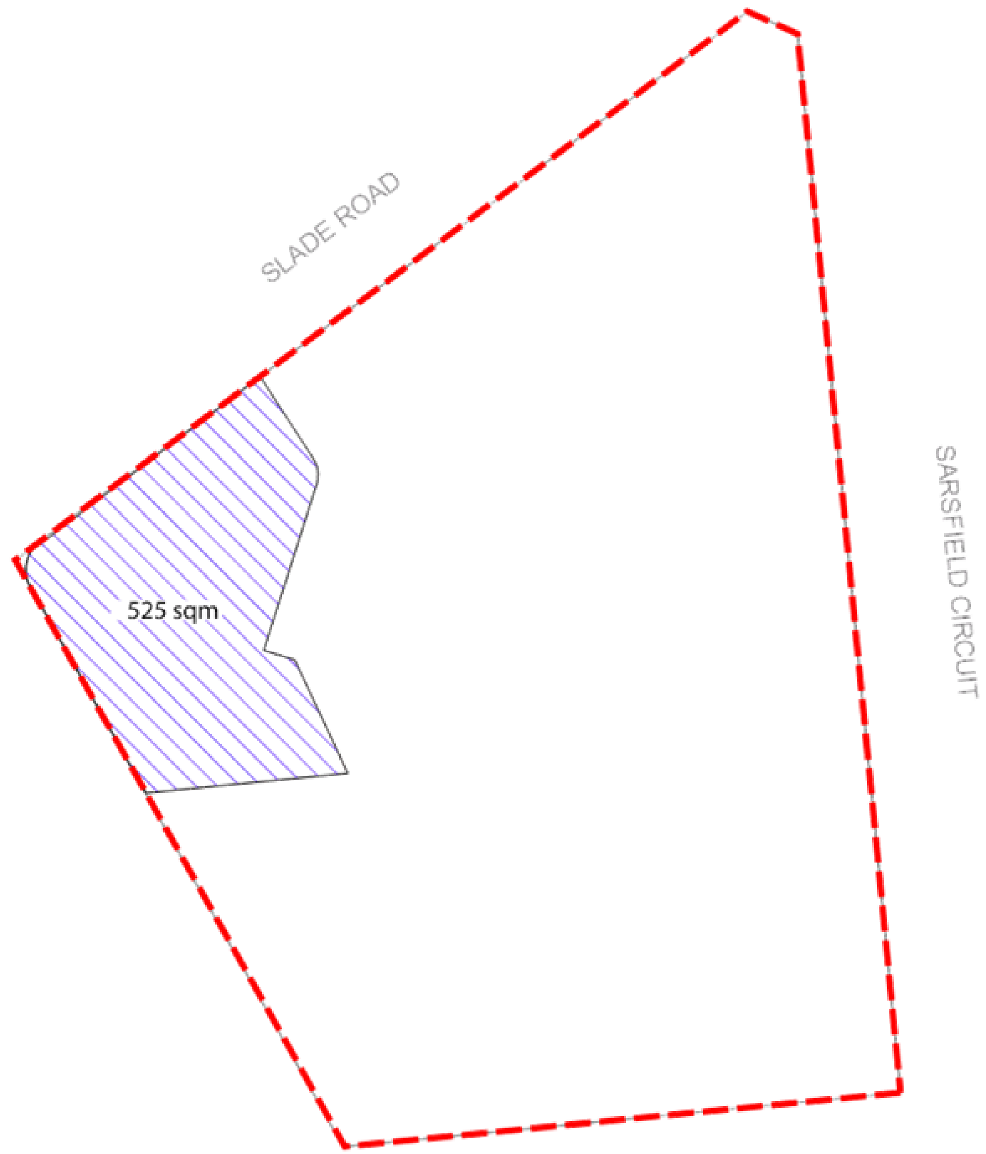

KEY

Site boundary

GBA

Level 07

18054 - PP - Bexley North - 187 Slade Road

Area Calculations - Estimated GBA

Prepared for: TUNBORN PTY LTD

SK-019
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SCALE: 1:500 @ A3*

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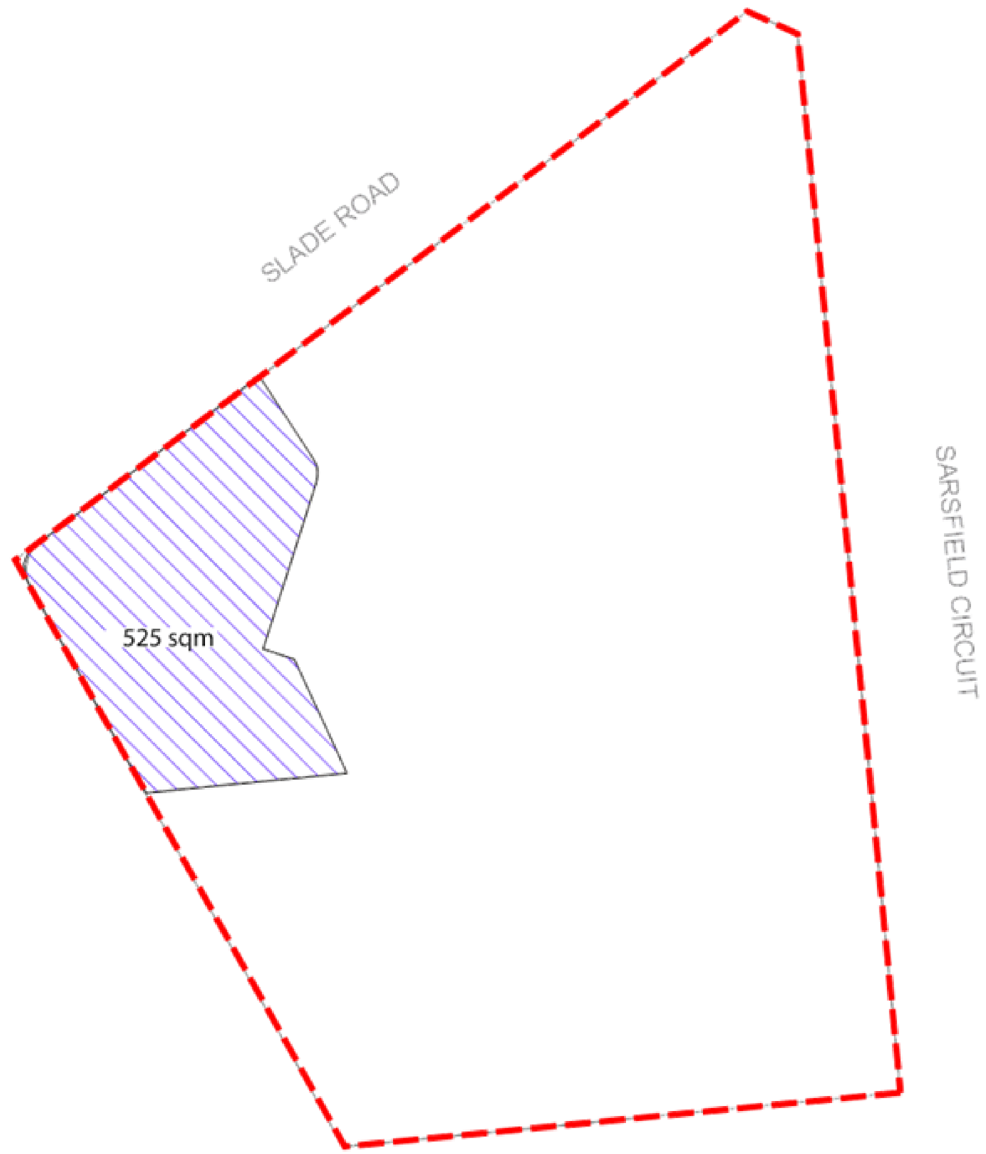
Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

GMU Urban Design & Architecture



Level 08

KEY

Site boundary

GBA

18054 - PP - Bexley North - 187 Slade Road

Area Calculations - Estimated GBA

Prepared for: TUNBORN PTY LTD

SK-020

Revision:A by DR

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SCALE: 1:500 @ A3*

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Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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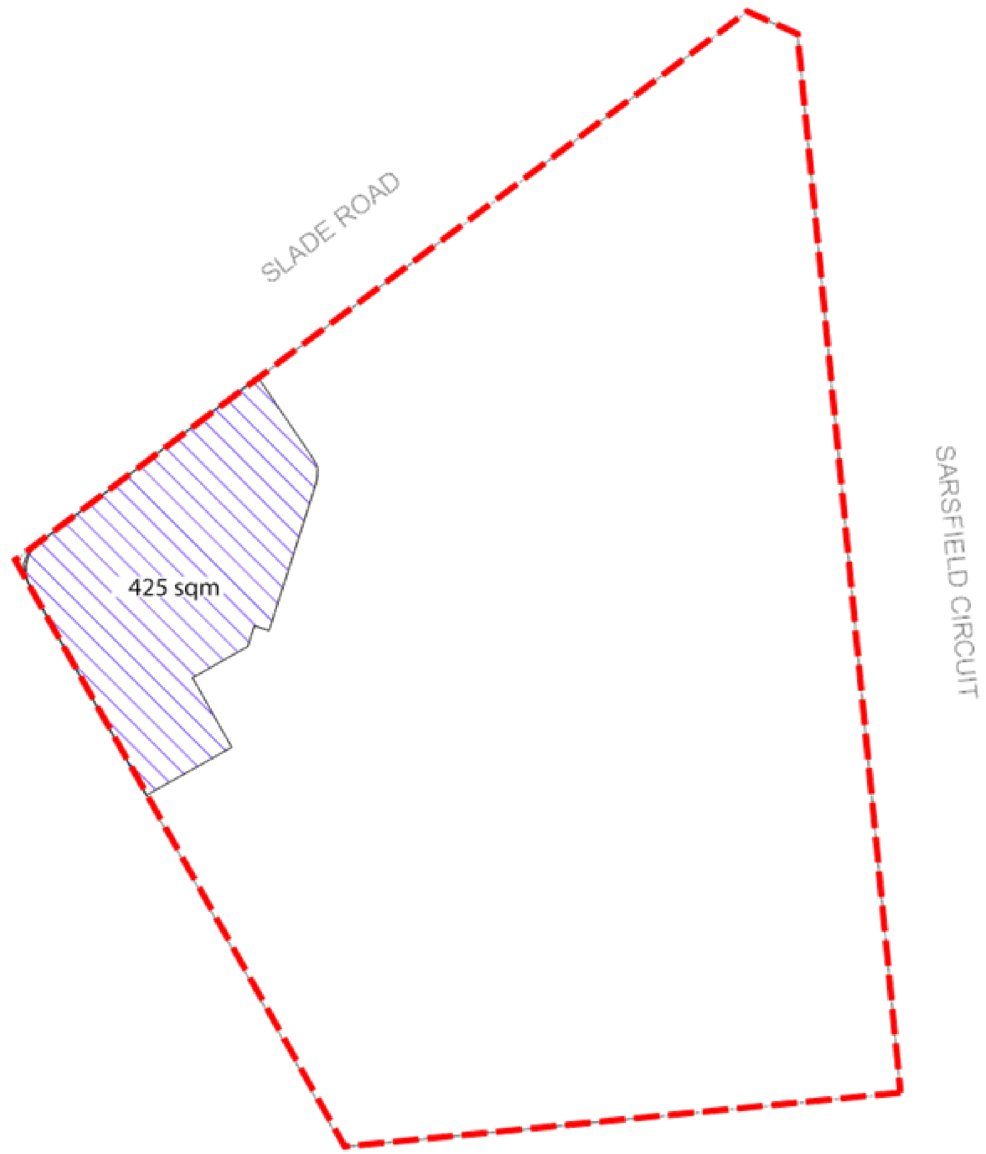

KEY

Site boundary

GBA

Level 09

18054 - PP - Bexley North - 187 Slade Road

Area Calculations - Estimated GBA

Prepared for: TUNBORN PTY LTD

SK-021
Revision:A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*

0 5 10 15 20 25m

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Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

GMU Urban Design & Architecture

GRC Hydro
Level 9, 233 Castlereagh Street
Sydney NSW 2000

Tel: +61 2 9030 0342
www.grchydro.com.au

Job Number: 190006
Date: 23 July 2021

David Waghorn
Planning Ingenuity
Suite 510, 531 – 533 Kingsway
Miranda NSW 2228

Dear David,

Re: Flood Investigation for 187 Slade Road, Bexley North

1. Introduction

Development is proposed for the subject Site located at 187 Slade Road, Bexley North. The development is located in an urban area with a 28-hectare upstream catchment. Under current conditions the Site is affected by minor flooding from the carpark to the South-West and from Sarsfield Circuit. The location of the Site is shown in Figure 1.

GRC Hydro have been engaged by Planning Ingenuity to investigate the existing flood liability in relation to Council's planning policies to assess the suitability of development for the Site and to identify flood mitigation measures.

2. Previous Studies

The Bardwell Creek 2D Flood Study Review was undertaken by WMAwater in 2018. The study used a hydrologic model (WBNM) and hydraulic model (TUFLOW) to model design flood behaviour for events ranging from the 20% Annual Exceedance Probability (AEP) to the Probable Maximum Flood (PMF). The modelling system was calibrated and validated to historic events. These models were found to adequately represent flood behaviour in the study area.

The TUFLOW model results were used as the basis for investigating flooding as part of this study. Some model amendments were made by GRC Hydro, in the vicinity of the Subject Site based on observations from Site visits and local knowledge of the area. The key model amendment was to facilitate the existing overland flow path through 232 Slade Road which had previously been blocked out of the model and exacerbated flood levels. Site visit revealed that the building basement is designed to allow flood water throughout the building and discharge into the railway line to the North (see Figure 2).

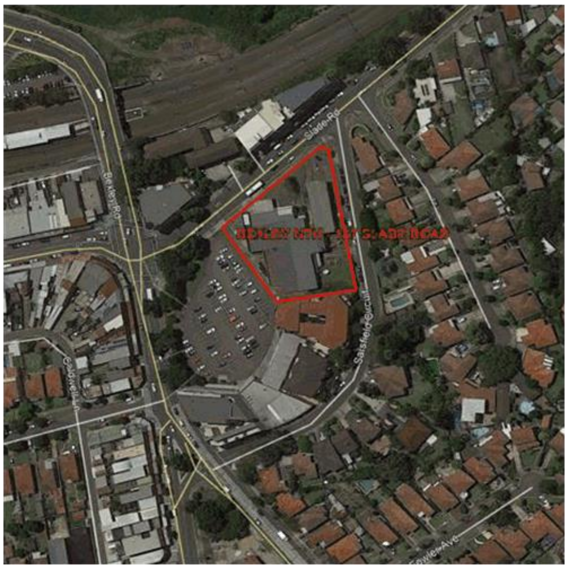


Figure 1: Project Site Location - 187 Slade Road - Bexley North

Figure 2: View of property in 232 Slade Road from Slade Road

3. Existing Flood Behaviour

The Site experiences flooding when rainfall in the catchment to the South exceeds system stormwater capacity and overland flow moves generally from South to North. Both the car park to the West and Sarsfield Circuit convey overland flow. The Site's upstream catchment is shown in Figure 3. Runoff from this catchment arrives at the intersection of Sarsfield Circuit and Bexley Road, flowing North. The flow is then split between Sarsfield Circuit and Bexley Road, with the latter flowing into the car park adjacent to the Site.

Figure 4 shows the 1% AEP flood depths in the vicinity of the Site. On the Site boundary, flood depths range from 0.1 to 0.2 m on Sarsfield Circuit while along the Western boundary there are depths of around 0.15m to 0.6 m (measured in the sag point into the car park area). On Slade Road depths range from 0.1m to 0.6m (measured in the Slade Road Sag point in front of building in 232 Slade Road). The figure also shows stormwater drainage in the vicinity of the Site, including a 900 mm diameter drain that runs underneath the existing building.

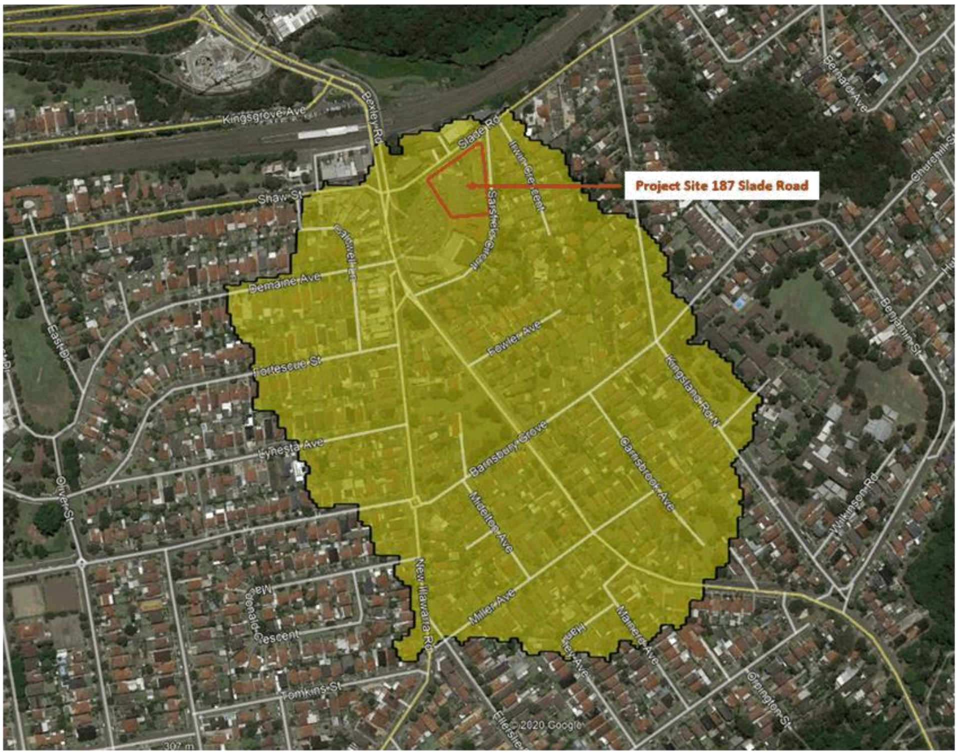


Figure 3: Subject Site upstream catchment (27.8ha)

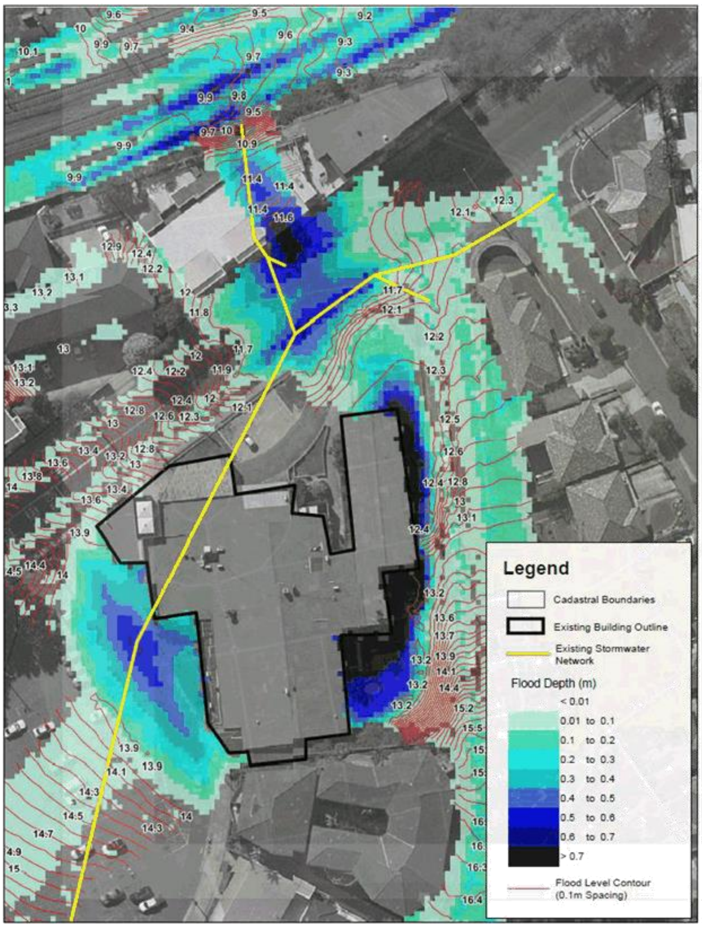


Figure 4: 1% AEP flood depth – existing case

Model results indicate that the relatively new development at the corner of Sarsfield Circuit and Bexley Road (building at 2-6 Sarsfield Circuit) redirected flow on to Sarsfield Circuit that would have otherwise continued on Bexley Road. This has likely contributed to the flood risk at the subject Site.

4. Flood Assessment of Proposed Development

The planning proposal is for an intensification of use of the subject Site whilst maintaining the existing use. The proposed construction consists of two new buildings. The area between the two buildings blocks (Laneway) is a publicly accessible open space. The proposed habitable surface is 2852 m², around 600 m² higher than the existing. Three basement levels are proposed with car access from Sarsfield Circuit at location shown in Figure 5.

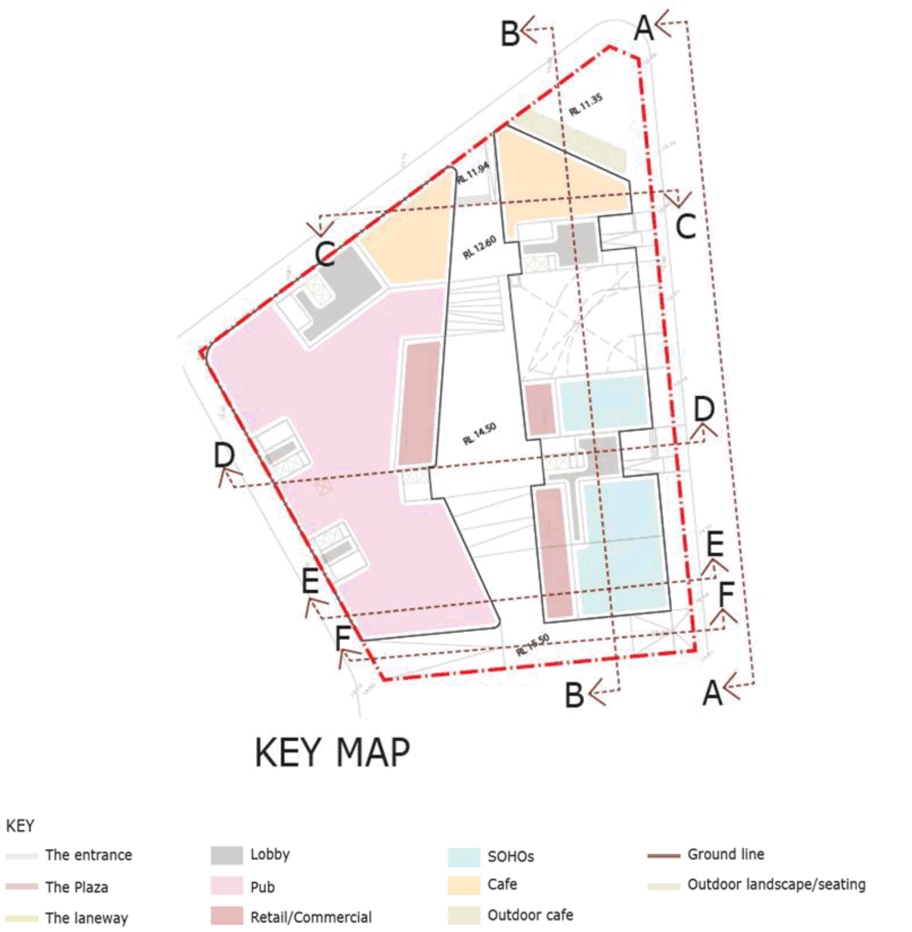


Figure 5: Proposed Development

The proposed development contains several features to replicate the existing flood behaviour and avoid flood level impacts. The features are shown in Figure 6 and are as follows:

1) **Pipe diversion and upgrade**: the existing 900 mm diameter pipe that traverses the Site will be demolished and replaced by a 1050 mm diameter pipe along Slade Road. The larger pipe will reduce friction losses and increase the pipe storage, reducing the hydraulic grade line and the potential impact in the car park area.
2) **Pipe upgrade:** The existing 900 mm pipe that crosses Slade Road will be upgraded to a 1200 mm diameter pipe or to an alternative drainage of similar cross-sectional area.
3) **Swale:** A swale will be included in the building landscaping on the East side of the development, to formalise the drainage path and improve drainage to the stormwater network. The proposed swale is 2m wide and 300-400 mm deep.
4) **Swale drainage:** The proposed swale will cross the proposed Car Park access ramp via a 2000mm x 700mm culvert. Swale profile will need to be adequately defined to allow sufficient cover above the crossing structure.
   At the downstream end of the proposed swale, a new pipe (500mm diameter) will join the swale to the existing stormwater network.
5) **Lowered ground**: At the end of the swale (North-East corner of the development), the ground is lowered from the existing level of 12.17 mAHD to 11.35 mAHD (tying into the swale) and then the ground is graded in the North-West direction towards the Slade Road footpath at level 11.23 mAHD.
6) **Connection Lane at South of development**: Following Council's request, a 6m wide lane has been allowed at the South end of the development for connection between the parking area at West and the Sarsfield Circuit. As per Council request, the lane must have a high point ("crest") at lEast 200mm higher than the 1% AEP water level in the Sarsfield Circuit gutter.

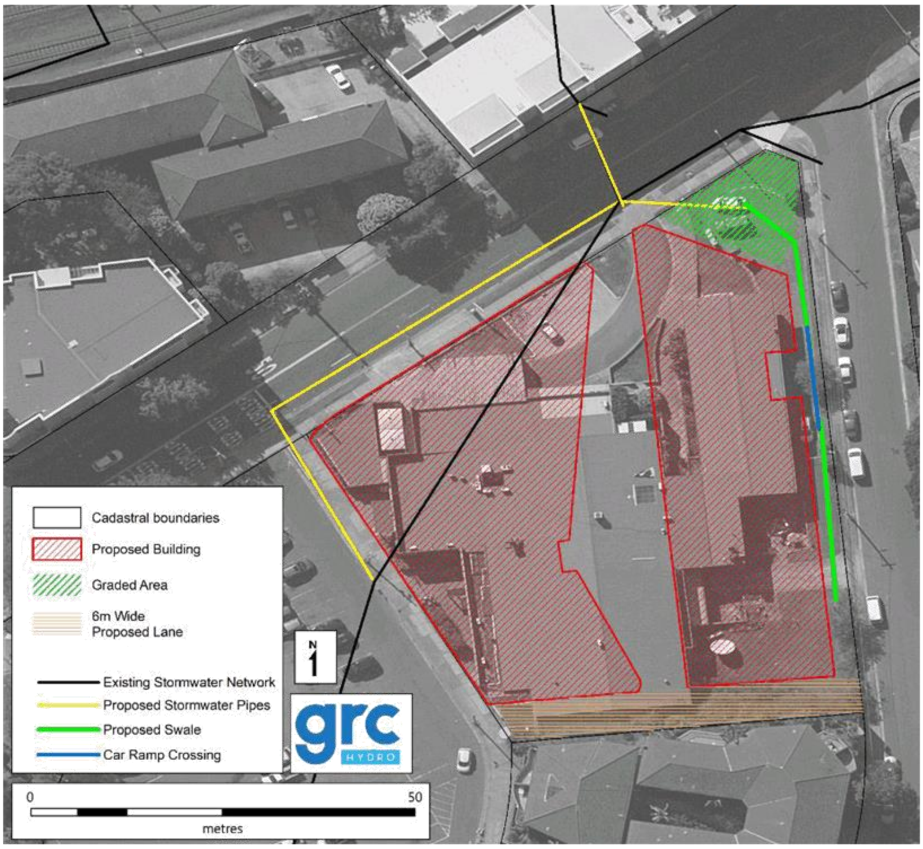


Figure 6: Proposed Flood Mitigation Measures

5. Relevant Planning Policy

Rockdale Development Control Plan

The Rockdale Council Development Control Plan (DCP) 2011 was adopted and is applicable for this development. Development control pertaining to Flood Risk Management can be found in Section 4.1.3 Water Management and are outlined below:

3. *Development must comply with Council's – Flood Management Policy which provides guidelines of controlling developments in different flood risk areas. It should be read in conjunction with the NSW Government's 'Floodplain Development Manual 2005'.*
4. *The filling of land up to the 1:100 Average Recurrence Interval (ARI) flood level (or flood storage area if determined) is not permitted, unless specifically directed by Council in very special and limited locations. Filling of land above the 1:100 ARI up to the Probable Maximum Flood (PMF) (or in flood*

fringe) is discouraged however it will be considered providing it does not adversely impact upon flood behaviour.

5. *Development should not adversely increase the potential flood affectation on other development or properties, either individually or in combination with the cumulative impact of similar developments likely to occur within the same catchment.*
6. *The impact of flooding and flood liability is to be managed, to ensure the development does not divert the flood waters, nor interfere with flood water storage or the natural functions of waterways. It must not adversely impact upon flood behaviour.*
7. *A flood refuge may be required to provide an area for occupants to escape to for developments where occupants require a higher standard of care. Flood refuges may also be required where there is a large difference between the PMF and the 1 in 100-year flood level that may place occupants at severe risk if they remain within the building during large flood events.*

Rockdale Local Environmental Plan 2011

Section 6.6 Flood Planning for the Rockdale Local Environmental Plan (LEP) outlines flood related controls relevant to the proposed development. These controls are provided below.

6.6 Flood planning

(1) The objectives of this clause are as follows:

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change,

(c) to avoid significant adverse impacts on flood behaviour and the environment.

(2) This clause applies to:

(a) land that is shown as "Flood planning area" on the Flood Planning Map, and

(b) other land at or below the flood planning level.

(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development:

(a) is compatible with the flood hazard of the land, and

(b) is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

(c) incorporates appropriate measures to manage risk to life from flood, and

(d) is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and

(e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

(4) A word or expression used in this clause has the same meaning as it has in the Floodplain Development Manual (ISBN 0 7347 5476 0), published in 2005 by the NSW Government, unless it is otherwise defined in this clause.

(5) In this clause:

flood planning level means the level of a 1:100 ARI (average recurrent interval) flood event plus 0.5 metre freeboard.

Flood Planning Map means the Rockdale Local Environmental Plan 2011 Flood Planning Map.

The Flood Planning Map from the Rockdale LEP does not highlight the subject Site as within the Flood Planning Area. This map is shown in Figure 7.

Figure 7:Rockdale LEP Flood Planning Area (subject Site outlined in red – not tagged)

6. Impact of the Proposed Development

The proposed development was schematised in the hydraulic model (TUFLOW). The development was represented as a 'proposed' scenario that modified the building footprints and drainage features around the Site, as described in the previous section. The hydraulic model was then used to assess the impact of the development on existing flood behaviour. The impact maps for the 20%,10% and 1% AEP events are shown in Appendix to this report in Figures 10 to 12.

The figures show that the building has a localised effect on the existing flood behaviour. On the West side of the building there is a slight decrease in flood level of less than 0.1 m. While there is a slight loss of flood storage (black area) this is offset by the increased stormwater capacity.

On Sarsfield Circuit there is also a loss of flood storage against the building, however it is offset by the swale and the level reduction at North-East of the development . The adverse impact is localised at the Southern-East end of the development and it is contained within the subject Site boundaries.

Overall, in regard to flood impact, the proposed development has minimal impacts on flood behaviour and does not result in flood impacts to other private properties or public roads. It will not result in increased requirement for government spending on flood mitigation measures.

7. Minimum Floor Level Requirements

Whilst the Site is flood liable in the 1% AEP event, flood risk itself is minimal. Flood depths are transitory (duration is limited), hazard is relatively minor owing to relative shallowness of flood waters. There is no expectation that flood waters cannot be managed such that risk to life can be managed. Far from being mainstream flooding which can pose a risk to life the flood affectation would more accurately be characterised as being overland flow (stormwater / flood fringe). Few depressed areas at South-East of the Site which are currently characterised as being flood storage will be blocked by the proposed development.

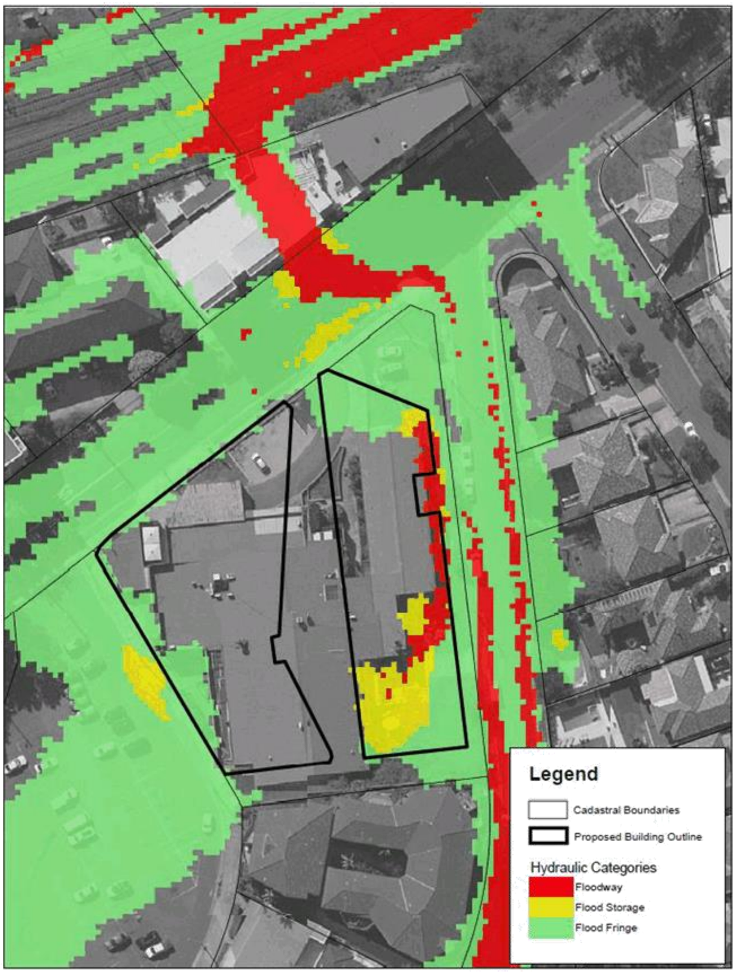


Figure 8: Flood Categories (1%AEP)

The main issue for any development will be achieving a complaint outcome in regard to flood impact. Other issues related to flood related development controls that seek to ensure appropriate development inclusive of levels etc. will be readily achieved. For example:

- Compliance with floor height controls;
- Compliance with controls relating to building resilience.

The PMF (Probable Max Flood) is a consideration in building design and risk management. The Floodplain Development Manual (2005), defines the PMF as "*[...] the largest flood that could conceivably occur at a particular location, usually estimated from Probable Maximum Precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event [...]*"

The PMF provides an upper limit of flooding. As can be seen from results in Figure 9, the PMF does not scale excessively at the Site with PMF levels being generally 0.3 to 0.5 m higher than 1% AEP levels. At North instead the PMF level is more than 1m higher than the 1% AEP level due to the limited capacity of the overland flow throughout the building car park at 232 Slade Road.

Location	1%AEP Level [mAHD]	PMF Level [mAHD]	FPL [mAHD]
Building Entrance "A"	13.1	13.1	13.6
Building Entrance "B"	12.1	13.0	12.6
Building Entrance "C"	13.6	14.0	14.5
Vehicular Entrance "D"	12.9*	13.29	13.39
South end of pedestrian Laneway (Location "E")	N/A	15.5	15.5
Gutter in Sarsfield Circuit at entrance to 6m wide access lane (Location "F")	15.6	15.9	15.85**
Building Entrance "G"	13.9	14.5	14.5
Building Entrance "H"	13.9	14.5	14.5

*= measured on Sarsfield Road

**= crest level at the 6m wide access lane

Table 1 : water levels and proposed FPL

Table 1 provides the computed peak water levels for the 1% AEP event and PMF against the proposed FPLs.

A minimum freeboard of 500mm above the 1%AEP water levels is assured at all building entrances, in respect of Council DCP. Building Entrance "C" is also above the PMF level.

The Vehicular entrance "D" is more than 300mm above the 1%AEP water level and is also above the PMF level.

Following Council's request, a crest at level 15.85m has been provided at the East entrance to the 6m wide lane at South of the subject development, approx. 250mm above the 1% water level in the Sarsfield Circuit gutter.

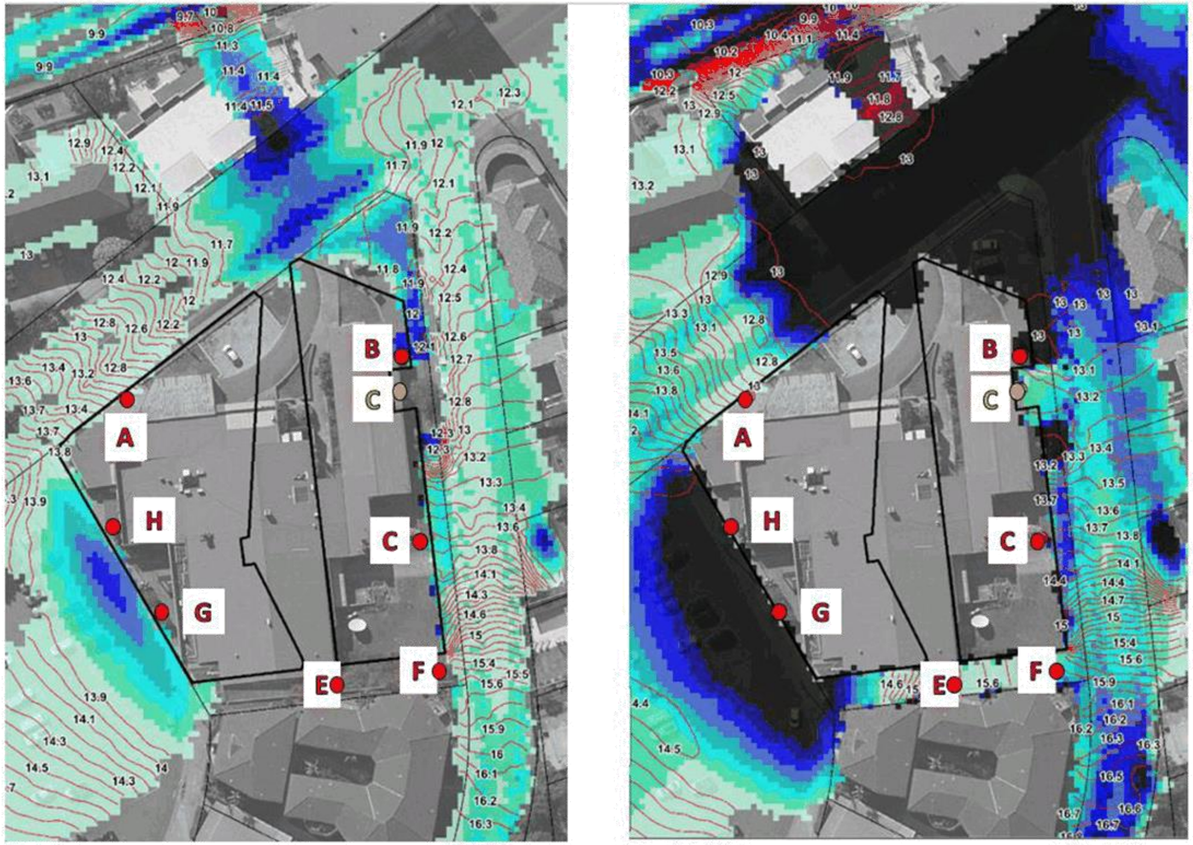


Figure 9: 1%AEP (Left) and PMF (Right) Flood depth Maps

8. Pipe Diversion

As mentioned in Section 4 of this report, the proposed development comprises diversion and upgrade of limited Council's stormwater pipes.

In the Existing Scenario in fact, a 900mm dia. pipe runs under the existing building in 187 Slade Road from the car park at West to a drainage pit on the Slade Road at North of the building (pipe "EXISTING (a)" in Figure 10).

From this pit, a 900mm dia. pipe crosses Slade Road and connects to a large pit located at the entrance of the car park of building in 232 Slade road (pipe "EXISTING (d)" in Figure 10) from where a 1200mm dia. pipe discharge to the railway line at North.

The new stormwater layout proposes to demolish the pipe "EXISTING (a)" and re-route it to North, along Slade Road, to avoid interferences with the new construction (pipes "PROPOSED (b)" and "PROPOSED (c)" in Figure 10). The proposed diversion will increase the length of the pipe by approximately 19m and will introduce some sharper deflection angles that might reduce the capacity of the existing system. To cater for the additional energy losses due to the extended length of the pipe (friction losses) and for the less efficient geometry of the network (minor losses), it is proposed to upsize the diversion pipes to 1050mm dia.

Additionally, it is proposed to upsize the 900mm dia. "EXISTING (d)" pipe to 1200mm dia. "PROPOSED (d)" pipe (or alternative drainage structure of equivalent cross-sectional area) to match the diameter of the pipe discharging to the railway line.

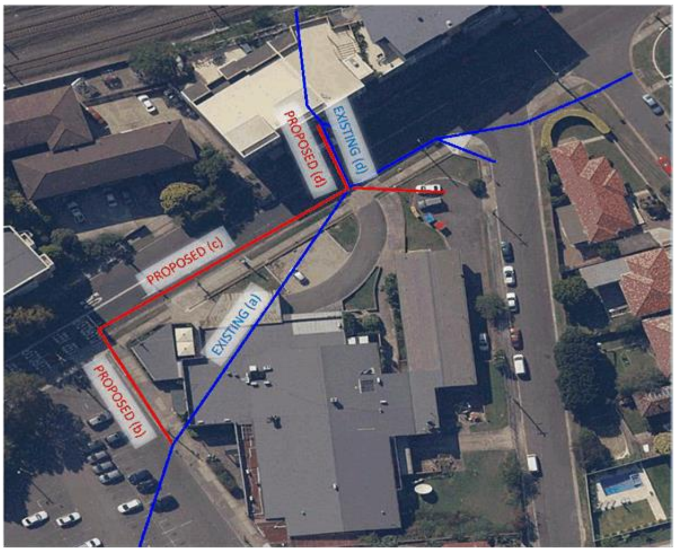


Figure 10: Pipe diversion scheme

TUFLOW simulations were run for events from the 20%AEP to the PMF event to test the new drainage scheme against the existing one.

In TUFLOW, the ENGELUND energy loss approach was used to calculate the minor losses due to the bends and change of direction. This approach calculates the loss coefficients at pipes junctions as sum of entry and exit head losses, losses due to the bend and drop in invert levels (further explanation can be found in Chapter 5.12.5.4 of TUFLOW manual).

Table 2 lists the computed losses coefficients at the peak flow time for the Existing and Proposed pipes in all events from the 20%AEP to PMF. The table reports:

- inlet loss coefficient i.e. the energy losses due to expansion of flow within the manhole at the outlet of the inlet culvert
- additional loss coefficient due to bend and change in invert levels and any manhole energy loss contribution
- outlet loss coefficient i.e. the energy losses due to contraction from the manhole and re-expansion of flow within the entrance of an outlet culvert

AEP	PEAK MINOR HEADLOSS COEFFICIENT (Inlet / Form / Outlet)				
	EXISTING		PROPOSED		
	(a)	(d)	(b)	(c)	(d)
20%	0.19/0.02/0.42	0.16/0.45/0.45	B	0.16/0.80/0.39	0.16/0.77/0.28
10%	0.19/0.02/0.42	0.16/0.45/0.46	0.17/0.16/0.39	0.16/0.80/0.41	0.16/0.77/0.29
1%	0.19/0.02/0.44	0.16/0.41/0.47	0.19/0.16/0.44	0.17/0.79/0.44	0.16/0.76/0.30
PMF	0.17/0.02/0.40	0.18/0.37/0.54	0.18/0.18/0.43	0.17/0.73/0.42	0.16/0.75/0.34

Table 2: TUFLOW minor losses coefficients

Table 2 shows that the total minor loss coefficient (sum of Inlet, Form and Outlet coefficients) increases from 0.65 to 0.79 at the first bend ("EXISTING (a)" and "PROPOSED (b)") and from 1.04 to 1.22 at the last one ("EXISTING (d)" and "PROPOSED (d)").

Additionally, in the proposed scheme, a 90-degree bend is introduced ("PROPOSED (c)") for which a total minor coefficient of around 1.4 is calculated.

Melbourne Water pit loss coefficient table (https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/standards-and-specifications/loss-coefficient)has been commonly referenced to by other Councils and Authorities . The table provides loss coefficients for a variety of junction pits configurations. A loss coefficient between 1.3 and 1.5 is recommended for pits at "L" bends which validates the coefficient calculated by TUFLOW.

Description	Q_u	Q_l	Q_g	k
Inlet pit with one outlet pipe:				
(a) side entry	-	-	≈Qo	10
(b) grated pit	-	-	≈Qo	5
Inlet pit on through pipe	~0.9Qo	-	some	0.5
	~0.7Qo	-	~0.3Qo	1.3
	~0.5Qo	-	~0.5Qo	2.1
Junction pit on through pipe	≈Qo	-	-	-
Inlet pit on through pipe with laterals	~0.9Qo	some	some	0.5
	~0.7Qo	some	some	1.1
	~0.5Qo	some	some	1.5
	~0.3Qo	0.7Qo	some	2.0
Junction pit on through pipe with laterals	~0.9Qo	some	-	0.5
	~0.5Qo	~0.5Qo	-	1.5
	~0.2Qo	~0.8Qo	-	2.0
Inlet pit on L bend	-	~Qo	some	1.5
Junction pit on L bend	-	≈Qo		1.3
Inlet bend on T junction with laterals	-	~Qo	some	1.8
Junction pit on T junction with laterals	-	≈Qo		1.6
Drop pit				
(a) direction change less than 45 degrees	~Qo	-	some	2.0
(b) direction change more than 45 degrees	~Qo	-	some	2.5

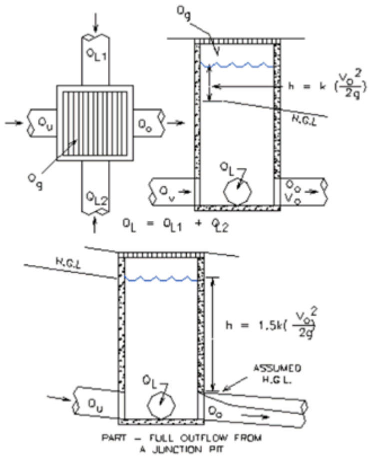


Table 3: Pit loss coefficients from Melbourne Water

TUFLOW also provides indication about the flow regime in the pipes at every simulation time step. All pipes at peak flow time are tailwater controlled with submerged entrance and exit (Flow regime type "F"). An exception is represented by the PROPOSED (b) pipe in the 20%AEP event where an inlet-controlled regime type B is calculated and for this reason TUFLOW does not provide minor loss coefficients results.

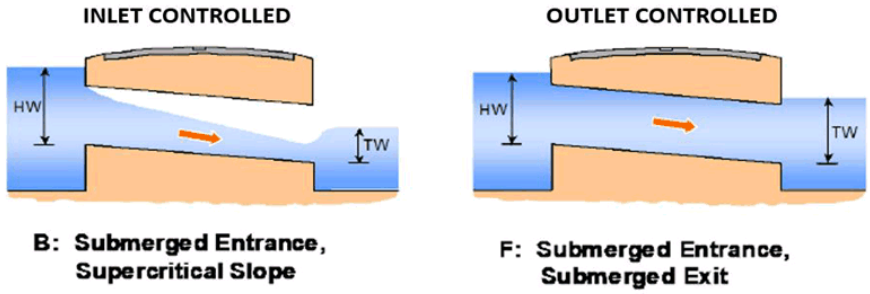


Figure 11: Flow regimes in diversion pipes

Table 4 are the peak flow rates in the existing and proposed network and the peak Hydraulic Grade Line (HGL) at the drainage pit in the car park at West of the Site (where the diversion pipe departs). Peak flow for all the simulated events increased by approximately 30% while the HGL at the pit in the car park ("U/S Peak HGL") reduces approx. by 150 to 200 mm for all events up to the 1% AEP and by 13mm in the PMF.

AEP	PEAK FLOW (m^3/s)					U/S PEAK HGL (mAHD)	
	EXISTING		PROPOSED			EXISTING	PROPOSED
	(a)	(d)	(b)	(c)	(d)		
20%	1.6804	1.919	1.962	1.987	2.579	13.042	12.854
10%	1.961	1.951	2.036	2.063	2.625	13.176	12.955
1%	2.107	2.07	2.258	2.295	2.748	13.526	13.382
PMF	2.306	2.697	2.456	2.668	3.476	14.52	14.507

Table 4: Peak flow rates and HGL in the existing and proposed network

Hand calculation has also been done to compare the existing and proposed pipe configuration. The calculation is based on the Gauckler-Manning-Strickler resistance formula for the friction energy losses calculation and on the TUFLOW computed minor loss coefficients to calculate the losses at each change in direction.

In the table below, a constant inflow of $2m^3/s$ was assumed for both the existing and proposed scheme and the total head loss (friction losses + minor head losses) was calculated under the assumption of uniform flow regime.

	EXISTING	PROPOSED	Comment
Q (m^3/s)	2.000	2.000	constant inflow ~ equal to the 1% AEP flow
Ltot (m)	83.670	101.960	total lenth of pipe = L1+L2
L1 (m)	67.780	86.070	L is the pipe length . L1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
L2 (m)	15.890	15.890	L is the pipe length . L2 refers to is pipe (d) in both the existing and proposed
k	66.660	66.660	Gaukler Strickler coefficient , corresponding to a Manning coefficient = 0.015
dia 1 (m)	0.900	1.050	dia is the pipe diameter. dia1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
dia 2 (m)	0.900	1.200	dia is the pipe diameter. dia2 refers to pipe (d) in both the existing and proposed
A1 (m^2)	0.636	0.866	A is the pipe cross sectional area. A1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
A2 (m^2)	0.636	1.131	A is the pipe cross sectional area. A2 refers to is pipe (d) in both the existing and proposed
R1 (m)	0.225	0.263	R is hydraulic radius. R1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
R2 (m)	0.225	0.300	R is hydraulic radius. R2 refers to is pipe (d) in both the existing and proposed
ΔHfr1 (m)	1.102	0.615	ΔHfr is head loss due to frictions. ΔHfr1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
ΔHfr2 (m)	0.258	0.056	ΔHfr is head loss due to frictions. ΔHfr2 refers to pipe (d) in both the existing and proposed
Δhfrtot (m)	1.360	0.670	Δhfrtot is the sum of ΔHfr1+ΔHfr2
V1 (m/s)	3.144	2.310	V is the average pipe cross sectional velocity. V1 refers to pipe (a) in the existing and pipe (b+c) in the proposed
V2 (m/s)	3.144	1.768	V is the average pipe cross sectional velocity. V2 refers to is pipe (d) in both the existing and proposed
φ1	0.650		minor head loss coeff of first bend in existing case
φ2	1.040		minor head loss coeff of second bend in existing case
φ3		0.790	minor head loss coeff of first bend in proposed case
φ4		1.400	minor head loss coeff of second bend in proposed case
φ5		1.220	minor head loss coeff of third bend in proposed case
ΔHBEND1 EXIST (m)	0.327		head loss (m) due to the first bend in the existing network. It is calculated with φ1 and the V^2/(2g) , where V is the velocity of the DS pipe
ΔHBEND2 EXIST (m)	0.524		head loss (m) due to thesecond bend in the existing network. It is calculated with φ2 and the V^2/(2g) , where V is the velocity of the DS pipe
ΔHBENDTOT EXIST (m)	0.851		total head loss due to bends in the existing network.
ΔHBEND1 PROP (m)		0.215	head loss (m) due to the first bend in the proposed network. It is calculated with φ3 and the V^2/(2g) , where V is the velocity in the DS pipe
ΔHBEND2 PROP (m)		0.381	head loss (m) due to the second bend in the proposed network. It is calculated with φ4 and the V^2/(2g) , where V is the velocity in the DS pipe
ΔHBEND3 PROP (m)		0.194	head loss (m) due to the third bend in the proposed network. It is calculated with φ5 and the V^2/(2g) , where V is the velocity in the DS pipe
ΔHBENDTOT PROP (m)		0.790	total head loss due to bends in the proposed network.
Δhtot exist (m)	2.211		sum of friction losses and bend losses in the existing network
Δhtot prop (m)		1.460	sum of friction losses and bend losses in the proposed network

Table 5: Head loss hand calculation – Existing VS Proposed network

Both TUFLOW and the hand calculation demonstrate that the new proposed scheme is hydraulically more efficient than the current one.

In TUFLOW, due to the increased pipe conveyance, peak flow in the diverted pipes is greater than in the existing ones while the peak Hydraulic Grade in the upstream pit (in the West car park) is reduced by approximately 150mm.

In the hand calculation, where same inflow is assumed in the pre and post development scheme, the total energy loss ("Δhtot") in the new scheme is significantly lower.

9. Flood Risk Assessment

The potential risk to life as a result of flooding can be ascertained by assessing the flood hazard. Flood hazard can be quantified by considering the flood depth and velocity in combination (AIDR, 2017).
The hazard categories based on the Australian Emergency Management Institute (2014) of Figure 12 were considered.

Available warning time for the Site is short due to the small size of the catchment upstream of the Site, leading to a "flash flood" classification. Review of the flood models found that the 1%AEP peak flood flow occurs approximately 10 minutes after the rainfall peak which leaves little time for flood evacuation and preparation. Evacuation of the buildings could potentially result in people entering hazardous floodwater areas. For flash flood catchments, the provision of an effective flood warning service is not available due to the difficulties with its prediction. A benefit of the flash flood setting is that the duration of flooding is typically short with hazardous flooding to typically last less than one hour.

Figures 13 and 14 in the Appendix, are the 1%AEP and PMF flood hazard maps for the Existing and Proposed Scenario. In the 1%AEP event, the flood hazard variations are negligible. In the PMF, a slight increase of the flood H5 hazard category is shown at the downstream end of the Sarsfield Circuit, which does not modify the overall hazard category of the area. Figures 15 and 16 in appendix highlights changes in flood hazard caused by the new development.

Hazard along the escape routes on Slade Road is generally low, being globally classified as H1 level. However, although significant flow path is only likely to occur in rare flood events, the type of potential flow presents a significant risk to people and vehicles. An analysis of the PMF event therefore yields the requirement that people are not moving around the Site once a certain threshold of depth is crossed. It is clear, however, that this threshold event will occur rarely (less often than once per one hundred years).

The Site access is limited by the trafficability of Slade Road, which is classified as H5 in the PMF as per flood hazard category. Therefore, shelter-in-place for Site occupants is recommended during flood event.

It shall be noted that, given the nature of public accessibility of the proposed Laneway, the proposed Site will represent a safe refuge for people caught by flash flooding.

10. Building Materials

All materials below PMF level in the proposed development shall be flood compatible.
No electrical equipment or wiring shall be installed below PMF level.

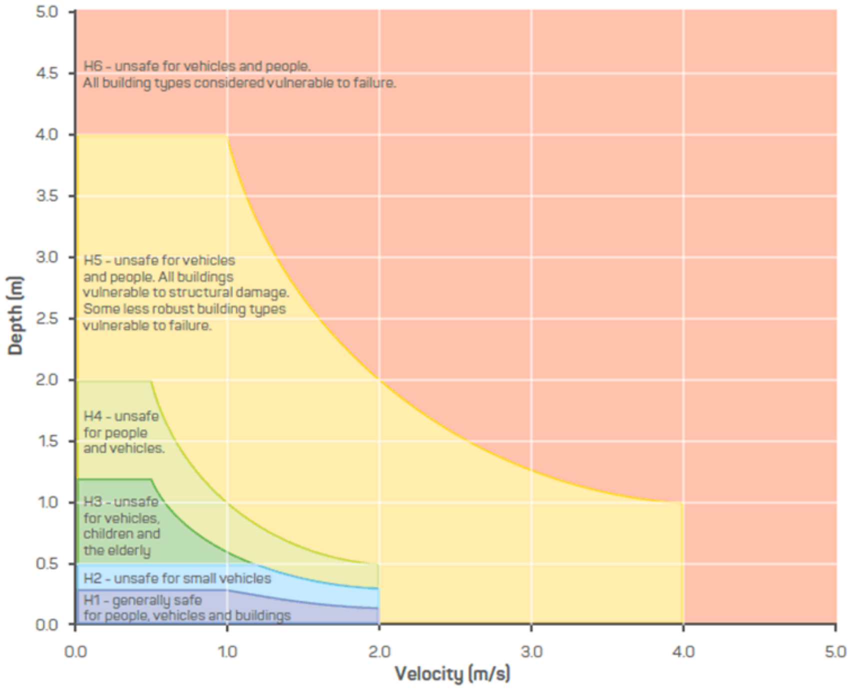


Figure 12: Flood Hazard Category by Australia Emergency Management Institute (2014)

11. Flood Management Plan

The Site is not subject to high level of flood risk and whilst in are events flow does occur, flood free areas in the PMF event are easily accessible on foot.

Hazard is relatively low for all but the rarest events. Flooding will be occurring simultaneously with the rainfall due to the small catchment, but flooding duration will be limited in time.

Due to the limited available warning time and the associated risk of people driving or walking through flood waters, it is not recommended that people evacuate the Site during times of flood and that shelter-in-place policy be adopted. This requires little management to achieve.

It is suggested signage be installed in the basement to advise that during rainfall or following rainfall, care should be taken as residents exit the carpark.

11.1 Preparedness

Preparations for flooding are to be incorporated into the management of the Site. These measures shall be communicated to the staff of the stores and to all residents in the buildings to ensure that the Site is prepared for flooding when it occurs. The preparatory measures are as follows:

- Keep a hard copy and digital version of this Flood Management Plan;
- Brief relevant staff of its content on an annual basis, or more frequently if staff turnover is high. There should always be at least one employee familiar with the Plan on duty whilst the stores are open;
- Brief resident of the buildings with the content of the Plan;
- Design temporary warning signage to marshal Site occupants during a flood including warning signs to not let people leave the Site during flood or accessing the car park;
- Maintain a loudspeaker system inside the Site that can be used for announcements during a flood. A flood warning message should be prepared for disseminations to occupants during times of flood. The message should contain information about the dangers of flood waters and advising people remain within the Site until an all-clear message is announced.

11.2 During a Flood

The main responsibility during a flood is to notify emergency services, to marshal Site occupants into safe areas and to assist those impacted by floodwaters.

The greatest risk is estimated to be to those leaving the Site end entering areas of high flood hazard.

The actions to be taken by the Site management, in chronological orders, are:

1) Call the State Emergency Service and advice that the Site is flooding and that assistance may be required;
2) Erect temporary warning signs at each Site exit stating to remain within the Site;
3) Turn off buildings power to reduce the risk of electrocution;
4) Announce (over the loudspeaker and in-person) to occupants of the Site that flooding is occurring outside and to remain calm and stay within the Site area until flooding passes. The Site should not be evacuated during flood event as the greatest flood risk is experienced in the car park and surrounding roads.
5) Ensure that no one is in the Basement areas;

6) Check outside if any vehicles or pedestrian have been caught in floodwaters or injured. Assist them if safe to do so (fast moving or deep floodwaters should be avoided) and if injuries are noted, call an ambulance;
7) Assist the elderly or those with children in finding a safe area to wait within the building.

11.3 Recovery

Once the floodwater subsides, announce that it is safe to now leave the building and car park, and take down the signage. Attend the occupants that are injured or show symptoms of shock. Call emergency 000 for assistance if required. If electrical or gas services have been inundated do not turn these appliances on until they have been checked by a qualified electrician or gas fitter.

Following the flood event, the Site management should liaise with stores' staff to understand the consequence of the flood event, including where repairs are required. This plan should then be reviewed and updated, if necessary, with any lesson learned. Damages to building, car park or other assets will be dealt with following the flood and they are not the focus of this plan.

12. Overview of Compliance

The proposed development has been assessed in regard to flooding and Council's flood planning controls. Table 6 presents the Development Control Plan controls and our assessment of each for the development.

Relevant Control	GRC Hydro Assessment
Development must comply with Council's – Flood Management Policy which provides guidelines of controlling developments in different flood risk areas. It should be read in conjunction with the NSW Government's 'Floodplain Development Manual 2005'.	The development complies with Council's policy and also with the NSW government's Floodplain Development Manual. The Manual describes how flood-affected areas can be safely developed, by ensuring the development is protected against flooding, and that it does not result in adverse flooding. These are the subject of the remaining controls in this table.
The filling of land up to the 1:100 Average Recurrence Interval (ARI) flood level (or flood storage area if determined) is not permitted, unless specifically directed by Council in very special and limited locations. Filling of land above the 1:100 ARI up to the Probable Maximum Flood (PMF) (or in flood fringe) is discouraged however it will be considered providing it does not adversely impact upon flood behaviour.	The existing Site is fully developed but has small areas of land below the 1:100 ARI flood level. These are not significant flow paths but rather they are low areas where runoff accumulates during a flood. Some low areas will be filled by the proposed development so as to prevent this accumulation from occurring and reduce the flood risk. To ensure there is no significant loss of flood storage, flood impact assessment has been carried out that shows there are no adverse impacts on other properties, as a result of the development.
Development should not adversely increase the potential flood affectation on other development or properties, either individually or in combination with the cumulative impact of similar developments likely to occur within the same catchment.	The Site is located in an urban area with many nearby properties. Impact assessment shows that by upgrading stormwater drainage and inclusion of a swale, there is no adverse impact on properties' flood affectation. The area does not have potential for cumulative impacts due to such development as the catchment is already fully developed.
The impact of flooding and flood liability is to be managed, to ensure the development does not divert the flood waters, nor interfere with flood water storage or the natural functions of waterways. It must not adversely impact upon flood behaviour.	As described, a number of design features, including upgraded stormwater drainage and a swale, have been incorporated into the development, so as to ensure no diversion of flood waters or interference with flood storage. There are no adverse impacts resulting from the development. These conclusions are demonstrated by the modelling carried out.
A flood refuge may be required to provide an area for occupants to escape to for developments where occupants require a higher standard of care. Flood refuges may also be required where there is a large difference between the PMF and the 1 in 100-year flood level that may place occupants at severe risk if they remain within the building during large flood events.	There is not a large difference between the PMF and the 1 in 100-year flood level at the Site, with around 0.3-0.6 m difference. The new development will be protected from flooding and will allow any occupants to take refuge during a flood.

Table 6: DCP Controls

Further to the DCP controls in Table 6, Table 7 sets out the compliance of the proposed development with Local Planning Directions in Section 9.1(2) of the Environmental Planning and Assessment Act 1979, specifically Section 4.3 Flooding.

Relevant Control	**GRC Hydro Assessment**
A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy, the NSW FDM 2005, Considering flooding in land use planning guideline 2021 and any local study adopted by Council.	The development complies with the NSW government's Floodplain Development Manual and Flood Prone Land Policy. The Manual describes how flood-affected areas can be safely developed, by ensuring the development is protected against flooding, and that it does not result in adverse flooding. The new 2021 guideline uses the Flood Planning Area concept but also introduces Special Flood Considerations for land outside the FPA. The subject site is affected in the 1% AEP and so is not outside the FPA.
A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Environmental Protection Zones to a Residential, Business, Industrial or Special Purpose Zones.	Not applicable - the site is not zoned Recreation, Rural, Special Purpose or Environmental Protection Zone.
A planning proposal must not contain provisions that apply to the flood planning area which: *(a) permit development in floodway areas,* *(b) permit development that will result in significant flood impacts to other properties,* *(c) permit development for the purposes of residential accommodation in high hazard areas,* *(d) permit a significant increase in the development and/or dwelling density of that land,* *(e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,* *(f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent,* *(g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road*	In response to each: a) No development is proposed in areas of floodway. There are some areas of floodway on Sarsfield Road and also downstream of the site on Slade Road. b) Impact assessment shows that by upgrading stormwater drainage and inclusion of a swale, there is no adverse impact on properties' flood affectation c) The development does not locate residential or other development in high hazard areas. d) The development increases the site's dwelling density but does not increase the density in flood affected areas. The existing use of the site is a pub/hotel with significant development at ground level with multiple entrances at grade. The proposed development raises ground floor entrances, significantly reducing the site's flood-affectation. The proposed development will therefore reduce the intensity of use in flood-affected areas. e) Effective evacuation is straightforward at the site. Evacuation strategy would consist of a shelter-in-place approach as flooding will occur with little to no warning and be of short duration.

infrastructure, flood mitigation infrastructure and utilities, or *(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.*	f) Not applicable g) The proposed design includes a number of stormwater drainage features to manage flooding and ensure building occupants are not placed at risk in the design flood. This ensures there is no increased requirement for government spending on mitigation or emergency management. h) Development does not include hazardous industries or hazardous storage establishments.
A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which	Not applicable - the development is not outside the flood planning area.

In summary then:

- GRC Hydro have done extensive work on flood modelling at the Site;
- Council have provided a TUFLOW model which is suitable for Site analysis;
- The Site is flood liable albeit to overland flows or what would tend to be called stormwater;
- Council stormwater assets on the Site currently lie under buildings – the re-development is an opportunity to put such assets in locations where they can be accessed should maintenance be required;
- Site's flood liability is very much affected by a re-distribution of flow that resulted from a 2010 development approved at the corner of Sarsfield Circuit and Bexley Road;
- Flood liability of the Site means that compliance with DCP controls is required to be achieved by any development;
- Compliance with risk management requirements (appropriate floor levels, building materials etc.) is straightforward;
- Compliance with impact consent conditions required the following mitigation measures:
    - Swale on the Eastern side of the development; and
    - Pipe diversion on Slade Road; and
    - Pipe upgrade across Slade Road.
- Flood risk can be effectively managed by an evacuation in place response which is the more "natural" or default response in any case.

In Conclusion, the proposed development is a better outcome than the existing as the Site in now protected from flooding. Moreover, the public accessible areas may provide safe refuge to those who are captured by floodwater around the Site.

This report demonstrates that the Site is capable to compliance with Council's requirements: management issues will be discussed as a part of a future Development Application.

Yours Sincerely,

Steve Gray
Director

Email: gray@grchydro.com.au
Tel: +61 413 631 447

GRC Hydro

APPENDIX

GRC Hydro


FIGURE 01
189 SLADE ROAD BEXLEY NORTH
PROPOSED CASE SCENARIO
Cadastral boundaries
Proposed Building
Graded Area
6m Wide
Proposed Lane
Existing Stormwater Network
Proposed Stormwater Pipes
Proposed Swale
Car Ramp Crossing
N
grc
HYDRO
0
50
metres

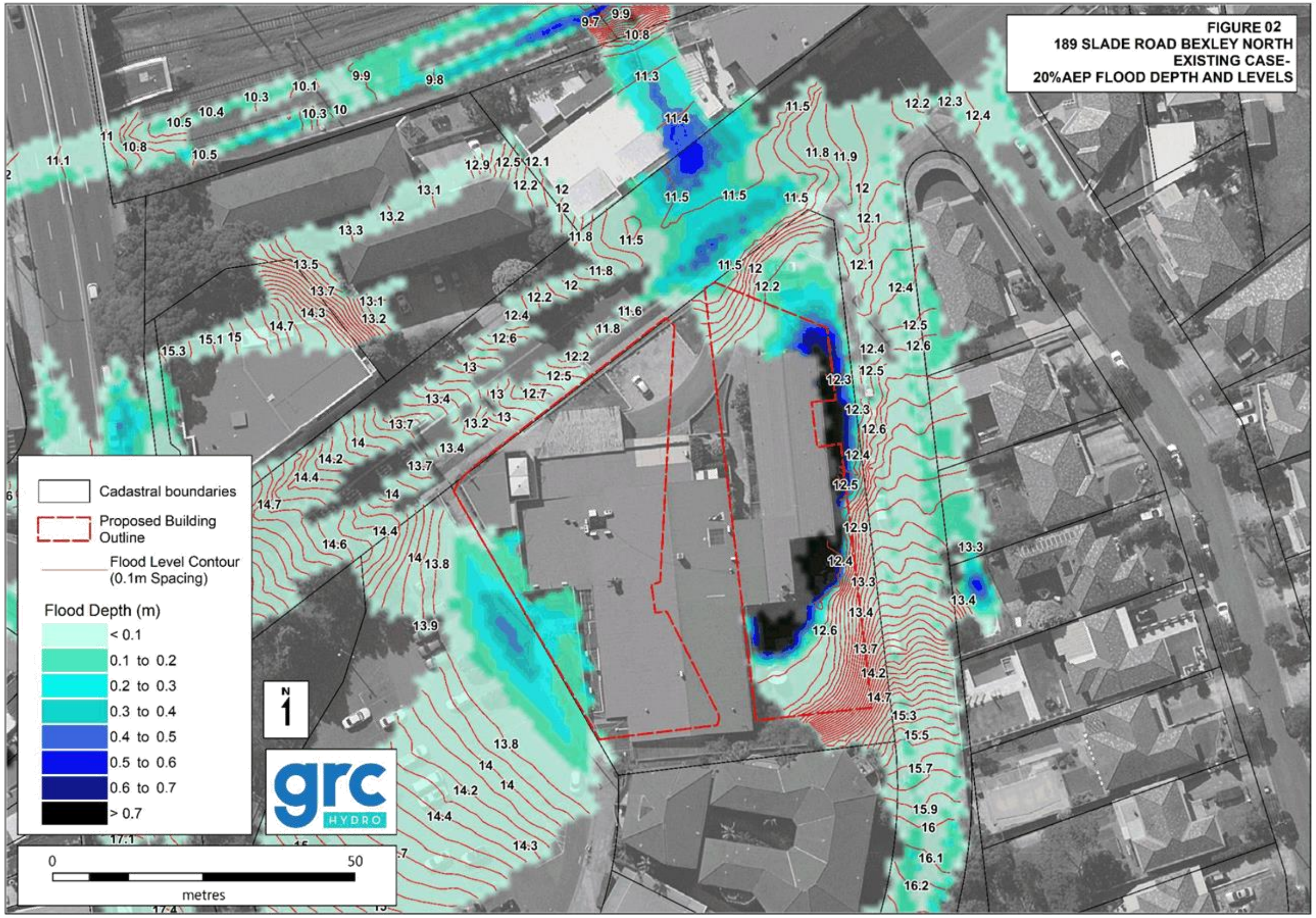


FIGURE 02
189 SLADE ROAD BEXLEY NORTH
EXISTING CASE-
20%AEP FLOOD DEPTH AND LEVELS
Cadastral boundaries
Proposed Building Outline
Flood Level Contour (0.1m Spacing)
Flood Depth (m)
< 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
> 0.7
N
grc
HYDRO
0
50
metres

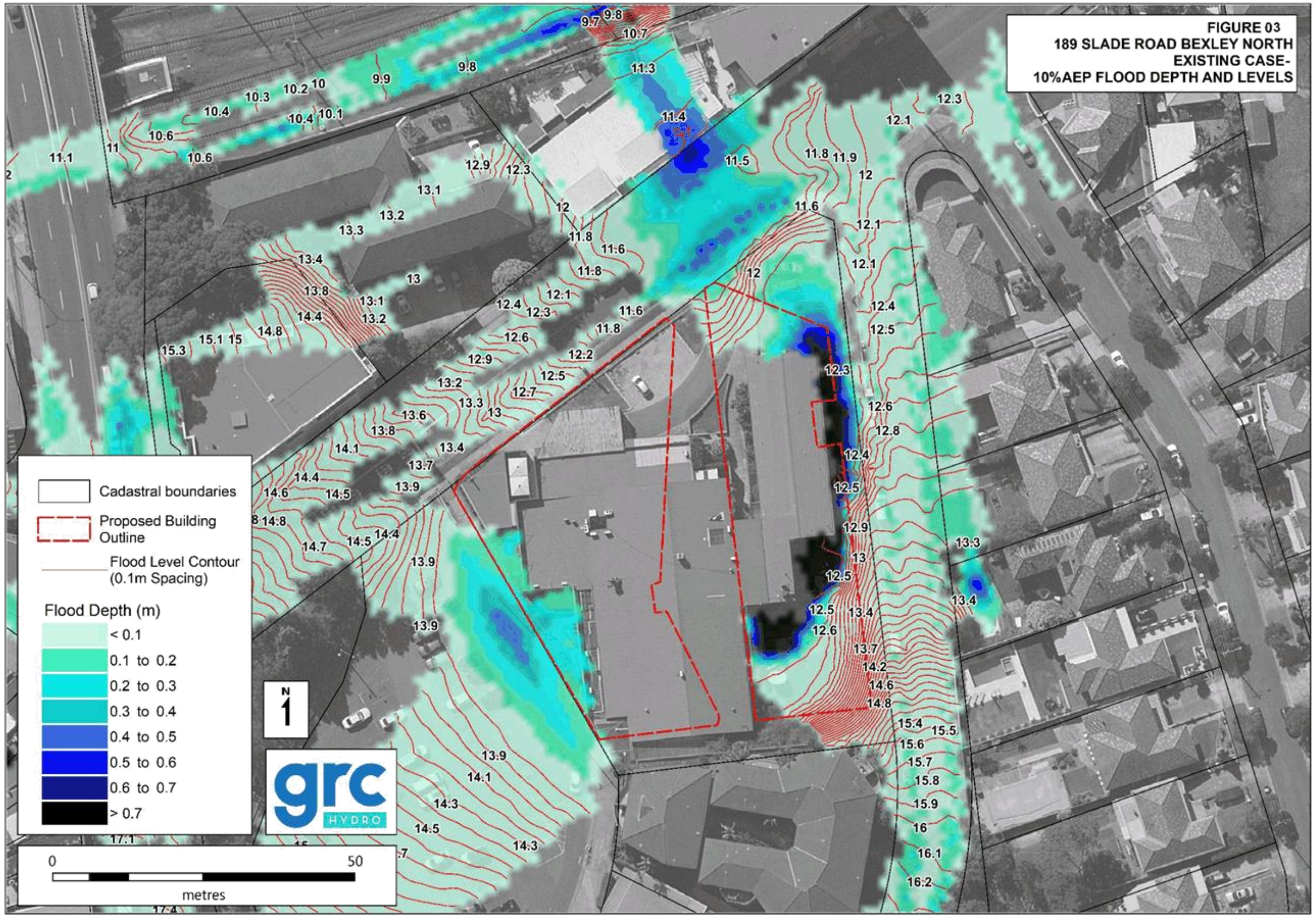


FIGURE 03
189 SLADE ROAD BEXLEY NORTH
EXISTING CASE-
10%AEP FLOOD DEPTH AND LEVELS
Cadastral boundaries
Proposed Building Outline
Flood Level Contour (0.1m Spacing)
Flood Depth (m)
< 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
> 0.7
0
50
metres
N
grc
HYDRO

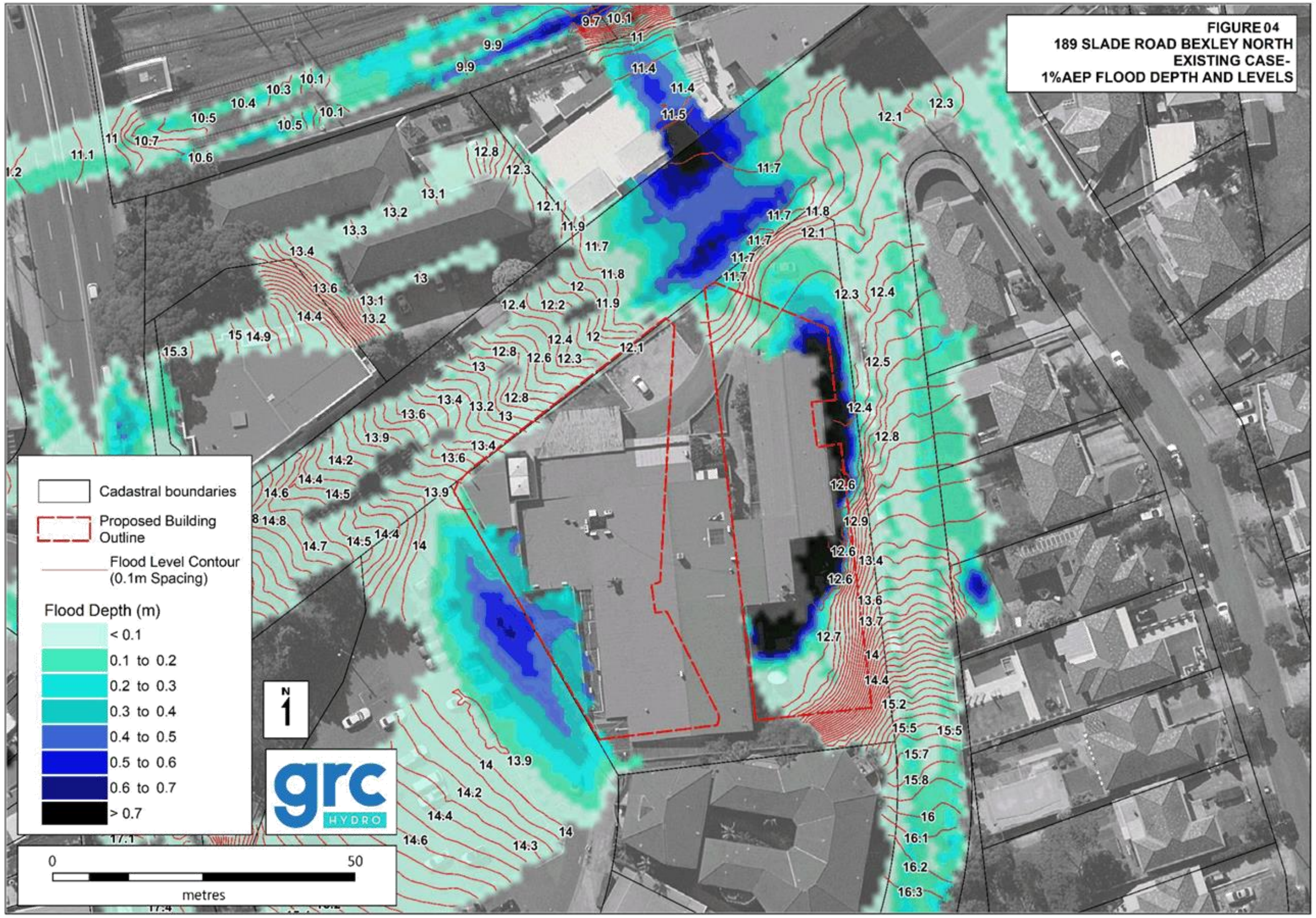


FIGURE 04
189 SLADE ROAD BEXLEY NORTH
EXISTING CASE-
1%AEP FLOOD DEPTH AND LEVELS
Cadastral boundaries
Proposed Building Outline
Flood Level Contour (0.1m Spacing)
Flood Depth (m)
< 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
> 0.7
N
grc
HYDRO
0
50
metres

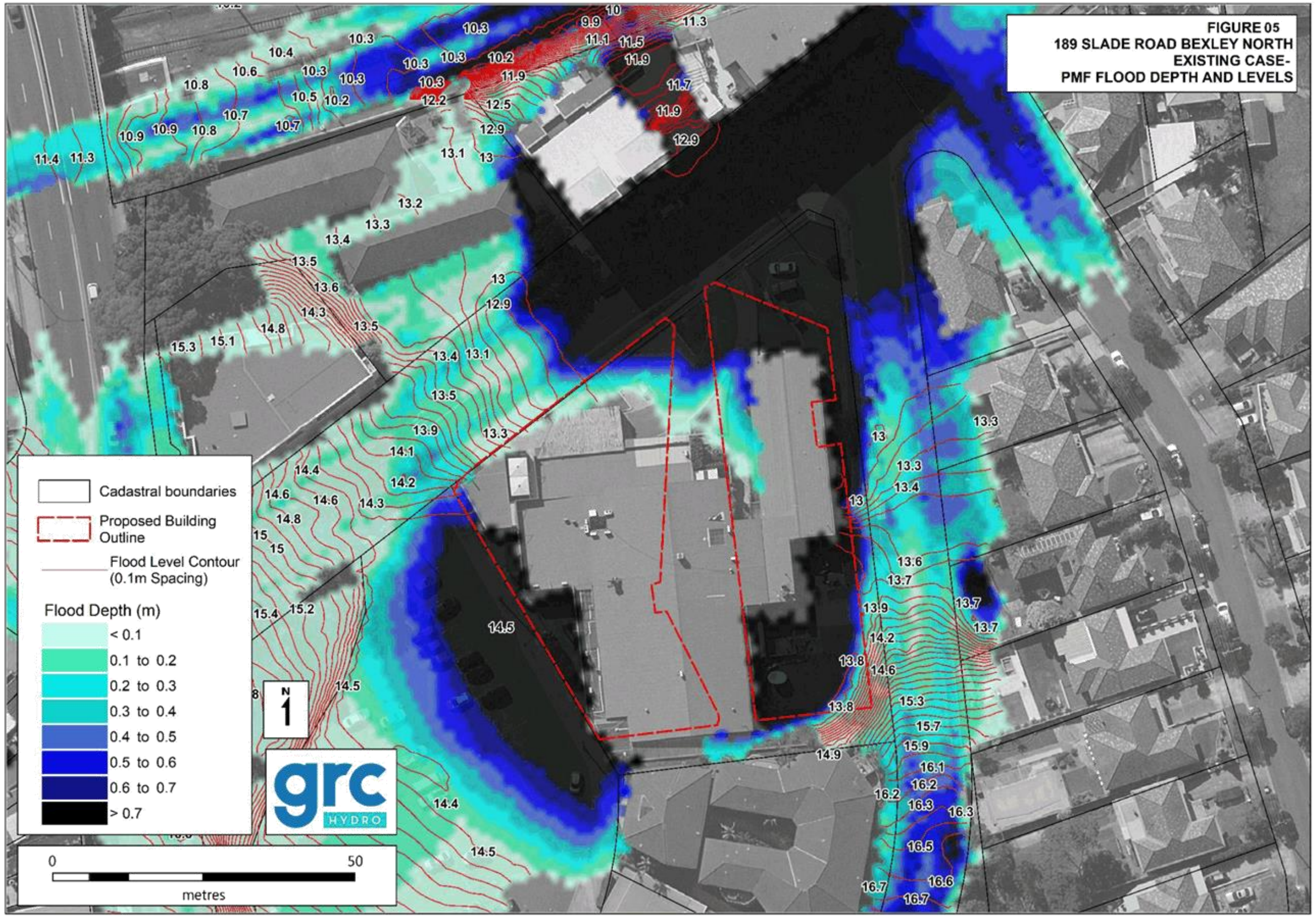


FIGURE 05
189 SLADE ROAD BEXLEY NORTH
EXISTING CASE-
PMF FLOOD DEPTH AND LEVELS
Cadastral boundaries
Proposed Building Outline
Flood Level Contour (0.1m Spacing)
Flood Depth (m)
< 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
> 0.7
N
grc HYDRO
0
50
metres

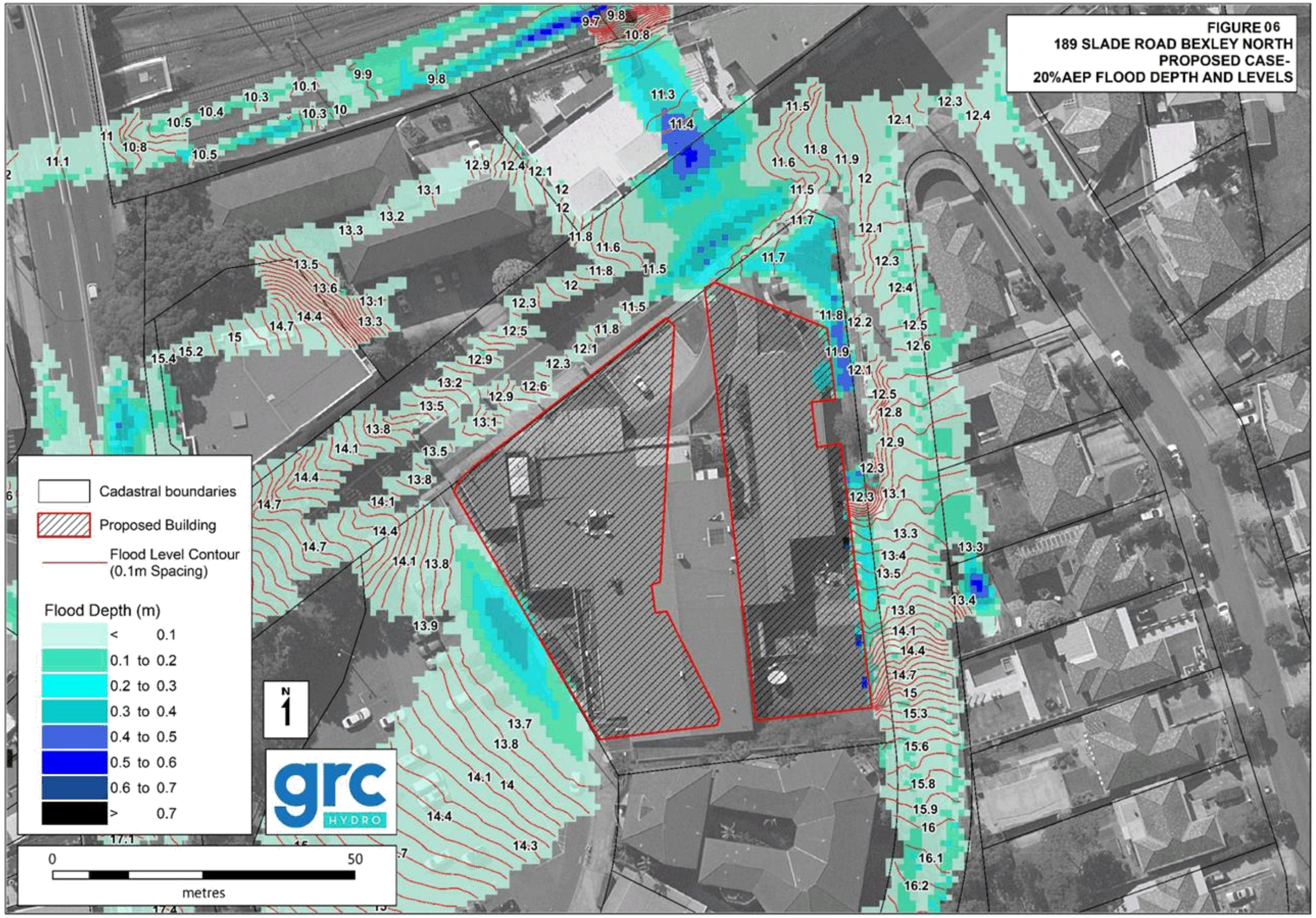


FIGURE 06
189 SLADE ROAD BEXLEY NORTH
PROPOSED CASE-
20%AEP FLOOD DEPTH AND LEVELS
Cadastral boundaries
Proposed Building
Flood Level Contour (0.1m Spacing)
Flood Depth (m)
< 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
> 0.7
N
grc HYDRO
0
50
metres

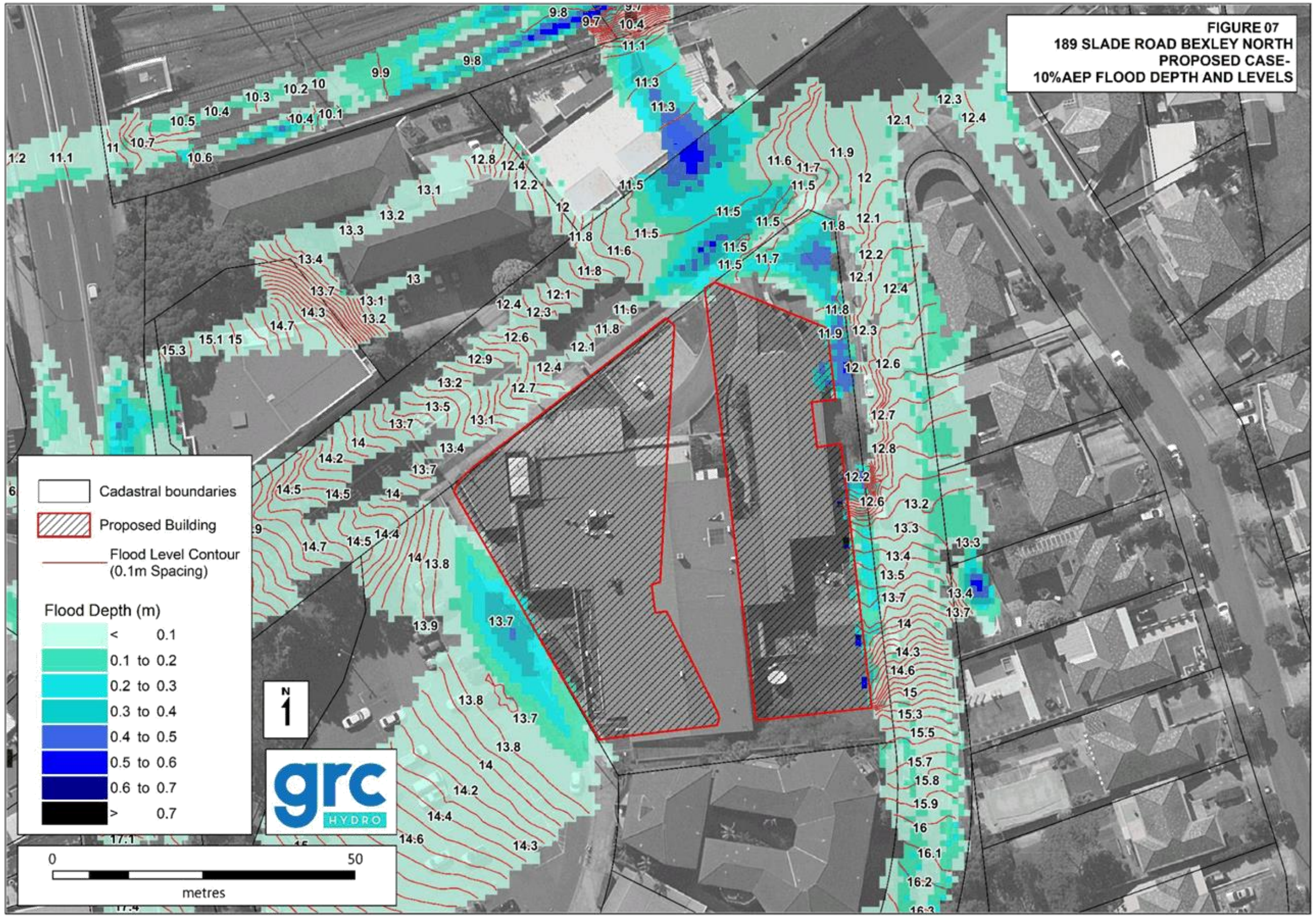


FIGURE 07
189 SLADE ROAD BEXLEY NORTH
PROPOSED CASE-
10%AEP FLOOD DEPTH AND LEVELS
Cadastral boundaries
Proposed Building
Flood Level Contour (0.1m Spacing)
Flood Depth (m)
< 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
> 0.7
N
grc HYDRO
0
50
metres

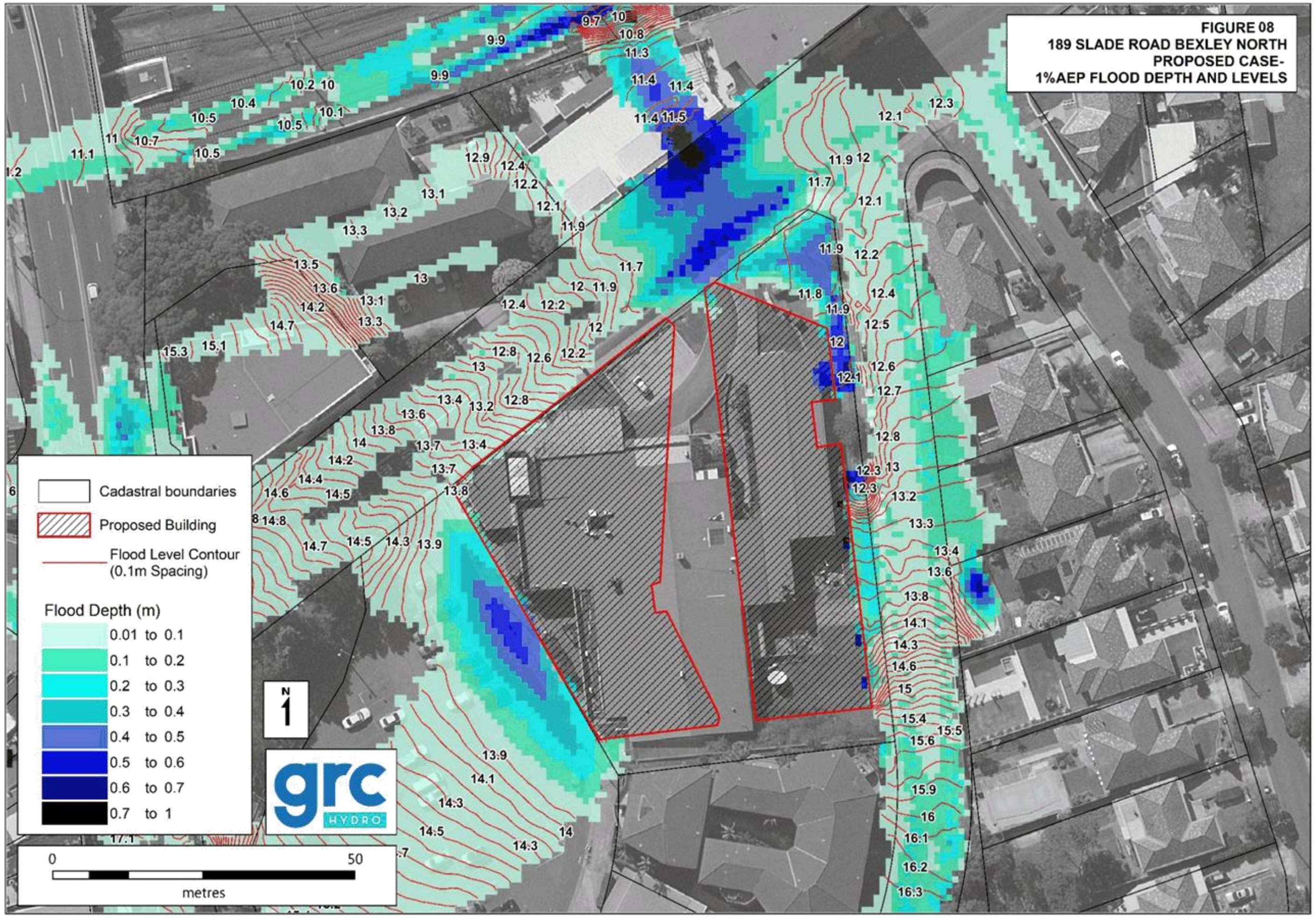


FIGURE 08
189 SLADE ROAD BEXLEY NORTH
PROPOSED CASE-
1%AEP FLOOD DEPTH AND LEVELS
Cadastral boundaries
Proposed Building
Flood Level Contour (0.1m Spacing)
Flood Depth (m)
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
0.7 to 1
N
grc
HYDRO
0
50
metres

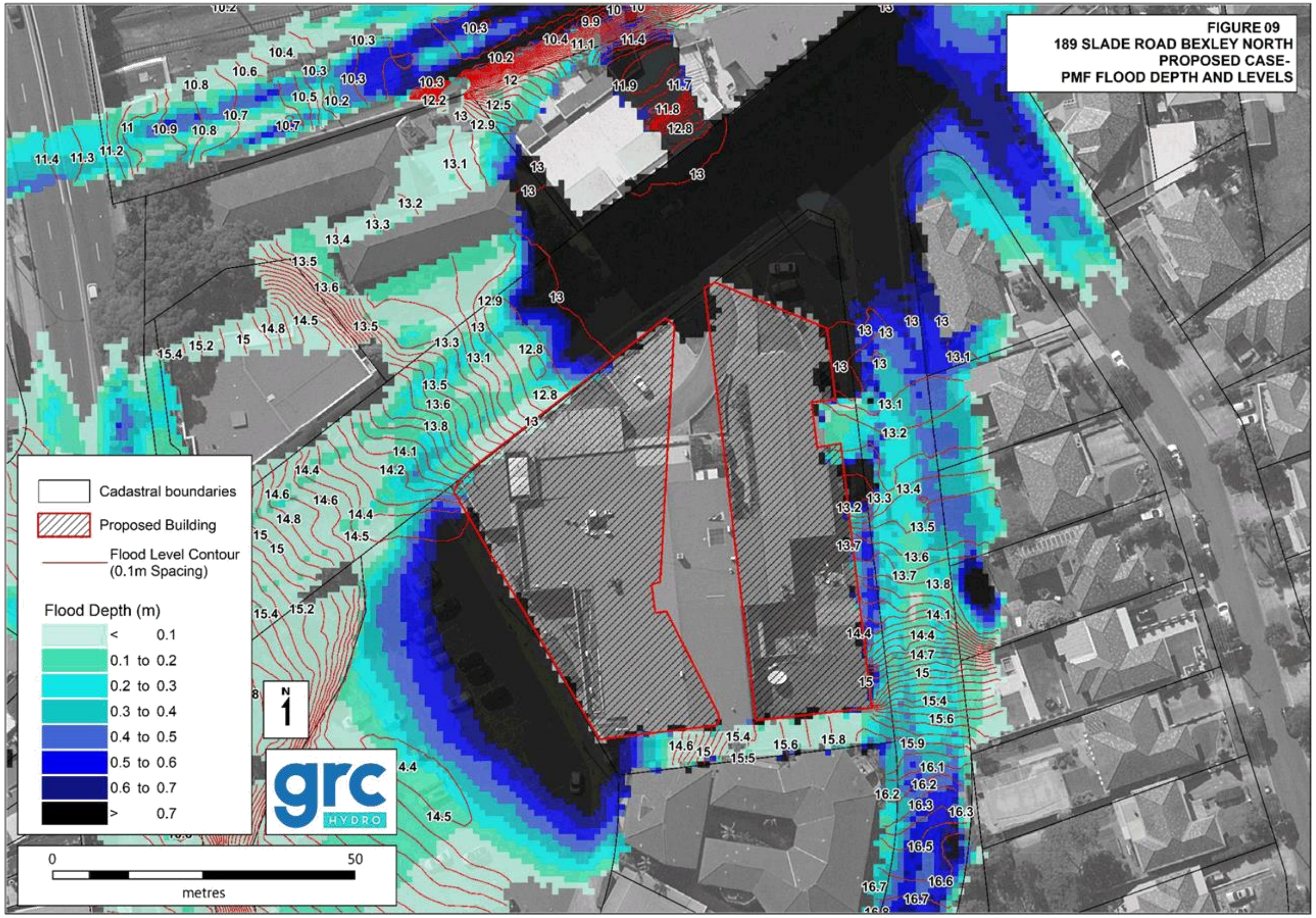


FIGURE 09
189 SLADE ROAD BEXLEY NORTH
PROPOSED CASE-
PMF FLOOD DEPTH AND LEVELS
Cadastral boundaries
Proposed Building
Flood Level Contour (0.1m Spacing)
Flood Depth (m)
< 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.6
0.6 to 0.7
> 0.7
N
grc HYDRO
0
50
metres

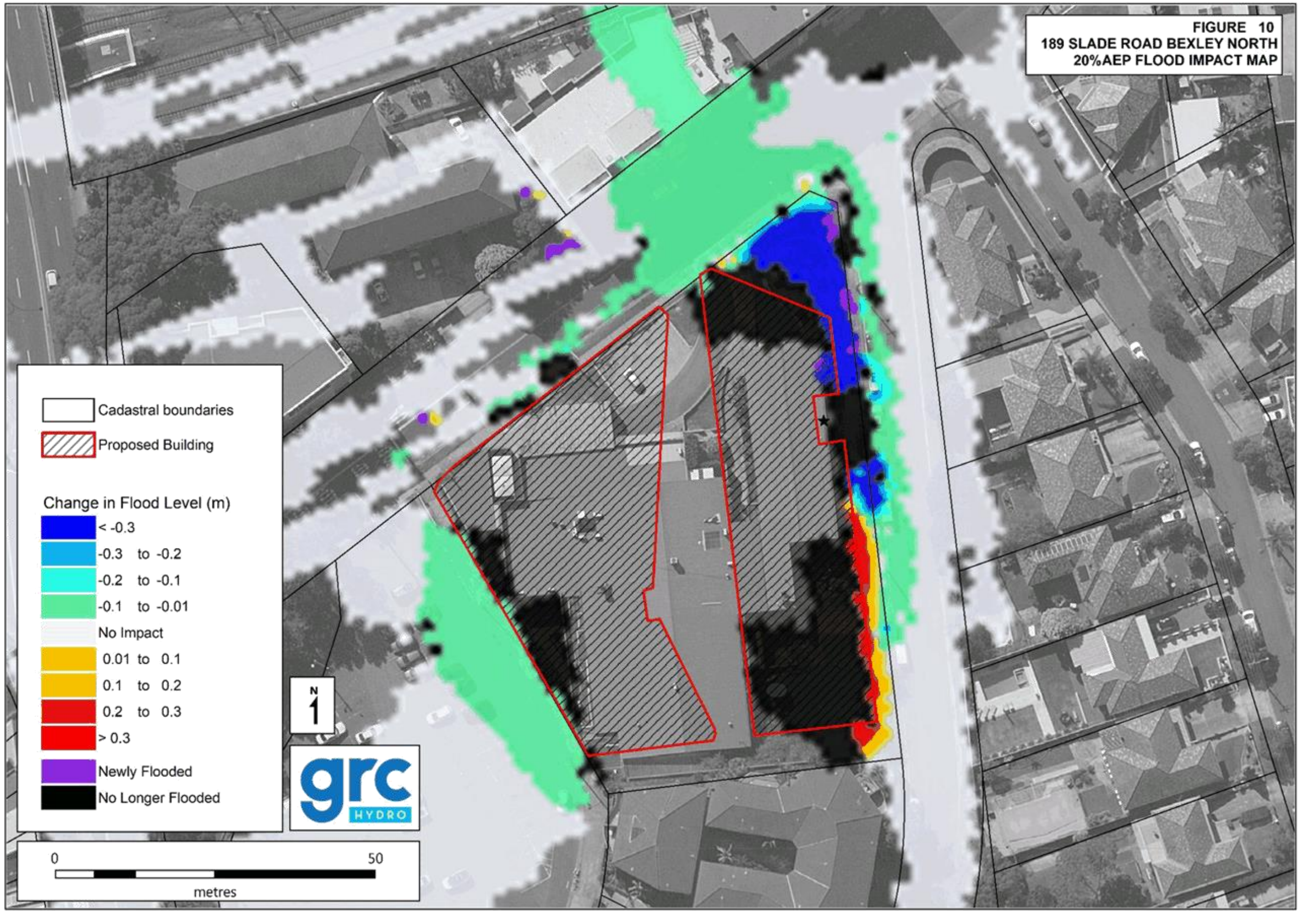


FIGURE 10
189 SLADE ROAD BEXLEY NORTH
20%AEP FLOOD IMPACT MAP
Cadastral boundaries
Proposed Building
Change in Flood Level (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
Newly Flooded
No Longer Flooded
N
grc HYDRO
0
50
metres

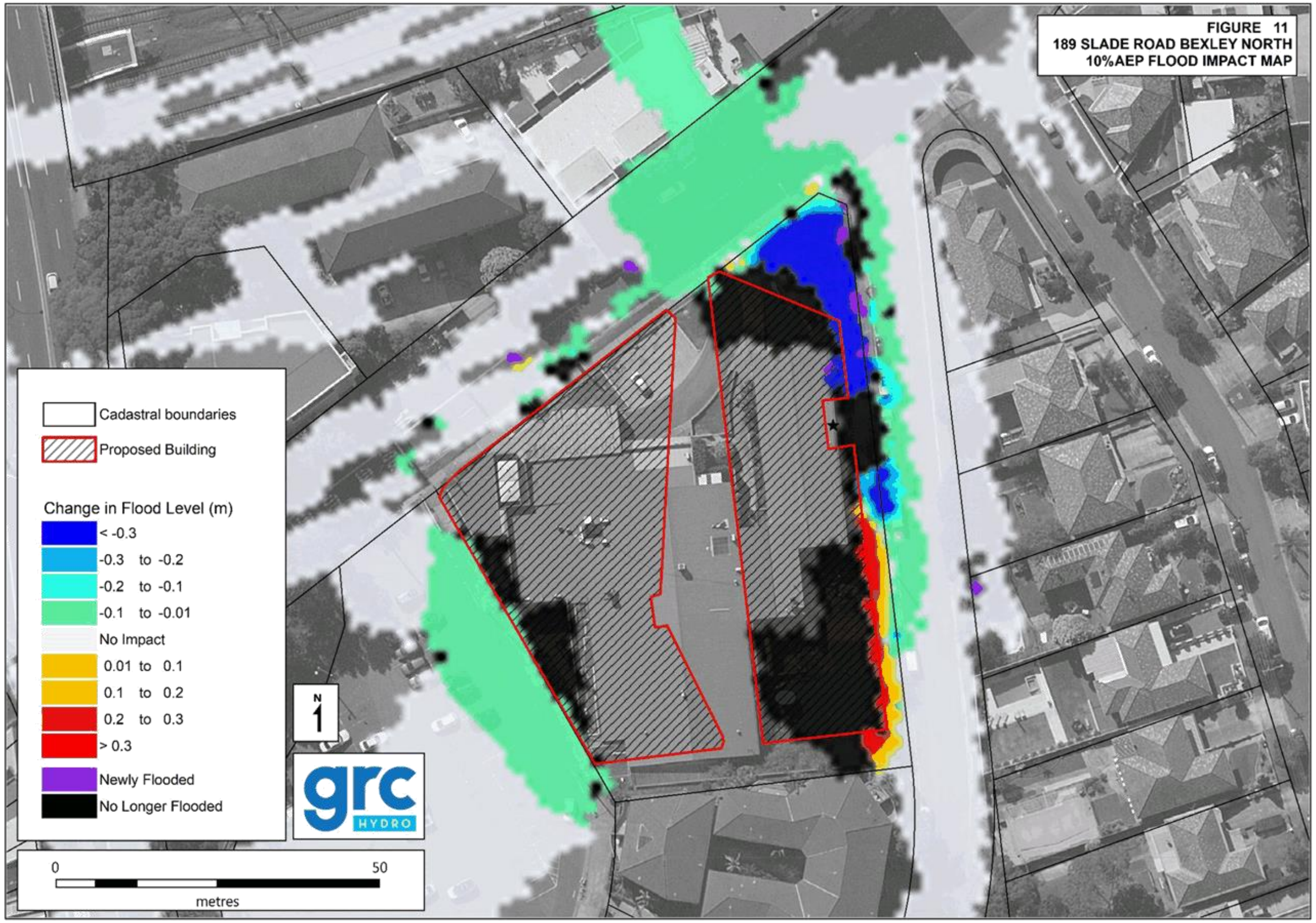


FIGURE 11
189 SLADE ROAD BEXLEY NORTH
10%AEP FLOOD IMPACT MAP
Cadastral boundaries
Proposed Building
Change in Flood Level (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
Newly Flooded
No Longer Flooded
N
grc
HYDRO
0
50
metres

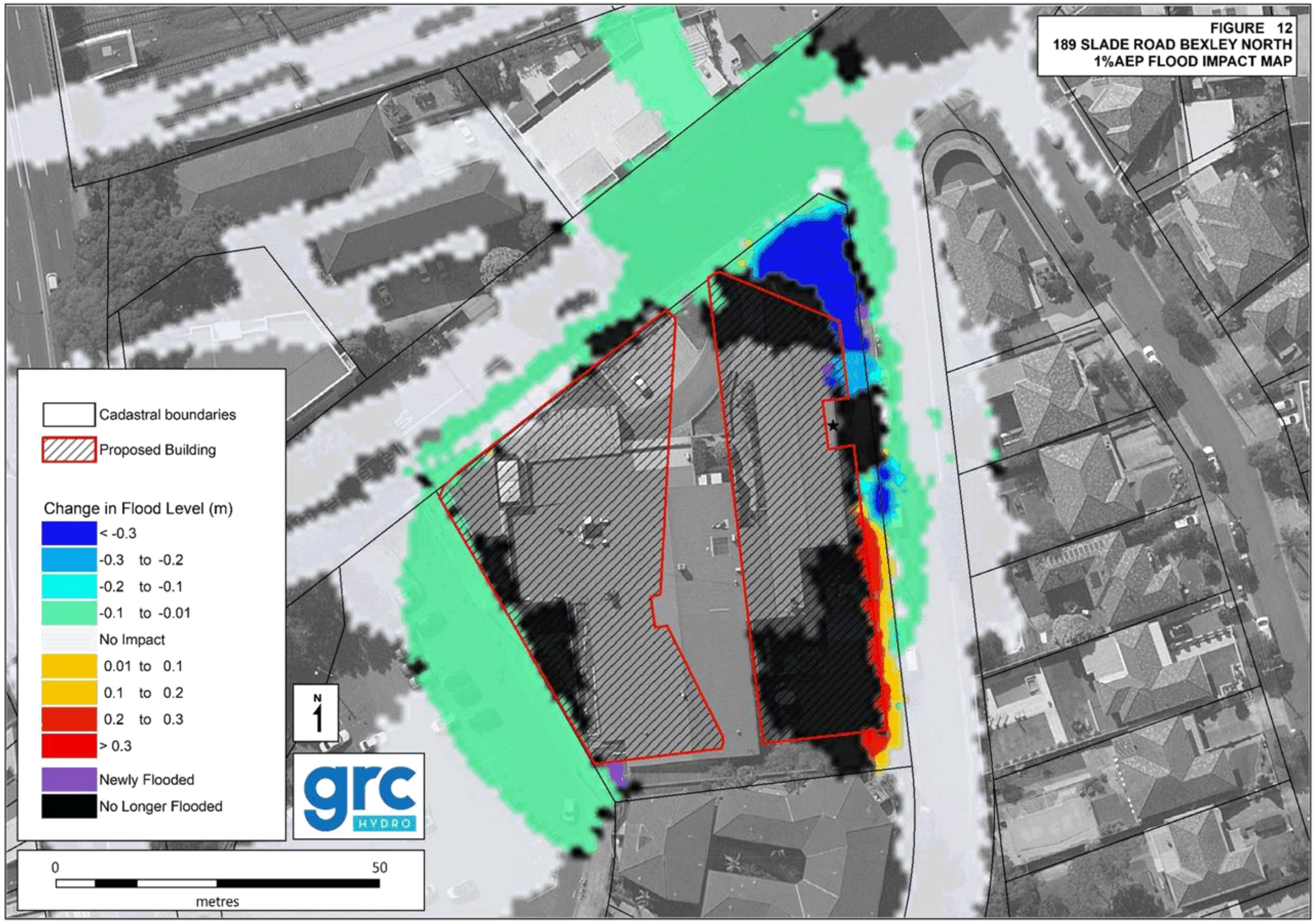
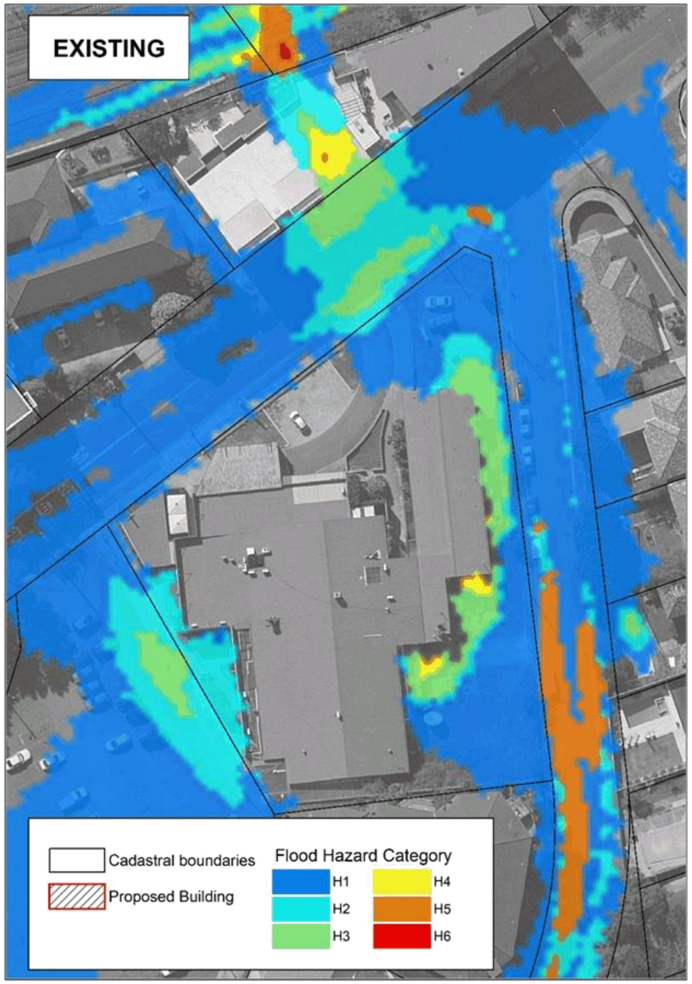
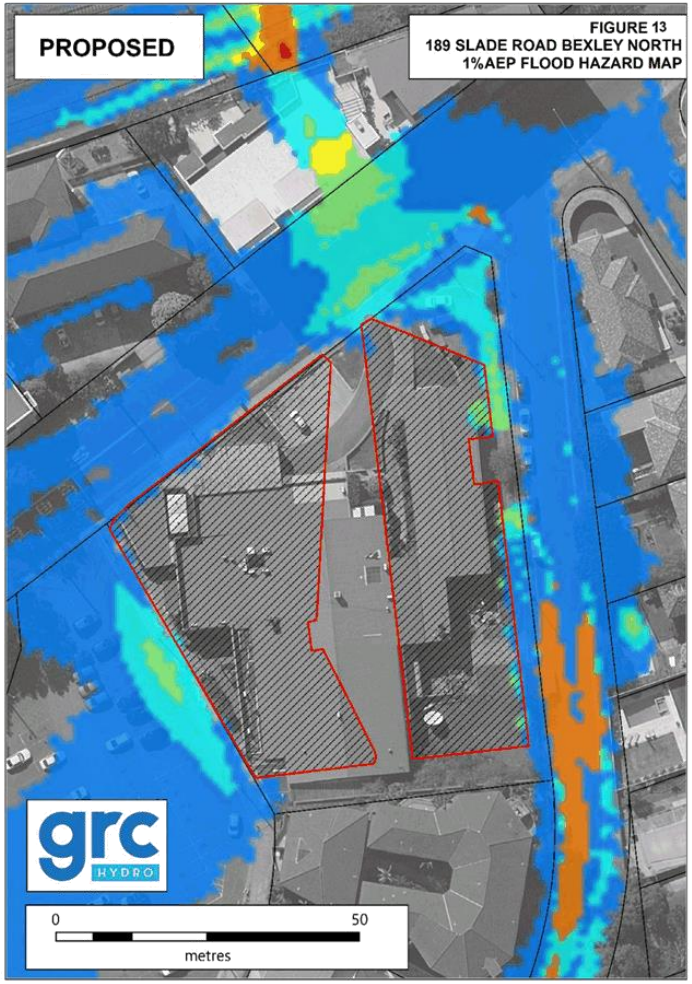
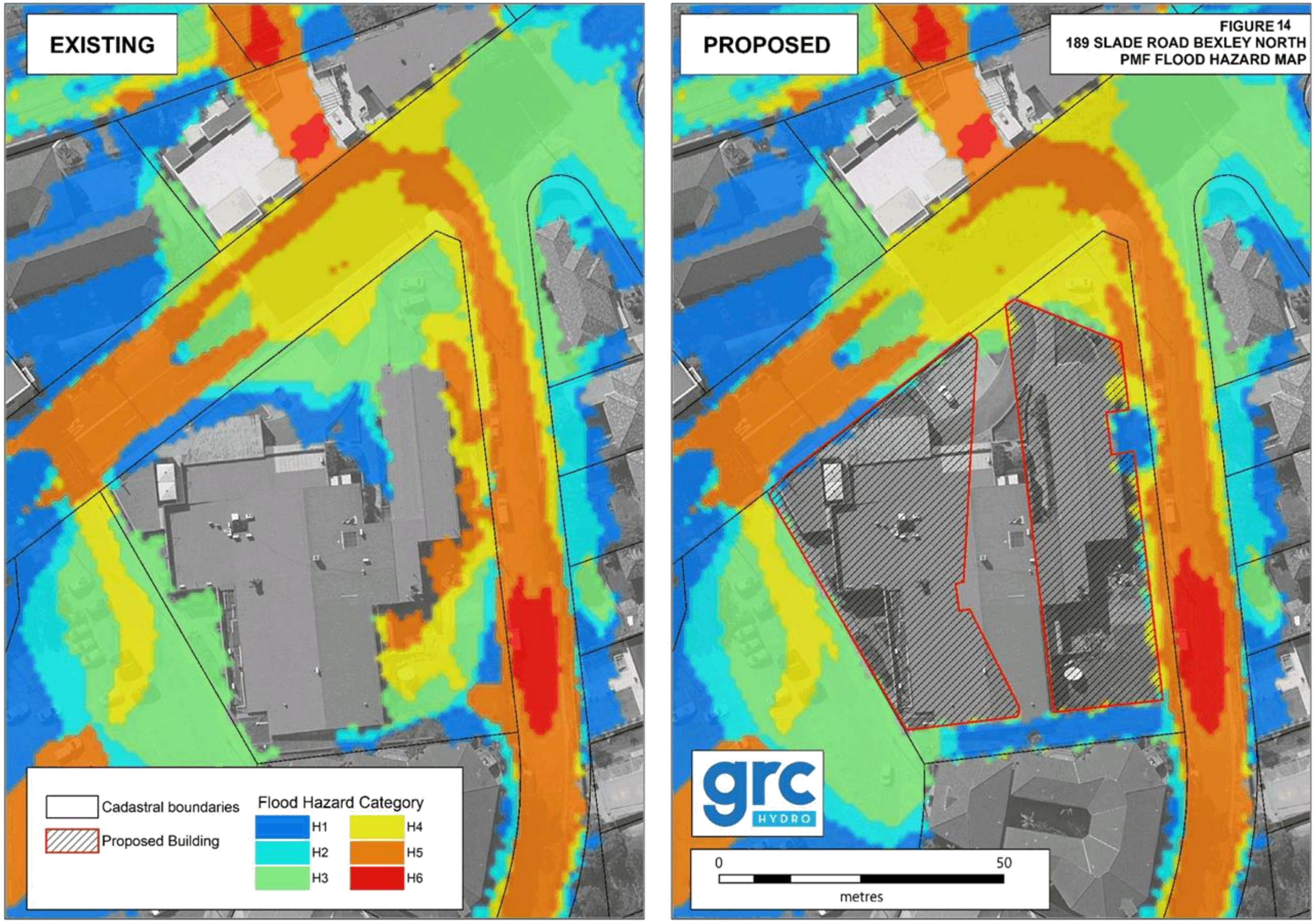


FIGURE 12
189 SLADE ROAD BEXLEY NORTH
1%AEP FLOOD IMPACT MAP
Cadastral boundaries
Proposed Building
Change in Flood Level (m)
< -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to -0.01
No Impact
0.01 to 0.1
0.1 to 0.2
0.2 to 0.3
> 0.3
Newly Flooded
No Longer Flooded
N
grc
HYDRO
0
50
metres


EXISTING
Cadastral boundaries
Proposed Building
Flood Hazard Category
H1
H2
H3
H4
H5
H6


PROPOSED
FIGURE 13
189 SLADE ROAD BEXLEY NORTH
1%AEP FLOOD HAZARD MAP
grc
HYDRO
0
50
metres


EXISTING
PROPOSED
FIGURE 14
189 SLADE ROAD BEXLEY NORTH
PMF FLOOD HAZARD MAP
Cadastral boundaries
Proposed Building
Flood Hazard Category
H1
H2
H3
H4
H5
H6
grc
HYDRO
0
50
metres

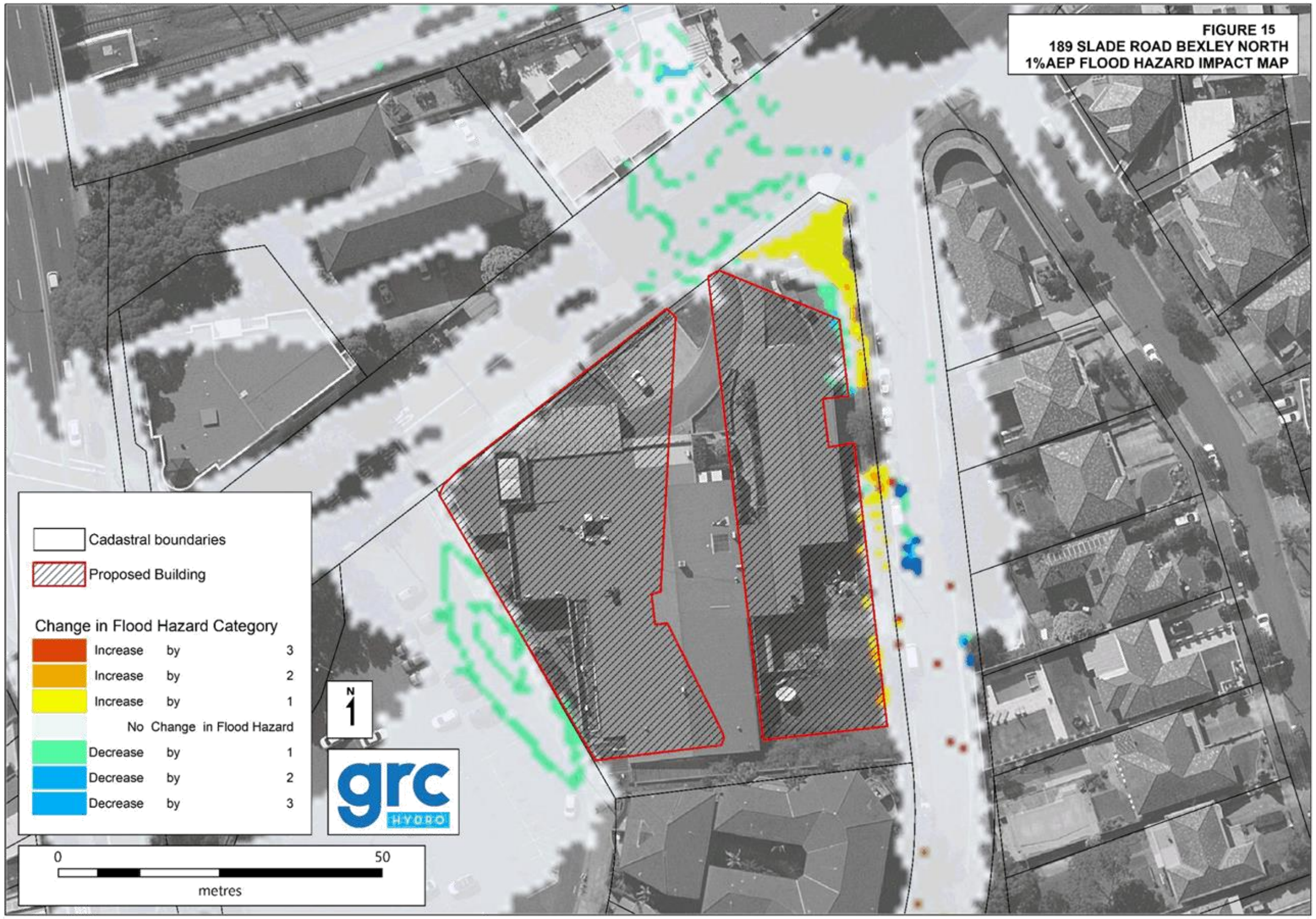


FIGURE 15
189 SLADE ROAD BEXLEY NORTH
1%AEP FLOOD HAZARD IMPACT MAP
Cadastral boundaries
Proposed Building
Change in Flood Hazard Category
Increase by 3
Increase by 2
Increase by 1
No Change in Flood Hazard
Decrease by 1
Decrease by 2
Decrease by 3
N
0
50
metres
grc
HYDRO


FIGURE 16
189 SLADE ROAD BEXLEY NORTH
PMF FLOOD HAZARD IMPACT MAP
Cadastral boundaries
Proposed Building
Change in Flood Hazard Category
Increase by 3
Increase by 2
Increase by 1
No Change in Flood Hazard
Decrease by 1
Decrease by 2
Decrease by 3
N
0
50
metres
grc
HYDRO

Western Built Form			Eastern Built Form	
Building Envelope			Building Envelope	
Level	GBA Sqm	GFA @75% efficiency Sqm	GBA Sqm	GFA @75% efficiency Sqm
Ground Floor	1560	1170	850	638
Level 01	1560	1170	1510	1133
Level 02	1555	1166	1530	1148
Level 03	1555	1166	1530	1148
Level 04	1300	975	1530	1148
Level 05	1300	975	860	645
Level 06	1045	784		
Level 07	525	394		
Level 08	525	394		
Level 09	425	319		
TOTAL	11350	8513	7810	5858

Site Area	4234
Estimated GFA	14370
Estimated FSR	3.40

18054 - PP - Bexley North - 187 Slade Road

Area Calculations - Estimated FSR

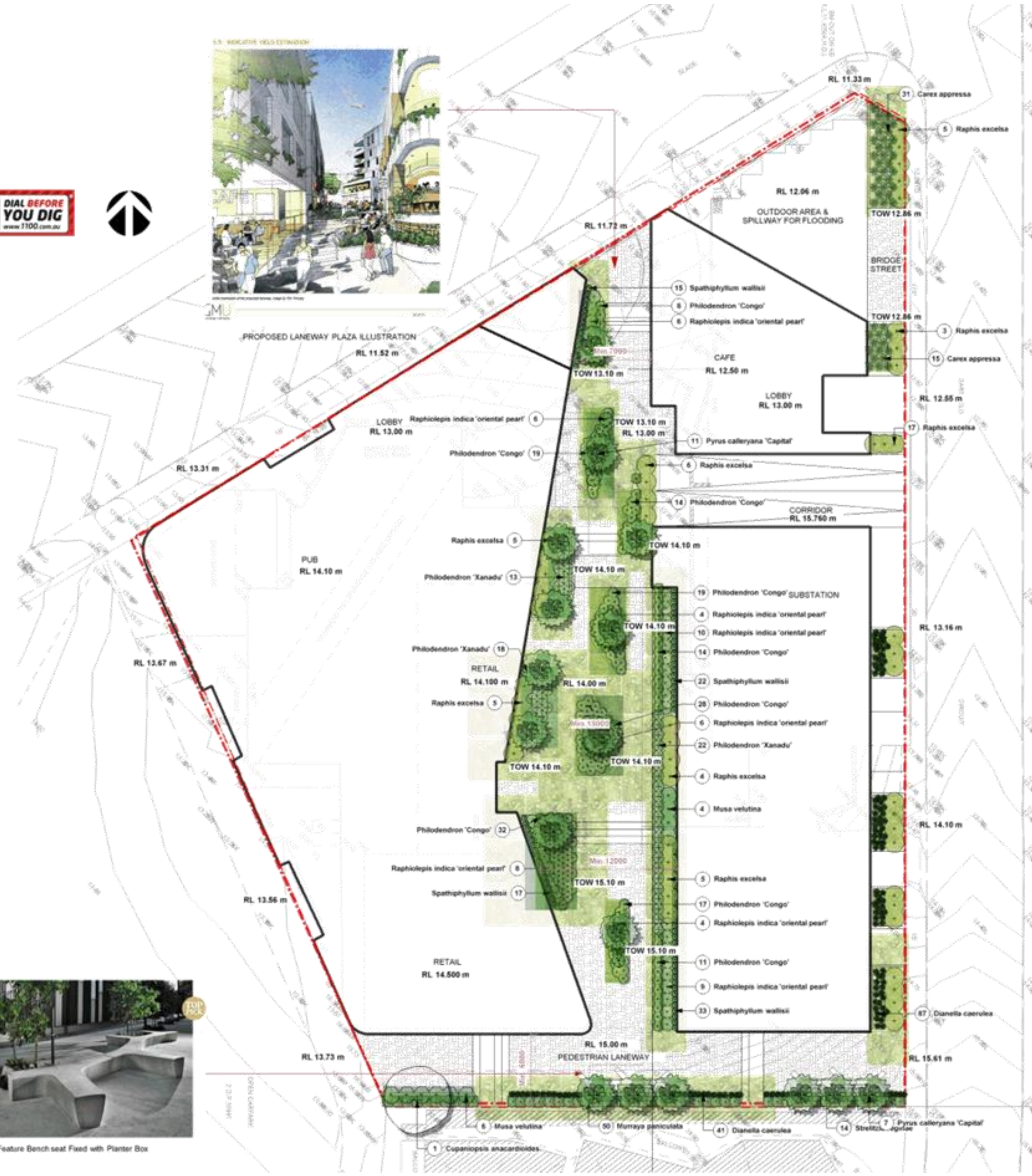
Prepared for: TUNBORN PTY LTD

SK-022
Revision:A by DR
Issued on 16 March 2020

Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

GMU Urban Design & Architecture



Feature Bench seat Fixed with Planter Box

LANDSCAPE MAINTENANCE NOTES

THE CONTRACTOR SHALL CONTINUOUSLY MAINTAIN ALL AREAS OF THE CONTRACT DURING THE PROGRESS OF THE WORKS. THE CONTRACTOR SHALL COMMENCE AND FULLY IMPLEMENT THE SHORT-TERM MAINTENANCE AND ESTABLISHMENT AFTER PRACTICAL COMPLETION HAS BEEN CONFIRMED.
SITE CONTROL: REPORT TO THE PRINCIPAL'S DESIGNATED REPRESENTATIVE ON ARRIVING AT AND BEFORE LEAVING THE SITE.
PLANT ESTABLISHMENT PERIOD: THE PERIOD BETWEEN THE DATE OF PRACTICAL COMPLETION AND THE DATE OF FINAL COMPLETION.
MAINTENANCE/ ESTABLISHMENT PERIOD: 12 MONTHS.

PLANT ESTABLISHMENT: MAINTAIN THE CONTRACT AREA DURING THE PLANT ESTABLISHMENT PERIOD. ENSURE THE GENERAL APPEARANCE AND PRESENTATION OF THE LANDSCAPE AND THE QUALITY OF PLANT MATERIAL AT DATE OF PRACTICAL COMPLETION IS MAINTAINED FOR THE FULL PLANTING ESTABLISHMENT PERIOD.
EXISTING PLANT MATERIAL: MAINTAIN EXISTING PLANTING WITHIN THE LANDSCAPE CONTRACT AREA AS SPECIFIED FOR NEW PLANTING.
REPLACEMENTS: REPLACE FAILED, DEAD AND/OR DAMAGED PLANTS AT MINIMUM 3 WEEK INTERVALS AS NECESSARY THROUGHOUT THE FULL PLANT ESTABLISHMENT PERIOD.
REPORTING: SUBMIT REGULAR REPORTS BY THE LAST FRIDAY OF EACH MONTH SUMMARISING THE GENERAL STATUS OF WORKS. INCLUDE A MAINTENANCE SCHEDULE, A LOG BOOK OF MAINTENANCE ACTIVITY, SOIL TEST RESULTS AS REQUIRED FOR ANY FERTILISING PROGRAMS, AND PLANT REPLACEMENT REQUIREMENTS.
WATER RESTRICTIONS: COORDINATE THE WATER SUPPLY AND CONFIRM THE WATERING REGIME AGAINST RELEVANT GOVERNMENT LEGISLATION AND RESTRICTIONS AT THE TIME.
STAKES AND TIES: REMOVE AT THE END OF THE PLANTING ESTABLISHMENT PERIOD.
TEMPORARY FENCES: REMOVE TEMPORARY PROTECTIVE FENCES AT THE END OF THE PLANTING ESTABLISHMENT PERIOD.
COMPLIANCE: PLANT ESTABLISHMENT SHALL BE DEEMED COMPLETE, SUBJECT TO THE FOLLOWING:
* REPAIRS TO PLANTING MEDIA COMPLETED.
* PESTS, DISEASE, OR NUTRIENT DEFICIENCIES OR TOXICITIES ARE NOT EVIDENT.
* MULCHED SURFACES HAVE BEEN MAINTAINED IN A WEED FREE AND TIDY CONDITION AND TO THE SPECIFIED DEPTH.
* VEGETATION IS ESTABLISHED AND WELL FORMED.
* PLANTS HAVE HEALTHY ROOT SYSTEMS.
* VEGETATION IS NOT RESTRICTING ESSENTIAL SIGHT LINES AND SIGNAGE.
* COLLECTION AND REMOVAL OF LITTER COMPLETED.
* REMOVAL OF MULCH FROM DRAINAGE AND ACCESS AREAS COMPLETED.
* ALL DEFECTS NOTIFICATIONS HAVE BEEN CLOSED OUT.

IRRIGATION GENERAL NOTES

ISSUE	DATE	COMMENT
E	19/12/19	Landscape Concept Issue
D	11/11/19	Landscape Concept Issue
C	20/9/17	DA ISSUE FOR REVIEW
B	15/9/17	DA ISSUE FOR REVIEW
A	3/5/17	ISSUE FOR DA REVIEW

AMENDMENTS -

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LANDSCAPE MAINTENANCE NOTES

[illegible]	W	M	M	W	F	M	D	W
[illegible]	W	M	M	W	F	M	D	W
[illegible]	W	M	M	W	F	M	D	W
[illegible]	F	M	M	F	M	M	D	W
[illegible]	F	N/A	M	F	M	M	D	W
[illegible]	F	N/A	M	M	M	M	D	W
[illegible]	M	N/A	M	M	N/A	N/A	2ND D	W
[illegible]	M	N/A	M	M	N/A	N/A	2ND D	W
[illegible]	M	N/A	M	M	N/A	N/A	2ND D	W
[illegible]	M	M	M	M	N/A	N/A	2ND D	W
[illegible]	F	F	M	F	M	M	D	W
[illegible]	F	F	M	F	M	M	D	W

IRRIGATION TAP KEY
The private open space of each dwelling must be provided with one tap with a removable water key, connected to a pump and the rainwater tank/OSD tank.

PLANT SCHEDULE

ID	Qty	Common Name	Botanical Name	Scheduled Size	Mature Height	Mature Spread
Trees						
CAne	1	Tuckeroo	Cupaniopsis anacardioides	45L	10 - 15m	3.5 - 6m
PCall-c	18	Capital Flowering Pear	Pyrus calleryana 'Capital'	45L	10 - 15m	2.0 - 3.5m
Shrubs						
Mur-pan	50	Orange Jessamine	Murraya paniculata	200mm	1.5 - 3m	3.5 - 6m
M-Vel	105	Pink Velvet Banana	Musa velutina	300mm	1.5-4m	1.5-4m
Phi-con	162		Philodendron 'Congo'	300mm	0.9 - 1.5m	0.9 - 1.2m
Phi-xan	95	Winterbom Philodendron	Philodendron 'Xanadu'	300mm	0.9 - 1.5m	0.9 - 1.2m
Rap-ind-op	362	Indian Hawthorn	Raphiolepis indica 'oriental pearl'	200mm	0.45 - 0.6m	1.2 - 2.0m
rap-exc	66	Lady Palm	Raphis excelsa	300mm	3 - 5m	2.0 - 3.5m
Str-reg	14	Bird Of Paradise	Strelitzia reginae	200mm	0.9 - 1.5m	0.9 - 1.2m
Ground Covers						
Myo-par	46	Carpet Spreading Myoporum	Myoporum parvifolium	150mm	0.45 - 0.6m	0.3m
Nep-exa	229	Sword Fern	Nephrolepis exaltata	150mm	0.9 - 1.5m	0.9 - 1.2m
Grasses						
cap-ap	46	Tall Sedge	Carex appressa	150mm	0.8m	1m
Dia-cae	1096	Paroo Lily, Blue Flax-lily	Dianella caerulea	150mm	0.6 - 0.75m	0.6 - 0.9m
Pe-ad'Rub	92	Purple Fountain Grass	Pennisetum advena 'Rubrum'	150mm	0.5 -1.5m	0.5 - 1m
Pen-alo-naf	128	Purple Fountain Grass	Pennisetum alopecuroides 'Nafray'	150mm	0.6 - 0.75m	0.3 - 0.6m
Pho-ma	72	Maori Sunrise New Zealand Flax	Phormium 'Maori Sunrise'	150mm	0.75 - 0.9m	0.6 - 0.9m
Spa-sp	675	Peace Lily	Spathiphyllum wallisii	150mm	0.45 - 0.6m	0.3 - 0.6m
Total	3257					

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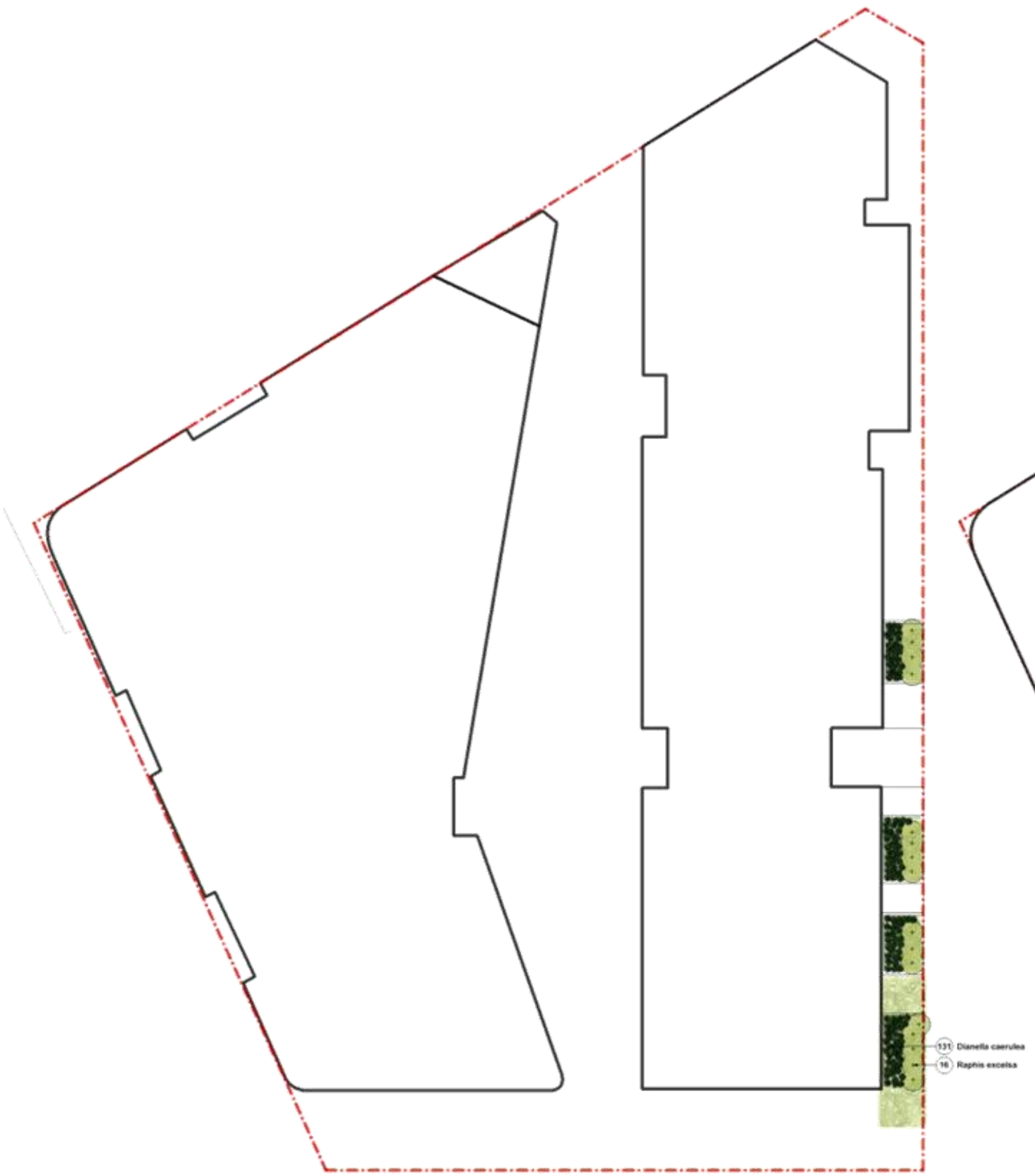
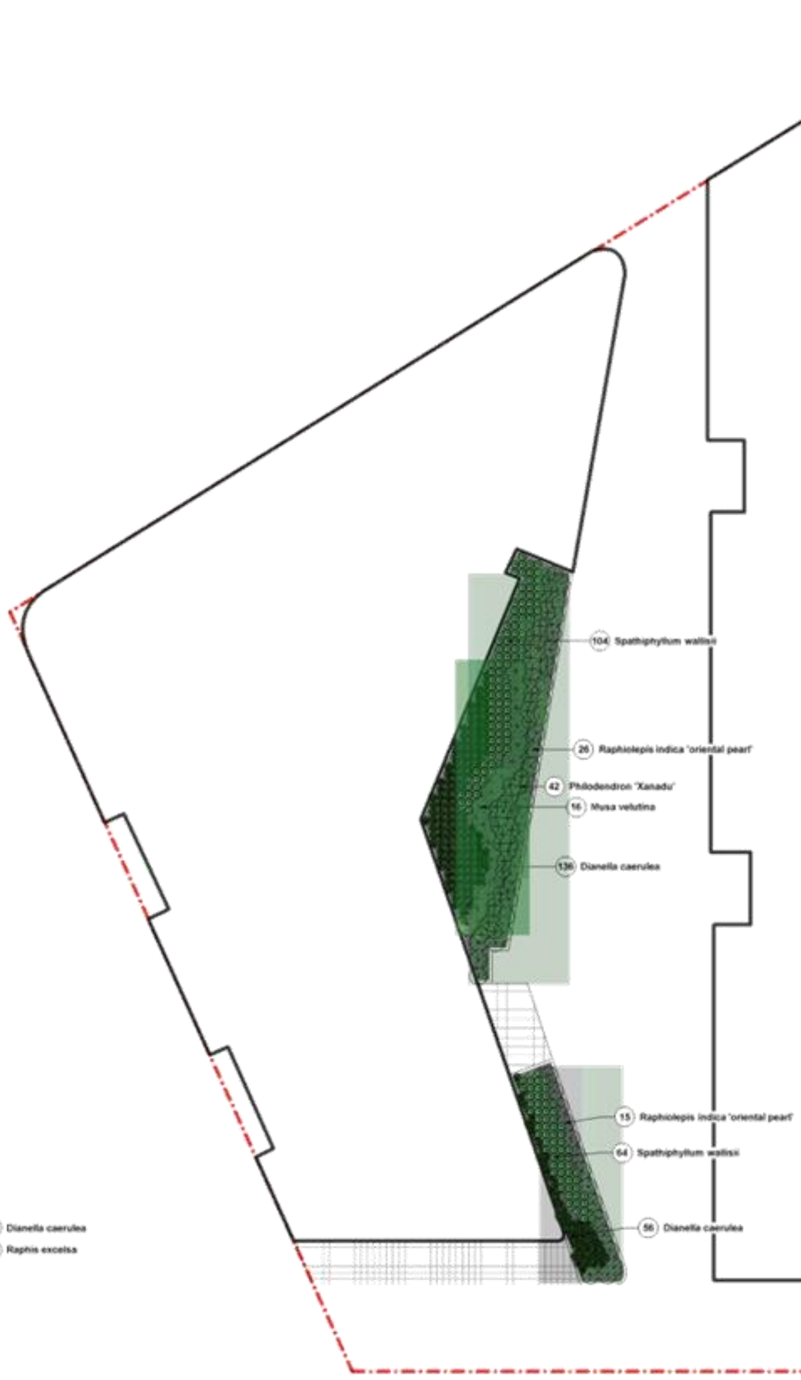
Project	BEXLEY NORTH REDEVELOPMENT		Page
Address	187 SLADE ROAD BEXLEY NORTH NSW 2207	Scale 1:200 @A1	
Drawing Title	Ground Floor Landscape Concept Plan		L-01
Client	BEXLEY NORTH HOTEL	Drawing No. 1015	



LEVEL 1 LANDSCAPE PLAN
SCALE 1:200



LEVEL 2,3 LANDSCAPE PLAN
SCALE 1:200

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E	19/12/19	Landscape Concept Issue
D	11/11/19	Landscape Concept Issue
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Scale	1:200 @A1
Drawing Title	Level 1, 2, 3 Landscape Concept Plans
Client	BEXLEY NORTH HOTEL
Drawing No.	1015
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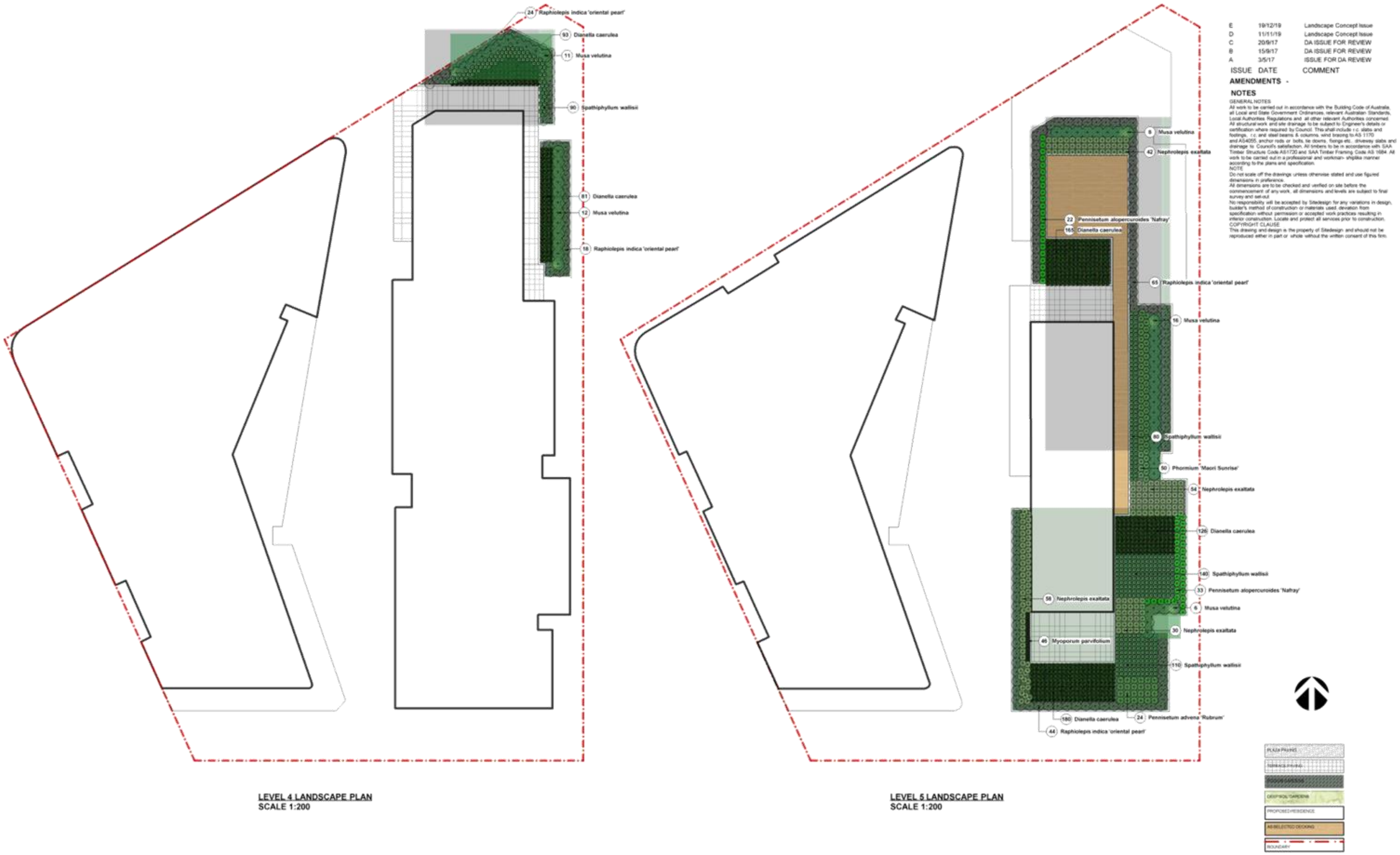

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Drawing Title	Level 4 and 5 Landscape Concept Plans
Client	BEXLEY NORTH HOTEL — Drawing No. 1015

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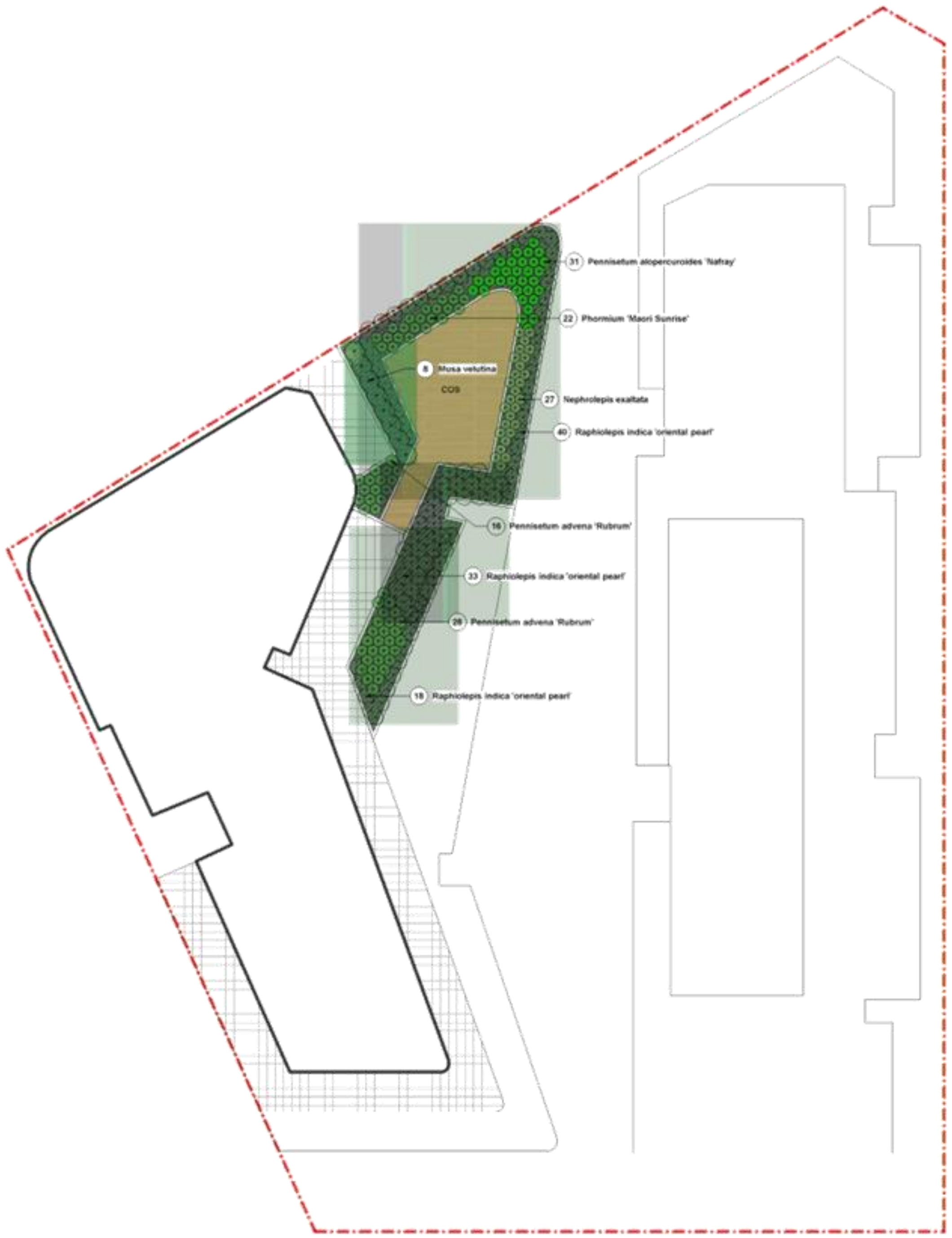
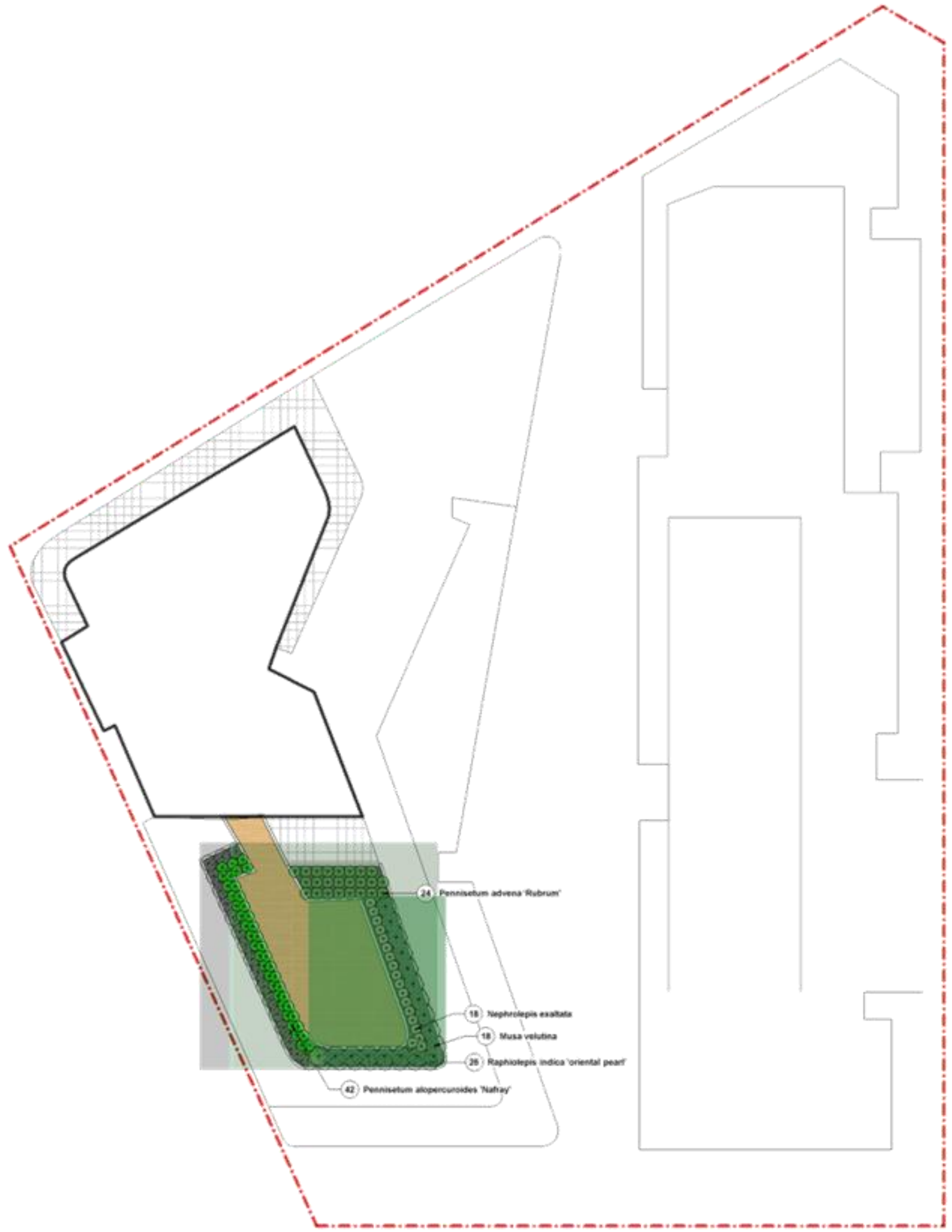


LEVEL 6 LANDSCAPE PLAN
SCALE 1:200



LEVEL 7 LANDSCAPE PLAN
SCALE 1:200

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D	11/11/19	Landscape Concept Issue
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Drawing Title	Level 6 and 7 Landscape Concept Plans		
Client	BEXLEY NORTH HOTEL	Drawing No.	1015

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Bexley North Hotel

Ethane Pipeline Risk Assessment

For Planning Ingenuity

8 February 2021

Doc. No.: J-000442-01

Revision: A

Arriscar Risk Engineering Solutions

Arriscar Pty Limited
ACN 162 867 763
www.arriscar.com.au

Sydney
Level 26
44 Market Street
Sydney NSW 2000
T: +61 2 9089 8804

Melbourne
Level 2 Riverside Quay
1 Southbank Boulevard
Southbank VIC 3006
T: +61 3 9982 4535

Distribution List

Name	Organisation	From (Issue)	To (Issue)
Trevor Tang	Bexley North Hotel	A	Current
David Waghorn	Planning Ingenuity	A	Current

Document History and Authorisation

Rev	Date	By	Description	Check	Approved
A	8-Feb-2021	JPM	First draft for client review.	PS	RR

Summary

This report is a Hazard Analysis (HA) to determine if proposed redevelopment at the Bexley North Hotel (BNH) in the suburb of Bexley North can be accommodated while satisfying the NSW Department of Planning, Industry and Environment's risk criteria as described in HIPAP 10.

Arriscar Pty Limited (Arriscar) has been requested by Planning Ingenuity, on behalf of Bexley North Hotel, to prepare a HA for the proposed development. The Bexley North Hotel development is located within the Notification Zone of the Moomba to Sydney Ethane (MSE) Pipeline that runs through the north western portion of the Bayside Council Local Government Area.

Based on a comprehensive review of pipeline safety literature, a set of failure scenarios were selected for each pipeline, varying from a small hole of 10-25mm in diameter to a full-bore rupture (FBR). Immediate ignition of release gas would result in a jet fire that will continue until the section of pipeline is isolated, and the isolated inventory depleted. A delayed ignition may result in a flash fire or vapour cloud explosion depending on congestion and may be followed by a jet fire.

Based on generic failure rates for natural gas and liquefied flammable gas pipelines in the literature, the most appropriate data was used for the risk assessment. The 'long pipeline model' in DNVGL's SAFETI 8.23 software was used. The resulting risk values were compared with the risk criteria in HIPAP No.10 [1].

The following results were obtained from the risk assessment:

- The individual risk of fatality at the BNH is less than 1.0×10^{-6} p.a. and does not exceed the corresponding risk criterion for residential uses and places of continuous occupancy, such as hotels in HIPAP No.10 [1].
- The individual risk of fatality at the BNH is 0.5×10^{-6} p.a. and exceeds the risk criterion for sensitive use in HIPAP No.10 [1]. The current planning proposal does not include sensitive land uses.
- All other individual risk levels comply with the corresponding quantitative risk criteria in HIPAP No.10 [1] (Refer to Sections 6.2 to 6.7).
- The entirety of the F-N curve is in the 'Negligible' or 'ALARP' regions and complies with the DPIE's indicative societal risk criteria (Refer Section 6.8).
- Recommendations have been made to ensure ongoing compliance with HIPAP 10.

Conclusions and Recommendations

The following recommendations are mode to ensure compliance with the HIPAP 10 land use criteria:

1. If further population intensification is considered, i.e. a significantly larger number of apartments, or increased commercial populations, than an additional risk analysis should be undertaken to ensure the societal risk criteria are still met.
2. As the 0.5×10^{-6} p.a. risk contour is exceeded at the site, sensitive land uses should not considered for this site.

Contents

List of Figures

List of Tables

Notation

Abbreviation	Description
APD	Australian Pipeline Database
APGA	Australian Pipeline and Gas Association
Arriscar	Arriscar Pty Limited
BoM	Bureau of Meteorology
BNH	Bexley North Hotel
CIA	Chemical Industries Association
Council	Bayside Council
DBYD	Dial Before You Dig
DoT	United States Department of Transport
DPIE	Department of Planning Industry and Environment
FBR	Full Bore Rupture
HAZID	Hazard Identification
HDD	Horizontal Directional Drilling
km	Kilometre
kPa	Kilo Pascals
kW/m^2	kiloWatts per square metre
LEP	Local Environmental Plan
LFL	Lower Flammable Limit
LGA	Local Government Area
LSIR	Location Specific Individual Risk
m	Metre
m/s	Metres per second
MAE	Major Accident Event
MAOP	Maximum Allowable Operating Pressure
mg/m^3	Milligrams per cubic metre
mm	millimetres
MPa	Mega Pascals
MSE	Moomba-Sydney Ethane pipeline
NSW	New South Wales
OGP	Oil and Gas Producers Association
p.a.	Per annum

Abbreviation	Description
QRA	Quantitative Risk Assessment
TPA	Third Party Activity
UK HSE	United Kingdom Health and Safety Executive
VCE	Vapour Cloud Explosion

1 INTRODUCTION

1.1 Background

The Bexley North Hotel is proposing to redevelop the site existing site at 187 Slade Road, Bexley North, NSW, [Lot 30 in DP 1222252]. The site currently consists of a single storey brick structure, the Bexley North Hotel, incorporating a drive through bottle shop and beer garden, as well as a two-storey hotel with undercroft parking [2].

Arriscar Pty Limited (Arriscar) has been requested by Planning Ingenuity, on behalf of Bexley North Hotel, to prepare a Hazard Analysis (Study) for the proposed development. The Bexley North Hotel development is located within the Notification Zone of the Moomba to Sydney Ethane (MSE) Pipeline that runs through the north western portion of the Bayside Council Local Government Area.

Undertaking a hazard analysis, including consultation with the pipeline operators, is a requirement of the Department of Planning, Industry and Environment (DPIE). The specific wording of DPIE's requirements is as follows:

1. Report on the consultation outcomes with the operator (APA Group) of high pressure dangerous goods or gas pipelines in the vicinity of the proposal with regards to Australian Standard 2885 Pipelines – Gas and liquid petroleum (AS 2885); and
2. A hazard analysis undertaken in accordance with the Department of Planning's Hazardous Industry Planning Advisory Paper No. 6, 'Hazard Analysis' and Multi-Level Risk Assessment (DoP, 2011). The hazard analysis must demonstrate that the proposed development would comply with the relevant qualitative and quantitative risk criteria detailed in the Department of Planning's Hazardous Industry Planning Advisory Paper No. 10, 'Land Use Safety Planning'.

1.2 Scope

The scope of the study included undertaking a hazard analysis for the high-pressure pipelines in the vicinity of 187 Slade Road Bexley North, in accordance with HIPAP No. 6 [3] and DPIE's specific requirements for the proposed redevelopment (Refer to Section 1.1). It included an assessment of the risks against the risk criteria for land use safety planning in HIPAP No. 10 [1].

The scope of the HA did not include preparation of a Safety Management Study (SMS), which may be required under AS 2885-2008 [4].

1.3 Objectives

The principal objective of the study was to perform a risk assessment covering the scope outlined in Section 1.2 and in accordance with the NSW HIPAP guidelines [3]. This included:

- Identification of release events from the ethane pipeline in the vicinity of the proposed development;
- Development of appropriate and relevant representative release scenarios that may impact on the proposed development;
- Quantification of the consequences of harmful effects for each representative scenario (fires, explosions, exposure to unignited gas), including the potential for impact on the proposed development;
- Quantification of the likelihood of occurrence of each representative scenario;

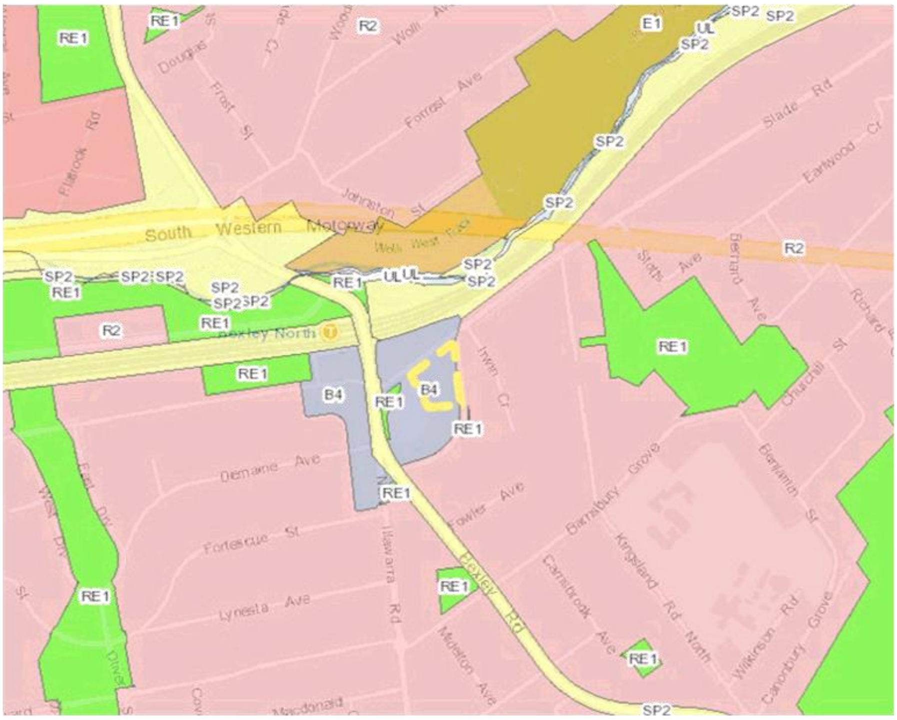
- Development and justification of assumptions for the risk assessment that are appropriate, with a focus on minimising uncertainty and obtaining a 'cautious best estimate' of risk to the proposed development;
- Generation of Location-Specific Individual Risk (LSIR) contours for comparison with the DPIE's risk criteria for land use safety planning, viz. as per HIPAP No.4 [5] and HIPAP No.10 [1]; and
- Estimation of societal risk for comparison with the DPIE's indicative risk criteria for land use safety planning, viz. as per HIPAP No. 4 [5] and HIPAP No.10 [1].

2 SITE DESCRIPTION

2.1 Existing and Surrounding Land Uses

The development at 187 Slade Road Bexley North is in the Bayside Council LGA. The current land use zoning for the site is B4 'Mixed Use'. The land surrounding the development is primarily zoned; R2 Low Density Residential, B4 Mixed Use, RE1 Public Recreation, and SP2 Special Purpose (road and rail infrastructure).

Figure 1 Current Land Use Zoning [6]



2.2 Proposed Site Location and Zoning

The proposed development is for two buildings with onsite parking and landscaping as shown in Figure 2 and Figure 3. Building 1 is a 9-level building [7] including a pub, gym, retail, and both hotel and residential apartment accommodation. Building 2 is a 5-level building including retail and residential apartment accommodation. The two buildings are connected via an underground carpark.

Figure 2 Proposed Site Layout – Ground Floor [7]

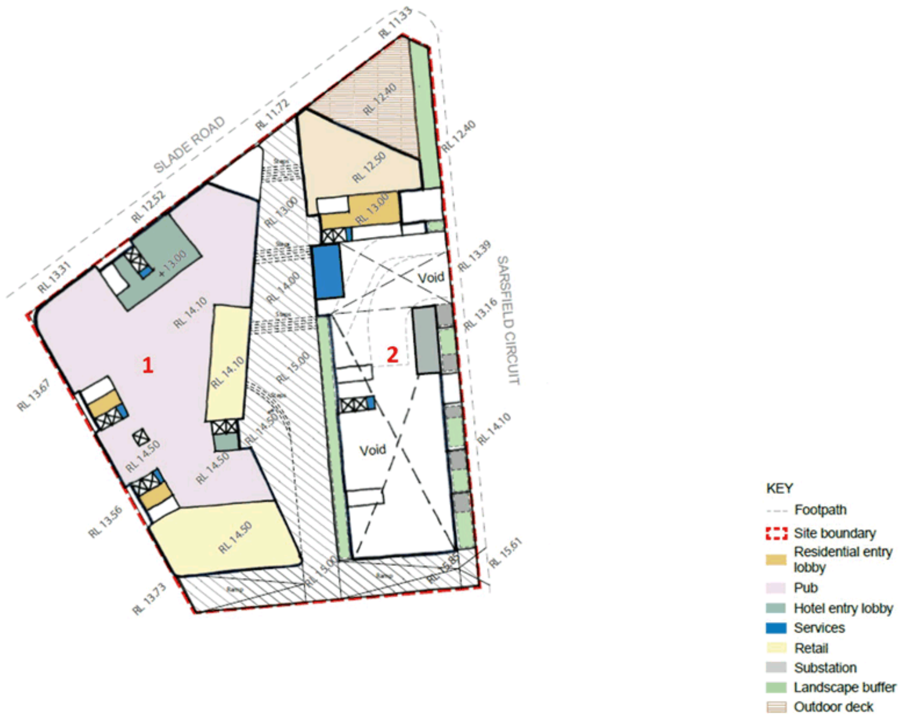
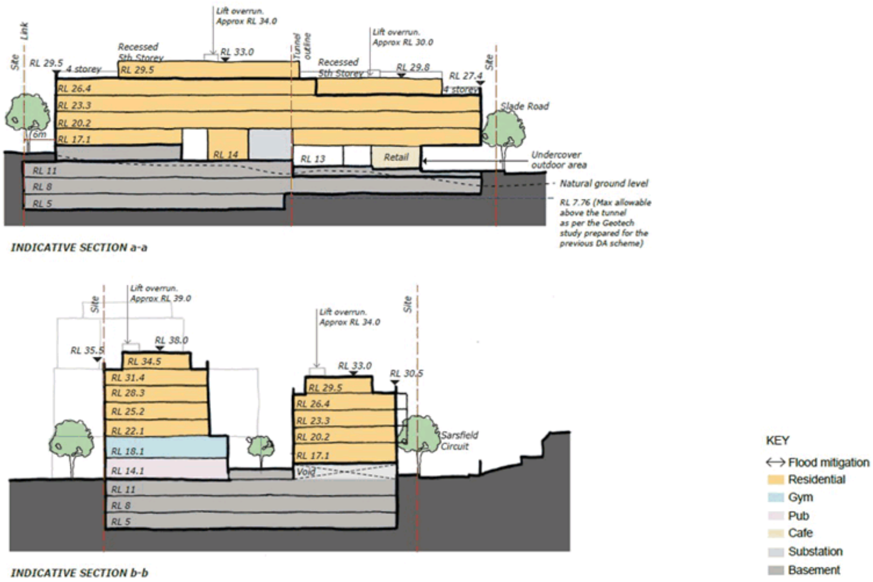


Figure 3 Proposed Site Layout – Elevations



The assumed population data for the various land uses is given in Appendix A.2 (Assumption No. 7 and Assumption No. 8).

2.3 Ethane Pipeline

The Moomba Sydney Ethane pipeline (MSE) runs parallel to the T8 South Line railway. The location of the MSE in relation to the BNH is shown in Figure 2. The pipeline is owned by APA Group, which has been contacted by Arriscar for details of the MSE close to the BNH. Information obtained from APA is presented in Table 1.

Figure 4 Location of the MSE in Relation to the BNH

Table 1 Data for the MSE Pipeline in Proximity to the BNH

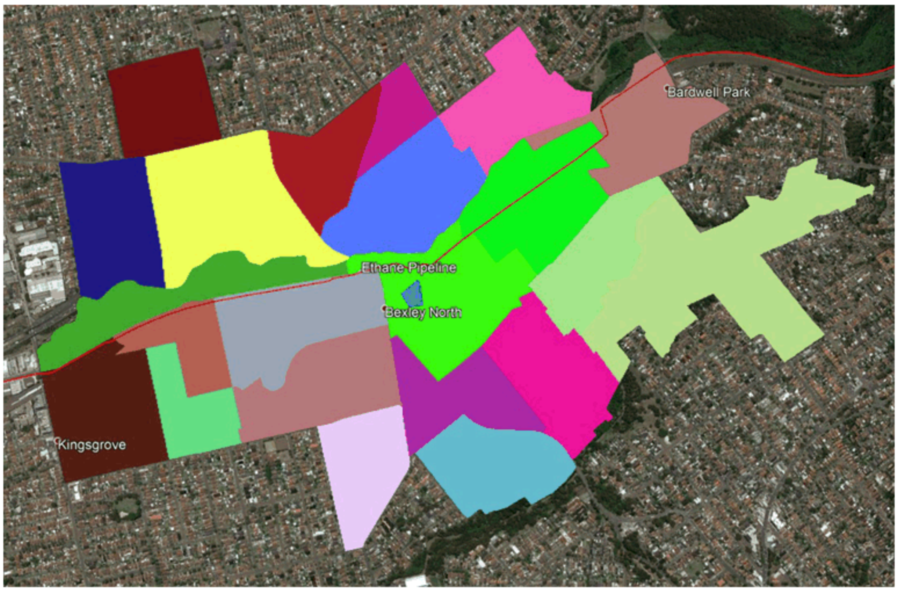
Description	MSE Pipeline
Pipeline Owner	Gorodok Pty Ltd (part of APA Group)
Pipeline Name	Moomba to Sydney Ethane Pipeline
Product in pipeline	Ethane
Pipeline Licence (NSW)	New South Wales Licence No 15
MAOP (Maximum allowable operating pressure)	10,000kPa
Actual Operating Pressure	8,200kPa
Operating Temperature	Typical 20°C
Material flow rate (pumping rate)	Typical 30 Tonne per hour
Pipeline Material	API -5L grade X60
Pipeline Diameter	200mm NB
Pipeline Wall Thickness	11.9mm in area of concern
Critical defect length	332mm
Minimum depth of cover	>1200mm – Varies between 1200 and 2500mm
Cathodic Protection for pipeline	Impressed Current Cathodic Protection applied.
External Coating on pipeline	HDPE (Yellowjacket) Joint Coating is 2 layer Tape Wrap system
Location of ALBVs from first ALBV upstream of BNH to first ALBV downstream of BNH	Upstream LV - Moorebank Ave kp1344 Downstream LV - Marsh Street kp1368
Pressure set points for ALBVs and approximate closure time	4500kPa

Description	MSE Pipeline
Frequency of inspections and patrols undertaken	Ground Patrol Daily (Monday to Friday) Aerial Patrol Fortnightly
Control measures for third party activity near pipeline	11.9mm pipe wall thickness >1.2m depth of cover 25mm Concrete Coating of pipeline (Rockjacket) Either Top slabbing or top and side slabbing in all areas of concern apart from Rail Easements Marker Posts DBYD Patrols Aerial patrol fortnightly Daily ground patrol Liaison with Councils, telecommunications companies, Electricity companies
Pigging done for pipeline? If so, how often?	Metal Loss intelligent pigging carried out on a risk basis program but is undertaken at 5 yearly presently
Was intelligent pigging carried out to determine rate of loss of wall thickness?	Yes – no wall thickness loss has been found in this section of pipeline
Location of nearest upstream pump / compressor station and pressure at this point	Bulla Park
Are there non-return valves located in the pipeline downstream of and where?	Bexley Rd kp1363 just off Bexley Rd approximately 110m from Bexley North Hotel. No further NRV's downstream

2.4 Surrounding Suburbs and Populations

The Statistical Area 1 locations for suburbs surrounding the BNH within the notification length of the MSE pipeline are shown in Figure 5 for which the populations as at the 2016 census were compiled.

Figure 5 Surrounding Suburbs and Population Statistical Areas



3 Risk Assessment Methodology

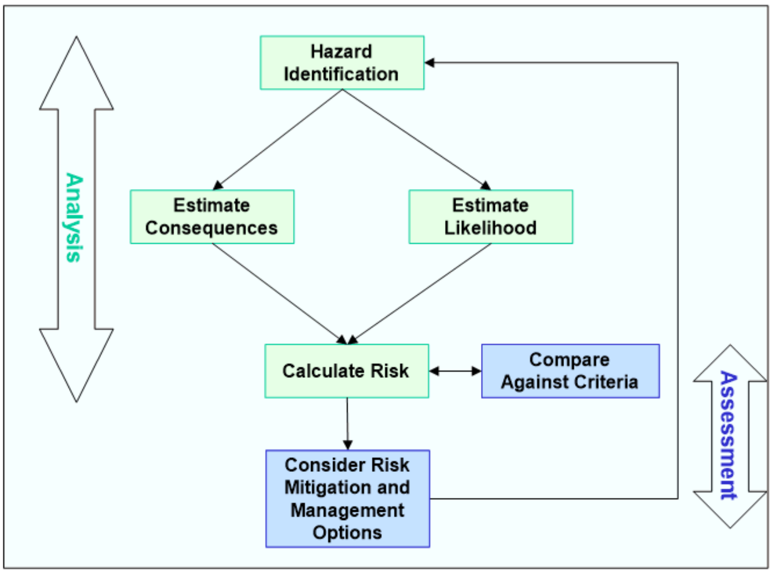
3.1 Introduction

This analysis involves the quantitative estimation of the consequences and likelihood of accidents (viz. a Quantitative Risk Assessment or QRA). For consequences to people, the most common risk measure is 'individual fatality risk' (viz. The likelihood of fatality per year).

In developing the estimates for use in a QRA, it is important to ensure that any estimates fall on the side of conservatism, particularly where there is uncertainty in the underlying data and assumptions. This precautionary approach uses 'cautious best estimate' values, which, whilst conservative, are still realistic. This approach is consistent with the DPIE's guidelines for undertaking this type of assessment [3].

Diagrammatically, the QRA process is as follows:

Figure 6 Overview of QRA Process [3]



3.2 Methodology Overview

3.2.1 Hazard Identification and Register of Major Accident Events

A hazard is something with the potential to cause harm (e.g. thermal radiation from a fire, physical impact from a moving vehicle or dropped object, exposure to stored energy, etc.). As well as identifying the hazards that exist, it is also important to identify how these hazards could be realised.

For example, the Hazard identification (or HAZID) step for a QRA of a potentially hazardous pipeline would identify representative events that could result in a release of the material from the pipeline with the potential to cause harm (e.g. due to a subsequent ignition and fire/explosion). The representative potentially hazard events are commonly described as 'Major Accident Events' (or MAEs). In the context of the QRA, an MAE is an event with the potential to cause: off-site fatality or injury; off-site property damage; or, long-term damage to the biophysical environment (i.e. any outcome for which DPI&E has defined an acceptable risk criterion – Refer to Section 3.4).

There is no single definitive method for hazard identification (HAZID); however, it should be comprehensive and systematic to ensure critical hazards are not excluded from further analysis.

When identifying hazards for modelling in a QRA, it is necessary to capture the following information, either during the hazard identification process, or as part of the preparation for hazard consequence modelling:

- Hazardous materials and material properties;
- Inventory of hazardous materials that could contribute to the accident;
- How the material is released (e.g. hole in a pipeline);
- The condition of the material prior to release (e.g. compressed gas at a specific temperature and pressure);
- The area/s into which the material is released (e.g. inside an enclosed area, etc.);
- Ambient conditions in the area where the material is released (e.g. air temperature, wind speed and direction, atmospheric stability);
- Locations of ignition sources around the release point; and
- Duration of release before it is isolated.

The above information was used to develop a detailed list of MAEs for the risk assessment. This QRA includes an estimate of the consequences and likelihood of each of these scenarios and aggregates the results to estimate the total risk.

3.2.2 Hazard Consequence Analysis

The physical consequences of a release of potentially hazardous material (e.g. flammable gas, flammable liquid, etc.) are generally dependent on:

- the quantity released;
- the rate of release; and,
- for fire and explosion events when ignition occurs.

The quantity of release depends on the inventory, size of release (viz. assumed equivalent hole diameter) and duration of release (how soon can the release be detected and isolated).

Meteorological conditions, such as wind speed, wind direction and weather stability class have an impact on the extent of the downwind and crosswind dispersion. Location-specific meteorological data is therefore required to undertake a QRA study. The representative wind directions, wind speeds and wind stability classes are normally determined from annual average of weather data available from the Bureau of Meteorology, for the local weather station.

In addition to wind speed, the Pasquill stability class has a significant impact on the vertical and crosswind dispersion of a released gas. Six wind stability classes (A to F) are normally used. Class A refers to more turbulent unstable conditions and Class F refers to more stable (inversion) conditions. Although the probability distribution of Pasquill stability classes is site-specific, it is generally observed that Class F conditions are more likely to occur during the night-time while Class D (neutral) conditions occur during the daytime (sunny conditions).

The wind direction, wind speed and stability class distribution used for the QRA is presented in Appendix A (Assumption No. 3).

The latest SAFETI software package was used for all consequence modelling and the generation of the risk contours and societal risk curves.

3.2.3 Impairment Criteria

Impairment criteria have been developed for the effects of explosions and fires as outlined below. The impairment criteria adopted for the QRA are included in Appendix A (Section A.6).

Explosion

During a flash fire, acceleration of the flame front can occur due to the turbulence generated by obstacles within in the combusting vapour cloud. When this occurs, an overpressure ('shock') wave is generated which has the potential to damage equipment and/or injure personnel.

The impact of explosion overpressure on humans takes two forms:

- For a person in the open, there could be organ damage (e.g. ear drum rupture or lung rupture), that may be considered to constitute serious harm.
- The person could be hit a flying missile, caused by the explosion, and this can lead to serious injury or even fatality.

The effects of exposure to explosion overpressure are summarised in Table 3 [3].

Table 2 Effects of Explosion Overpressure

Overpressure [kPa]	Effect/s
0.3	Loud noise.
1.0	Threshold for breakage of glass.
4.0	Minimal effect in the open. Minor injury from window breakage in building.
7.0	Glass fragments fly with enough force to cause injury. Probability of injury is 10%. No fatality. Damage to internal partitions and joinery of conventional buildings, but can be repaired.
14.0	1% chance of ear drum rupture. House uninhabitable and badly cracked.
21.0	10% chance of ear drum rupture. 20% chance of fatality for a person within a conventional building. Reinforced structures distort. Storage tanks fail.
35.0	50% chance of fatality for a person within a conventional building and 15% chance of fatality for a person in the open. House uninhabitable. Heavy machinery damaged. Significant damage to plant.
70.0	100% chance of fatality for a person within a building or in the open. 100% loss of plant.

Fire

The potential for injury or property damage from a fire is determined by the intensity of the heat radiation emitted by the fire and the duration of exposure to this heat radiation.

The effects of exposure to thermal radiation are summarised in Table 4 [3]. The vulnerability criteria used in the risk analysis are included in Appendix A.6.

Table 3 Effects of Thermal Radiation

Heat Radiation [kW/m²]	Effect/s
1.2	Received from sun in summer at noon.
1.6	Minimum necessary to be felt as pain.
4.7	Pain in 15 to 20 seconds, 1st degree burns in 30 seconds. Injury (second degree burns) to person who cannot escape or seek shelter after 30s exposure.
12.6	High chance of injury. 30% chance of fatality for extended exposure. Melting of plastics (cable insulation). Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure. Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure.
23.0	Fatality on continuous exposure. 10% chance of fatality on instantaneous exposure. Spontaneous ignition of wood after long exposure. Unprotected steel will reach thermal stress temperatures, which can cause failure. Pressure vessel needs to be relieved or failure would occur.
35.0	25% chance of fatality on instantaneous exposure.
60.0	Fatality on instantaneous exposure.

The dominant effect in a flash fire is direct engulfment by flame within the combusting cloud. To estimate the magnitude of the flammable gas cloud, the furthest distance from the release location with a concentration equal or above the lower flammability limit (LFL) is estimated using a dispersion model.

3.2.4 Frequency and Likelihood Analysis

Once the consequences of the various accident scenarios have been estimated, it is necessary to estimate the likelihood of each scenario. In a QRA, the likelihood must be estimated in quantitative terms (i.e. occurrences per year). Exponential notation (e.g. 5.0×10^{-6} per year or 5E-06 per year) is normally used because the likelihood of a MAE is usually a low number (i.e. less than 1 chance in 1000 to 10000 per year).

The likelihood of each scenario is normally estimated from historical incident and failure data. This is only possible because data on such incidents and failures has been collected by various organisations over a number of years. Various databases and reference documents are now available that provide this data.

When using historical data to forecast the likelihood of a future event, it is important to ensure any specific conditions that existed at the time of the historical event are taken into account. For very low frequency events (i.e. where historical occurrences are very rare), it might not be possible to estimate the likelihood values directly from the historical data and other techniques such as fault tree analysis may be required.

The frequency analysis data and results are summarised in Section 4.3 and Appendix C.

3.2.5 Risk Analysis and Assessment

Risk analysis and assessment are separate tasks although they are often undertaken together. Risk analysis involves combining the consequence and likelihood estimates for each scenario and then summing the results across all the accident scenarios to generate a complete picture of the risk. The risk assessment step involves comparing the risk results against risk criteria.

Location-specific individual risk (LSIR) contours are usually used to represent off-site risk for a land-use safety QRA study. These iso-risk contours are superimposed on a plan view drawing of the site. Example risk levels that are typically shown as iso-risk contours include: 1×10^{-6} per year, 10×10^{-6} per year and 50×10^{-6} per year.

The iso-risk contours show the estimated frequency of an event causing a specified level of harm at a specified location, regardless of whether or not anyone is present at that location to suffer that harm. Thus, individual iso-risk contour maps are generated by calculating individual risk at every geographic location, assuming a person will be present and unprotected at the given location 100% of the time (i.e. peak individual risk with no allowance for escape or occupancy).

The assessment of risk results involves comparing the results against risk criteria. In some cases, this assessment may be a simple listing of each criterion together with a statement that the criterion is met. In other, more complex cases, the risk criteria may not be met, and additional risk mitigation controls may be required to reduce the risk.

The latest SAFETI 8.23 software package was used to generate the iso-risk contours / transects and societal risk results (Refer to Section 6).

3.3 Study Assumptions

It is necessary to make technical assumptions during a risk analysis. These assumptions typically relate to specific data inputs (e.g. material properties, equipment failure rates, etc.) and modelling assumptions (e.g. release orientations, impairment criteria, etc.).

To comply with the general principles outlined in Section 2.2 of HIPAP No. 6 [3], all steps taken in the risk analysis should be: "*traceable and the information gathered as part of the analysis should be well documented to permit an adequate technical review of the work to ensure reproducibility, understanding of the assumptions made and valid interpretation of the results*". Therefore, details of the key assumptions adopted for the risk analysis are provided in Appendix A.

3.4 Quantitative Risk Criteria

3.4.1 Individual Fatality Risk

The individual fatality risk imposed by a proposed (or existing) industrial activity should be low relative to the background risk. This forms the basis for the following individual fatality risk criteria adopted by the NSW DPIE [1] and [5].

Table 4 Individual Fatality Risk Criteria

Land Use	Risk Criterion [per million per year]
Hospitals, schools, childcare facilities and old age housing developments	0.5
Residential developments and places of continuous occupancy, such as hotels and tourist resorts	1
Commercial developments, including offices, retail centres, warehouses with showrooms, restaurants, and entertainment centres	5
Sporting complexes and active open space areas	10
Industrial sites	50 *

* HIPAP 4 allows flexibility in the interpretation of this criterion. For example, 'where an industrial site involves only the occasional presence of people, such as in the case of a tank farm, a higher level of risk may be acceptable'.

The DPIE has adopted a fatality risk criterion of 1 x 10^{-6} per year (or 1 chance of fatality per million per year) for residential area exposure because this risk is very low in relation to typical background risks for individuals in NSW. For sensitive land uses such as schools, the criterion is one-half that for residential area, viz. 0.5 x 10^{-6} pe year.

3.4.2 Injury Risk

The DPIE has adopted risk criteria for levels of effects that may cause injury to people but will not necessarily cause fatality. Criteria are included in HIPAP No. 4 [5] for potential injury caused by exposure to heat radiation, explosion overpressure and toxic gas/ smoke/dust.

The DPIE's suggested injury risk criterion for heat radiation is as follows:

- *Incident heat flux radiation at residential and sensitive use areas should not exceed 4.7 kW/m² at a frequency of more than 50 chances in a million per year.*

The DPIE's suggested injury/damage risk criterion for explosion overpressure is as follows:

- *Incident explosion overpressure at residential and sensitive use areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year.*

The DPIE's suggested injury risk criteria for toxic gas/ smoke/dust exposure are as follows:

- *Toxic concentrations in residential and sensitive use areas should not exceed a level which would be seriously injurious to sensitive members of the community following a relatively short period of exposure at a maximum frequency of 10 in a million per year.*
- *Toxic concentrations in residential and sensitive use areas should not cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community over a maximum frequency of 50 in a million per year.*

3.4.3 Risk of Property Damage and Accident Propagation

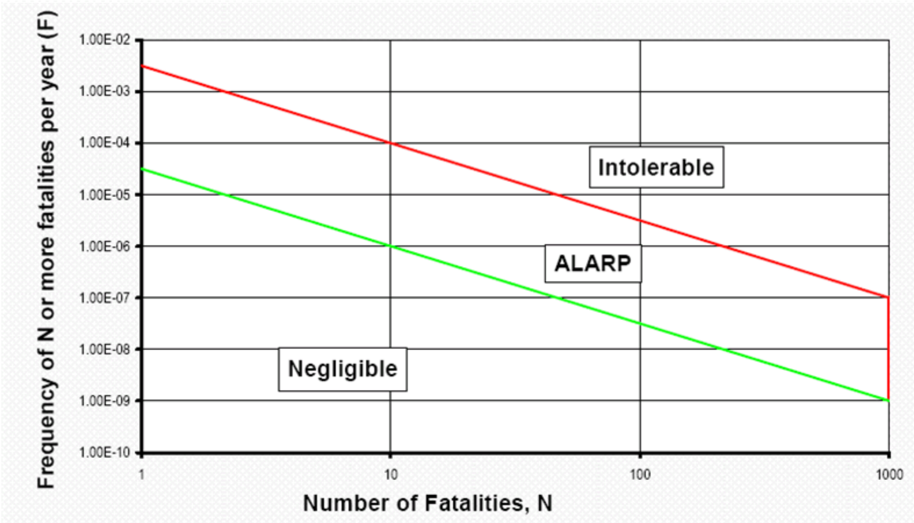
Heat radiation exceeding 23 kW/m² may cause unprotected steel to suffer thermal stress that may cause structural damage and an explosion overpressure of 14 kPa can cause damage to piping and low-pressure equipment. The DPIE's criteria for risk of damage to property and accident propagation are as follows [5]:

- *Incident heat flux radiation at neighbouring potentially hazardous installations or at land zoned to accommodate such installations should not exceed a risk of 50 in a million per year for the 23 kW/m² heat flux level.*
- *Incident explosion overpressure at neighbouring potentially hazardous installations, at land zoned to accommodate such installations or at nearest public buildings should not exceed a risk of 50 in a million per year for the 14 kPa explosion overpressure level.*

3.4.4 Societal Risk

The DPIE's suggested societal risk criteria (Refer to Figure 5), recognise that society is particularly intolerant of accidents, which though infrequent, have a potential to create multiple fatalities. Below the negligible line, provided other individual criteria are met, societal risk is not considered significant. Above the intolerable level, an activity is considered undesirable, even if individual risk criteria are met. Within the 'As Low As Reasonably Practicable' (ALARP) region, the emphasis is on reducing risks as far as possible towards the negligible line. Provided other quantitative and qualitative criteria of HIPAP 4 [5] are met, the risks from the activity would be considered tolerable in the ALARP region.

Figure 7 Indicative Societal Risk Criteria



The F-N criterion in NSW imposes an absolute upper limit of N=1000 (i.e. an incident that could cause more than 1000 fatalities is not tolerable), regardless of how low the frequency is.

HIPAP No.4 [5] also states that the criteria in Figure 5 are an indicative criteria and provisional only and do not represent a firm requirement in NSW.

3.5 Qualitative Risk Criteria

Irrespective of the numerical value of any risk criteria for risk assessment purposes, it is essential that certain qualitative principles be adopted concerning the land use safety acceptability of a proposed development or existing activity. The qualitative risk criteria outlined in HIPAP No. 4 [5] encompass the following general principles:

- Avoidance of all 'avoidable' risks;
- Reduction, wherever practicable, of the risk from a major hazard, even where the likelihood of exposure is low;
- Containment, wherever possible, within the site boundary of the effects (consequences) of the more likely hazardous events; and,
- Recognition that if the risk from an existing installation is already high, further development should not be permitted if it significantly increases that existing risk.

4 Hazard Identification

4.1 Introduction

The hazard identification was based on a review of the: information on the MSE pipeline; properties of Ethane; and potential failure modes and consequences if a leak were to occur from a pipeline. These findings are presented as follows:

Section 4.2 - Properties of Ethane.

Section 4.3 - Pipeline Failure Modes.

Section 4.4 - Consequences.

Section 4.5 - Control Measures.

The representative MAEs carried forward to the consequence analysis are listed in Section 4.6.

4.2 Properties of Ethane

Ethane is principally used as a raw material for the manufacture of ethylene. It is modelled as 100% Ethane in the QRA.

Physical properties are listed in Table 6.

Table 5 Physical Properties of Ethane

Boiling Point	-88.6 °C
Autoignition Temperature	515 °C
Relative Density (Air =1)	1.05
Lower Flammability Limit in air (vol. %)	2.4%
Upper Flammability Limit in air (vol. %)	14.3%

Ethane is:

- A gas at ambient conditions;
- Flammable;
- A similar density to air at ambient temperatures; and
- Colourless and non-toxic.

Ethane is transported by pipeline as a liquefied gas under pressure.

4.3 Pipeline Failure Modes

Pipelines may leak due to various causes. The four principal failure modes that may result in a leak from an underground pipeline include [8]:

- **Mechanical failures**, including material defects or design and construction faults;
- **Corrosion**, including both internal and external corrosion;
- **Ground movement and other failure modes**, including ground movement due to earthquakes, heavy rains/floods or operator error, and other natural hazards such as lightning, etc.; and

- **Third Party Activity (TPA)**, including damage from heavy plant and machinery, damage from drills/boring machines and hot tapping, etc.

The relative likelihood of each failure mode is shown in Appendix C for underground pipelines.

4.3.1 Mechanical Failure

Leaks due to mechanical failures are usually caused by a construction fault, a material fault / defect or design of the pipeline.

This failure mode is credible for the MSE pipeline; however, historical incident data for other pipelines (Refer to Appendix C) indicates this is generally a low likelihood failure mode, particularly for more recently manufactured pipelines (i.e. post 1980).

4.3.2 Corrosion

Leaks due to internal corrosion are generally a function of the material being transported, the wall thickness of the pipeline and the materials of construction.

Leaks due to external corrosion do not depend on the material being transported and are generally dependent on the soil type / conditions, pipeline coating and materials of construction, and the age of the pipeline.

This failure mode is credible for the MSE pipeline; however, historical incident data for other pipelines (Refer to Appendix C) indicates this is a low likelihood failure mode, particularly for pipelines with a higher wall thickness (i.e. > 10 mm) and more recently manufactured pipelines (i.e. post 1980).

4.3.3 Ground Movement and Other Failure Modes

Pipeline leaks may occur due to ground movement (e.g. following a landslide or earthquake). The potential also exists for ground movement in the vicinity of water crossings (water erosion) or as a result of construction activities (new road infrastructure and buildings).

Other external events, such as lightning strikes, operational errors and erosion may also lead to a leak.

This failure mode is credible for the MSE pipeline.

4.3.4 Third Party Activity

Most leaks due to Third Party Activity (TPA) are caused by construction vehicles and equipment (drills, etc.) or by farm machinery in rural areas. The leak typically occurs immediately upon contact; however, it may be delayed (i.e. if the TPA only weakens the pipeline such that it fails at a later time).

Leaks due to TPA include those caused by horizontal directional drilling (HDD), which is commonly used to install utilities and services (communication cables, etc.).

Leaks due to TPA are particularly relevant when considering development in the vicinity of existing pipelines due to the potential for significant construction activities (e.g. new road infrastructure and buildings).

This failure mode is credible for the MSE pipeline.

4.4 Consequences of Gas Release

4.4.1 Asphyxiation

Although non-toxic, Ethane has the potential to cause asphyxiation at higher concentrations due to oxygen depletion, particularly if exposure occurs in a confined space.

thane is a simple asphyxiant with low toxicity to humans. If a release does not ignite, then the potential exists for the gas concentration to be high enough to present an asphyxiation hazard to individuals nearby.

An atmosphere with marginally less than 21% oxygen can be breathed without noticeable effects. However, at 19.5% (which is OSHA's lower limit for confined space entry in 29 CFR 1915.12 [9]) there is a rapid onset of impairment of mental activity.

An oxygen concentration of about 15% will result in impaired coordination, perception and judgment. This may prevent a person from performing self-rescue from a confined space.

The potential for unconsciousness and fatality is only significant at less than 10% oxygen. However, to reduce the oxygen concentration to 10% requires a relatively high concentration (viz. approximately 52% v/v, which equates to 641,000 mg/m^3 for Ethane).

Oxygen deficiency from exposure to Ethane should not be a major issue because the fire hazards are usually the dominant effects in most locations (the LFL for Ethane is approximately one-twentieth, or 5%, of the fatal asphyxiant concentration). Therefore, the potential for fatality from asphyxiation was not carried forward to the consequence, likelihood and risk estimation steps of the QRA.

4.4.2 Jet Fire

A release of Ethane at high pressure through a hole in a pipeline may create a jet plume. The gas plume extends several metres in the direction of discharge due to its momentum jet effect, entraining air. Ignition would result in a jet fire.

The potential for fatality due to exposure to heat radiation from a jet fire (including direct exposure to the jet) was included in the QRA.

4.4.3 Flash Fire

Ignition of an unconfined gas or vapour cloud will usually progress at low flame front velocities and will not generate a significant explosion overpressure. Unobstructed combustion of the gas cloud is referred to as a flash fire, which has the potential to cause injuries or fatalities for individuals within the ignited cloud.

A flash fire was included in the QRA as a potential outcome for all the gas releases. The potential for fatality due to direct exposure to a flash fire was included in the QRA.

4.4.4 Vapour Cloud Explosion

A high degree of confinement and congestion is required to produce high flame speeds (i.e. > 100 m/s) in a flammable gas or vapour cloud, due to promotion of turbulence and accelerated combustion. This may occur inside buildings and around obstacles (e.g. buildings, vehicles, trees etc.).

4.4.5 Gas Ingress into Buildings

The gas jet would disperse downwind, once the momentum effect is lost. If the wind direction were oriented towards the school buildings, there is potential for flammable gas to be drawn into the buildings through ventilation air intake, and through open windows. If the gas reaches lower flammability limit, an ignition within the building would result in a confined explosion with serious harm to occupants and structural damage.

4.4.6 Toxic Smoke

Large quantities of smoke can be produced from hydrocarbon fires; however, this is rarely injurious for persons at ground level due to the buoyancy of the hot plume and its subsequent dispersion at heights well above ground level. Ethane is a relatively clean burning fuel and the potential for injury due to smoke exposure was not carried forward to the consequence, likelihood and risk estimation steps of the QRA. The smoke plume would rise above the building roof height.

4.5 Control Measures

Under the NSW Pipelines Act (1967) and Pipeline Regulations (2013), a pipeline operator must ensure the design, construction, operation and maintenance of a licensed pipeline is in accordance with the relevant provisions of Australian Standard AS 2885 [10] for gas and liquid petroleum pipelines.

A licensee must implement a pipeline management system that relates to the pipeline operated under the licence and is in accordance with the relevant provisions of AS 2885.

4.5.1 Prevention of Mechanical Failure

Operators of licensed pipelines under the NSW Pipelines Regulation 2013 are required to develop and implement systems and processes to ensure the pipeline structural integrity for the design life of the pipeline in accordance with Section 6 of AS 2885.3:2012 [11] as part of the pipeline management system.

Continual monitoring is required while the pipeline is in operation to ensure that pipeline structural integrity is maintained. They shall not be operated above the maximum allowable operating pressure (MAOP). Anomalies should be assessed, and defects repaired.

4.5.2 Corrosion Prevention

Operators of licensed pipelines under the NSW Pipelines Regulation 2013 are required to develop and implement systems and processes to ensure the pipeline structural integrity for the design life of the pipeline. (as per Section 6 of AS 2885.3:2012) as part of the pipeline management system. This should include corrosion protection systems.

Two key control measures are typically implemented by pipeline operators to minimise the likelihood of failure due to corrosion: cathodic protection systems and external pipe coatings.

The MSE pipeline is inspected using 'intelligent pigging' (Refer to Section 2.2) and has a significant wall thickness (11.9 mm). It is equipped with a cathodic protection system and a double layered HDPE coating (Refer to Section 2.2).

4.5.3 Prevention of Damage due to Ground Movement and Other Failures

Normal loads (e.g. due to the internal and external pressure, weight of soil, traffic loads, etc.) and occasional loads (e.g. due to flood, earthquake, transient pressures in liquid lines and land movement due to other causes) are considered during design of a pipeline (as per AS2885.1:2012). To comply with AS2885.1:2012 [12], additional depth of cover may also be required where the minimum depth of cover cannot be attained because of the action of nature (e.g. soil erosion, scour).

4.5.4 Prevention of Damage due to Third Party Activity

Operators of licensed pipelines under the NSW Pipelines Regulation 2013 are required to undertake a Safety Management Study (as per Section 11 of AS 2885.3:2012) to assess the risks associated with threats to the pipeline and to instigate appropriate measures to manage the identified threats.

Two key control measures are typically implemented by pipeline operators to minimise the likelihood of impact from TPA: the 'Dial Before You Dig' (DBYD) process and daily / weekly patrols.

Statistical data indicates that the pipelines in NSW are 100% cathodically protected with effectiveness between 95 and 100%, and that over 96% of parties contacted DBYD before any excavation work [13].

The probability of leak on impact depends on the pipeline wall thickness. The depth of cover may also reduce the likelihood of impact.

4.5.5 Mitigation Control Measures

Operators of licensed pipelines under the NSW Pipelines Regulation 2013 are required to develop and implement an Emergency Response Plan (as per Section 11 of AS 2885.3:2012) as part of the pipeline management system.

The Emergency Response Plan should detail the response and recovery strategies and procedures to address all pipeline related emergency events, including: loss of containment; full-bore pipeline rupture; fires; and, natural events.

Leaks may be detected during visual inspections, incident notifications and/or by instrumented monitoring systems. If a leak is detected, then the MSE pipeline can be isolated by closing automated and/or manual valves (Refer to Section 2.3 for locations of upstream and downstream isolation valves).

4.6 MAEs for Risk Analysis

The list of MAEs included in the risk analysis is provided in Table 7.

Table 6 List of MAEs

MAE	Potential Consequences
Release of High Pressure Ethane from APA Moomba-Sydney Ethane Pipeline	Jet Fire, Flash Fire or Explosion

5 CONSEQUENCE ANALYSIS

5.1 Release of Flammable Liquid / Gas

5.1.1 Representative Hole Diameter

Representative hole diameters were selected for the consequence modelling. These were selected to align with the leak frequency data (Refer to Appendix C), which includes four hole size categories: Pinhole (≤ 25 mm); Small Hole (> 25 mm to ≤ 75 mm), Large Hole (> 75 mm to ≤ 110 mm); and, Rupture (> 110 mm). The representative hole diameter/s in each hole size category were selected based on a review of the available historical data (Refer to Appendix B.1):

- Leaks from underground pipelines in the Pinhole size category tend to be larger for TPA incidents (i.e. typically c. 20 mm to 25 mm - Refer to Appendix D) than for the other failure modes (i.e. typically less than c. 10 mm). Therefore, two representative hole diameters were selected in this category: 25 mm for TPA and 10 mm for all other failure modes.
- There is insufficient historical incident data for Ethane to determine the representative hole diameter/s in each hole size category. Therefore, the representative hole diameters were assumed to be the same as proposed by the UK HSE for LPG.

Table 7 Representative Hole Diameters Selected for Consequence Analysis

Pipeline/s	Internal Diameter (mm)	Representative Hole Diameter (mm)			
		Pinhole (≤ 25 mm)	Small Hole (> 25 mm to ≤ 75 mm)	Large Hole (> 75 mm to ≤ 110 mm)	Rupture (> 110 mm)
APA Ethane Pipeline	202.9	10 or 25*	75	110	Full bore

* 10 mm for all failure modes except TPA. 25 mm for TPA only.

5.1.2 Rate of Release

Release events were modelled using the 'Long Pipeline' model in SAFETI. The estimated release rates are tabulated below for each representative hole size.

Table 8 Representative Hole Diameters Selected for Consequence Analysis

MAE	Hole Diameter (mm)	Release Rate [kg/s]
Release of High Pressure Ethane from APA Moomba-Sydney Ethane Pipeline	10	3.5
	25	21.7
	75	195.4
	110	420.2
	FBR	317.8 *

* Average release rate from 'Long Pipeline' model for t = 0 to 20 seconds.

5.1.3 Height and Orientation of Release

All releases were modelled as vertical releases at ground level. The SAFETI GASPIPE module determines a crater size and air entrainment for a release from a buried pipeline.

The release of high pressure gas or liquefied gas from a buried pipeline would result a crater and gas would be released vertically from the crater [14].

5.1.4 Duration of Release

Ethane is flammable and any adverse impact will occur quickly (fire or explosion); therefore, the duration of exposure is not as critical as it would be if there were a toxic material in the pipeline (i.e. where the adverse impact can significantly increase for longer exposure durations).

The isolation time and duration of release is not specified in the QRA as these will be significantly longer than the period of exposure required for an adverse effect to people (Refer to Section A.6) and the time required for each representative release case to reach steady state.

Duration of release becomes significant only from a fire escalation point and not required for risk assessment based on short duration exposure to fire.

5.2 Fire Modelling

The latest SAFETI software package (Version 8.23) was used to model all the representative fire events included in the risk analysis.

The key data and assumptions used to model the representative fire events are included in Appendix A.4.

5.2.1 Jet Fire

Example distances to heat radiation levels of 4.7, 12.5, 23 and 35 kW/m^2 are tabulated in Appendix B.1.2 for representative jet fire events included in the risk analysis.

5.2.2 Flash Fire

Example distances to the lower flammability limit (LFL) concentration are tabulated in Appendix B.1.2 for representative flash fire events included in the risk analysis.

5.3 Vapour Cloud Explosion

When a flammable vapour cloud ignites, the flame front advances as the cloud burns. If there are obstacles in the path of the flame front, the level of turbulence increases causing accelerated burning and thus the flame front accelerates, reaching speeds of 100-200 m/s. The whole combustion process occurs over a period of less than a second, but this short burst of high speed flame front results in a blast wave, resulting in a pressure above the atmospheric pressure on the target surface (referred to as blast overpressure).

The blast wave can cause damage to the structure and injury/ fatality to exposed individuals and is commonly called vapor cloud explosion (VCE).

The Multi-Energy model in SAFETI was used to estimate the overpressure for a VCE. Results are provided in Appendix B.2.4.

6 RISK ANALYSIS

6.1 Individual Risk of Fatality

The risk contours for individual risk of fatality at 1.0 and 0.5 x 10^{-6} per annum (p.a.) for the MSE pipeline are shown in Figure 8. These are the risk criteria in HIPAP No.10 [1] for: (i) residential uses and places of continuous occupancy, such as hotels; and (ii) sensitive land uses.

Figure 8 Location Specific Individual Fatality Risk Contours

The 1.0 x 10^{-6}p.a. risk contour is not reached at the BNH site. The 0.5 x 10^{-6} risk contour crosses the northern corner of the site. This location on the site is proposed to be for outdoor decking and retail, Figure 2, and not for sensitive use.

6.2 Risk of Acute Toxic Injury or Irritation

No events with the potential to cause acute toxic injury or irritation were identified for inclusion in the risk analysis (Also refer to Section 4.4.6); therefore the proposed BNH development complies with the relevant DPIE risk criteria (Refer to Section 3.4.2).

6.3 Risk of Property Damage and Accident Propagation (Exceeding 14 kPa)

The cumulative risk of property damage and accident propagation (Overpressure exceeding 14 kPa) does not reach 50 x 10^{-6} per annum. This criterion does not apply to the proposed BNH development (Refer to Section 3.4.3).

6.4 Risk of Property Damage and Accident Propagation (Exceeding 23 kW/m^2)

The cumulative risk of property damage and accident propagation (Heat radiation exceeding 23 kW/m^2) does not reach 50 x 10^{-6} per annum. This criterion does not apply to the proposed BNH development (Refer to Section 3.4.3).

6.5 Risk of Injury (Exceeding 7 kPa)

The cumulative risk of injury (Overpressure exceeding 7 kPa) does not reach 50 x 10^{-6} per annum; therefore, the proposed BNH development complies with the relevant DPIE risk criterion (Refer to Section 3.4.2).

6.6 Risk of Injury (Exceeding 4.7 kW/m^2)

The cumulative risk of injury (Heat radiation exceeding 4.7 kW/m^2) does not reach 50 x 10^{-6} per annum; therefore, the proposed BNH development complies with the relevant DPIE risk criteria (Refer to Section 3.4.2).

6.7 Qualitative Risk Criteria

Irrespective of the numerical value of any risk criteria level for risk assessment purposes, it is essential that certain qualitative principles be adopted concerning the land use safety acceptability of a proposed development or existing activity. The proposed development is considered to comply with the qualitative risk criteria outlined in HIPAP No. 4, as follows:

- Avoidance of all 'avoidable' risks – The MSE pipeline is an existing facility and cannot be relocated to avoid risk exposure.
- Reduction, wherever practicable, of the risk from a major hazard, even where the likelihood of exposure is low.
- Containment, wherever possible, within the site boundary of the effects (consequences) of the more likely hazardous events – The effects (consequences) of the more likely hazardous events (i.e. the smaller representative hole sizes) do not reach the proposed BNH development (Refer to Appendix B.1.2).
- Recognition that if the risk from an existing installation is already high, further development should not be permitted if it significantly increases that existing risk – The risk to the proposed development meets the individual risk criteria.

6.8 Societal Risk

It is possible that an incident at a hazardous facility may affect more than a single individual off-site, especially in the case of a full-bore rupture of a high pressure pipeline, and the potential exists for multiple fatalities.

The societal risk concept evolved from the concept of 'risk aversion', i.e. society is prepared to tolerate incidents that cause single fatalities at a more frequent interval (e.g. motor vehicle accidents) than for incidents causing multiple fatalities (e.g. an aircraft accident).

Two parameters are required to define societal risk: (a) Number of fatalities that may result from an incident; and (b) the frequency (likelihood) of occurrence of the incident.

Societal risk can be represented by F-N curves, which are plots of the cumulative frequency (F) of various accident scenarios against the number (N) of casualties associated with the modelled incidents. In other words, 'F' represents the frequency of exceedance of number of fatalities, N.

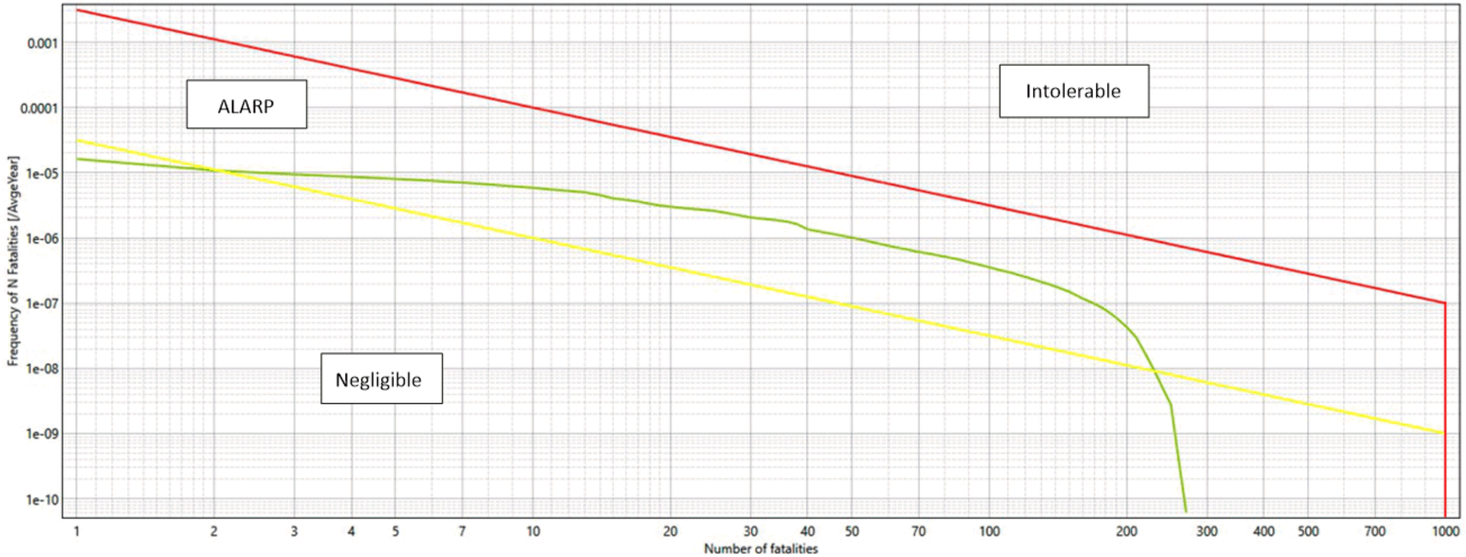
The F-N plot is cumulative in the sense that, for each frequency on the plot, N is the number of fatalities that could be equalled ***or exceeded***, and F is the frequency of exceedance of the specified number of fatalities.

In HIPAP 10 [1], the following is reported in regard to the F-N criteria:

If a development proposal involves an intensification of population in the vicinity of a potential source of risk, then the incremental change in societal risk needs to be taken into account, even if individual risk criteria are met [Ref.2, Section 5.5.4]. The incremental societal risk should be compared against the indicative societal risk criteria in Section 5.4.2 of HIPAP No. 10 [Figure 4 below]. If the incremental societal risk lies within the 'Negligible' region, then the development should not be precluded and if it lies within the 'Tolerable if ALARP' region, then options should be considered to relocate people away from the affected areas [Ref.2, Section 5.5.4]. If, after taking this step, there is still a significant portion of the societal risk plot within the 'Tolerable if ALARP' region, the proposed development should only be approved if benefits clearly outweigh the risks [Ref.2, Section 5.5.4].

An FN curve depicting the societal risk from the MSE pipeline in the area is shown in Figure 9. The entirety of this curve is in the 'Negligible' or 'ALARP' regions and complies with the DPIE's indicative societal risk criteria.

Figure 9 Societal Risk



7 Findings and Recommendations

7.1 Findings

The following findings were made from the risk assessment:

- The individual risk of fatality at the BNH is less than 1.0 x 10^{-6} p.a. and does not exceed the risk criterion for residential uses and places of continuous occupancy, such as hotels in HIPAP No.10 [1].
- The individual risk of fatality at the BNH is 0.5 x 10^{-6} p.a. and exceeds the risk criterion for sensitive use in HIPAP No.10 [1]. The current planning proposal does not include sensitive land uses.
- All other individual risk levels comply with the corresponding quantitative risk criteria in HIPAP No.10 [1] (Refer to Sections 6.2 to 6.7)
- The entirety of the F-N curve is in the 'Negligible' or 'ALARP' regions and complies with the DPIE's indicative societal risk criteria (Refer Section 6.8)
- Recommendations have been made to ensure ongoing compliance with HIPAP 10.

7.2 Recommendations

The following recommendations are mode to ensure compliance with the HIPAP 10 land use criteria:

1. If further population intensification is considered, i.e. a significantly larger number of apartments, or increased commercial populations, then an additional risk analysis should be undertaken to ensure the societal risk criteria are still met.
2. As the 0.5x10^{-6} p.a. risk contour is exceeded at the site, sensitive land uses should not considered for this site.

8 REFERENCES

[1] NSW Department of Planning, "Hazardous Industry Planning Advisory Paper No.10 - Land Use Safety Planning," Sydney, 2011.

[2] Planning Ingenuity , "Planning Proposal Report - 187 Slade Rd Bexley North," Sydney, 2020.

[3] NSW Department of Planning, "Hazardous Industry Planning Advisory Paper No.6 - Hazard Analysis," Sydney, 2011.

[4] Standards Australia, "AS/NZS 2885.0:2018 - Pipelines - Gas and Liquid Petroleum - General Requirements," 2018.

[5] NSW Department of Planning, "Hazardous Industry Planning Advisory Paper No.4 - Risk Criteria for Land Use Safety Planning," Sydney, 2011.

[6] "NSW Land Use Maps," New South Wales Government, [Online]. Available: https://www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/lga. [Accessed 20 December 2020].

[7] GMU Urban Design and Architecture, "Revised Concept Plans 18054-PP-Bexley North 187 Slade Rd," Sydney, 2020.

[8] Health and safety Laboratory, "Research Report RR 1035 - Update of pipeline failure rates for land use planning assessments," HSE Books, London, 2015.

[9] Occupational Safety and Health Administration, "Precautions and the order of testing before entering confined and enclosed spaces and other dangerous atmospheres.," US Department of Labour, Washington, D.C., 1995.

[10] Standards Australia, "AS 2885.0 - Pipelines - Gas and Liquid Petroleum. Part 0 - General Requirements," 2008.

[11] Standards Australia, "Pipelines - Gas and Liquid Petroleum Operations and Maintenance," 2012.

[12] Standards Australia, "Pipelines - Gas and liquid petroleum Design and construction," 2018.

[13] NSW Planning & Environment, "New South Wales 2017-18 Gas Networks Performance Report," 2018.

[14] DNVGL, "SAFETI 8.2.3 Technical reference manual," 2019.

[15] E. N. F. e. M. P. a. K. Silva, "Underground parallel pipelines domino effect: An analysis based on pipeline crater models and historical accidents," vol. 43, no. June, 2016.

Appendices

Appendix A Assumptions

It is necessary to make technical assumptions during a risk analysis. These assumptions typically relate to specific data inputs (e.g. material properties, equipment failure rates, etc.) and modelling assumptions (e.g. release orientations, impairment criteria, etc.).

To comply with the general principles outlined in Section 2.2 of HIPAP No. 6, all steps taken in the risk analysis should be: "*traceable and the information gathered as part of the analysis should be well documented to permit an adequate technical review of the work to ensure reproducibility, understanding of the assumptions made and valid interpretation of the results*". Therefore, details of the key assumptions adopted for the risk analysis are provided in this Appendix.

Each assumption is numbered and detailed separately. The basis for each assumption is explained together with its potential impact on the risk results and the MAEs potentially affected. Key references are also listed for each assumption, where relevant.

It is important that the assumptions be supported by:

- experimental data in the literature, where available;
- actual operating experience, where available;
- similar assumptions made by experts in the field and a general consensus among risk analysts; and
- engineering judgement of the analyst.

The main objectives are to minimise uncertainty in the risk estimate as far as is possible, and to ensure that the assumptions result in a 'conservative best estimate' of the risk. Such an approach is consistent with the following extract from Section 5 of HIPAP No. 6: "*In the consequence analysis and throughout the hazard analysis, the analyst must be conscious of the uncertainties associated with the assumptions made. Assumptions should usually be made on a 'conservative best estimate' basis. That is, wherever possible the assumptions should closely reflect reality. However, where there is a substantial degree of uncertainty, assumptions should be made which err on the side of conservatism.*"

List of Assumptions

A.1 Operational Data

Assumption No. 1: Pipeline Operating Conditions
Subject: Operational Data
Assumption/s: • All pipeline operating conditions (pressure, temperature, etc.) are as reported in Section 2.2.
Justification and Impact/s of Assumption/s: • All operational data for the pipelines was provided by the pipeline owner (APA Group). • Operating conditions (particularly operating pressure) are required to undertake the release and dispersion modelling.
MAE/s Affected: • All.
Reference/s: • Data provided by APA Group.

Assumption No. 2 Pipeline Utilisation
Subject: Operational Data
Assumption/s: • The MSE pipeline is utilised 100% of the time.
Justification and Impact/s of Assumption/s: • Utilisation data is required to undertake the release and dispersion modelling and to estimate the release frequency.
MAE/s Affected: • All.
Reference/s: • Data provided by APA Group.

A.2 Locational Data

Assumption No. 3: Representative Wind Speeds, Wind Directions and Stability Classes
Subject: Locational Data
Assumption/s: • The probabilistic distribution of wind speed and wind direction for the representative stability classes is provided in Table 11 and Table 12. • The data was split into daytime and night time conditions. • Night-time is considered the period from 1 hour before sunset, to one hour after sunrise. This approximates to 10 hours daytime and 14 hours night-time.
Justification and Impact/s of Assumption/s: • Meteorological data (mean cloud cover, temperature, wind speeds) is collected by the Bureau of Meteorology (BoM) for the Bankstown Airport weather station. This raw data was rationalised into a set of wind speed/weather stability classes for dispersion calculations. The Bankstown Airport weather station was selected as being the closest to the BNH with sufficient data and most representative. • Wind will cause flames to tilt downwind. The higher the wind speed, the greater the tilt. The net effect of the tilt is to increase the heat radiation in the downwind direction. This is much more pronounced for pool fires than jet fires because jet fires have much greater momentum. An allowance for flame tilt is included in the SAFETI models for pool fires and vertical jet fires. The SAFETI model assumes horizontal jet fires are directed in the same direction as the wind. • The downwind gas concentrations, and hence the hazard ranges for dispersion of flammable gas or vapour, vary with wind speed and weather stability class. Therefore, multiple representative wind speed and stability class categories are included in accordance with standard practice for undertaking a quantitative risk assessment (QRA). • The day/night split of the weather data is required to allow for the fact that residential, commercial and industrial occupancies change over a 24 hour period.
MAE/s Affected: • All.
Reference/s: • BoM meteorological data for Bankstown AWS.

Table 9 Probability of Representative Stability Classes and Wind Speeds (Day)

Stab. Class	Wind Speed (m/s)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
B	3.0	0.025	0.012	0.011	0.011	0.014	0.009	0.008	0.006	0.010	0.008	0.011	0.013	0.023	0.022	0.020	0.020	0.222
D	7.4	0.006	0.001	0.008	0.020	0.018	0.029	0.038	0.036	0.027	0.005	0.007	0.015	0.022	0.015	0.006	0.006	0.259
D	4.4	0.026	0.011	0.020	0.031	0.038	0.031	0.028	0.022	0.030	0.014	0.027	0.028	0.032	0.025	0.027	0.022	0.414
D	1.8	0.008	0.003	0.002	0.002	0.003	0.002	0.003	0.003	0.006	0.006	0.008	0.009	0.014	0.015	0.014	0.008	0.105
Total		0.064	0.026	0.042	0.064	0.073	0.072	0.076	0.067	0.073	0.033	0.053	0.065	0.092	0.076	0.068	0.056	1.000

Table 10 Probability of Representative Stability Classes and Wind Speeds (Night)

Stab. Class	Wind Speed (m/s)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
D	7.4	0.001	0.000	0.001	0.000	0.001	0.003	0.007	0.010	0.007	0.002	0.002	0.004	0.006	0.003	0.002	0.001	0.050
D	4.1	0.016	0.008	0.022	0.015	0.016	0.018	0.021	0.020	0.027	0.014	0.021	0.020	0.021	0.012	0.013	0.018	0.283
D	1.2	0.008	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.006	0.006	0.007	0.007	0.009	0.006	0.007	0.009	0.082
E	2.6	0.005	0.003	0.005	0.003	0.004	0.004	0.003	0.003	0.006	0.005	0.007	0.007	0.006	0.005	0.005	0.006	0.076
F	1.1	0.043	0.018	0.023	0.022	0.024	0.018	0.015	0.015	0.035	0.029	0.039	0.042	0.056	0.037	0.043	0.049	0.508
Total		0.074	0.032	0.053	0.043	0.048	0.044	0.048	0.050	0.081	0.055	0.077	0.081	0.098	0.063	0.070	0.083	1.000

Assumption No. 4: Ambient Conditions

Subject: Locational Data

Assumption/s:

- The typical ambient conditions (temperature, atmospheric pressure, solar radiation and relative humidity) are listed in Table 13 and Table 14.

Table 11 Average Temperature, Relative Humidity and Solar Radiation (Day)

Stability Class	Wind Speed (m/s)	Average Temp (°C)	Average Solar Radiation (kW/m^2)	Average Relative Humidity (fraction)
B	3.0	23.7	0.8	0.42
D	7.4	22.7	0.5	0.47
D	4.4	20.6	0.4	0.52
D	1.8	16.8	0.3	0.69

Table 12 Average Temperature, Relative Humidity and Solar Radiation (Night)

Stability Class	Wind Speed (m/s)	Average Temp (°C)	Average Solar Radiation (kW/m^2)	Average Relative Humidity (%)
D	7.4	18.0	0.0	0.61
D	4.1	16.7	0.0	0.68
D	1.2	11.8	0.1	0.89
E	2.6	13.9	0.0	0.81
F	1.1	10.9	0.0	0.90

Justification and Impact/s of Assumption/s:

- The average ambient temperature is a required input for the SAFETI model. The temperature of the material in each pipeline is similar; therefore, the average ambient temperature does not have a significant impact on the consequence calculations.
- The average relative humidity is a required input for the SAFETI model. This is used in thermal radiation calculations to attenuate the heat radiation.
- The average solar radiation is a required input for the SAFETI model.

MAE/s Affected:

- All.

Reference/s:

- BoM meteorological data for Bankstown Airport.

Assumption No. 5: Surface Roughness Length

Subject: Locational Data

Assumption/s:

- The roughness length for different surface types, as listed in the SAFETI user manual, is shown below in Table 15.

Table 13 Surface Roughness Length

Description	Roughness Length (m)
Open water, at least 5 km	0.0002
Mud flats, snow, no vegetation, no obstacles	0.005
Open flat terrain, grass, few isolated objects	0.03
Low crops; occasional large obstacles, x/h > 20	0.1
High crops, scattered large obstacles, 15<x/h<20	0.25
Parkland, bushes, numerous obstacles, x/h<15	0.5
Regular large obstacle coverage (suburb, forest)	1
City centre with high- and low-rise buildings	3

- A conservative roughness length of 0.5 m is applicable for Bexley North.

Justification and Impact/s of Assumption/s:

- The surface roughness affects the dispersion analysis. As the surface roughness increases, a release of gas or vapour will disperse more quickly with increasing distance from the source. Therefore, it is necessary in SAFETI to select a surface roughness length that is representative of the types of terrain and obstacles near the source of release.
- It is not possible to define different surface roughness lengths for different locations within a single SAFETI model. Only a single representative value can be defined for the entire area.

MAE/s Affected:

- Dispersion modelling for all relevant MAEs.

Reference/s:

- SAFETI software documentation.

Assumption No. 6: Location of High Pressure Gas Pipelines
Subject: Locational Data
Assumption/s: • The location of the MSE pipeline is sourced from the Australian Pipeline and Gas Association's (APGA) Australian Pipeline Database.

Justification and Impact/s of Assumption/s:
• The Australian Pipeline Database (APD) is made available to users to raise awareness of the location of high-pressure hydrocarbon pipelines and facilitate discussions between pipeline operators and stakeholders regarding the potential for planning and development decisions to trigger requirements in the Australian Standard, AS 2885, for pipeline Safety Management Studies.
• Use of the APD is conditional on several factors that are consistent with the objectives of this study, including:
  • The APD is to be used solely for the purpose of facilitating discussion regarding planning activity and decisions in the vicinity of pipelines. **This is consistent with the objectives of this study**.
  • The APD is not to be used for proving and construction activities. Dial Before You Dig enquiries must be made for these activities and any condition complied with. **It is not the intent of this study to provide detailed construction information**.
• When overlayed onto aerial photos, the APGA Pipeline database accuracy appears no less accurate than the accuracy expected of the consequence models and frequency estimates.

MAE/s Affected: • All.
Reference/s: • APGA Australian Pipeline Database.

Assumption No. 7: Total Population (Day and Night)

Subject: Locational Data

Assumption/s:

- The risk analysis includes the estimated population within the Development. Surrounding residential populations located outside the Development (within the maximum estimated hazard range) are also included in the risk analysis.
- Populations are evenly distributed across each relevant area.
- **Proposed Residential Apartment and Hotel** – The population in the apartments and hotel of the Development is conservatively based on an occupancy rate of 2.2 persons per room, with 83 apartments and 66 hotel rooms. 40% of this population is assumed to be present during the day and 100% is present during the night.
- **Retail and Commercial Population** – The retail and commercial populations associated with the BNH was estimated as per the Table D1.13 of the National Construction Code on Area per person according to use.
- **Existing Residential Areas** – The population in the surrounding residential area has been based on occupancy rates from the 2016 Census (within the maximum estimated hazard range) is given in Table 14. The majority of these dwellings are residential houses.

Table 14 Surrounding Residential Population

Statistical Area 1 7-digit identifier	Population		Statistical Area 1 7-digit identifier	Population	
	Night	Day		Night	Day
1136409	257	129	1137721	456	246
1136412	446	271	1137722	530	291
1136425	262	151	1137723	363	211
1136433	572	325	1137724	444	225
1136437	451	237	1137725	350	196
1136442	436	241	1137726	273	148
1136443	353	180	1137727	670	313
1137704	438	247	1137728	399	201
1137709	279	135	1137729	557	254
1137710	281	126	1137730	397	181
1137711	207	89	1137521	0	0

Assumption No. 7: Total Population (Day and Night)

Justification and Impact/s of Assumption/s:

- The occupancy rate and % of the total population present during the day and night was estimated from 2016 census data.
- As the data given in Table D1.13 of the National Construction Code apply to the specific use of an area as a maximum occupancy and the areas given in the planning proposal for each use include bathrooms, hallways, kitchens, etc., and occupancy may change given time of day factors were applied as in Table 15.

Table 15 Retail and Commercial Use Population

Use	Area (m2)	No people per m2	Occupancy Factor		Population	
			Night	Day	Night	Day
Pub	2060	1	0.5	0.25	1030	515
Retail	287	5	0.25	1	14	57
Gym	297	3	0.5	0.5	50	50
Café	160	1	0.5	0.5	80	80

- The total population and the % of the total population present during the day and night is required for estimation of the societal risk.

MAE/s Affected:

- All societal risk calculations. Population density, along with the area of consequence distances, determines the fn points of societal risk.
- Locational specific risk is not impacted by these assumptions.

Reference/s:

- Australian Bureau of Statistics, 2016 census data.
- National Construction Code, Building Code of Australia 2019, Volume 1.

Assumption No. 8: Indoor / Outdoor distribution of people
Subject: Locational Data

Assumption/s:

- 99% of the night time population will be located indoors.
- 90% of the daytime population will be located indoors.
- All population is located at ground level.

Justification and Impact/s of Assumption/s:

- The default values recommended by the TNO ['Purple Book'] for residential and industrial areas are tabulated below.

Table 16 Proportion of Population Indoor and Outdoor During Day and Night [TNO]

Location	Day Time (8am to 6:00pm)	Night Time (6:00pm to 8am)
Indoor	93%	99%
Outdoor	7%	1%

- The % of the total population located indoors and outdoors was estimated from similar risk analyses (Including some data provided by DPIE). It is reported in these analyses that the % of people indoors and outdoors is 90% indoors and 10% outdoors during the day, which differs slightly from the TNO data, but is typically justified as being more applicable for Australian environmental conditions. Similarly, it is reported in these analyses that the % of people indoors and outdoors is 95 to 99% indoors and 1 to 5% outdoors during the night.

MAE/s Affected:

- All societal risk calculations

Reference/s:

- • TNO, VROM, Guidelines for Quantitative Risk Assessment, 'Purple Book', CPR18E, 3rd Edition.

A.3 Risk Analysis Methodology

Assumption No. 9: Location and Segmentation of Pipelines
Subject: Risk Analysis Methodology
Assumption/s: • Representative release events are modelled using the 'Long Pipeline' model in SAFETI, which distributes these events along the pipeline at set intervals.
Justification and Impact/s of Assumption/s: • The 'Long Pipeline' model in SAFETI is used to estimate the time-dependent release from a long pipeline. The 'Long Pipeline' model includes inputs for use in the risk calculations, such as pipeline burial depth, leak frequency, etc. • The interval at which representative incidents are distributed along the pipeline is selected automatically by the 'Long Pipeline' model based on the incident consequence.
MAE/s Affected: • All.
Reference/s: • SAFETI software documentation.

A.4 Consequence Analysis

Assumption No. 10: Representative Materials
Subject: Consequence Analysis
Assumption/s: • Ethane is modelled as 100% Ethane.
Justification and Impact/s of Assumption/s: • The composition and materials used affect the magnitude of the consequences. Materials containing multiple components are simplified for modelling purposes by choosing a representative component to best approximate the variable composition. Modelling a representative material rather than a multi-component material reduces complexity, limits the potential for inconsistencies and ultimately has a minimal effect on the results. • The MSE pipeline carries ethane which has been processed to serve as a petrochemical feed stock.
MAE/s Affected: • All.
Reference/s: • Data provided by APA Group.

Assumption No. 11: Pressure and Flow for Release Modelling
Subject: Consequence Analysis
Assumption/s: • A release of Ethane from the Moomba to Sydney Ethane Pipeline is modelled at 8.2 MPag (Operating pressure), compared to an MAOP of 10 MPag. • Release events are modelled using the 'Long Pipeline' model in SAFETI and may be based on a time varying release rate (depending on hole size). • 30 tonnes per hour flow is assumed.
Justification and Impact/s of Assumption/s: • The release rate is dependent on the pressure and the MAOP is the maximum pressure permitted under an existing licence. • The pressure used to model the release rates was based on the pipeline pressure near the proposed development, as advised by the pipeline owner. • The long pipeline model assumes the input pressure is reduced by frictional losses along the pipeline length until the breach point. This results in a lower initial release rate. • Providing a flow will slow the rate of pressure reduction calculated by the long pipeline model, but this is insignificant for the initial 30 second release, the basis of which the impact for jet fire has been assumed. • Specifying a flow rate will increase the residual pressure that the long pipeline model calculates; however, this is not relevant as it will take much longer than 30 seconds to reach this residual pressure.
MAE/s Affected: • All.
Reference/s: • Data provided by APA Group.

Assumption No. 12: Representative Hole Diameters for Release Modelling

Subject: Consequence Analysis

Assumption/s:

- Consequence modelling is based on the following representative hole diameters:

Table 17 Representative Hole Diameters Selected for Consequence Analysis

Pipeline/s	Material	Internal Pipeline Diameter (mm)	Representative Hole Diameter (mm)			
			Pinhole	Small Hole	Large Hole	Rupture
			(≤ 25 mm)	(> 25 mm to ≤ 75 mm)	(> 75 mm to ≤ 110 mm)	(> 110 mm)
APA Ethane Pipeline	Ethane	202.9	10 or 25*	75	110	Full bore

* 10 mm for all failure modes except Third Party Activity (TPA). 25 mm for TPA only.

Justification and Impact/s of Assumption/s:

- The representative hole diameters were selected to align with the leak frequency data (Refer to C.1), which includes four hole size categories: Pinhole (≤ 25 mm); Small Hole (> 25 mm to ≤ 75 mm), Large Hole (> 75 mm to ≤ 110 mm); and, Rupture (> 110 mm). The representative hole diameter/s in each hole size category were selected based on a review of the available historical data (Refer to Appendix B.1):
  - Leaks from underground pipelines in the Pinhole size category tend to be larger for TPA incidents (i.e. typically c. 20 mm to 25 mm – Refer to Appendix D) than for the other failure modes (i.e. typically less than c. 10 mm). Therefore, two representative hole diameters were selected in this category: 25 mm for TPA and 10 mm for all other failure modes.
  - There is insufficient historical incident data for Ethane to determine the representative hole diameter/s in each hole size category. Therefore, the representative hole diameters were assumed to be the same as proposed by the UK HSE for LPG (Refer to C.1). Ethane is transported as a liquefied flammable gas.

MAE/s Affected:

- All.

Reference/s:

- Refer to Appendix B.1.

Assumption No. 13: Location of Release for Transmission Pipelines
Subject: Consequence Analysis
Assumption/s: • High pressure gas releases would create a crater on the ground. The direction of release for underground pipeline failures from the crater is always vertical. • The location of failure on the pipe can be taken as: - Top of the pipe (unobstructed releases); or - Middle of the pipe (on the side – obstructed releases) • The release frequency is distributed between the two locations (37% from middle of pipe and 63% from top of pipe for all release cases except non-TPA events with a hole size less than or equal to 25mm, which are modelled as 100% from middle of pipe).
Justification and Impact/s of Assumption/s: • The crater size depends on the location of the hole on the pipe and hence all three locations (top, middle and bottom) may be modelled (DNVGL, 2020). Top releases are taken as non-obstructed releases and middle/ bottom releases are taken as obstructed releases. • Impingement reduces the momentum of the release and the dispersion modelling is dominated by the representative wind conditions. • The UK HSE [RR 1034] reports that some data from UKOPA includes the 'hole circumferential position' for releases from underground pipelines. Based on the 71 recorded incidents (All pipelines and materials) and average crater dimensions, an unobstructed release (c. ±71° from vertical) was estimated to occur for 63% of the releases and an obstructed release was estimated to occur for the balance (37% of releases). The distribution is not reported for different failure modes.
MAE/s Affected: • All.
Reference/s: • SAFETI software documentation. • UK HSE, 2015, *Review of the Event Tree Structure and Ignition Probabilities used in HSE's Pipeline Risk Assessment Code MISHAP*, Research Report (RR) 1034.

Assumption No. 14: Maximum Extent of Flash Fire
Subject: Consequence Analysis
Assumption/s: • The maximum extent of a flash fire is defined by the downwind and crosswind distances from the release location to a concentration equal to 100% of the lower flammability limit (LFL) concentration calculated using a 18.75s averaging time.
Justification and Impact/s of Assumption/s: • Justification is provided in (Benintendi, 20171031, p. 341): For passive dispersion models, the shorter the averaging time, the higher the centreline concentration, and there is concern that flammable concentrations may exist beyond the 100% LFL contour determined for a specific averaging time. To take into account the different averaging times, the following empirical formula is recommended for converting concentrations from 10 minute averaging time to another (Hanna et al., 1993): $\frac{C_t}{C_{600}} = \left(\frac{600}{t}\right)^{0.2}$ ...(1) where time is in seconds. C_t denotes time averaged concentration at the new averaging time of t seconds Hanna claims that experimentally: $C_{max} = 2 \times C_{600}$ ...(2) where C_{max} is the maximum peak concentration in the plume. Substituting C_{max} from (2) with $C_{600}\left(\frac{600}{t}\right)^{0.2}$ from (1) and solving for t, it yields *t = 18.75 s.* This time should be adopted to carry out worst case predictions for the extent of 100% LFL. It is the core averaging time for flammable dispersion in SAFETI. • For the materials under consideration, flash fires are not expected to be a major contributor because the gases involved are either buoyant, or have a neutral buoyancy, and should ignition occur, effects from jet fires are expected to dominate.
MAE/s Affected: • All MAEs with a flash fire as a potential outcome.
Reference/s: • SAFETI software documentation. • Benintendi, R. (20171031). Process Safety Calculations. [[VitalSource Bookshelf version]]. Retrieved from vbk://9780081012291. • Hanna, S.R., Strimaitus, D.G., Chang, J., 1993. Hazard Response Modeling Uncertainty (A Quantitative Method) Vol 11 - Evaluation of Commonly Used Hazardous Gas Dispersion Models, Environics Division Air Force Engineering & Services Center, Engineering & Services Laboratory.

Assumption No. 15: Isolation Time and Duration of Release
Subject: Consequence Analysis
Assumption/s: • Isolation time and duration of release is not specified as these will be significantly longer than the period of exposure required for an adverse effect to people (Refer to Section A.6) and time required for each representative release case to reach steady state.
Justification and Impact/s of Assumption/s: • Ethane is flammable and any adverse impact will occur quickly (fire or explosion); therefore, the duration of exposure is not as critical as it would be if there were toxic materials in the pipeline (i.e. where the adverse impact can significantly increase for longer exposure durations). • The assumption is justified from the consequence calculations of the Long Pipeline Model, using a 30 sec. exposure time (user specified), compared to isolation valve closure times which typically vary from minutes (full bore rupture case) to hours (small to medium leaks).
MAE/s Affected: • All.
Reference/s: • SAFETI software documentation.

Assumption No. 16: Shielding by Intervening Structures
Subject: Consequence Analysis
Assumption/s: • The presence of intervening structures (e.g. buildings) does not shield other receptors from the heat radiation from a jet fire.
Justification and Impact/s of Assumption/s: • In the SAFETI software, it is not possible to take account of the potential protection provided by intervening structures. • This analysis is taking place during the concept stage of development of a large growth area. There is insufficient information available to determine the location of large structures that could offer protection against radiant heat. • People located indoors are typically less vulnerable to fire, which is a relevant consideration for the societal risk assessment (Refer to Assumption No. 21).
MAE/s Affected: • All MAEs with a pool fire or jet fire as a potential outcome.
Reference/s: • SAFETI software documentation.

Assumption No. 17: 3D Explosion Model Parameters
Subject: Consequence Analysis
Assumption/s: • The maximum explosive mass in a flammable gas or vapour cloud is the maximum mass between the LFL and UFL concentration for that section of the cloud that overlaps a congested area. • The peak side-on overpressure resulting from an explosion is estimated using the Extended Explosion Modelling option in the SAFETI software. • The severity of the blast is based on an unconfined blast strength of 4, with no specified obstruction region. • The blast strength is estimated based on the obstructed volume (%) and potential obstructions in each congested area. The following congested areas are included in the QRA: • **Buildings** - A medium obstructed volume (60% for a residential building) and level of congestion is assumed to simulate entry of the gas or vapour into the building and the subsequent confined explosion. This equates to TNO Model curve number 4. • Only overpressure effects are included. Projectiles and whole-body displacement are not included.
Justification and Impact/s of Assumption/s: • The explosive mass and blast strength are key parameters for modelling the overpressure from a VCE. • There are no significantly congested locations in the study area; however, a confined explosion could occur if gas or vapour enters a building. • The open space between the buildings in the study area is not strictly a congested area; however, the presence of vehicles, trees etc. at ground level may contribute to flame acceleration and the formation of an overpressure if ignition occurs. Therefore, TNO Model curve number 2 was assumed to apply, which is the default value in the SAFETI software. • The 3D Obstructed Region Explosion Modelling option considers the interactions between the flammable cloud and obstructed regions that have been defined for the study area. This is more valid than simple models (e.g. TNT equivalence) which do not consider these interactions.
MAE/s Affected: • All MAEs with a VCE as a potential outcome.
Reference/s: • Centre for Chemical Process Safety, Estimating the flammable mass of vapour clouds", American Institute of Chemical Engineers, 1999. • TNO, VROM, 'Yellow Book'. • SAFETI software documentation.

A.5 Likelihood Analysis

Assumption No. 18: Likelihood of Release (Loss of Containment)
Subject: Likelihood Analysis
Assumption/s: • The likelihood of each representative release is provided in Appendix C.3. • The UK HSE pipeline failure rate data is the primary data used for the risk assessment. • The contribution to pipeline failure from ground movement has been adjusted down to allow for local conditions.
Justification and Impact/s of Assumption/s: • The estimated likelihood of release (or loss of containment) is a critical and significant input for the risk analysis. The risk results are directly proportional to this input. • Generic failure rate data for cross-country pipelines from the UK, USA and Europe were reviewed. The UK data incorporates the European data. There are two sources of data from the UK: (a) HSE recommended data for land use safety planning (RR 1035); and (b) British Standards Institute PD 8010-3:2009+A1:2013. The HSE data is primarily used in this study, which is consistent with the NSW performance data. • The HSE data identifies four contributors to pipeline failure: (a) mechanical failure; (b) corrosion; (c) ground movement/other; and (d) Third Party Activity (TPA). Of these, mechanical, corrosion and TPA are similar to conditions in Australia and hence no frequency adjustments due to local conditions are justified. • The justification for the data used in this risk analysis is provided in Appendix C.1.
MAE/s Affected: • All.
Reference/s: • Refer to Appendix C.1.

Assumption No. 19: Ignition Probability
Subject: Likelihood Analysis
Assumption/s: • The probability of ignition for each representative release is provided in Appendix C.2.
Justification and Impact/s of Assumption/s: • The estimated probability of ignition is a critical and significant input for the risk analysis. The risk results are directly proportional to this input. • The justification for the data used in this risk analysis is provided in Appendix C.2.
MAE/s Affected: • All.
Reference/s: • Refer to Appendix C.2.

Assumption No. 20: Probability of VCE or Flash Fire
Subject: Likelihood Analysis
Assumption/s: • Ignition of a free gas or vapour cloud is modelled as a flash fire in uncongested areas and as a vapour cloud explosion in congested areas. • Congested areas include buildings in the vicinity of the pipelines.
Justification and Impact/s of Assumption/s: • Ignition of a free gas cloud may demonstrate characteristics of a flash fire and/or an explosion. SAFETI uses the delayed ignition probability resulting in either of the events. • Obstructed areas in the dispersing vapour cloud are defined by the user in the layout map. As the model calculates gas dispersion, it automatically calculates the consequence as vapour cloud explosion in congested areas and flash fires in uncongested areas. • The current version of SAFETI, with the 3D obstructed area module, does not require a conditional probability of an explosion given ignition.
MAE/s Affected: • All MAEs with clouds in an obstructed region.
Reference/s: • SAFETI software documentation. • TNO, VROM, *Guidelines for Quantitative Risk Assessment*, 'Purple Book', CPR18E, 3rd Edition.

A.6 Vulnerability Parameters

Assumption No. 21: Exposure to Heat Radiation from a Fire (Indoor or Outdoor)

Subject: Vulnerability Parameters

Assumption/s:

- For individuals located outdoors, the probability of fatality is based on the following probit equation [TNO 'Purple Book']:

$$Y = -36.38 + 2.56\ln\left(I^{1.333}t\right)$$

  Where Y is the probit value, *I* is the heat radiation intensity (W/m^2) and t is the exposure duration (seconds).
- A maximum exposure duration of 30 seconds is applicable for individuals located outdoors in an urban setting. It is assumed after 30 seconds, the persons will have found shelter from heat radiation.
- The probability of fatality for an individual located outdoors (30 seconds exposure), as calculated using the above probit equation, is as follows:

Table 18 Probability of Fatality for Exposure to Heat Radiation (Outdoor)

Heat Radiation Intensity (kW/m^2)	Probit	Probability of Fatality
4.7	1.19	0
12.6	4.55	0.32
15.9	5.35	0.63
23.0	6.61	0.94
35.0 *	8.04	1.0

* - SAFETI assumes fatal injuries are incurred at 35 kW/m^2 and above, regardless of the exposure duration.

- For the calculation of societal risk:
  - The probability of fatality for individuals located outdoors is factored by 0.14 (SAFETI default) to allow for the protection provided by clothing and the possibility of seeking shelter behind obstacles.
  - The probability of fatality for an individual located indoors is 0 at less than 35 kW/m^2 and 1.0 at 35 kW/m^2 or greater.

Assumption No. 21: Exposure to Heat Radiation from a Fire (Indoor or Outdoor)

Justification and Impact/s of Assumption/s:

- The probit equation adopted for the risk analysis is generally consistent with the following data from HIPAP No. 4.

Table 19 Effects of Thermal Radiation

Heat Radiation Intensity [kW/m²]	Effect/s
1.2	Received from sun in summer at noon.
1.6	Minimum necessary to be felt as pain.
4.7	Pain in 15 to 20 seconds, 1st degree burns in 30 seconds. Injury (second degree burns) to person who cannot escape or seek shelter after 30s exposure.
12.6	High chance of injury. 30% chance of fatality for extended exposure. Melting of plastics (cable insulation). Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure. Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure.
23.0	Fatality on continuous exposure. 10% chance of fatality on instantaneous exposure. Spontaneous ignition of wood after long exposure. Unprotected steel will reach thermal stress temperatures, which can cause failure. Pressure vessel needs to be relieved or failure would occur.
35.0	25% chance of fatality on instantaneous exposure.
60.0	Fatality on instantaneous exposure.

- It is reported in the TNO 'Purple Book' that people indoors are assumed to be protected from heat radiation until the building catches fire. The threshold for the ignition of buildings in the TNO 'Purple Book' is set at 35 kW/m^2 and if the building is set on fire, all the people inside the building are assumed to die (i.e. The probability of fatality indoors is 1 if the heat radiation exceeds 35 kW/m^2 and it is 0 if the heat radiation is less than 35 kW/m^2).

MAE/s Affected:

- All MAEs with a pool fire or jet fire as a potential outcome.

Reference/s:

- TNO, VROM, *Methods for the determination of possible damage*, 'Green Book', CPR16E.
- TNO, VROM, *Guidelines for Quantitative Risk Assessment*, 'Purple Book', CPR18E, 3rd Edition.

Assumption No. 22: Exposure to Flash Fire (Indoor or Outdoor)
Subject: Vulnerability Parameters
Assumption/s: • For calculation of location-specific individual risk, the probability for fatality = 1 for any individual located within the flammable cloud (Distance to LFL concentration). • For calculation of societal risk, the probability for fatality for any individual located within the flammable cloud (Distance to LFL concentration) is 1 (outdoor) or 0.1 (indoor).
Justification and Impact/s of Assumption/s: • The assumed probabilities differ from the guidance in the TNO 'Purple Book' and the default values in the SAFETI software. In both cases, the probability of fatality is set at 1 for all individuals (outdoor or indoor). This was considered too conservative. The probability of fatality indoors was set at 0.1 to take account of the possibility of open doors / windows and/or failure to evacuate.
MAE/s Affected: • All MAEs with a flash fire as a potential outcome.
Reference/s: • SAFETI software documentation. • TNO, VROM, *Guidelines for Quantitative Risk Assessment*, 'Purple Book', CPR18E, 3rd Edition.

Assumption No. 23: Exposure to Explosion Overpressure (Indoor or Outdoor)

Subject: Vulnerability Parameters

Assumption/s:

- The probability of fatality from exposure to the peak side-on overpressure from an explosion is as shown in Table 20 (Person located outdoors) and Table 21 (Person located indoors).

Table 20 Probability of Fatality from Exposure to Peak Side on-Overpressure (Outdoor)

Overpressure (kPa)	Probability of Fatality	Source
30	1.0	SAFETI software (default value)

Table 21 Probability of Fatality from Exposure to Peak Side on-Overpressure (Indoor)

Overpressure (kPa)	Probability of Fatality	Source
10	0.025	SAFETI software (default value)
30	1.0	SAFETI software (default value)

Justification and Impact/s of Assumption/s:

- When calculating location-specific individual injury or fatality risk contours (peak individual risk), all individuals must be considered to be located outdoors for 100% of the time since this is the underlying basis for the NSW DPI&E's individual risk criteria. Vulnerability parameters for individuals located indoors are only applicable for the calculation of societal risk.
- The probability of fatality is higher for an individual located in a conventional building than when outdoors due to the higher chance of harm from collapse of the structure.
- The NSW DPIE's injury/damage risk criterion for explosion overpressure is as follows: "Incident explosion overpressure at residential and sensitive use areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year".

Incidents Affected:

- All incidents with a VCE as a potential outcome.

Reference/s:

- NSW Department of Planning and Infrastructure, Jan 2011, Hazardous Industry Planning Advisory Paper (HIPAP) No. 4, *Risk Criteria for Land Use Safety Planning*.
- SAFETI software documentation.
- Oil & Gas Producers Association (OGP), Risk Assessment Data Directory, Report No. 434-14.1, *Vulnerability to Humans*, March 2010.
- Chemical Industries Association (CIA), 2003, *Guidance for the location and design of occupied buildings on chemical manufacturing sites*, 2nd. ed.

Appendix B Consequence Analysis – Example Data and Results

B.1 Representative Hole Diameters

Representative hole diameters were selected for the consequence modelling. These were selected to align with the leak frequency data, which includes four hole size categories: Pinhole (≤ 25 mm); Small Hole (> 25 mm to ≤ 75 mm), Large Hole (> 75 mm to ≤ 110 mm); and, Rupture (> 110 mm). The representative hole diameter/s in each hole size category were selected based on a review of the following available historical data.

B.1.1 Leak Data for Above Ground or Underground Cross-Country Pipelines – Various Materials

United Kingdom Onshore Pipeline Operators' Association (UKOPA), Major Accident Hazard Pipelines (1962-2014)

The definition of a Major Accident Hazard Pipeline (MAHP) from the Pipelines Safety Regulations 1996 (PSR 96) includes various materials (e.g. including natural gas at >8 bar, flammable liquids, etc.). The pipeline may be above or below ground.

The failure reports in the UKOPA database include the length and width of the failures. The failure area is also recorded for some events. The equivalent diameter of a circular opening with the same cross-sectional area was calculated.

The following table includes the recorded incidents where the hole size was reported [Cited by HSE in RR1035]. This data is almost exclusively for Natural Gas (NG) leaks, with only one leak from another material (Propylene).

Table 22 Dimensions of Leaks for Above Ground or Underground Cross-Country Natural Gas or Propylene Pipelines (UKOPA - Reported Values Only)

Fault ID	Discovery Date	Product	Wall Thickness (mm)	Diameter (in)	Diameter (mm)	Equivalent Hole Diameter (mm)	Cause
1950	1998	NG	4.4	3.9	100	1.1	Corrosion
1948	1997	NG	4.4	3.9	100	11.3	Corrosion
400	1998	NG	Not Recorded	4	102	2.8	Corrosion
3112	2010	NG	4.4	4.5	114	1.1	Corrosion
1424	1990	NG	4.5	4.5	114	3.6	Corrosion
1998	2001	NG	4.8	5.9	150	24.5	Corrosion
2569	2005	NG	4.7	6.4	163	1.1	Corrosion
2979	2009	NG	4.3	6.4	163	17.8	Corrosion
728	1990	NG	6	6.6	168	1.1	Corrosion
425	2000	NG	6.6	8.6	218	1.1	Corrosion
417	1998	NG	5.2	8.6	218	3.2	Corrosion
402	1999	NG	5.2	8.6	218	3.6	Corrosion
422	1999	NG	6.6	8.6	218	3.6	Corrosion
1934	1993	NG	6.4	14	356	1.1	Corrosion
730	1994	NG	6.4	18	457	1.1	Corrosion
1460	2001	NG	6.35	12.7	323	3.6	Ground movement/Other
1490	1989	NG	6.4	12.8	325	1.1	Ground movement/Other
1489	1989	NG	6.4	12.8	325	3.6	Ground movement/Other
1388	1998	NG	8	18	457	2.3	Ground movement/Other

Fault ID	Discovery Date	Product	Wall Thickness (mm)	Diameter (in)	Diameter (mm)	Equivalent Hole Diameter (mm)	Cause
2923	2008	NG	9.52	18	457	3.4	Ground movement/Other
2872	2000	NG	9.52	18	457	27.8	Ground movement/Other
1972	1990	NG	4.5	3.5	89	3.6	Mechanical
1949	1997	NG	4.4	3.9	100	3.6	Mechanical
1947	1990	NG	4.4	4	102	3.6	Mechanical
1909	1989	NG	4.4	4	102	11.3	Mechanical
1913	1990	NG	4.4	4	102	11.3	Mechanical
1914	1990	NG	4.4	4	102	11.3	Mechanical
1916	1990	NG	4.4	4	102	11.3	Mechanical
1917	1990	NG	4.4	4	102	11.3	Mechanical
1919	1990	NG	4.4	4	102	11.3	Mechanical
363	1997	NG	Not recorded	5.9	150	1.1	Mechanical
1928	1990	NG	4.5	5.9	150	11.3	Mechanical
1973	1990	NG	4.5	5.9	150	11.3	Mechanical
2028	1990	NG	4.8	5.9	150	11.3	Mechanical
2078	1989	NG	5.6	5.9	150	11.3	Mechanical
1996	1993	NG	4.8	6.6	168	1.1	Mechanical
1875	1989	NG	5.2	6.6	168	11.3	Mechanical
1886	1990	NG	4.4	6.6	168	11.3	Mechanical
1887	1990	NG	4.4	6.6	168	11.3	Mechanical
1925	1989	NG	4.4	6.6	168	11.3	Mechanical
1926	1989	NG	4.4	6.6	168	11.3	Mechanical
1940	1990	NG	4.4	6.6	168	11.3	Mechanical
2069	1990	NG	6.4	8.6	218	3.6	Mechanical
1876	1989	NG	6.4	8.6	218	11.3	Mechanical
2055	1989	NG	6.4	8.6	218	11.3	Mechanical
1710	1989	NG	7.9	14	356	3.6	Mechanical
1842	1992	NG	9.5	17.7	450	1.1	Mechanical
1361	1994	NG	9.5	24	610	1.1	Mechanical
1117	1993	NG	12.7	36	914	160.1	Mechanical
1918	1990	NG	4.4	4	102	22.6	TPA
1987	1990	NG	4.8	6.6	168	23.9	TPA
2980	2009	NG	5.56	6.6	168	25	TPA
1645	1992	NG	7.1	8.6	218	5.5	TPA
366	1991	NG	4.8	8.6	218	24	TPA
2783	2006	NG	4.5	8.6	219	25	TPA
1560	1989	NG	6.4	12.8	325	56.2	TPA
1185	1998	NG	10.4	15.7	400	20	TPA
1193	1990	NG	9.5	16	406	25	TPA
3109	2009	Propylene	7.1	6.6	168	6.8	TPA

B.1.2 Leak Data for Underground Cross-Country Pipelines – Natural Gas

US Department of Transportation (DoT), Pipeline and Hazardous Materials Safety Administration (PHMSA), Accident Reports - Reported Data for Underground Natural Gas Steel Pipelines (January 2010 to September 2017)

The dimensions of a leak are not always included in the US DoT database. The following tables include all recorded incidents where the hole size was reported.

The length and width of the hole is reported in the US DoT database; therefore, the equivalent diameter of a circular opening with the same cross-sectional area was calculated.

Table 23 Dimensions of Rupture Events for Underground Natural Gas Steel Pipelines (US DoT - Reported Values Only)

MAOP		Pipe Diameter (in)	Rupture Length (in)	Rupture Width (in)	Approx. Rupture Area (sq.in)	% of Cross-Section Area	Equiv. Hole Diameter (mm)	Cause
(psig)	(kPag)							
15	205	1.66	1.5	1.5	1.8	81.7	38.1	Natural Force - High Winds
95	756	20	16	1	12.6	4.0	101.6	Corrosion - External
15	205	1	3.3	1	2.6	330.0	46.1	Excavation Damage
60	515	1.25	2	0.1	0.2	12.8	11.4	Excavation Damage
60	515	2	7.5	0.5	2.9	93.8	49.2	Material Failure of Pipe or Weld - Butt Weld
60	515	2.375	6.5	2.1	10.7	242.0	93.8	Material Failure of Pipe or Weld - Butt Weld
60	515	2.375	2	2	3.1	70.9	50.8	Excavation Damage
433	3087	4	10	0.2	1.6	12.5	35.9	Excavation Damage
60	515	6.625	12.5	0.5	4.9	14.2	63.5	Material Failure of Pipe or Weld - Pipe
78	639	16	16	16	201.1	100.0	406.4	Other Cause - Unknown

Table 24 Dimensions of Puncture Events for Underground Natural Gas Steel Pipelines (US DoT - Reported Values Only)

MAOP		Pipe Diameter (in)	Puncture Axial Length (in)	Puncture Circumfe rential Length (in)	Approx. Puncture Area (sq.in)	% of Cross-Section Area	Equiv. Hole Diameter (mm)	Cause
(psig)	(kPag)							
60	515	0.75	0.5	0.5	0.2	44.4	12.7	Other Outside Force - Electrical arcing
260	1894	0.75	0.8	0.8	0.5	113.8	20.3	Excavation Damage
60	515	1.25	1.5	0.7	0.8	67.2	26.0	Excavation Damage
4	129	2	2	1	1.6	50.0	35.9	Excavation Damage
9.5	167	2	1	3	2.4	75.0	44.0	Excavation Damage
25	274	2	3.5	0.7	1.9	61.3	39.8	Incorrect Operation
52	460	2	0.5	0.5	0.2	6.3	12.7	Other Outside Force - Electrical arcing
60	515	2	1	0.5	0.4	12.5	18.0	Excavation Damage
60	515	2	0.5	0.5	0.2	6.3	12.7	Excavation Damage
60	515	2	1.5	0.7	0.8	26.3	26.0	Other Outside Force - Not Specified
35	343	2.375	1	1	0.8	17.7	25.4	Excavation Damage
440	3135	2.375	2.5	0.5	1.0	22.2	28.4	Excavation Damage
60	515	3	3	9.4	22.1	313.3	134.9	Excavation Damage
17	219	4	1.3	1.3	1.3	10.6	33.0	Excavation Damage
30	308	4	6	3	14.1	112.5	107.8	Excavation Damage
35	343	4	2	2	3.1	25.0	50.8	Excavation Damage
35	343	4	3	3	7.1	56.3	76.2	Excavation Damage
57	494	4	5	2	7.9	62.5	80.3	Excavation Damage

MAOP (psig)	MAOP (kPag)	Pipe Diameter (in)	Puncture Axial Length (in)	Puncture Circumferential Length (in)	Approx. Puncture Area (sq.in)	% of Cross-Section Area	Equiv. Hole Diameter (mm)	Cause
60	515	4	24	2	37.7	300.0	176.0	Excavation Damage
60	515	4	9	3	21.2	168.8	132.0	Excavation Damage
60	515	4	0.8	0.8	0.5	4.0	20.3	Excavation Damage
250	1825	4	5	3	11.8	93.8	98.4	Excavation Damage
285	2066	4	0.6	1.3	0.6	4.9	22.4	Excavation Damage
300	2170	4.5	1	12.6	9.9	62.2	90.2	Excavation Damage
10	170	6	6	6	28.3	100.0	152.4	Excavation Damage
35	343	6	3	3	7.1	25.0	76.2	Excavation Damage
60	515	6	6	6	28.3	100.0	152.4	Excavation Damage
60	515	6	6	6	28.3	100.0	152.4	Excavation Damage
60	515	6	6	6	28.3	100.0	152.4	Excavation Damage
60	515	6	0.5	0.5	0.2	0.7	12.7	Other Outside Force - Electrical arcing
150	1136	6	1.5	0.5	0.6	2.1	22.0	Excavation Damage
200	1480	6	1.2	1	0.9	3.3	27.8	Excavation Damage
200	1480	6	2	2	3.1	11.1	50.8	Excavation Damage
300	2170	6	0.5	0.5	0.2	0.7	12.7	Excavation Damage
400	2859	6	4	1	3.1	11.1	50.8	Excavation Damage
500	3549	6	1	0.5	0.4	1.4	18.0	Other Outside Force - Other Vehicle
60	515	6.58	1	1	0.8	2.3	25.4	Other Outside Force - Other Vehicle
300	2170	6.625	3	4	9.4	27.3	88.0	Excavation Damage
50	446	8	2.1	2.1	3.5	6.9	53.3	Excavation Damage
50	446	8	11	4	34.6	68.8	168.5	Excavation Damage
60	515	8	0.1	0.1	0.0	0.0	2.5	Excavation Damage
80	653	8	12	8	75.4	150.0	248.9	Excavation Damage
120	929	8	6.5	2.5	12.8	25.4	102.4	Excavation Damage
157	1184	8	3.9	3.2	9.8	19.5	89.7	Excavation Damage
300	2170	8	4	2	6.3	12.5	71.8	Excavation Damage
400	2859	8	2	6	9.4	18.8	88.0	Excavation Damage
870	6100	8	25.1	25.1	494.8	984.4	637.5	Excavation Damage
0.43	104	8.625	6	6	28.3	48.4	152.4	Excavation Damage
60	515	8.625	1	1	0.8	1.3	25.4	Other Outside Force - Not Specified
250	1825	8.625	1	5	3.9	6.7	56.8	Excavation Damage
15	205	10	5	5	19.6	25.0	127.0	Excavation Damage
50	446	10	1.5	0.5	0.6	0.8	22.0	Excavation Damage
60	515	10	0.3	13	3.1	3.9	50.2	Excavation Damage
60	515	10	1	3	2.4	3.0	44.0	Excavation Damage
150	1136	10	7.5	1.1	6.5	8.3	73.0	Excavation Damage
240	1756	10	2	2	3.1	4.0	50.8	Excavation Damage
82	667	10.75	3	2	4.7	5.2	62.2	Excavation Damage
33	329	12	11	4	34.6	30.6	168.5	Excavation Damage
60	515	12	3	3	7.1	6.3	76.2	Excavation Damage
100	791	12	2.3	2.5	4.5	4.0	60.9	Excavation Damage
100	791	12	3	3	7.1	6.3	76.2	Excavation Damage
225	1653	12	7	6.3	34.6	30.6	168.7	Excavation Damage

MAOP (psig)	MAOP (kPag)	Pipe Diameter (in)	Puncture Axial Length (in)	Puncture Circumferential Length (in)	Approx. Puncture Area (sq.in)	% of Cross-Section Area	Equiv. Hole Diameter (mm)	Cause
0.64	106	12.75	2.5	2.5	4.9	3.8	63.5	Other Outside Force - Not Specified
15	205	12.75	6	6	28.3	22.1	152.4	Excavation Damage
170	1273	14	6	3	14.1	9.2	107.8	Other Outside Force - Other Vehicle
58	501	16	2.5	5	9.8	4.9	89.8	Excavation Damage
188	1398	16	4	4	12.6	6.3	101.6	Excavation Damage
300	2170	16	1.1	3.5	3.0	1.5	49.8	Excavation Damage
150	1136	20	5	1	3.9	1.3	56.8	Excavation Damage
400	2859	26	0.2	0.2	0.0	0.0	5.1	Excavation Damage

B.2 Consequence Analysis Results for Representative Release Scenarios

Hazard ranges for the modelled release cases are tabulated in Sections B.2.1 to B.2.4

B.2.1 Discharge Results

Table 25 Discharge Results

Hole Size	Release rate [kg/s]	Release duration [s]	Release velocity [m/s]	Droplet diameter [um]	Release temperature [°C]	Liquid fraction	Release phase
10mm MID	3.36283	3600	27.8388	12.2374	-88.572	0.526525	Two phase
25mm MID	21.0177	3600	27.896	12.2374	-88.572	0.526525	Two phase
75mm MID	189.159	3600	77.104	12.2374	-88.572	0.526525	Two phase
75mm TOP	189.159	3600	223.95	12.2374	-88.572	0.526525	Two phase
110mm MID	406.902	2191.2	108.958	12.2374	-88.572	0.526525	Two phase
110mm TOP	406.902	2191.2	242.953	12.2374	-88.572	0.526525	Two phase
FBR	262.322	833.6	18.3191	170.88	-88.572	0.431467	Two phase

B.2.2 Flash Fire Consequence Analysis Results

Flash fire consequences are summarised in Table 26 and Table 27.

Table 26 Night Conditions Flash Fire Consequence Results @ 1.5m

Scenario	Weather	Distance to UFL [m]	Distance to LFL [m]
10mm MID	Night 7.4D	0.30	0.494
	Night 4.1D	0.26	0.42
	Night 1.2D	0.24	0.37
	Night 2.6E	0.25	0.37
	Night 1.1F	0.24	0.36
25mm MID	Night 7.4D	0.61	0.94
	Night 4.1D	0.57	0.93
	Night 1.2D	n/a	n/a
	Night 2.6E	0.56	0.85
	Night 1.1F	0.74	1.25
75mm MID	Night 7.4D	0.97	1.41
	Night 4.1D	0.90	1.36
	Night 1.2D	n/a	n/a
	Night 2.6E	0.99	1.46
	Night 1.1F	1.13	1.65
75mm TOP	Night 7.4D	0.45	0.67
	Night 4.1D	0.48	0.64
	Night 1.2D	0.44	0.57
	Night 2.6E	0.40	0.68
	Night 1.1F	0.52	0.68
110mm MID	Night 7.4D	1.10	1.64
	Night 4.1D	1.13	1.60
	Night 1.2D	n/a	n/a

Scenario	Weather	Distance to UFL [m]	Distance to LFL [m]
	Night 2.6E	1.11	1.66
	Night 1.1F	1.18	2.15
110mm TOP	Night 7.4D	0.58	0.88
	Night 4.1D	0.64	0.89
	Night 1.2D	0.55	0.74
	Night 2.6E	0.65	0.73
	Night 1.1F	2.13	2.40
FBR	Night 7.4D	2.52	4.01
	Night 4.1D	2.48	63.92
	Night 1.2D	n/a	563.38
	Night 2.6E	5.45	240.70
	Night 1.1F	n/a	760.34

Table 27 Day Conditions Flash Fire Consequence Results @ 1.5m

Scenario	Weather	Distance to UFL [m]	Distance to LFL [m]
10mm MID	Day 3.0B	0.26	0.41
	Day 7.4D	0.30	0.50
	Day 4.4D	0.27	0.42
	Day 1.8D	0.24	0.38
25mm MID	Day 3.0B	0.58	0.91
	Day 7.4D	0.61	0.94
	Day 4.4D	0.59	0.90
	Day 1.8D	0.57	0.88
75mm MID	Day 3.0B	0.95	1.39

Scenario	Weather	Distance to UFL [m]	Distance to LFL [m]
	Day 7.4D	0.97	1.42
	Day 4.4D	0.98	1.41
	Day 1.8D	0.96	1.42
75mm TOP	Day 3.0B	0.44	0.61
	Day 7.4D	0.45	0.67
	Day 4.4D	0.47	0.58
	Day 1.8D	0.46	0.58
110mm MID	Day 3.0B	1.10	1.59
	Day 7.4D	1.09	1.64
	Day 4.4D	1.05	1.64
	Day 1.8D	1.16	1.46
110mm TOP	Day 3.0B	0.61	0.73
	Day 7.4D	0.57	0.89
	Day 4.4D	0.61	0.76
	Day 1.8D	0.61	0.82
FBR	Day 3.0B	2.63	72.23
	Day 7.4D	2.53	4.00
	Day 4.4D	2.54	3.98
	Day 1.8D	n/a	369.77

B.2.3 Jet Fire Consequence Results

Table 28 Night Conditions Downwind Distance (m) to Varying Heat Radiation Levels @1.5m Height

Scenario	Weather	Flame length [m]	4.7 kW/m²	12.5 kW/m²	23 kW/m²	35 kW/m²
10mm MID	Night 7.4D	15.41	36.23	25.73	20.72	17.31
	Night 4.1D	17.58	35.20	22.91	18.38	14.95
	Night 1.2D	24.04	31.47	15.22	5.16	2.65
	Night 2.6E	20.01	33.06	22.13	15.27	8.73
	Night 1.1F	24.43	30.99	13.94	4.52	2.38
25mm MID	Night 7.4D	33.01	82.83	56.41	43.29	37.15
	Night 4.1D	37.64	80.38	51.97	40.77	32.55
	Night 1.2D	51.49	74.13	38.52	15.18	7.18
	Night 2.6E	42.84	76.98	50.55	35.14	21.98
	Night 1.1F	52.31	73.34	36.39	7.81	6.39
75mm MID	Night 7.4D	75.75	178.05	114.44	90.34	75.09
	Night 4.1D	86.39	179.55	118.08	86.41	62.55
	Night 1.2D	118.17	188.86	95.50	36.47	10.38
	Night 2.6E	98.32	188.00	114.78	72.16	39.31
	Night 1.1F	120.05	187.67	92.35	31.79	11.12
75mm TOP	Night 7.4D	67.38	134.77	88.21	63.25	43.15
	Night 4.1D	76.84	137.00	79.18	42.62	16.32
	Night 1.2D	105.10	148.44	62.16	9.33	3.09
	Night 2.6E	87.45	141.50	72.67	26.48	7.74
	Night 1.1F	106.78	149.42	60.24	8.49	n/a

Scenario	Weather	Flame length [m]	4.7 kW/m²	12.5 kW/m²	23 kW/m²	35 kW/m²
110mm MID	Night 7.4D	100.74	222.99	144.57	112.38	89.27
	Night 4.1D	114.88	223.13	141.19	94.24	58.09
	Night 1.2D	157.14	235.82	110.14	31.67	10.33
	Night 2.6E	130.74	231.47	132.26	72.30	30.33
	Night 1.1F	159.65	236.37	107.93	21.45	9.24
110mm TOP	Night 7.4D	92.08	178.50	114.71	78.51	48.39
	Night 4.1D	105.01	180.59	101.06	49.32	17.48
	Night 1.2D	143.63	195.57	75.88	10.01	n/a
	Night 2.6E	119.51	186.13	91.78	28.40	8.28
	Night 1.1F	145.93	196.98	74.66	8.96	3.56
FBR	Night 7.4D	95.03	216.79	141.10	111.62	93.96
	Night 4.1D	108.37	244.58	158.81	122.43	97.00
	Night 1.2D	148.23	243.25	140.58	77.67	42.14
	Night 2.6E	123.33	246.72	161.30	115.69	82.08
	Night 1.1F	150.60	242.68	137.61	73.24	39.08

Table 29 Day Conditions Downwind Distance (m) to Varying Heat Radiation Levels @1.5m Height

Scenario	Weather	Flame length [m]	4.7 kW/m²	12.5 kW/m²	23 kW/m²	35 kW/m²
10mm MID	Day 3.0B	19.21	33.88	22.57	16.77	11.07
	Day 7.4D	15.41	36.23	25.73	20.72	17.31
	Day 4.4D	17.24	35.47	23.00	18.58	15.52
	Day 1.8D	22.03	32.73	19.97	10.10	4.68
25mm MID	Day 3.0B	41.13	77.65	51.47	37.66	26.13
	Day 7.4D	33.01	82.80	56.39	43.28	37.14

Scenario	Weather	Flame length [m]	4.7 kW/m²	12.5 kW/m²	23 kW/m²	35 kW/m²
	Day 4.4D	36.92	81.03	52.26	41.24	33.62
	Day 1.8D	47.18	76.38	46.64	26.38	12.86
75mm MID	Day 3.0B	94.41	185.95	117.04	77.91	48.31
	Day 7.4D	75.75	177.96	114.40	90.31	75.05
	Day 4.4D	84.74	179.16	117.82	87.53	64.91
	Day 1.8D	108.29	191.60	107.96	56.32	23.58
75mm TOP	Day 3.0B	83.97	140.63	75.19	31.46	9.71
	Day 7.4D	67.38	134.71	88.17	63.21	43.11
	Day 4.4D	75.38	136.63	80.38	45.39	18.63
	Day 1.8D	96.32	144.92	67.04	16.01	4.20
110mm MID	Day 3.0B	125.54	230.34	136.20	79.41	37.82
	Day 7.4D	100.74	222.86	144.50	112.33	89.21
	Day 4.4D	112.70	222.56	142.47	97.65	62.33
	Day 1.8D	144.00	234.49	122.19	49.89	17.89
110mm TOP	Day 3.0B	114.76	185.10	95.37	34.97	10.64
	Day 7.4D	92.08	178.40	114.65	78.45	48.31
	Day 4.4D	103.01	180.27	102.80	54.63	19.82
	Day 1.8D	131.63	190.61	83.92	17.07	5.06
FBR	Day 3.0B	118.43	247.66	163.52	120.89	90.12
	Day 7.4D	95.03	216.69	141.03	111.58	93.92
	Day 4.4D	106.31	241.12	156.03	121.05	96.62
	Day 1.8D	135.84	245.53	153.52	99.41	60.97

B.2.4 Explosion Consequence Analysis Results

Table 30 Night conditions distance (m) to varying overpressures

Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
25mm MID	Night 4.1D	0.07 0.1379 0.2068	22.33 Not reachable Not reachable	36.88 0 0
	Night 1.2D	0.07 0.1379 0.2068	29.89 Not reachable Not reachable	49.94 0 0
	Night 2.6E	0.07 0.1379 0.2068	23.88 Not reachable Not reachable	39.70 0 0
	Night 1.1F	0.07 0.1379 0.2068	29.49 Not reachable Not reachable	49.08 0 0
75mm MID	Night 7.4D	0.07 0.1379 0.2068	45.36 Not reachable Not reachable	74.06 0 0
	Night 4.1D	0.07 0.1379 0.2068	47.41 Not reachable Not reachable	78.51 0 0
	Night 1.2D	0.07 0.1379 0.2068	52.33 Not reachable Not reachable	88.81 0 0
	Night 2.6E	0.07 0.1379 0.2068	50.05 Not reachable Not reachable	82.83 0 0
	Night 1.1F	0.07 0.1379 0.2068	54.04 Not reachable Not reachable	89.93 0 0

Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
75mm TOP	Night 7.4D	0.07 0.1379 0.2068	34.63 Not reachable Not reachable	56.83 0 0
	Night 4.1D	0.07 0.1379 0.2068	32.95 Not reachable Not reachable	55.61 0 0
	Night 1.2D	0.07 0.1379 0.2068	25.17 Not reachable Not reachable	45.16 0 0
	Night 2.6E	0.07 0.1379 0.2068	29.80 Not reachable Not reachable	51.53 0 0
	Night 1.1F	0.07 0.1379 0.2068	30.14 Not reachable Not reachable	52.61 0 0
110mm MID	Night 7.4D	0.07 0.1379 0.2068	63.27 Not reachable Not reachable	102.07 0 0
	Night 4.1D	0.07 0.1379 0.2068	52.85 Not reachable Not reachable	90.40 0 0
	Night 1.2D	0.07 0.1379 0.2068	76.44 Not reachable Not reachable	126.99 0 0
	Night 2.6E	0.07 0.1379 0.2068	56.53 Not reachable Not reachable	96.48 0 0
	Night 1.1F	0.07 0.1379 0.2068	73.00 Not reachable Not reachable	120.38 0 0

Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
110mm TOP	Night 7.4D	0.07 0.1379 0.2068	50.11 Not reachable Not reachable	82.17 0 0
	Night 4.1D	0.07 0.1379 0.2068	49.22 Not reachable Not reachable	82.32 0 0
	Night 1.2D	0.07 0.1379 0.2068	24.02 Not reachable Not reachable	44.67 0 0
	Night 2.6E	0.07 0.1379 0.2068	36.23 Not reachable Not reachable	64.08 0 0
	Night 1.1F	0.07 0.1379 0.2068	83.33 Not reachable Not reachable	121.52 0 0
FBR	Night 7.4D	0.07 0.1379 0.2068	85.77 Not reachable Not reachable	135.30 0 0
	Night 4.1D	0.07 0.1379 0.2068	107.35 Not reachable Not reachable	170.76 0 0
	Night 1.2D	0.07 0.1379 0.2068	489.24 Not reachable Not reachable	452.41 0 0
	Night 2.6E	0.07 0.1379 0.2068	208.58 Not reachable Not reachable	249.83 0 0
	Night 1.1F	0.07 0.1379 0.2068	742.75 Not reachable Not reachable	488.28 0 0

Table 31 Night Conditions Distance (m) to Varying Overpressures

Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
25mm MID	Day 4.4D	0.07 0.1379 0.2068	22.13 Not reachable Not reachable	36.51 0 0
	Day 1.8D	0.07 0.1379 0.2068	25.99 Not reachable Not reachable	43.33 0 0
75mm MID	Day 3.0B	0.07 0.1379 0.2068	31.50 Not reachable Not reachable	56.19 0 0
	Day 7.4D	0.07 0.1379 0.2068	45.53 Not reachable Not reachable	74.27 0 0
	Day 4.4D	0.07 0.1379 0.2068	47.18 Not reachable Not reachable	78.05 0 0
	Day 1.8D	0.07 0.1379 0.2068	53.48 Not reachable Not reachable	89.04 0 0
75mm TOP	Day 3.0B	0.07 0.1379 0.2068	27.00 Not reachable Not reachable	47.30 0 0
	Day 7.4D	0.07 0.1379 0.2068	34.82 Not reachable Not reachable	57.08 0 0
	Day 4.4D	0.07 0.1379 0.2068	33.83 Not reachable Not reachable	56.67 0 0
	Day 1.8D	0.07 0.1379 0.2068	24.26 Not reachable Not reachable	43.48 0 0

Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
110mm MID	Day 3.0B	0.07 0.1379 0.2068	55.97 Not reachable Not reachable	95.42 0 0
	Day 7.4D	0.07 0.1379 0.2068	63.38 Not reachable Not reachable	102.21 0 0
	Day 4.4D	0.07 0.1379 0.2068	67.17 Not reachable Not reachable	109.36 0 0
	Day 1.8D	0.07 0.1379 0.2068	72.51 Not reachable Not reachable	119.85 0 0
110mm TOP	Day 3.0B	0.07 0.1379 0.2068	32.41 Not reachable Not reachable	58.01 0 0
	Day 7.4D	0.07 0.1379 0.2068	50.26 Not reachable Not reachable	82.37 0 0
	Day 4.4D	0.07 0.1379 0.2068	49.014 Not reachable Not reachable	81.92 0 0
	Day 1.8D	0.07 0.1379 0.2068	28.15 Not reachable Not reachable	51.47 0 0
FBR	Day 3.0B	0.07 0.1379 0.2068	96.61 Not reachable Not reachable	162.78 0 0
	Day 7.4D	0.07 0.1379 0.2068	86.23 Not reachable Not reachable	135.93 0 0

Scenario	Weather	Overpressure level [bar]	Maximum distance [m]	Diameter [m]
	Day 4.4D	0.07	105.4	167.14
		0.1379	Not reachable	0
		0.2068	Not reachable	0
	Day 1.8D	0.07	324.74	335.91
		0.1379	Not reachable	0
		0.2068	Not reachable	0

Appendix C Likelihood Analysis - Data and Results

C.1 Likelihood of Release from Underground Pipelines

The likelihood of a release (i.e. leak) from each underground pipeline was estimated based on a review of relevant data sources. The primary data sources included:

- Department of Industry, Resources and Energy, New South Wales, *2017-18 Licensed Pipelines Performance Report*. This includes data for all licensed pipelines in NSW for the 5-year period: 2013/14 to 2017/18; and
- UK Health and Safety Executive (HSE), 2015, *Update of Pipeline Failure Rates for Land Use Planning Assessments*, Research Report (RR) 1035.
- British Standards Institute, 2013, *Pipeline Systems – Part 3: Steel Pipelines on Land – Guide to the Application of Pipeline Risk Assessment to Proposed Developments in the Vicinity of Major Accident Hazard Pipelines Containing Flammables – Supplement to PD 8010-1:2004*, PD 8010-3:2009+A1:2013.
- US Department of Transportation (DoT), Pipeline and Hazardous Materials Safety Administration (PHMSA), Accident Reports - Hazardous Liquid Pipeline Systems (January 2010 to September 2018).

The leak frequency data reported in RR1035 was adopted for the QRA as it is comparable to the NSW performance data and it includes the leak frequency for four hole size categories (pinhole, small hole, large hole and rupture), four failure mode categories (mechanical failure, corrosion, ground movement / other and third party activity), and in some cases for varying pipe diameters and / or wall thicknesses.

The leak frequency data derived from the British Standards Institute PD 8010-3:2009+A1:2013 was not used since the leak rates (other than ruptures) are not clearly defined for all failure modes and the UK HSE does not accept the use of zero frequencies. Also, the rupture frequencies are disproportionally higher than for other hole sizes (unless factored down to account for concrete slab protection), which is not consistent with other data sources.

The leak frequency data reported in RR1035 has been based on:

- An analysis of pipeline failure data from multiple organisations, including:
  - CONCAWE (CONservation of Clean Air and Water in Europe);
  - UKOPA (United Kingdom Onshore Pipeline Operators' Association); and
  - EGIG (European Gas pipeline Incident Group).
- A conservative, yet realistic, analysis of the available data. For example:
  - For failure mode categories where zero failures have occurred, assumptions have been made to estimate the chance of a failure, even if not seen historically (over the observation period).
  - Only the most recent 22 years of historical incident data was analysed to ensure a consistent pipeline population and to remove the older incident data, which may not be as representative of current practice.
  - Incident data for pipelines carrying products at elevated temperatures was excluded from the analysis.

- Although the location of failures (e.g. rural or urban) may be recorded in the various databases, it is recognised that there is insufficient data to estimate the leak frequency for different locations.
- The recommended failure rates for specific materials have been derived from the most appropriate dataset (e.g. for a specific substance the failure rates for corrosion may derived from the CONCAWE products dataset, whilst the mechanical failure rates may be derived from the UKOPA dataset).

NSW Performance Report

The average leak frequency from the 2018 NSW Performance Report for all licensed pipelines in NSW for the 5-year period 2013/14 to 2017/18 is 8.2E-05 per km per year.

UK HSE (RR1035)

The is no leak frequency data specifically for Ethane in RR1035. The data for natural gas (methane), ethylene and LPG (propane and butane) was reviewed. The data for LPG was selected as it is slightly more conservative for the larger leak diameters and is more applicable for a liquefied gas.

The total leak frequency data reported in Section 7.6 of RR1035 for underground LPG pipelines is slightly more conservative (e.g. 2.1E-04 per km per year for a pipeline with wall thickness ≥ 5 mm to < 10 mm) and was adopted in the QRA for the underground HP Ethane pipeline (Refer to Table 32).

Table 32 Leak Frequencies for Underground LPG Pipelines

Failure Mode	Pipeline Diameter (mm)	Wall Thickness (mm)	Leak Frequency (per km per yr)				
			Pinhole (≤ 25 mm)	Small Hole (> 25 mm to ≤ 75 mm)	Large Hole (> 75 mm to ≤ 110 mm)	Rupture (> 110 mm)	Total Leak Frequency
Mechanical Failure	All	All	5.7E-05	1.3E-05	6.7E-06	8.3E-06	8.5E-05
Corrosion	All	< 5	1.6E-04	8.9E-07	4.5E-07	1.3E-06	1.6E-04
		5 to < 10	8.4E-05	2.4E-07	4.8E-07	7.3E-07	8.6E-05
		10 to < 15	4.5E-06	1.3E-08	2.6E-08	3.9E-08	4.6E-06
		≥ 15	4.3E-07	1.2E-09	2.5E-09	3.7E-09	4.4E-07
Ground Movement / Other	All	All	1.2E-05	2.5E-06	1.5E-07	2.5E-06	1.7E-05
TPA	All	All	2.2E-05	2.4E-06	1.0E-07	1.0E-07	2.5E-05
Total Leak Freq. =	All	5 to < 10	1.7E-04	1.8E-05	7.4E-06	1.2E-05	**2.1E-04**
% =			82.4	8.7	3.5	5.5	

British Standards Institute (PD 8010-3:2009+A1:2013)

The data and approach included in Annex B of PD 8010-3:2009+A1:2013 was used to estimate the leak frequencies for the Moomba to Sydney Ethane Pipeline (Refer to Table 33). The data applicable for a pipeline with a wall thickness of 8.1 mm, manufactured after 1980, was used.

Leak frequency data is not reported for internal corrosion; therefore, the total leak frequencies reported in Table 33 may be underestimated.

For leaks or ruptures due to 'Ground Movement / Other', the landslide potential in the study area was assumed to be "low to nil" in accordance with the description in Table B.15 of PD 8010-3:2009+A1:2013.

For leaks (other than ruptures) due to 'Ground Movement / Other', the estimated leak frequency was assumed to be distributed evenly across the other hole sizes (Note: There is no guidance in PD 8010-3:2009+A1:2013 on how to distribute the non-rupture events).

For leaks (other than ruptures) due to 'TPA', the estimated leak frequency was assumed to be distributed across the smaller hole sizes and weighted to the smaller hole size categories (Note: There is no guidance in PD 8010-3:2009+A1:2013 on how to distribute the non-rupture events).

The rupture frequency due to 'TPA' was derived from the generic pipeline failure frequency, which was modified in accordance with the relevant parameters for the Moomba to Sydney Ethane Pipeline (i.e. location, design factor, wall thickness and depth of cover). As this pipeline has concrete slab protection and marker tapes, the base rupture frequency was reduced by a factor of 0.125 (Table A.0, p.31).

Table 33 Approx. Leak Frequencies for Underground Ethane Pipeline

Failure Mode	Approx. Leak Frequency (per km per yr)				
	Pinhole (≤ 25 mm)	Small Hole (> 25 mm to ≤ 75 mm)	Large Hole (> 75 mm to ≤ 110 mm)	Rupture (> 110 mm)	Total Leak Frequency
Mechanical Failure	8.0E-06	3.2E-06	0.0E+00	0.0E+00	1.1E-05
Corrosion	3.2E-05	1.1E-05	3.0E-06	0.0E+00	4.6E-05
Ground Movement / Other	4.9E-07	4.9E-07	4.9E-07	6.6E-08	1.5E-06
TPA	6.1E-06	4.0E-06	2.0E-06	8.1E-06	2.0E-05
Total Leak Freq. =	4.7E-05	1.9E-05	5.5E-06	8.1E-06	**7.9E-05**
% =	59.0	23.7	7.0	10.3	

US Department of Transportation (DoT)

The US Department of Transportation (DoT), Pipeline and Hazardous Materials Safety Administration (PHMSA), Accident Reports - Hazardous Liquid Pipeline Systems (January 2010 to September 2018) include incidents for Ethane pipelines; however, the total length of the Ethane pipelines is not available (i.e. it is not possible to determine the leak rate per km.year).

To enable a comparison with the UK data, the data for all Highly Volatile Liquids (Except Ammonia) was analysed and the leaks categorised using the same representative hole sizes as reported in the UK (i.e. RR1035 and PD8010). The results are reported in Table 34.

.

Period of Recorded Incident Data =	8.75	years	(Jan 2010 to Sept 2018)
Total Length of All HVL Pipelines =	102663	km	Note: Average for 2010 to 2017 for ALL HVLs

Table 34 Leak Frequencies for Underground HVL Pipelines (Excluding Ammonia)

Failure Mode	Approx. Leak Frequency (per km per yr)					Comments
	Pinhole (≤ 25 mm)	Small Hole (> 25 mm to ≤ 75 mm)	Large Hole (> 75 mm to ≤ 110 mm)	Rupture (> 110 mm)	Total Leak Frequency	
Mechanical Failure	3.9E-05	0.0E+00	0.0E+00	0.0E+00	3.9E-05	Excludes pipelines manufactured prior to 1980.
Corrosion	5.6E-06	0.0E+00	0.0E+00	1.1E-06	6.7E-06	Excludes external corrosion (other than SCC).
Ground Movement / Other	5.6E-06	2.2E-06	1.1E-06	5.6E-06	1.4E-05	
TPA	8.9E-06	6.7E-06	2.2E-06	8.9E-06	2.7E-05	
Total Leak Freq. =	5.9E-05	8.9E-06	3.3E-06	1.6E-05	**8.7E-05**	
% =	67.9	10.3	3.8	17.9		

C.2 Ignition Probability

The ignition probabilities adopted in the risk analysis are listed below. This was based on a review of relevant ignition probability data and ignition probability correlations (Refer to Sections C.2.1 - C.2.3).

Ethane

1. The total ignition probability was based on OGP Scenario 3, which is release rate dependent (Refer to Section C.2.1).

   No historical ignition data was identified for ethane pipelines; however, it is typically grouped with other liquefied gases such as propane.

2. The total ignition probability was split 50:50 for immediate ignition: delayed ignition.

   The OGP data assumes an immediate ignition probability of 0.001. A 50:50 split was assumed for the QRA.

Ignition data is usually reported by hole size rather than failure mode and inconsistent reporting of immediate ignition due to TPA (which is sometimes reported to be the highest immediate ignition probability and sometimes not) means it was not possible to estimate the immediate ignition probability based on failure mode.

C.2.1 Ignition Probability Data for Above Ground or Underground Cross-Country Pipelines – Various Materials

United Kingdom Onshore Pipeline Operators' Association (UKOPA), Major Accident Hazard Pipelines (1962-2014)

The definition of a Major Accident Hazard Pipeline (MAHP) from the Pipelines Safety Regulations 1996 (PSR 96) includes various materials (e.g. including natural gas at >8 bar, flammable liquids, etc.). The pipeline may be above or below ground.

There were 9 out of 192 (4.7%) product loss incidents that resulted in ignition.

Table 35 Ignition Probability - UKOPA

Hole Size Class #	Total Number of Incidents	Number of Incidents with Ignition	Total Ignition Probability	Total Ignition Probability
Full Bore and Above	7	1	0.14	0.09
110mm – Full Bore	4	0	0.0	
40mm – 110mm	7	1	0.14	0.03
20mm – 40mm	23	0	0.0	
6mm – 20mm	31	3	0.10	0.05
0 – 6mm	118	4	0.03	
Unknown	2	0	0.0	0.0
Total =	192	9	0.047	0.047

OGP, Ignition Probabilities for Pipe-Gas-LPG-Industrial (Scenario 3: Gas or LPG release from onshore pipeline in an industrial or urban area)

The following data applies for releases of flammable gases, vapours or liquids significantly above their normal (Normal Atmospheric Pressure (NAP)) boiling point from onshore cross-country pipelines running through industrial or urban areas.

The OGP Data applies for cross-country pipelines. Although not explicitly stated, it is assumed the pipeline may be above ground or underground.

These curves represent "total" ignition probability. The method assumes that the immediate ignition probability is 0.001 and is independent of the release rate.

Table 36 Ignition Probability – OGP Scenario 3

Release Rate (kg/s)	Total Ignition Probability
0.1	0.0010
0.2	0.0017
0.5	0.0033
1	0.0056
2	0.0095
5	0.0188
10	0.0316
20	0.0532
50	0.1057
100	0.1778
200	0.2991
500	0.5946
1000	1.0000

C.2.2 Ignition Probability Data for Underground Cross-Country Pipelines – Flammable or Combustible Liquids

US Department of Transportation (DoT), Pipeline and Hazardous Materials Safety Administration (PHMSA), Accident Reports - Hazardous Liquid Pipeline Systems (January 2010 to September 2018)

Reporting of data is required by 49 CFR Part 195. An accident report is required for each failure in a pipeline system subject to this part in which there is a release of the hazardous liquid or carbon dioxide transported resulting in any of the following:

(a) Explosion or fire not intentionally set by the operator.

(b) Release of 5 gallons (19 litres) or more of hazardous liquid or carbon dioxide, except that no report is required for a release of less than 5 barrels (0.8 cubic meters) resulting from a pipeline maintenance activity if the release is:

(1) Not otherwise reportable under this section;

(2) Not one described in §195.52(a)(4);

(3) Confined to company property or pipeline right-of-way; and

(4) Cleaned up promptly;

(c) Death of any person;

(d) Personal injury necessitating hospitalisation;

(e) Estimated property damage, including cost of clean-up and recovery, value of lost product, and damage to the property of the operator or others, or both, exceeding $50,000.

Table 37 Ignition Probability – US DoT

Liquid	Leak			Mechanical Puncture			Other			Rupture			Total		
	# with Ignition	# with no ignition	Prob. of Ignition	# with Ignition	# with no ignition	Prob. of Ignition	# with Ignition	# with no ignition	Prob. of Ignition	# with Ignition	# with no ignition	Prob. of Ignition	# with Ignition	# with no ignition	Prob. of Ignition
HVLs *	0	46	0.0	0	7	0.0	4	2	0.7	5	5	0.5	9	60	0.13

* Highly Volatile Liquids (Includes Ethane).

C.2.3 Ignition Probability Data for Underground Cross-Country Pipelines – Gases Other Than Natural Gas

UK HSE (RR 1034) - Typical Event Tree Probabilities for Flammable Gas other than Natural Gas

The following data is proposed in RR 1034 for the HSE's computer program MISHAP to calculate the level of risk around Major Accident Hazard Pipelines (MAHPs), particularly in land use planning (LUP) assessments. A MAHP may be above or below ground; however, the MISHAP model appears to be primarily for underground pipelines. The probabilities are not reported for varying hole sizes and appear to be only applicable for larger release events.

For MISHAP, the risk associated with VCE events is negligible because the development of MISHAP (and its predecessors) was based on areas with low congestion and confinement (e.g. rural pipelines), which are not conducive for creating the large flammable clouds required by VCE. It is acknowledged in RR 1034 that this may require further review.

Table 38 Ignition Probability – UK HSE (RR 1034)

Outcome	Probability of Outcome		
	R12 Materials with a MIE < 0.2 mJ (1)	R12 Materials with a MIE ≥ 0.2 mJ (2)	R11 and Low Reactive Materials (3)
Immediate ignition, fireball and jet fire	0.350	0.300	0.250
Delayed ignition and jet fire	0.325	0.210	0.188
Delayed ignition, flash fire and jet fire	0.096	0.145	0.167
No ignition	0.229	0.345	0.396

(1) For example: ethylene

(2) For example: butane, ethane and propane

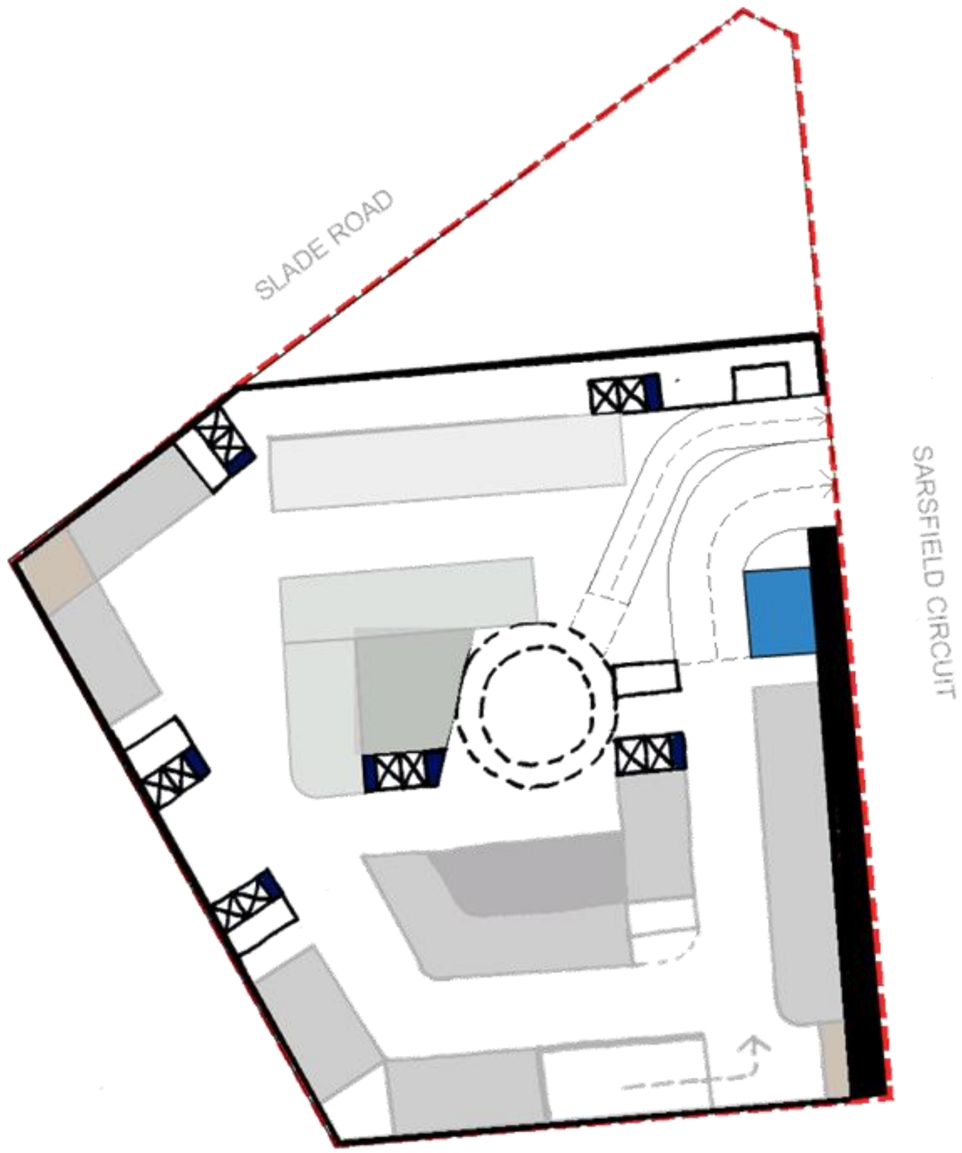
(3) For example: ammonia, carbon monoxide

C.3 Likelihood of Representative Release Scenarios

The estimated likelihood of each representative release scenario is listed in Table 43.

Table 39 Release Frequency – Ethane Pipeline (MSE)

Leak Scenario	Release Frequency (per km per year)			Probability of scenario compared to total
	TPA	All Other Failure Modes	Total Release Frequency	
10mm MID		1.53E-04	1.53E-04	0.7200
10mm TOP		0.00E+00	0.00E+00	0.0000
25mm MID	2.20E-05		2.20E-05	0.1036
25mm TOP	0.00E+00		0.00E+00	0.0000
75mm MID	2.40E-06	5.94E-06	8.34E-06	0.0393
75mm TOP	0.00E+00	1.01E-05	1.01E-05	0.0476
110mm MID	1.00E-07	2.70E-06	2.80E-06	0.0132
110mm TOP	0.00E+00	4.60E-06	4.60E-06	0.0217
FBR	1.00E-07	1.15E-05	1.16E-05	0.0547
Total	2.46E-05	1.88E-04	**2.124E-04**	1.0000



KEY

- Site boundary
- Services
- Parking
- Storage areas
- Deep soil
- Waste rooms

Basement Level 01

Approximately 58-62 car spaces**

** Pending accessible spaces

18054 - PP - Bexley North - 187 Slade Road

Concept plans (to scale)

Prepared for: TUNBORN PTY LTD

SK-001
Revision:B by DR
Issued on 22 July 2020

SCALE: 1:500 @ A3*

0 5 10 15 20 25m

*Please note subject any printing margins

Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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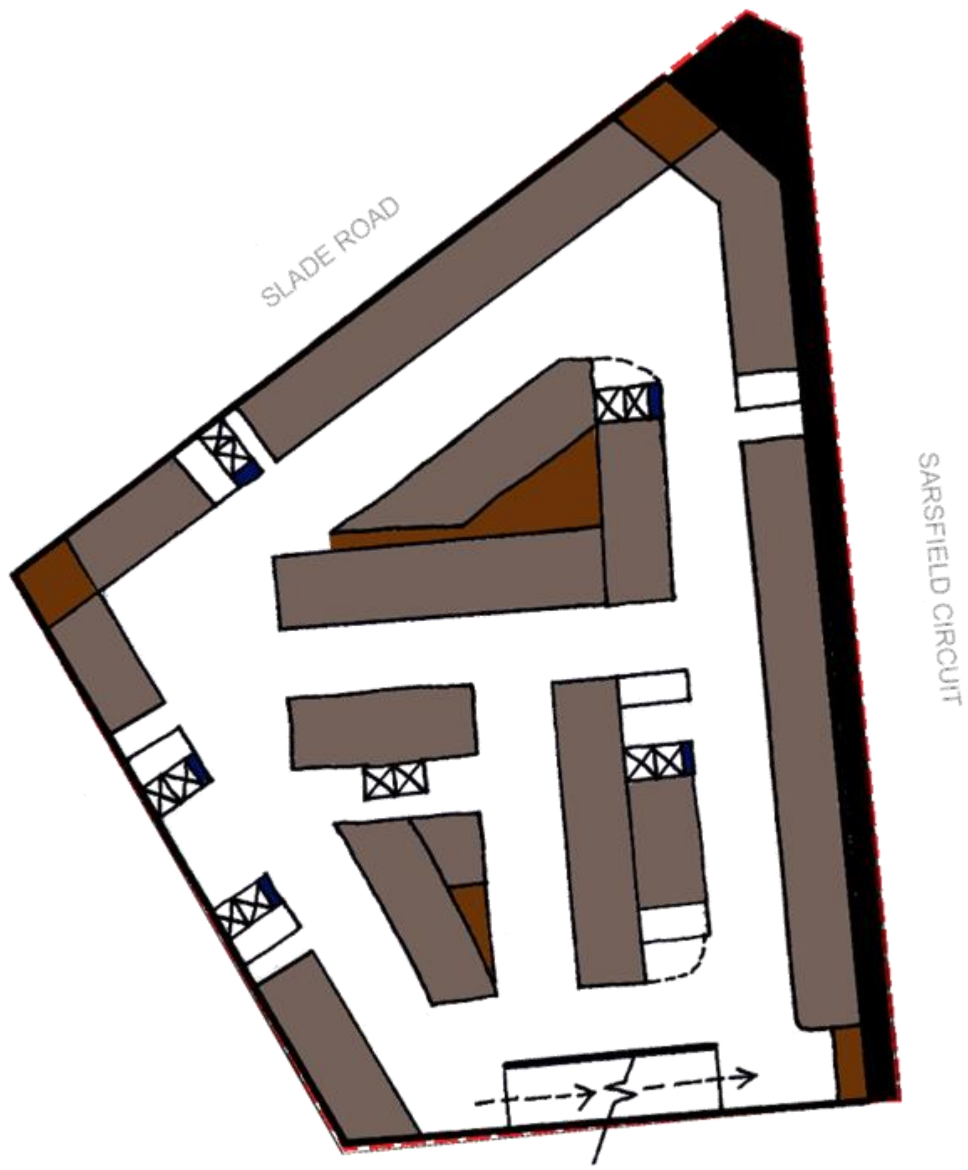

KEY
- Site boundary
- Services
- Parking
- Storage areas
- Deep soil

Basement Level 02

Approximately 108-110car spaces**

** Pending accessible spaces

18054 - PP - Bexley North - 187 Slade Road

Concept plans (to scale)

Prepared for: TUNBORN PTY LTD

SK-002
Revision:A by DR
Issued on 25 March 2020

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North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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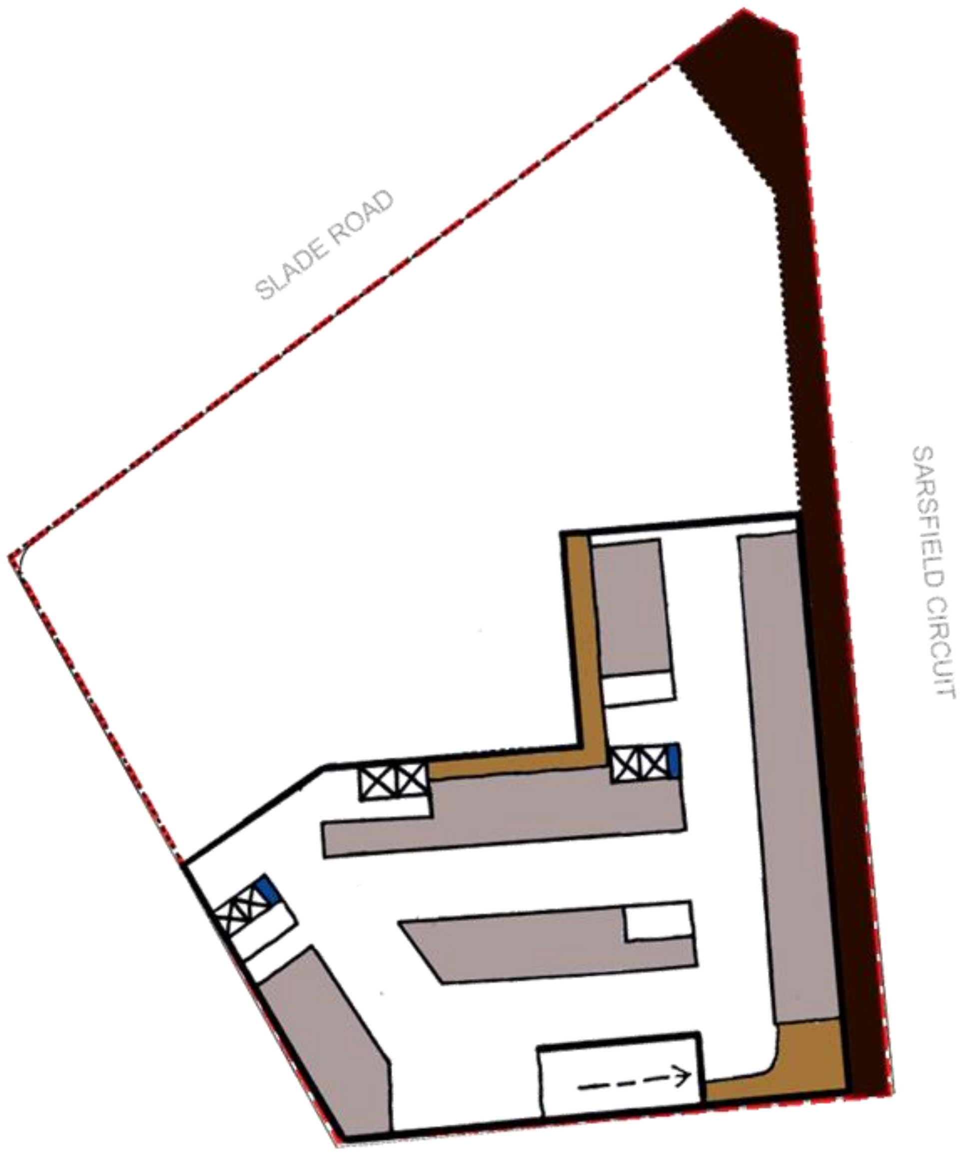

KEY
- Site boundary
- Services
- Parking
- Storage areas
- Deep soil

Basement Level 03

Approximately 40-42 car spaces**

** Pending accessible spaces

18054 - PP - Bexley North - 187 Slade Road

Concept plans (to scale)

Prepared for: TUNBORN PTY LTD

SK-003
Revision: A by DR
Issued on 25 March 2020

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Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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KEY
Footpath
Site boundary
Residential entry lobby
Pub
Hotel entry lobby
Services
Retail
Substation
Landscape buffer
Outdoor deck

Ground Level

**Subject to loading at basement

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-004
Revision:B by DR
Issued on 14 July 2020

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Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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KEY
Site boundary
1 bedroom unit
2 bedroom unit
3 bedroom unit
Services
Pub
Gym
Substation
Landscape buffer

Level 01

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-005
Revision: A by DR
Issued on 25 March 2020

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Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

GMU Urban Design & Architecture

KEY
- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services
- Green roof - Non trafficable
- Hotel rooms

Levels 02 - 03

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-006
Revision: A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*
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Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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KEY
- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services
- Green roof - Non trafficable
- Hotel rooms

Level 04

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-007
Revision: A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*
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Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

KEY
- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services
- Rooftop COS
- Green roof - Non trafficable
- Hotel rooms

Level 05

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-008
Revision:A by DR
Issued on 25 March 2020

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Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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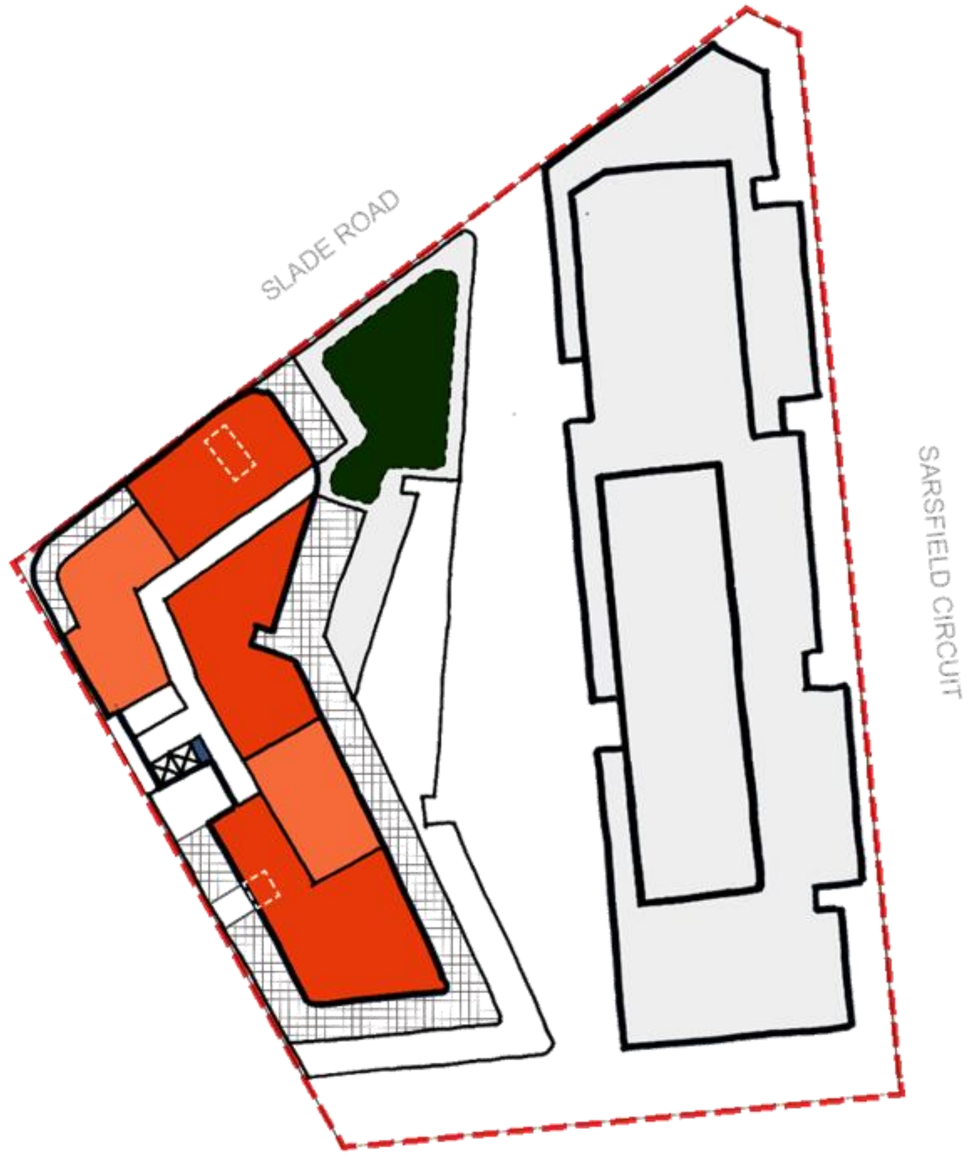

KEY
- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services
- Rooftop COS

Level 06

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
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SK-009
Revision: A by DR
Issued on 25 March 2020

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Tel (02) 8920 8388
Web www.gmu.com.au

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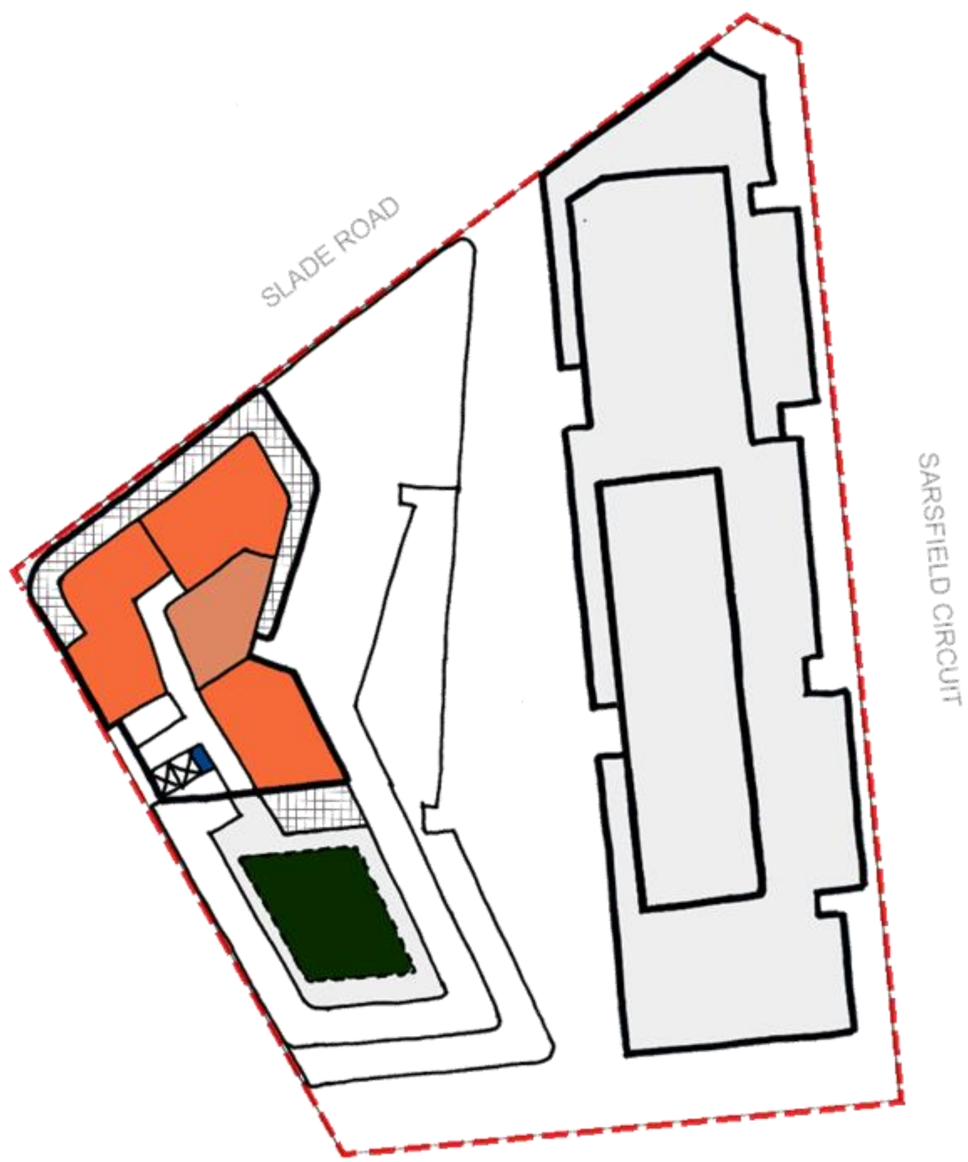

KEY

- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services
- Rooftop COS

Level 07

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
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SK-010
Revision: A by DR
Issued on 25 March 2020

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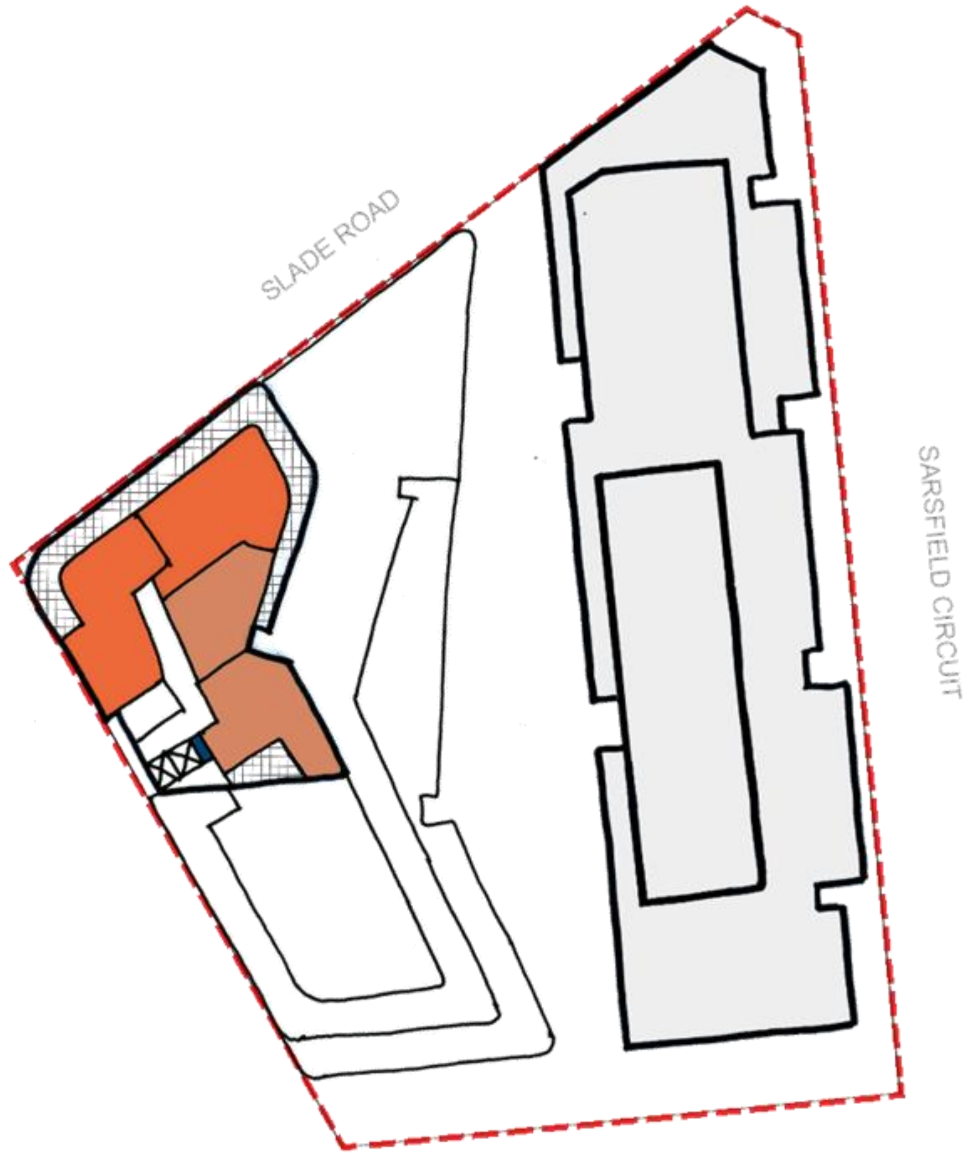

KEY

- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services

Level 08

18054 - PP - Bexley North - 187 Slade Road

Concept plans (to scale)

Prepared for: TUNBORN PTY LTD

SK-011

Revision: A by DR

Issued on 25 March 2020

SCALE: 1:500 @ A3*

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North Sydney NSW 2060
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Web www.gmu.com.au

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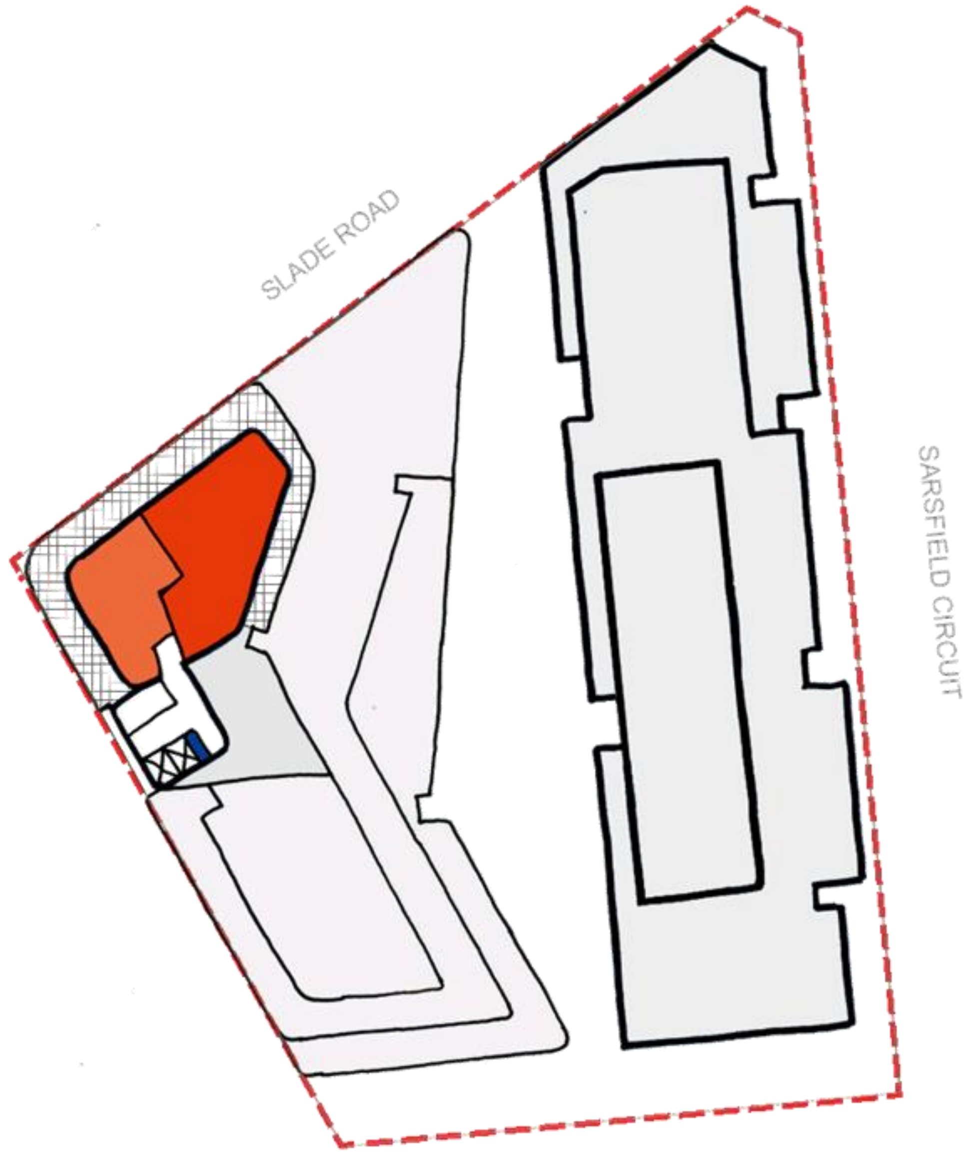

KEY

- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services

Level 09

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-012
Revision: A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*
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North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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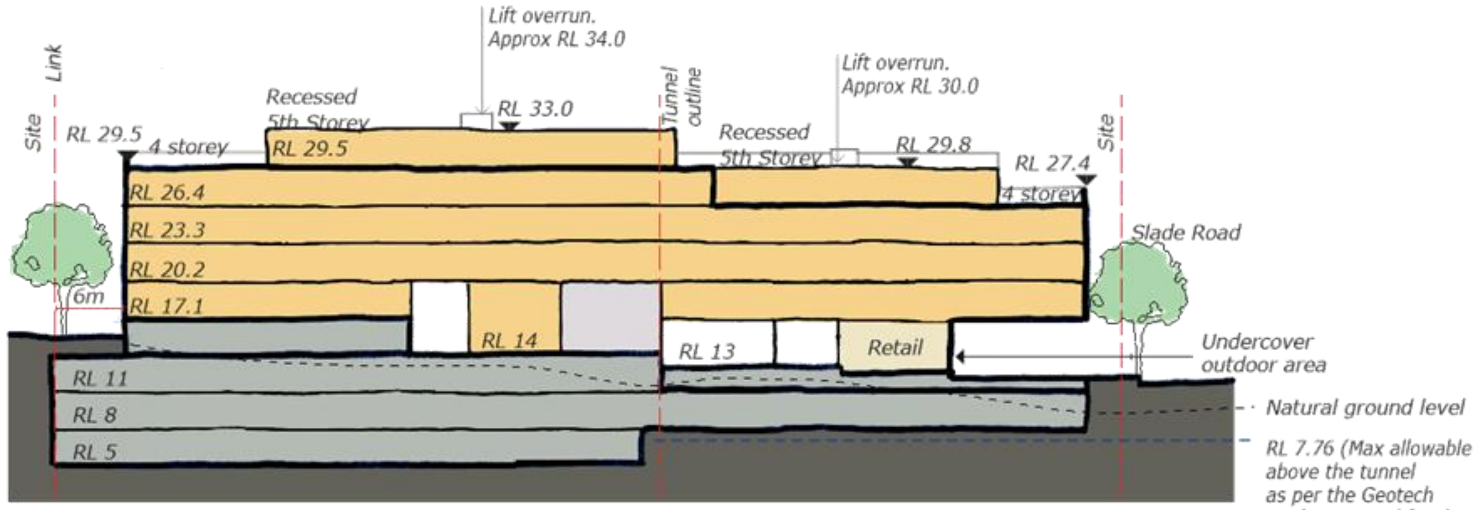
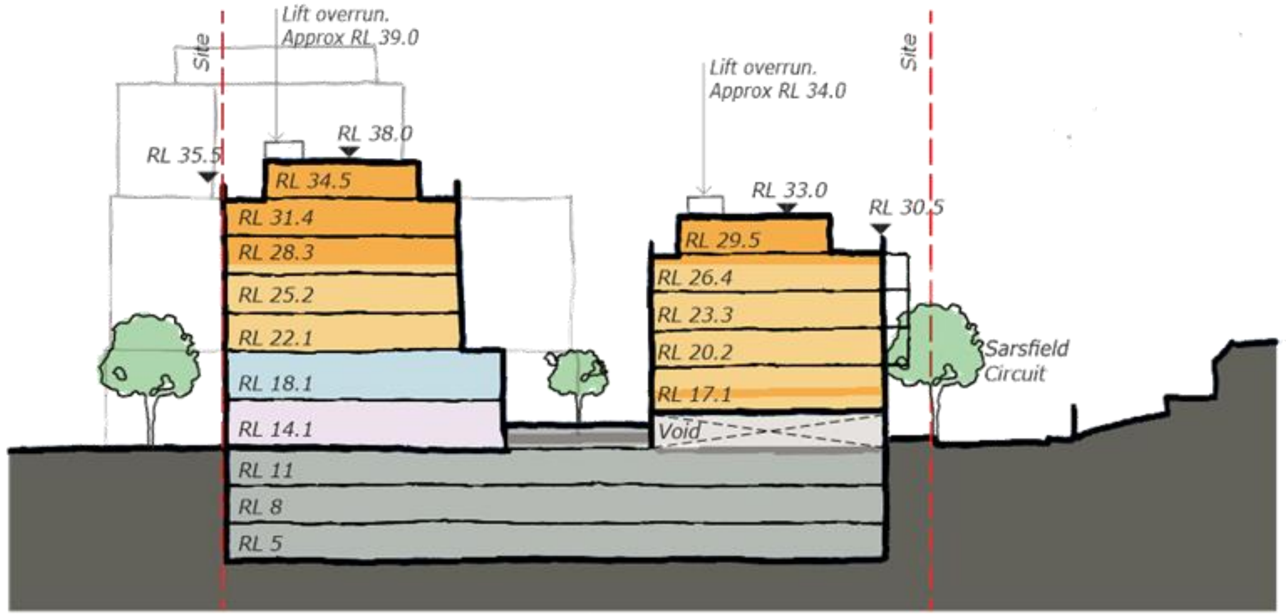


INDICATIVE SECTION a-a



INDICATIVE SECTION b-b

KEY

- Flood mitigation
- Residential
- Gym
- Pub
- Cafe
- Substation
- Basement

18054 - PP - Bexley North - 187 Slade Road

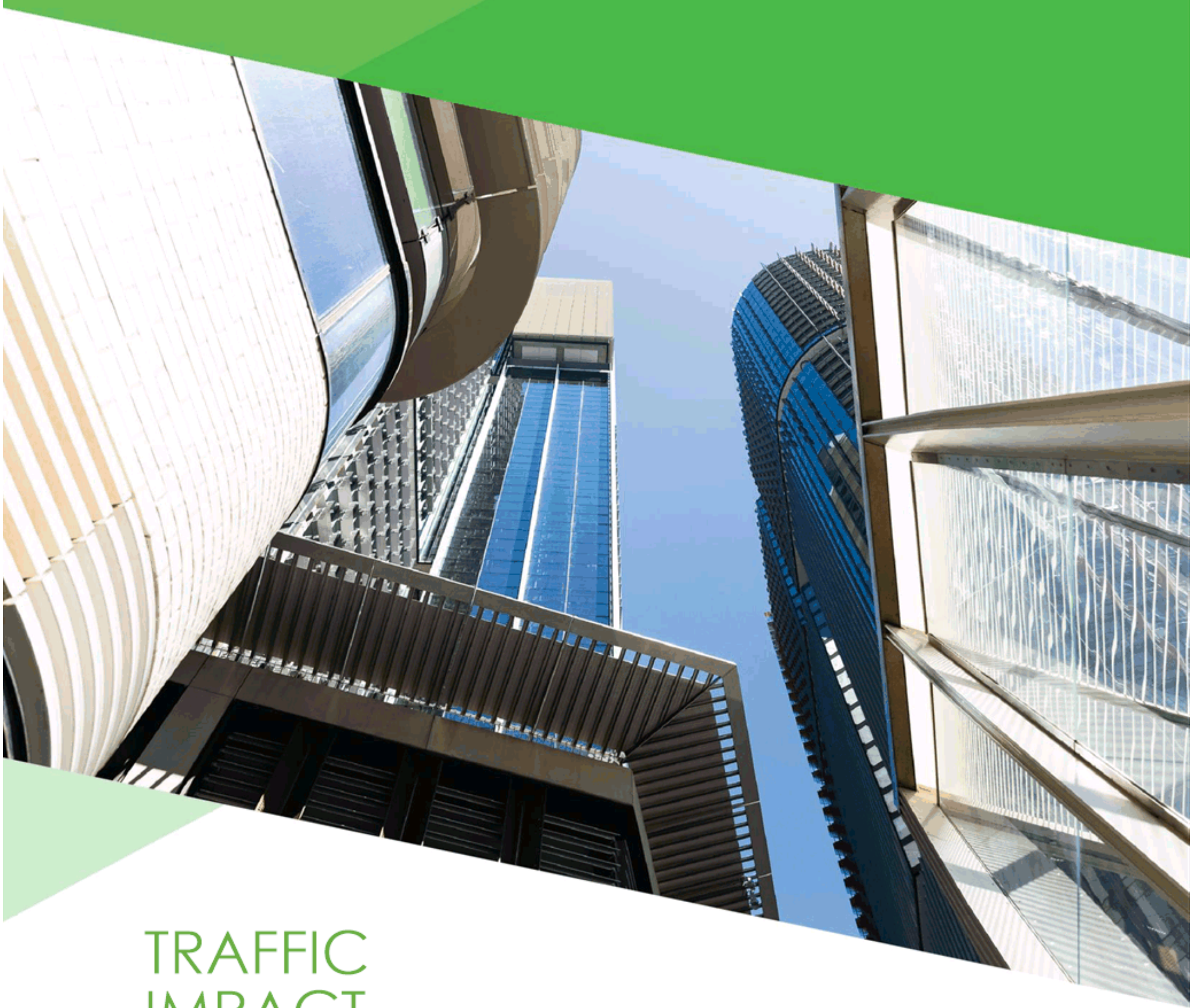
Indicative sectional studies

Prepared for: TUNBORN PTY LTD

Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

GMU Urban Design & Architecture



TRAFFIC IMPACT ASSESSMENT

Planning Proposal – Mixed-Use Development
187 Slade Road, Bexley North

Reference: 17.091r02v03
Date: August 2020

TRAFFIX
TRAFFIC & TRANSPORT PLANNERS
Suite 2.08, 50 Holt St
Surry Hills, NSW 2010
t: (02) 8324 8700
w: www.traffix.com.au

DOCUMENT VERIFICATION

Job Number	17.091			
Project	187 Slade Road, Bexley North			
Client	Bexley North Hotel			
Revision	Date	Prepared By	Checked By	Signed
v03	17/08/2020	Shenara Wanigasekera	Ben Liddell	

CONTENTS

1. INTRODUCTION

TRAFFIX has been commissioned by Bexley North Hotel to undertake a traffic impact assessment (TIA) in support of a planning proposal relating to a proposed mixed-use development on this site located at 187 Slade Road, Bexley North. It is proposed to vary the floor space ratio and building height controls for the site under the Rockdale Local Environmental Plan 2011. This site is commonly known as the Bexley North Hotel and is located within the amalgamated Bayside Council Local Government Area (LGA), formerly Rockdale City Council and has been assessed under that council's controls.

A two (2) stage concept scheme has been prepared by GMU Urban Design & Architecture, consisting of residential apartments, hotel rooms, retail, a hotel (pub), gym and café. This report assesses the traffic impacts and parking requirements arising from this scheme, which is considered to be representative of the site being developed to its full potential when incorporating the proposed planning controls.

This report documents the findings of our investigations and should be read in the context of the Statement of Environmental Effects (SEE) prepared separately. The proposed access is located over 90 metres to a classified road and therefore does not require referral to the RMS under the provisions of State Environmental Planning Policy (SEPP) (Infrastructure) 2007.

The report is structured as follows:

- Section 2: Describes the site and its location
- Section 3: Documents existing traffic conditions
- Section 4: Describes the proposed development
- Section 5: Assesses the parking requirements
- Section 6: Assesses traffic impacts
- Section 7: Discusses access and internal design aspects
- Section 8: Presents the overall study conclusions.

2. LOCATION AND SITE

The subject site at 187 Slade Road, Bexley North is legally known as Lot 1 in DP31941. It is situated on the north-eastern corner at the intersection of Slade Road and Sarsfield Circuit. In a regional context, it is approximately 160 metres south-east of Bexley North Railway and approximately 12 kilometres south-west of the Sydney central business district (CBD).

The site has an irregular configuration with a total site area of 4,236m^2. It has an eastern frontage of approximately 87 metres to Sarsfield Circuit and a northern site frontage of approximately 75 metres to Slade Road. The site is bound by a neighbouring council carpark (Bexley North Carpark) to the west that measures 55 metres and has an irregular southern boundary to a residential flat building (22-24 Sarsfield Circuit, Bexley North) of approximately 46 metres.

The site currently has four (4) vehicular access driveways servicing the hotel and associated accommodation. Two (2) vehicular driveways are located at the rear of the site on Sarsfield Circuit and two (2) driveways are located on Slade Road which provide access to the on-site drive-through liquor store.

A Location Plan is presented in Error! Reference source not found., with a Site Plan presented in **Figure 2**. Reference should also be made to the Photographic Record presented in **Appendix A** which provides an appreciation of the site and surrounding road network.

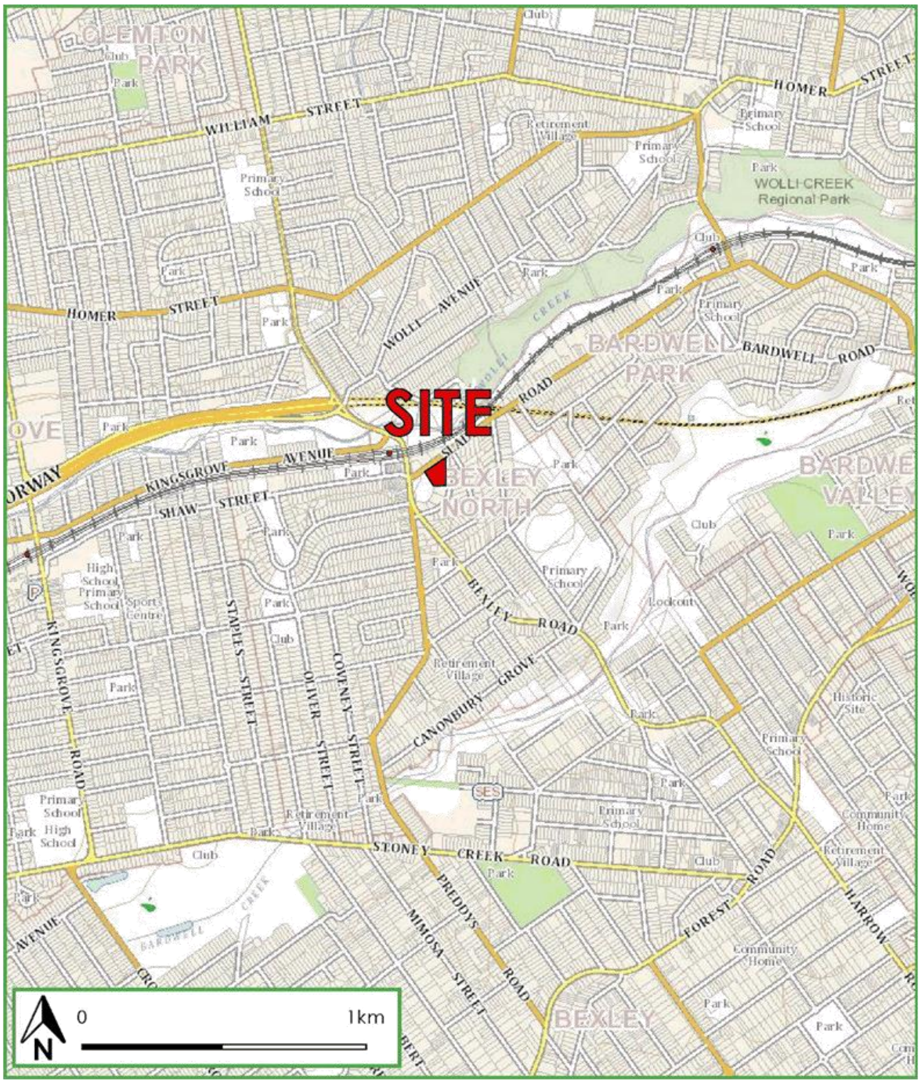


Figure 1: Location Plan

17.091r02v03 TRAFFIX Planning Proposal,187 Slade Road, Bexley North 3

Figure 2: Site Plan

3. EXISTING TRAFFIC CONDITIONS

3.1 Road Network

The road hierarchy in the vicinity of the site is shown in **Figure 3** with the following roads of particular interest:

- Bexley Road: an RMS classified State Road (MR 169) that generally runs in a north-south direction between Canterbury Road in the north and Forest Road in the south. It carries approximately 34,200 vpd in the vicinity of the site and is generally subject to 60km/h speed zoning. Bexley Road carries two (2) lanes of traffic in both directions within a divided carriageway.
- Slade Road: an unclassified regional road (7030) that runs in an east-west direction between Darley Road in the east and Bexley Road in the west. Slade Road is subject to a 50km/h speed zoning, accommodates a single traffic lane in either direction and permits unrestricted kerbside parking along both sides.
- Sarsfield Circuit: a local road that runs in a north-south direction between Slade Road in the north and Bexley Road in the south. Sarsfield Circuit is subject to a 50km/h speed zoning and unrestricted kerbside parking is permitted on the western side of the road only; whilst the eastern side is subject to 'No Parking' restrictions. In addition, the intersection of Bexley Road and Sarsfield Circuit is restricted to a left-in/left-out arrangement.

It can be seen from **Figure 3** that the site is conveniently located with respect to the arterial and local road systems serving the region with connections to the north and south (via Bexley Road) using Slade Road and Sarsfield Circuit. It is therefore able to effectively distribute traffic onto the wider road network, minimising traffic impacts particularly on local roads.

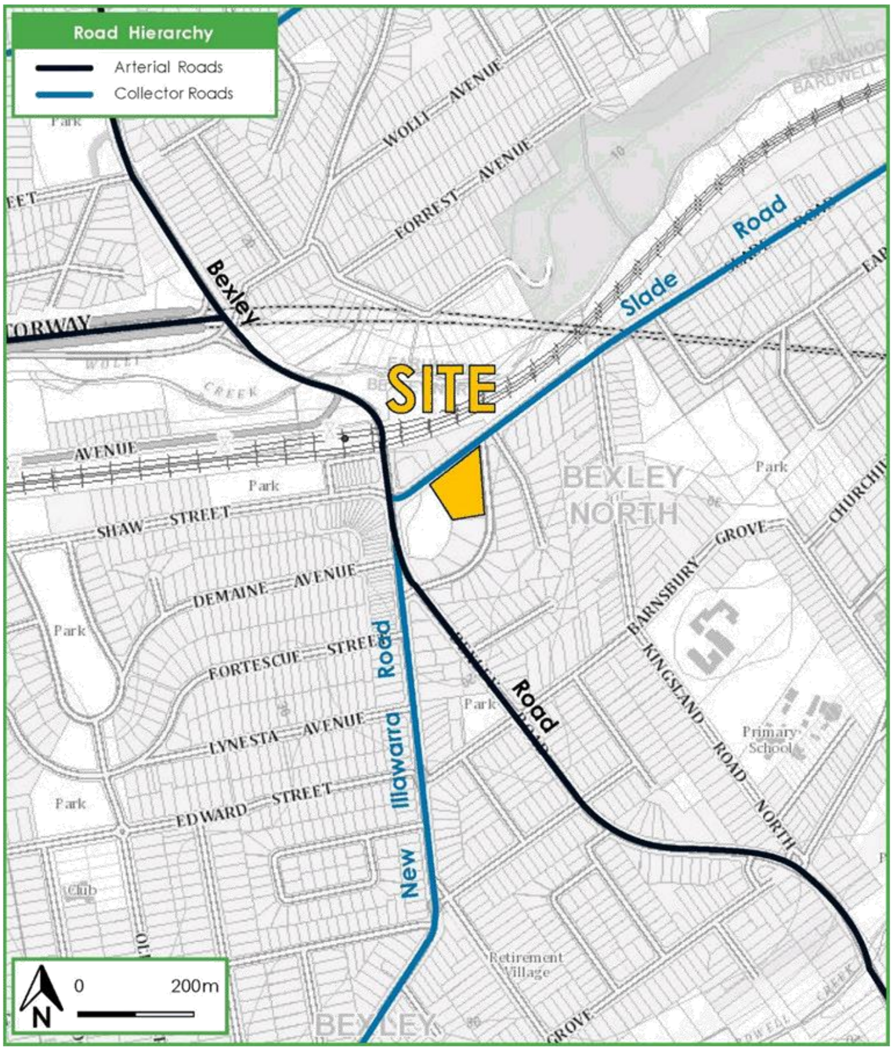


Figure 3: Road Hierarchy

3.2 Public Transport

The existing rail and bus services that operate in the locality are shown in **Figure 4**. It is evident that the site is highly accessible public transport services, notably to rail being located within 160 metre walking distance (3-minute walk) to Bexley North Railway Station. This station provides services on the T8 line, connecting the site to major attractors such as the domestic and international airports, Central Station, Wolli Creek, Campbelltown and the wider rail network.

In additional there are multiple bus stops within 400m of the subject site, notably on Slade Road and Bexley Road, that are serviced by bus routes (M40, 446, 400, 491 and 493) providing connections to urban centres such as Rockdale, Drummoyne, Roselands, Kogarah, Five Dock, Hurstville, Burwood and Bondi Junction.

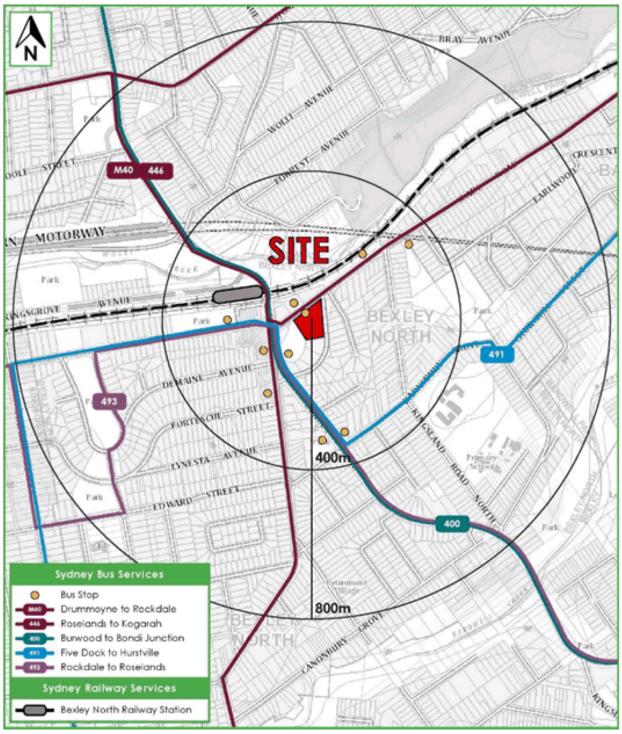


Figure 4: Public Transport

3.3 Pedestrian Access

There are a number of key pedestrian activity generators in the vicinity of the site including Bexley North Railway Station and the Bexley mixed use area located along Bexley Road, Shaw Street and New Illawarra Road. A number of pedestrian facilities enable these movements as discussed below.

3.3.1 Bexley North Railway Station

Bexley Road and Slade Road link the subject site and the Railway Station, providing a pedestrian footpath along either side of the road. The signalised intersection of Bexley Road, Shaw Street and Slade Road provides a signalised pedestrian crossing on all legs of the intersection.

3.3.2 Mixed Use Zone

The roads within the vicinity of the mixed use area including Bexley Road, Shaw Street, New Illawarra Road and Slade Street all provide pedestrian footpaths along either side of the road with the signalised intersection at Bexley Road, Shaw Street and Slade Road providing a signalised pedestrian crossing on all legs.

As such, these pedestrian routes allow for safe and convenient access to key pedestrian activity centres.

3.4 Key Intersections

Three (3) key intersections have been identified in the vicinity of the site. These intersections are located at the junction of main thoroughfares that will be utilised by users associated with the future development.

3.4.1 Bexley Road, Slade Road and Shaw Street

Figure 5: Intersection of Bexley Road and Slade Road (Source: NearMap)

It can be seen from **Figure 5** that the intersection of Slade Road and Bexley Road is a signalised intersection with all approaches providing signalised pedestrian crossings. The main attributes of each approach are outlined below:

Bexley Road (north and south legs)

- The northbound approach provides two (2) through lanes with the left lane permitting left turns onto Slade Road and the right lane permitting right turns onto Slade Road.
- The southbound approach provides two (2) through lanes with the left lane permitting left turns onto Slade Road. No right turn is permitted from the northbound direction on Bexley Road onto Slade Road.

- Slade Road
  - The westbound approach provides two (2) through lanes with left turns onto Bexley Road permitted from the left lane and right turns onto Bexley Road permitted from the right lane.

- Shaw Street
  - The eastbound approach provides two (2) through lanes with left turns onto Bexley Road permitted from the left lane and right turns onto Bexley Road permitted from the right lane.

3.4.2 Bexley Road and Sarsfield Circuit

Figure 6: Intersection of Bexley Road and Sarsfield Circuit (Source: NearMap)

It can be seen from **Figure 6** that the intersection of Bexley Road and Sarsfield Circuit is a three-legged T-intersection. The intersection is priority-controlled with Sarsfield Circuit the minor leg. The main attributes of each approach are outlined below:

- Bexley Road (north and south legs)
  - The northbound approach provides two (2) through lanes. Right turns onto Sarsfield Circuit are not permitted.
  - The southbound approach provides two (2) through lane with left turns onto Sarsfield Circuit permitted from the left lane.
- Sarsfield Circuit

- The westbound approach provides a single lane and permits left turns onto Bexley Road. Right turns onto Bexley Road are not permitted.

3.4.3 Slade Road and Sarsfield Circuit

Figure 7: Intersection of Slade Road and Sarsfield Circuit (Source: NearMap)

It can be seen from **Figure 7** that the intersection of Slade Road and Sarsfield Circuit is a three-legged T-intersection. The intersection is priority-controlled with Sarsfield Circuit being the minor leg. The main attributes of each approach are outlined below:

- Sarsfield Circuit
  - The northbound approach provides a single through lane and permits left and right turns onto Slade Road.
- Slade Road (east and west legs)
  - The eastbound approach provides a single lane and permits left and right turns onto Sarsfield Circuit.
  - The westbound approach provides a single lane and permits left and right turns onto Sarsfield Circuit.

4. DESCRIPTION OF PROPOSED DEVELOPMENT

A detailed description of the proposed development is provided in the Planning Report prepared separately. In summary, approval is sort to change the current floor space ratio and building height controls of the site.

For the purpose of assessment, a concept development scheme for a two (2) staged mixed-use development has been prepared, which is representative of the full development potential of the site under the planning proposal. The concept development comprises the following:

- 83 residential apartments comprising the following:
  - 24 x one-bedroom apartments
  - 38 x two-bedroom apartments; and
  - 21 x three-bedroom apartments.
- 2,656m² of hotel GFA (60 rooms);
- 2,060m² of pub GFA;
- 287m² of retail GFA;
- 297m² of gym GFA;
- 160m² of café GFA; and
- Three (3) basement levels accommodating approximately 214 parking spaces.

The parking and traffic impacts arising from the development are discussed in **Section 5** and **Section 6**. Reference should be made to the plans submitted separately to Council which are presented at reduced scale in **Appendix B**.

5. PARKING REQUIREMENTS

5.1 Car Parking

5.1.1 Residential – Council Controls

The Rockdale Council Development Control Plan (DCP) 2011, Part 4.6 Car Parking, Access and Movement requires high density residential developments to provide car parking in accordance with **Table 1** below:

Table 1: Council Parking Rates

Type	Units	Minimum Parking Rate	Minimum Spaces Required
1 Bed	24	1.0 spaces per unit	24
2 Bed	38	1.0 spaces per unit	38
3+ Bed	21	2.0 spaces per unit	42
Residential Visitor	83	1.0 space per 5 units	17
Total			**121**

5.1.2 Residential - SEPP 65 Controls

The SEPP 65 Apartment Design Guide provides parking requirements for high density apartment developments within accessible locations (defined as being located within 800 metres of a railway station). SEPP 65 permits the use of the parking rates provided in the Roads and Maritimes Services Guide to Traffic Generating Developments (RMSGTGD) for high density residential developments within 'metropolitan sub-regional centres'. RMSGTGD parking requirements are outlined in the **Table 2** below:

Table 2: Roads and Maritime Services (SEPP 65) Parking Rates

Type	Units	Minimum Parking Rate	Minimum Spaces Required
1 Bed	24	0.6 spaces per unit	14
2 Bed	38	0.9 spaces per unit	34
3+ Bed	21	1.4 spaces per unit	29
Residential Visitor	83	1.0 space per 5-7 units	17
Total			**94**

It can be seen from **Table 1** and **Table 2** that the proposed development is required to provide a minimum of 94 residential parking spaces, being the lesser of the DCP and RMS guide requirements, in accordance with SEPP 65.

5.1.3 Retail / Hotel / Pub

Council's DCP requires mixed-use developments (non-residential components) to provide car parking in accordance with the rates shown in **Table 3**.

With regards to parking rates relating to 'pub' uses, the Roads and Maritime Services (RMS) Guide to Traffic Generating Developments (2002) provides the following advice regarding parking provisions for 'club' developments which are comparable to 'pub' uses.

> *"Off-street car parking must be provided to satisfy the average maximum demand. Research has indicated that the demand for parking varies substantially depending on the type of club and cannot readily be related to building floor areas or to the membership. The determination of the number of parking spaces required is therefore based on the characteristics of the proposed development. Comparisons must be drawn with similar clubs." (RMS Guide to Traffic Generating Developments)*

TRAFFIX has undertaken parking surveys of a club located in the Fairfield City Council LGA, within 500m of a Railway Station. This club has similar characteristics, being within walking distance of a Railway Station and town centre. As such, an average parking demand rate has been derived from this comparable development based on the existing parking demand surveys

Application of the Council rates and survey-based demand rate for pubs results in the following:

Table 3: Council Parking Rates

Type	Rooms / GFA	Parking Rate	Minimum Spaces Required[2]
Hotel Rooms	60	1 space per 4 rooms	15
Pub	2,060m²	1 space per 26m² GFA[1]	80
Retail	287 m²	1 space per 40m² GFA	8
Café	160 m²	1 space per 40m² GFA	4
Total			**107**

[1] Based on survey data of similar developments.

[2] Parking numbers rounded up to next whole number as per DCP

It can be seen from **Table 3** that a minimum of 107 parking spaces are required for the hotel, pub, retail and café components of the development, in accordance with Council's DCP.

5.1.4 Gym

The RMSGTGD requires gymnasiums developments within 'metropolitan sub-regional centres' to provide a minimum of 4.5 spaces per 100m² GFA. The development proposes a gym of 297m² GFA. Therefore, a parking provision of 13 spaces is required to satisfy the RMS requirements.

5.1.5 Total Car Parking Requirement

In summary, the minimum car parking allowance for the entire development is outlined in **Table 4** below:

Table 4: Overall Car Parking Requirements

Type	Units / Rooms / GFA	Minimum Parking Rate	Minimum Spaces Required[2]
Residential Component (SEPP 65)			
1 Bed	24	0.6 spaces per unit	14
2 Bed	38	0.9 spaces per unit	34
3+ Bed	21	1.4 spaces per unit	29
Residential Visitor	83	1.0 space per 5-7 units	17
		Sub-Total	**94**
Other Land Uses (DCP & RMS)			
Hotel Rooms	60	1 space per 4 rooms	15
Pub	2,060m²	1 space per 26m² GFA[1]	80
Retail	287m²	1 space per 40m² GFA	8
Gym	297m²	4.5 spaces per 100m² GFA	13
Café	160m²	1 space per 40m² GFA	4
		Sub-Total	**120**
		Total	**214**

[1] Based on survey data of similar developments.

[2] Parking numbers rounded up to next whole number as per DCP

It can be seen from Table 4 that overall; the development is required to provide a minimum car parking provision for 214 spaces, in compliance with the SEPP 65, Council's DCP and RMSGTGD, as appropriate. In response, the concept plans show approximately 214 parking spaces throughout three (3) basement levels, thus demonstrating that the site is capable of accommodating all required parking. Nevertheless, this will be further assessed at development application stage/s.

5.2 Accessible Parking

5.2.1 Residential

Part 4.6 Car Parking, Access and Movement of Council's DCP requires the proposed development to provide one (1) accessible space per adaptable dwelling. Details relating to the number and location of accessible parking spaces for the residential component of the proposed development will be determined at future development applications stage/s, at which time, the parking arrangement will be optimised.

5.2.2 Hotel

The Building Code of Australia (BCA) requires Class 3 buildings to provide accessible parking in accordance with the statement below:

> *"To be calculated by multiplying the total number of carparking spaces by the percentage of:*
>
> *a) Accessible sole-occupancy units to the total number of sole-occupancy units; or*
> *b) Accessible bedrooms to the total number of bedrooms; and*
>
> *the calculated number is to be taken to the next whole figure."*

Details relating to the number and location of accessible parking spaces for the hotel component of the proposed development will be determined at future development applications stage/s, at which time, the parking arrangement will be optimised.

5.2.3 Hotel Licensed Area (Pub)

The Building Code of Australia (BCA) requires Class 9b (assembly buildings) to provide one (1) accessible space for every 50 car parking spaces or part thereof up to 1,000 car parking spaces. Details relating to the number and location of accessible parking spaces for the pub component of the proposed development will be determined at future development applications stage/s, at which time, the parking arrangement will be optimised.

5.2.4 Retail/Gym/Café

The Building Code of Australia (BCA) requires Class 6 buildings to provide one (1) accessible space for every 50 car parking spaces or part thereof up to 1,000 car parking spaces. Details relating to the number and location of accessible parking spaces for the retail/gym/café components of the proposed development will be determined at future development applications stage/s, at which time, the parking arrangement will be optimised.

5.3 Bicycle Parking

5.3.1 All Uses

Part 4.6 Car Parking, Access and Movement of Council's DCP requires mixed-use developments to provide bicycle parking in accordance with the rates shown in **Table 5**:

Table 5: Council Bicycle Parking Rates

Type	Employee / Staff Parking Rates	Visitor / Shopper Parking Rates
Residential	1 space per 10 units	NA
Retail	1 space per 200m2 GFA	15% to be accessible by visitors
Gym (Indoor recreation facility)	1 space per 200m2 GFA	15% to be accessible by visitors
Café (Restaurant)	1 space per 200m2 GFA	15% to be accessible by visitors

Details relating to the number and location of bicycle parking spaces for the proposed development will be determined at future development applications stage/s, at which time, the parking arrangement will be optimised.

5.4 Motorcycle Parking

Council's DCP requires mixed-use developments to provide motorcycle parking in accordance with the rates shown in **Table 6**:

Table 6: Council Motorcycle Parking Rates

Type	Parking Rates
Residential	1 space per 15 units
Retail	1 space per 20 car spaces
Gym	1 space per 20 car spaces
Café (Restaurants)	1 space per 20 car spaces

Details relating to the number and location of motorcycle parking spaces for the proposed development will be determined at future development applications stage/s, at which time, the parking arrangement will be optimised.

5.5 Car Wash Bay

Council's DCP requires buildings with 5 dwellings or more to provide at least one (1) visitor car parking space to be equipped with car wash facilities.

5.6 Refuse Collection and Servicing

The Rockdale Council Technical Specification – Traffic, Parking and Access 2011 requires mixed-use developments to provide off-street service bays in accordance with the **Table 7, 8** and **9** below:

Table 7: Council Service Bay Requirements - Residential

Number of Units	Service Bays Required			
	Van	SRV	MRV	HRV
0-9	1[1]	-	-	-
10-49	-	1[2]	-	-
50-99	-	1	1	-
100-149	-	2	1	-
150-249	1	2	1	1
250-500	1	2	2	1
500 and over	2	2	2	1

[1] The van space may be shared with visitor parking or service bay for retail/commercial/business in a shop top housing development.

[2] The SRV space may be shared with a service bay for retail/commercial/business in a shop top housing development.

Table 8: Council Service Bay Requirements – Retail

Gross Floor Area (m^2)	Service Bays Required				
	Van	SRV	MRV	HRV	AV
0-199	1	-	-	-	-
199-999	-	1	-	-	-
1,000-2,999	1	-	1	-	-
3,000-4,499	1	1	1	-	-
4,500-5,999	2	1	1	-	-
6,000-8,999	3	2	2	1	1
9,000-14,999	5	3	3	1	1
15,000-26,999	6	3	3	2	2
27,000-39,999	8	3	4	3	2
40,000 and over	"Subject to study" under DCP				

Table 9: Council Service Bay Requirements – Hotel/Motel

Number of Rooms	Service Bays Required			
	Van	SRV	MRV	HRV
0-199	1	-	1	-
200-399	1	-	1	1
400-599	1	1	1	1
600 and over	1	2	1	1

In accordance with Council's DCP, one (1) van bay, two (2) SRV bays and two (2) MRV bays are required. As noted above, the DCP states that the van space may be shared with a visitor parking space and the MRV space can be shared between the residential and retail components for a shop-top development.

The above requirement assumes independent provision for each land use component (a cumulative assessment) and therefore takes no account of a 'managed' approach, with shared loading arrangements subject to a loading dock management plan. It also does not reflect the likely operational requirements of the proposed uses.

The development proposes a single service bay that can accommodate a 6.4m long Small Rigid Vehicle. The development proposes to engage a private contractor for waste collection. The loading area also provides an SRV turntable to ensure that service vehicles can enter and leave the site in a forward direction.

To satisfy any concerns, a Loading Dock Management Plan (LDMP) is invited as a condition of consent, requiring approval prior to the release of an occupation certificate, if deemed necessary by Council. The LDMP would outline the requirements of the site in relation of deliveries and servicing activities, anticipated vehicle sizes and frequencies, noting that this detailed information will be available in the later stages of the project. The LDMP could include the following information:

- Details of all delivery and servicing activities to be carried out for all uses on-site;
- Details of how waste services will be accommodated to meet service requirements;
- Details of vehicle types required to conduct expected activities; and
- Details of frequency of vehicles accessing the dock.

In summary, the detailed information regarding the servicing arrangements with a LDMP will be provided at subsequent development application stage/s, based on the operational characteristics of the proposed development.

6. TRAFFIC AND TRANSPORT IMPACTS

6.1 Existing Site Generation

The subject site currently accommodates a hotel known as the Bexley North Hotel. The development includes a bar, bistro, 17 motel style rooms and a drive-thru liquor store. The estimated GFA of the current Bexley North Hotel including the drive-through bottle shop is approximately 1,500m².

6.1.1 Hotel Licensed Area (Pub)

The Roads and Maritime Guide to Traffic Generating Developments (RMSGTGD) 2002 recommends the analysis of traffic generation for a proposed 'Hotel – Traditional' development be based on surveys of similar existing hotels.

In addition to the above, the utilisation of this component the proposed development is more akin to a 'club' development. As such, the RMS Guide provides the following similar advice for 'club' developments:

> *"Surveys of licenced clubs conducted by the RTA in 1978 indicate that it is difficult to generalise on their traffic generation because of the diversified nature of clubs. Traffic generation is affected by such factors as the provision of live entertainment, gambling facilities, number of members and club location. Behavioural changes since 1978, such as the introduction of random breathing testing, also make such generalisations more difficult."*

Traffic generation rates are therefore not specified in the RMS Guide for this type of development and in any event, such a rate would not be as accurate or reliable. As such, the RMS Guide prefers a methodology based survey assessment of comparable developments. TRAFFIX has had extensive experience with developments of this nature and has identified an average traffic generation rate, based on traffic surveys undertaken at the comparable development within the Fairfield City Council LGA, referred to in Section 5. This average rate is summarised as follows:

- 2.34 vehicle trips per 100m² GFA in the evening peak hour.

It should be noted that a large majority of staff arrive to the pub after the morning peak and therefore do not contribute to traffic generation in the morning peak period Application of the average traffic generation rate to the existing 1,500m² GFA and assuming a modal split of 50:50 for this type of development, will result in the following anticipated traffic generation:

- 35 vehicle trips per hour during the evening peak hour (18 in, 17 out)

6.1.2 Hotel

The RMSGTGD specifies an evening trip rate of 0.4 veh/hr per unit/room for motels (applicable for assessment purposes). Application of this rate to the existing 17 hotel rooms and adopting a spit of 80/20 provides the following generation:

- 7 vehicle trips per hour during the morning peak hour (1 in, 6 out)
- 7 vehicle trips per hour during the evening peak hour (6 in, 1 out)

6.1.3 Combined Existing Generation

The combined trip generation of the existing land use is summarised below:

- 7 vehicle trips per hour during the morning peak hour (1 in, 6 out)
- 42 vehicle trips per hour during the evening peak hour (24 in, 18 out)

6.2 Development Trip Generation

The impacts of the proposed mixed-use development on the external road network have been assessed having regard for the indicative yield scenarios as summarised in **Section 4** above. This assessment has been undertaken in accordance with the requirements of the RMSGTGD and as such, the traffic generation rates published in the RMS Guide have been adopted for each individual land use. The result of this assessment is summarised below.

6.2.1 Residential

In August 2013, RMS released Technical Direction TDT 2013/04a, which provides revised trip generation advice for a number of land uses based on survey data obtained since 2009. One of the land uses covered by TDT 2013/04a is high density residential development. The average Sydney weekday trip rates provided by TDT 2013/04a have been adopted for assessing the traffic generating potential of the subject development. The relevant trip rates are as follows:

- 0.19 vehicle trips per unit during the morning peak hour; and
- 0.15 vehicle trips per unit during the evening peak hour.

Application of these trip rates to the 83 residential units proposed, and adopting an 80:20 split, results in the following generation:

- 16 vehicle trips per hour during the morning peak hour (3 in, 13 out)
- 12 vehicle trips per hour during the evening peak hour. (10 in, 2 out)

6.2.2 Hotel

The RMSGTGD specifies an evening trip rate of 0.4 veh/hr per unit/room for motels (applicable for assessment purposes). A morning trip rate is not specified within the RMS Guide; therefore, a morning trip rate equal to the evening trip rate has been assumed. Application of this rate to the proposed 60 hotel rooms and adopting an 80:20 split provides the following generation:

- 24 vehicle trips per hour during the morning peak hour (5 in, 19 out)
- 24 vehicle trips per hour during the evening peak hour (19 in, 5 out)

It is noted that the anticipated trip generation above is considered a conservative assessment as it does not factor the proximity of the Bexley North Railway Station and proposed operation (including clientele) of the hotel which would likely reduce the trip generation. Noting that Bexley North Railway Station is on the T8 – City to Macarthur line and is an 8 - 11 minute train ride from the international and domestic airports respectively. Moreover, it is reasonable to expect that most hotel patrons would either be travelling by rail or taxi/uber given the site's proximity to railway services and Sydney City.

6.2.3 Retail

The RMSGTGD provides traffic generation rates for secondary retail developments, which it defines as retail stores tending not to be the primary attractor to the development and thus are applicable to the retail component of the development. The RMSGTGD recommends an evening weekday peak traffic generation rate of 4.6 veh/hr per 100 m² gross floor leasable area (GLFA) for secondary retail uses. Whilst no rates are provided for morning peak hourly traffic generation, it is assumed that the morning peak traffic generation is 30% of the evening peak, representing staff arrivals. As referenced in the RMSGTGD, GLFA is about 75% of the GFA.

On this basis, the 287m² of retail GFA equates to 215m² GLFA. Application of the above trip rate and adopting a 50:50 split results in the following generation:

- 3 vehicle trips per hour during the morning peak hour (3 in, 0 out)
- 10 vehicle trips per hour during the evening peak hour (5 in, 5 out)

The above anticipated traffic generation of the retail component is considered a conservative assessment, noting the proximity to the Bexley North Railway Station and the likelihood of linked trips between the various retail/commercial uses on- site and in the immediate area. Furthermore, it is anticipated that many of the customers associated with the proposed retail tenancies would reside in the surrounding local area, further reducing vehicle trips.

6.2.4 Gym

The RMSGTGD recommends an evening weekday peak traffic generation rate of 9 veh/hr per 100 m² gross floor area (GFA) for gymnasium uses which are in Metropolitan Sub Regional Areas. The morning peak traffic generation is assumed to be 30% of the evening peak traffic generation to account for staff arrivals. Application of this rate to the proposed 297m² of gym and adopting a 50:50 split results in the following generation:

- 8 vehicle trips per hour during the morning peak hour (4 in, 4 out)
- 27 vehicle trips per hour during the evening peak hour (13 in, 14 out)

6.2.5 Licensed Area (Pub)

As discussed in **Section 6.1.1**, a rate of 2.34 trips per 100m² GFA in the evening peak hour has been used for the intended pub use to calculate trip generation, based on other developments of a similar nature. A majority of staff arrive to the pub after the morning peak period and therefore do not generate contribute to traffic generation in the morning peak period.

Application of this rate to the proposed 2,060 m² of pub GFA and adopting a 70:30 split results in the following generation:

- 48 vehicle trips per hour during the evening peak period (24 in, 24 out)

6.2.6 Café

The restaurant land use in RMS GTGD includes cafes, tea rooms, eating houses or the like. Therefore, the rate of 5 veh/hr per 100 m² for restaurant has been adopted for this assessment.

Application of this rate to the proposed 160m² of cafe GFA and adopting a 50:50 split in the morning and a 0:100 split in the evening results in the following generation:

- 8 vehicle trips per hour during the morning peak period (4 in, 4 out)
- 8 vehicle trips per hour during the evening peak period (0 in, 8 out)

6.2.7 Combined Traffic Generation

The combined generation of the residential and non-residential components can be summarised as follows:

- 59 vehicle trips per hour during the morning peak hour (19 in, 40 out)
- 129 vehicle trips per hour during the evening peak hour (71 in, 58 out)

Nevertheless, this is a cumulative (worst case) scenario that does not take full account of the synergies that exist within a mixed-use development, whereby people attending one use will simply walk to another use and this has the effect of 'internalising' trips and reducing traffic generation. This effect has been ignored in order to assess a worst-case scenario and/or to account for any variations to trip rates.

6.2.8 Net Traffic Impact

The above traffic generation is not a net increase over existing conditions. When accounting for the existing uses of the site as discussed above, the proposed development will generate:

- +52 vehicle trips per hour during the morning peak hour (+18 in, +34 out)
- +87 vehicle trips per hour during the evening peak hour (+47 in, +40 out)

6.3 Traffic Distribution

Vehicle trips generated by the proposed development have been distributed throughout the surrounding road network using existing traffic survey data. In other words, the percentage of trips coming from the North, South, East and West to the study area were extracted from the traffic surveys during each peak period and applied to the proposed development trip generation, noting some allowance for driver behaviour. These percentages were also applied to the outbound vehicle trips.

Collectively, the development volumes assessed have been distributed across the road network as illustrated in **Figure 8** and **Figure 9**, for morning and evening peaks, respectively. The analysis assumes that access to the site will be achieved from Sarsfield Circuit, in accordance with the concept plans.

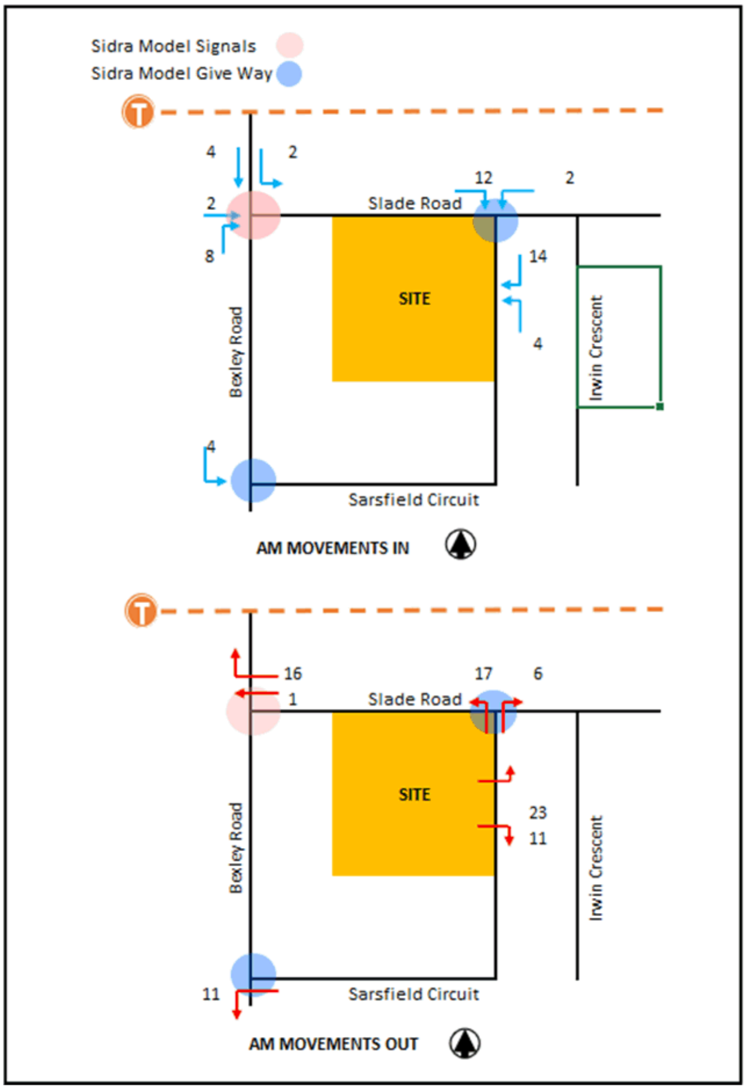


Figure 8: AM Peak Period Distribution (Vehicle trips per hour)

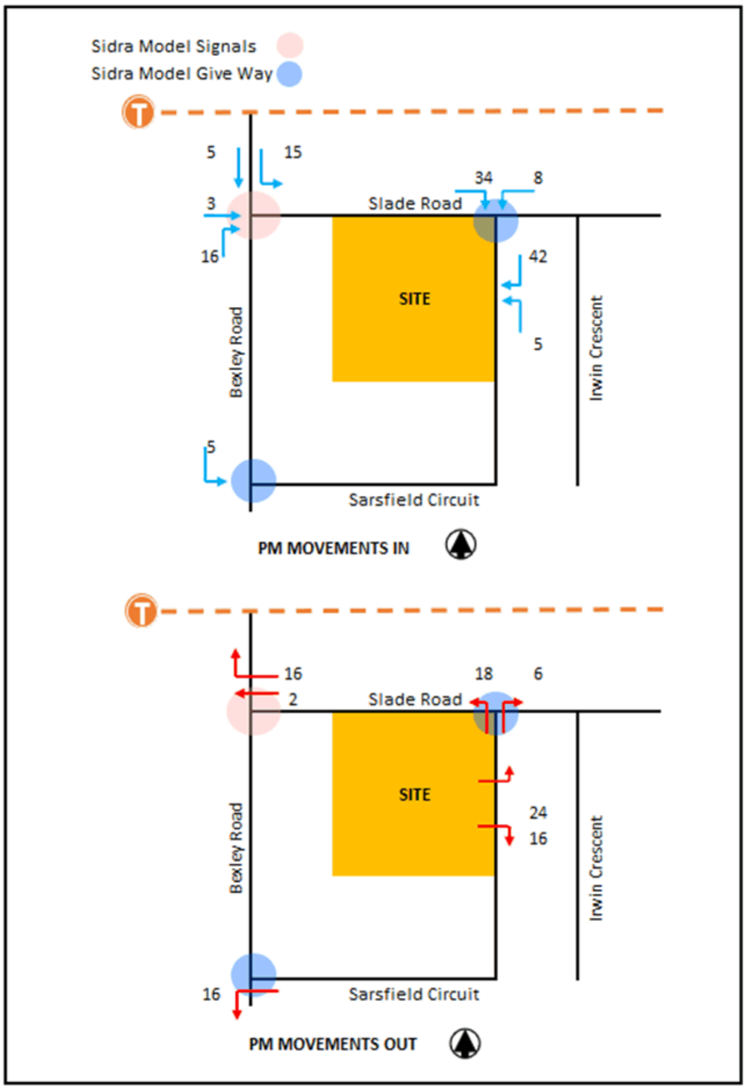


Figure 9: PM Peak Period Distribution (Vehicle trips per hour)

6.4 Peak Period Intersection Performance

In order to assess the potential traffic impacts of the proposed development, the following scenarios were identified:

- 2019 Base Case; and
- 2019 Base Case + Development.

Traffic surveys were undertaken of the intersections mentioned above, which are considered to be most critical in relation to the site. These counts were undertaken on 19 February 2019 during the network peak periods, being between 7:00am and 9:00am (morning peak period) and 4:00pm and 6:00pm (evening peak period).

The traffic volumes in these surveys formed the base case volumes for software modelling undertaken to assess intersection performance characteristics under existing traffic conditions. The SIDRA Intersection 8 model produces a range of outputs, the most useful of which are the Degree of Saturation (DOS) and Average Vehicle Delay per vehicle (AVD). The AVD is in turn related to a level of service (LOS) criteria. These performance measures can be interpreted using the following explanations:

DoS - the DoS is a measure of the operational performance of individual intersections. As both queue length and delay increase rapidly as DoS approaches 1, it is usual to attempt to keep DoS to less than 0.9. When DoS exceeds 0.9 residual queues can be anticipated, as occurs at many major intersections throughout the metropolitan area during peak periods. In this regard, a practical limit at 1.1 can be assumed. For intersections controlled by roundabout or give way/stop control, satisfactory intersection operation is generally indicated by a DoS of 0.8 or less.

AVD - the AVD for individual intersections provides a measure of the operational performance of an intersection. In general, levels of acceptability of AVD for individual intersections depend on the time of day (motorists generally accept higher delays during peak commuter periods) and the road system being modelled (motorists are more likely to accept longer delays on side streets than on the main road system).

LoS - this is a comparative measure which provides an indication of the operating performance of an intersection as shown in **Table 10** below.

Table 10: Existing and Future Intersection Performance Indicators (RMS)

Level of Service (LoS)	Average Delay per Vehicle (sec/veh)	Traffic Signals, Roundabout	Give Way and Stop Signs
A	Less than 14	Good Operation	Good Operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and space capacity
C	29 to 42	Satisfactory	Satisfactory but accident study required
D	42 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents will cause excessive delays. Roundabouts require other control mode	At capacity and requires other control mode
F	More than 70	Unsatisfactory and requires additional capacity	Unsatisfactory and requires other control mode or major treatment

A summary of the modelled results is provided below in **Table 11**. Reference should also be made to the SIDRA outputs provided in **Appendix B** which provide detailed results for individual lanes and approaches.

Table 11: Existing and Future Intersection Performances

Intersection	Control	Scenario	Period	Degree of Saturation	Average Delay (s)	LoS
Bexley Road / Sarsfield Circuit	Priority Controlled	Base	AM	0.395	7.5	A
			PM	0.421	9.0	A
		Base + Dev	AM	0.398	7.9	A
			PM	0.448	9.2	A
Slade Road / Sarsfield Circuit	Priority Controlled	Base	AM	0.293	8.9	A
			PM	0.277	8.4	A
		Base + Dev	AM	0.307	9.9	A
			PM	0.281	9.7	A
Bexley Road / Slade Road	Signalised	Base	AM	1.097	115.2	F
			PM	0.926	51.5	D
		Base + Dev	AM	1.075	118.9	F
			PM	0.926	55.4	D

6.4.1 Priority Controlled Intersection Performance

It can be seen from **Table 11** that the intersections of Bexley Road and Sarsfield Circuit recorded a minimal change to average delay of 0.4 second in the morning peak period and 0.2 seconds in the evening peak period. The intersection remains at a level of service 'A' during both peaks during the base case plus development scenario. The intersection of Slade Road and Sarsfield Circuit also recorded an acceptable level of service 'A' in the morning and evening peak periods, representing a small increase in average delay of 1.0 seconds and 1.3 seconds respectively. In this regard, the impact of the development on these priority controlled intersections during the morning and evening peak periods is considered acceptable with no external improvements required to support the development scheme.

6.4.2 Signalised Intersection Performance

It can be seen from **Table 11** that the intersection of Bexley Road and Slade Road currently operates at a level of service 'F' during the morning peak period and a level of service 'D' during the evening peak period. The intersection will however continue to operate at these levels of service in the base case plus development scenario.

Morning Peak

During the morning peak, the net development impact is less than one vehicle per minute overall: and slightly less than this through this intersection. This represents a net increase of generally one vehicle per signal cycle, with average delays increasing by only 3.7 seconds, which is moderate and will be generally imperceptible.

Evening Peak

During the evening peak, the net development impact is also less than one vehicle per minute overall; and again, this is slightly less than this through this intersection. This similarly represents a net increase of generally one vehicle per signal cycle, with average delays increasing by only 3.9 seconds, which is moderate and will be imperceptible.

It is reiterated that this assessment represents a worst-case scenario, with no account taken of the trip reductions from internalised (multi-purpose) trips that will occur in practice, due to the synergy between each land use component. That is, improved conditions can be expected, with reduced delays and no unacceptable traffic impacts.

Finally, the site is presently zoned B4-Mixed Use and under this current zoning the highest traffic generating land use that is permissible is a retail use. This is a higher generating use than the proposed use, noting that high density residential uses are low traffic generating uses.

In summary, the surrounding road network will experience small increases to average delays during peak periods, but these impacts are moderated with no external improvements required in support the assessed concept scheme. The traffic generation will nevertheless be revisited at subsequent development application stage/s.

7. ACCESS AND INTERNAL DESIGN ASPECTS

7.1 Site Vehicular Access

7.1.1 Light Vehicle Access

The concept development provides a total of 214 parking spaces with access to Sarsfield Circuit, a local road. Under AS 2890.1 (2004), a Category 2 driveway is required, being a combined entry and exit driveway of 6.0 to 9.0 meters. The driveway should also incorporate a 600mm wide median to facilitate a visitor intercom to ensure satisfactorily operation. The proposed access driveway can be optimised further during later DA stage/s.

7.1.2 Heavy Vehicle Access

The concept development provides a separate heavy vehicle access driveway to Sarsfield Circuit. Under AS 2890.2 (2018), a 3.5m wide (kerb to kerb) entry/exit lane is required to accommodate SRVs. The proposed access driveway can be optimised further during later DA stage/s.

7.2 Internal Design

The internal car park should comply with the requirements of AS 2890.1 (2004), AS 2890.2 (2018) and AS 2890.6 (2009), and the following characteristics are noteworthy:

7.2.1 Parking Modules

- All residential/employee car parking spaces are to be designed in accordance with User Class 1A. These spaces are provided with a minimum space length of 5.4m, a minimum width of 2.4m and a minimum aisle width of 5.8m.
- All hotel/pub/gym visitor car parking spaces are to be designed in accordance with User Class 2. These spaces are provided with a minimum space length of 5.4m, a minimum width of 2.5m and a minimum aisle width of 5.8m.

- All retail visitor car parking spaces are to be designed in accordance with User Class 3. These spaces are provided with a minimum space length of 5.4m, a minimum width of 2.6m and a minimum aisle width of 5.8m.
- All accessible parking spaces are to be designed in accordance with AS 2890.6 (2009), being 2.4m wide, 5.4m long and located adjacent to a dedicated shared area of the same dimensions.
- All spaces located adjacent to obstructions of greater than 150mm in height are to be provided with an additional width of 300mm and all columns are to be located outside of the parking space design envelope shown in Figure 5.2 of AS 2890.1 (2004).
- Dead-end aisles are to be provided with the required 1.0m aisle extension in accordance with Figure 2.3 of AS 2890.1 (2004).

7.2.2 Ramps

- All vehicle ramps accessed by retail visitors to have a maximum gradient of 20% (1 in 5) for up to 20 metres long, with a minimum 2.0 metre long transition at 12.5% (1 in 8), in accordance with the public car park requirements of AS 2890.1 (2004).
- All vehicle ramps accessed by residents/employees to have a maximum gradient of 25% (1 in 4) for up to 20 metres long, with a minimum 2.0 metre long transition at 12.5% (1 in 8), in accordance with the residential car park requirements of AS 2890.1 (2004).
- The access driveway is to have a maximum gradient of 1:20 (5%) extending from the property boundary line for at least 6.0m in accordance with AS 2890.

7.2.3 Clear Head Heights

- A minimum clear head height of 2.2m is provided for all areas within the basement car park as required by AS 2890.1 (2004).
- A minimum clear head height of 2.5m is to be provided above all accessible spaces in accordance with AS 2890.6 (2009).
- Head height clearances for roadways/loading docks accessed by service vehicles are to be provided in accordance with Table 2.1 of AS 2890.2 (2018).

7.2.4 Loading/Service Bays

- All loading bays are to be designed to accommodate the largest vehicle in accordance with AS 2890.2 (2018).
- Roadways/ramps accessed by waste/service vehicles are to be designed in accordance with Table 3.2 of AS 2890.2 (2018).
- The maximum gradient for any part of the service bay shall be 1:25 (4%) measured in any direction including directions oblique to the bay centre-line as required by AS 2890.2 (2018).

7.2.5 Other Considerations

- Visual splays are to be provided at the access driveway in accordance with Figure 3.3 of AS 2890.1 (2004).
- Bicycle parking should be designed in accordance with AS 2890.3 (2015).

7.3 Summary

In summary, the internal configuration of the car park should be designed in accordance with AS 2890.1 (2004), AS 2890.2 (2018) and AS 2890.6 (2009). The car parking and service bay arrangements can be further optimised during future DA stage/s.

8. CONCLUSIONS

The following matters are noteworthy:

- The planning proposal seeks approval to vary the floor space ratio and building height controls for the site at 187 Slade Road, Bexley North. A concept scheme has been assessed which is representative of the site being developed to its full potential with these proposed changes, comprising of a mixed-use development with residential apartments, hotel rooms, retail, a hotel (pub), gym and café.
- The subject site is well connected to the public transport network with reliable access to regular bus and rail services. The site is located within 160 metres to Bexley North Railway Station and numerous bus stops, which ensures that the site is ideally situated for a mixed-use development as it provides a good opportunity to encourage future tenants, employees and visitors to use public transport modes.
- The concept scheme has been assessed to require 214 parking spaces under the SEPP 65, RMS and Council DCP requirements. In response, concept plans demonstrate an ability to accommodate 214 parking spaces within three (3) basements levels, thus demonstrating that the site is able to accommodate all parking demands.
- The traffic generation arising from the development has been assessed as a net increase over existing conditions and equates to an additional 52 vehicle trips per hour during the morning peak period and 87 vehicle trips during the evening peak period. This is a worst-case assessment that does not take account of multi-purpose trips that occur in a mixed-use development. Nevertheless, SIDRA modelling demonstrates no unacceptable impacts, with no change in levels of service and minor increases in average delays at critical intersections.
- The parking and traffic impacts will be reassessed at future development application stages, based on committed uses and associated yields.
- The access and basement car park will be designed to comply with the requirements of AS 2890 in order to ensure safe and efficient operation.
- The loading bay will be designed to accommodate the largest vehicle expected in accordance with AS 2890.2 (2018).

It is therefore concluded that the planning proposal is supported on transport planning grounds and will operate satisfactorily, even based on the set of worst-case assumptions made for the concept development.

APPENDIX A

Photographic Record

Bexley Road / Slade Road / Shaw Street Intersection

Slade Road / Sarsfield Circuit Intersection

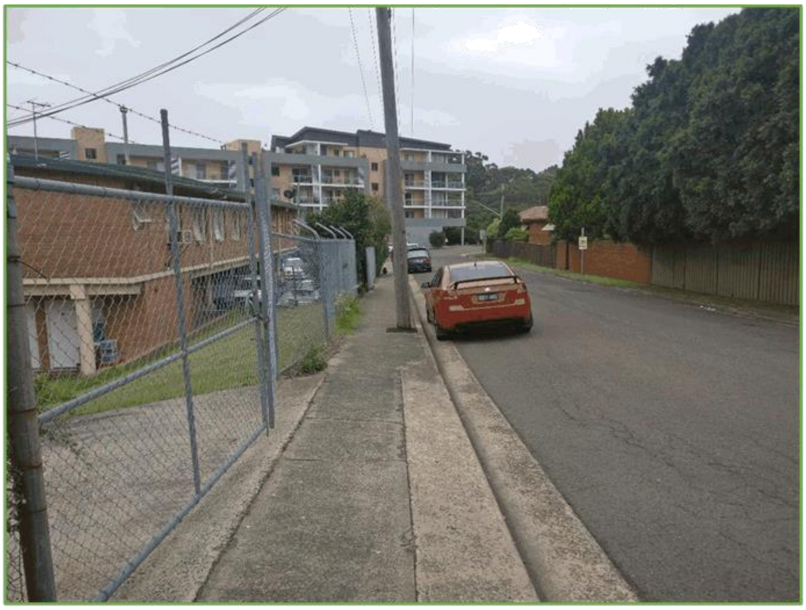
Bexley Road / Sarsfield Circuit Intersection

Subject Development Frontage to Slade Road

Existing Access Driveway to Shared Carpark

Subject Development Area – View looking East

Subject Development Area – View looking East



Subject Development Frontage to Sarsfield Circuit

APPENDIX B

Reduced Plans

KEY

- Footpath
- Site boundary
- Residential entry lobby
- Pub
- Hotel entry lobby
- Services
- Retail
- Substation
- Landscape buffer
- Outdoor deck

Ground Level

**Subject to loading at basement

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-004
Revision:B by DR
Issued on 14 July 2020

SCALE: 1:500 @ A3*
0 5 10 15 20 25m
*Please note subject any printing margins

Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

GMU Urban Design & Architecture

Level 01

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-005
Revision: A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*
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Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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KEY
- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services
- Green roof - Non trafficable
- Hotel rooms

Levels 02 - 03

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-006
Revision: A by DR
Issued on 25 March 2020

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Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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KEY
- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services
- Green roof - Non trafficable
- Hotel rooms

Level 04

18054 - PP - Bexley North - 187 Slade Road

Concept plans (to scale)

Prepared for: TUNBORN PTY LTD

SK-007
Revision: A by DR
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Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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KEY
- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services
- Rooftop COS
- Green roof - Non trafficable
- Hotel rooms

Level 05

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-008
Revision:A by DR
Issued on 25 March 2020

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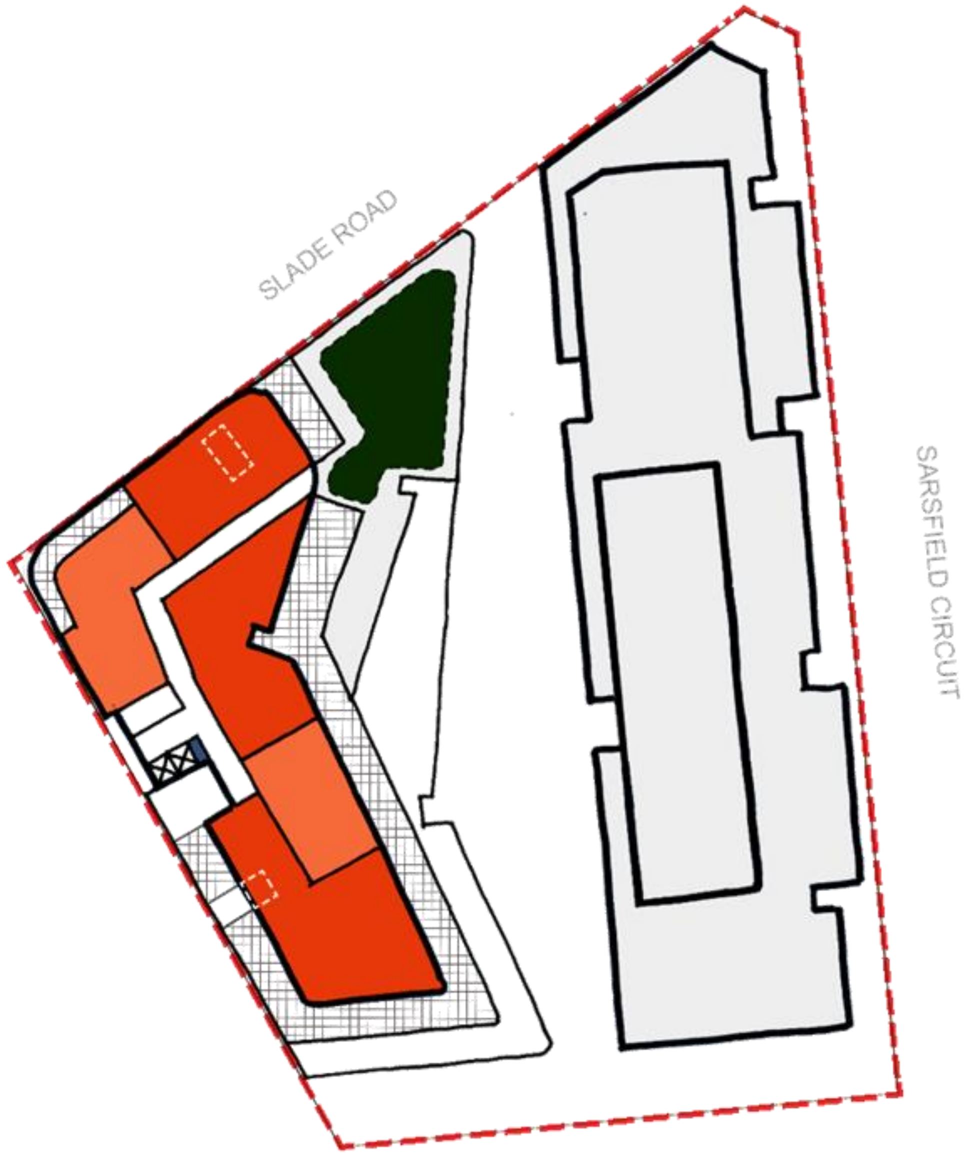

KEY

- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services
- Rooftop COS

Level 06

18054 - PP - Bexley North - 187 Slade Road

Concept plans (to scale)

Prepared for: TUNBORN PTY LTD

SK-009
Revision: A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*

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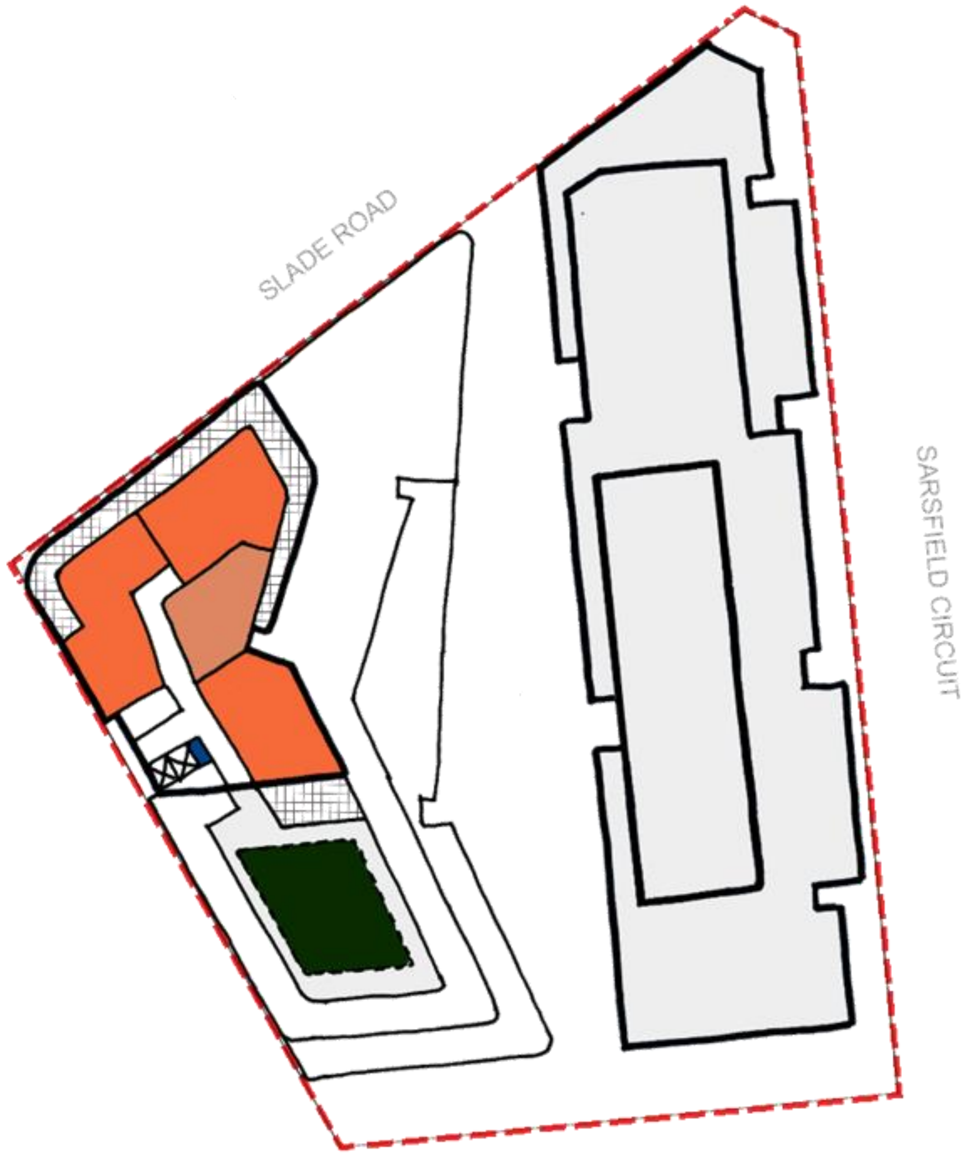

KEY

- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services
- Rooftop COS

Level 07

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-010
Revision: A by DR
Issued on 25 March 2020

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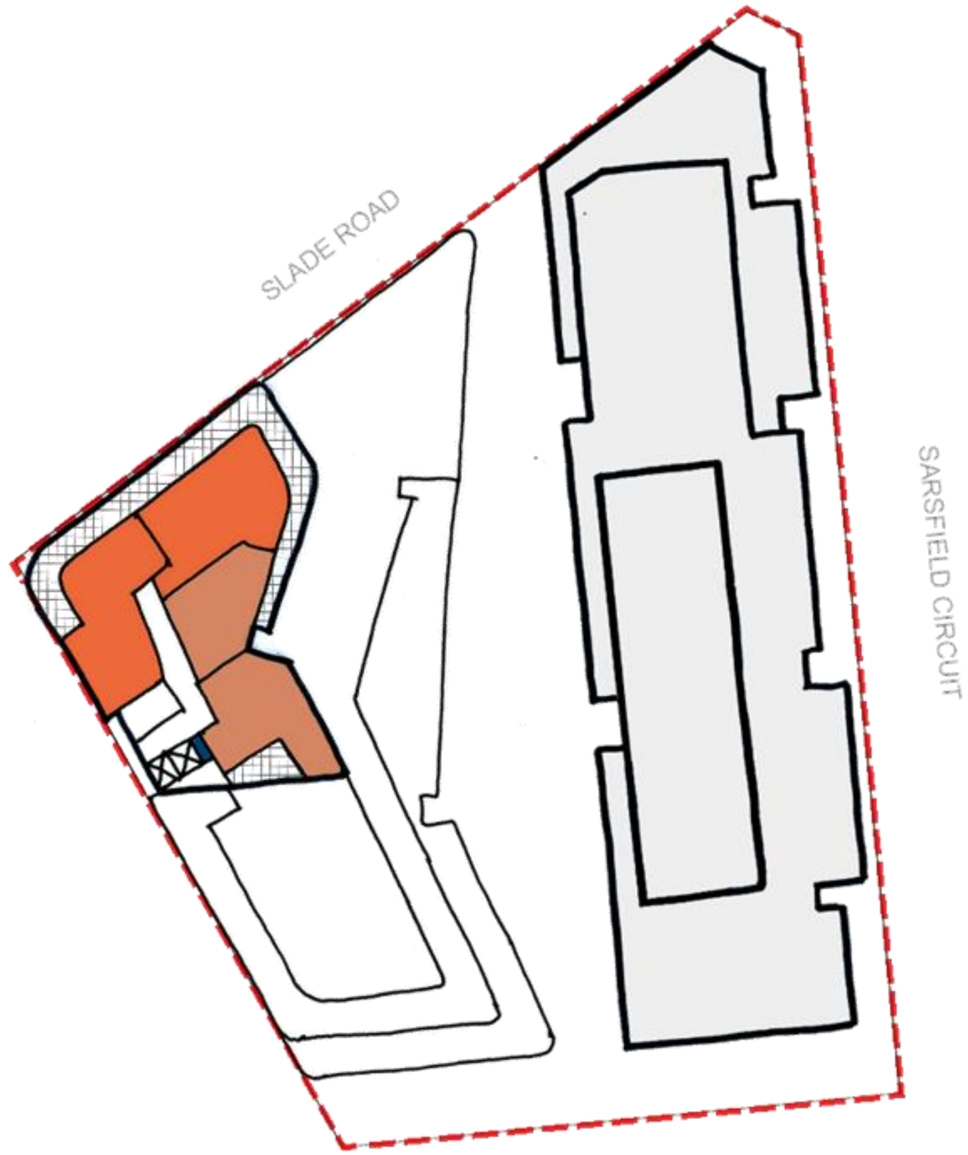

KEY

- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services

Level 08

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-011
Revision: A by DR
Issued on 25 March 2020

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North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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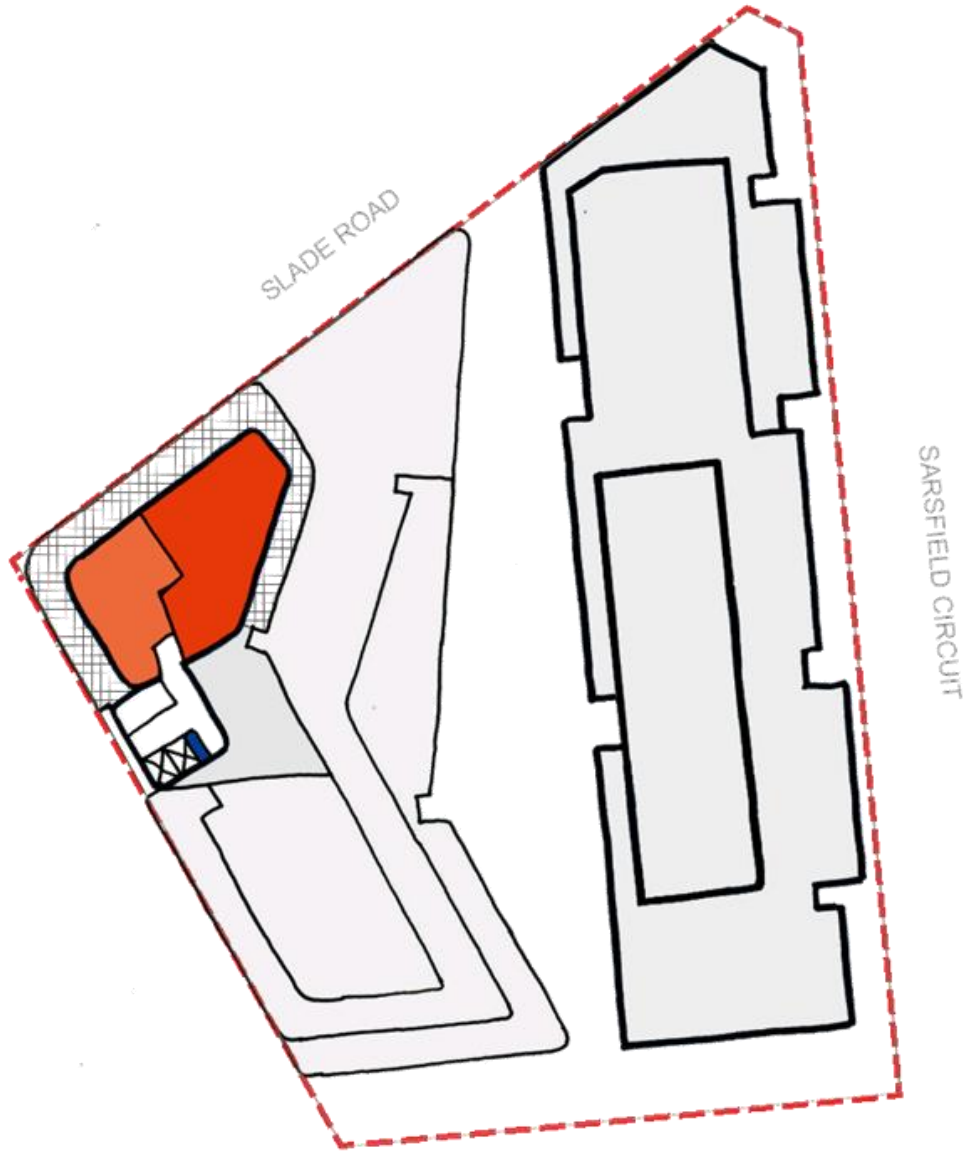

KEY
- Site boundary
- 1 bedroom unit
- 2 bedroom unit
- 3 bedroom unit
- Services

Level 09

18054 - PP - Bexley North - 187 Slade Road
Concept plans (to scale)
Prepared for: TUNBORN PTY LTD

SK-012
Revision: A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*
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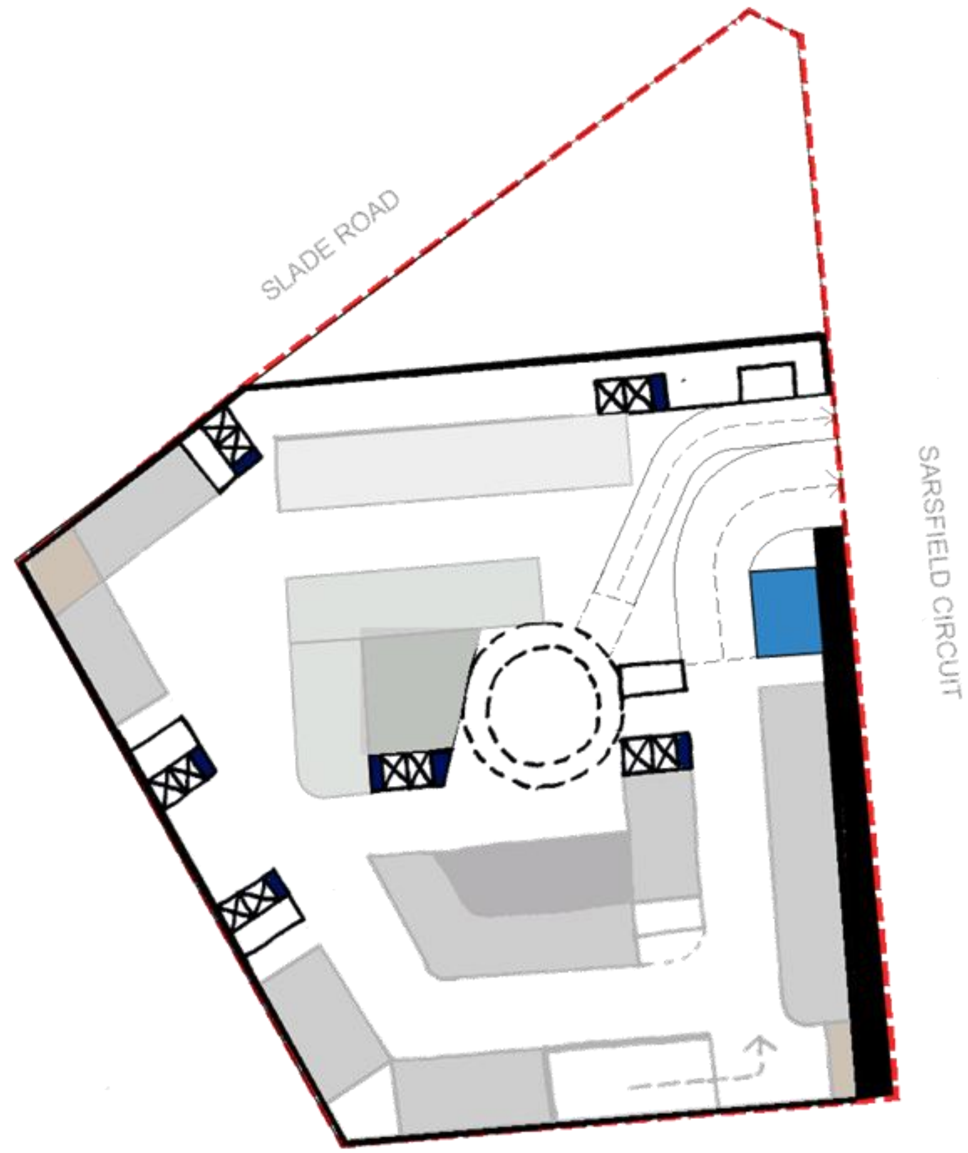

KEY
- Site boundary
- Services
- Parking
- Storage areas
- Deep soil
- Waste rooms

Basement Level 01

Approximately 58-62 car spaces**

** Pending accessible spaces

18054 - PP - Bexley North - 187 Slade Road

Concept plans (to scale)

Prepared for: TUNBORN PTY LTD

SK-001
Revision:B by DR
Issued on 22 July 2020

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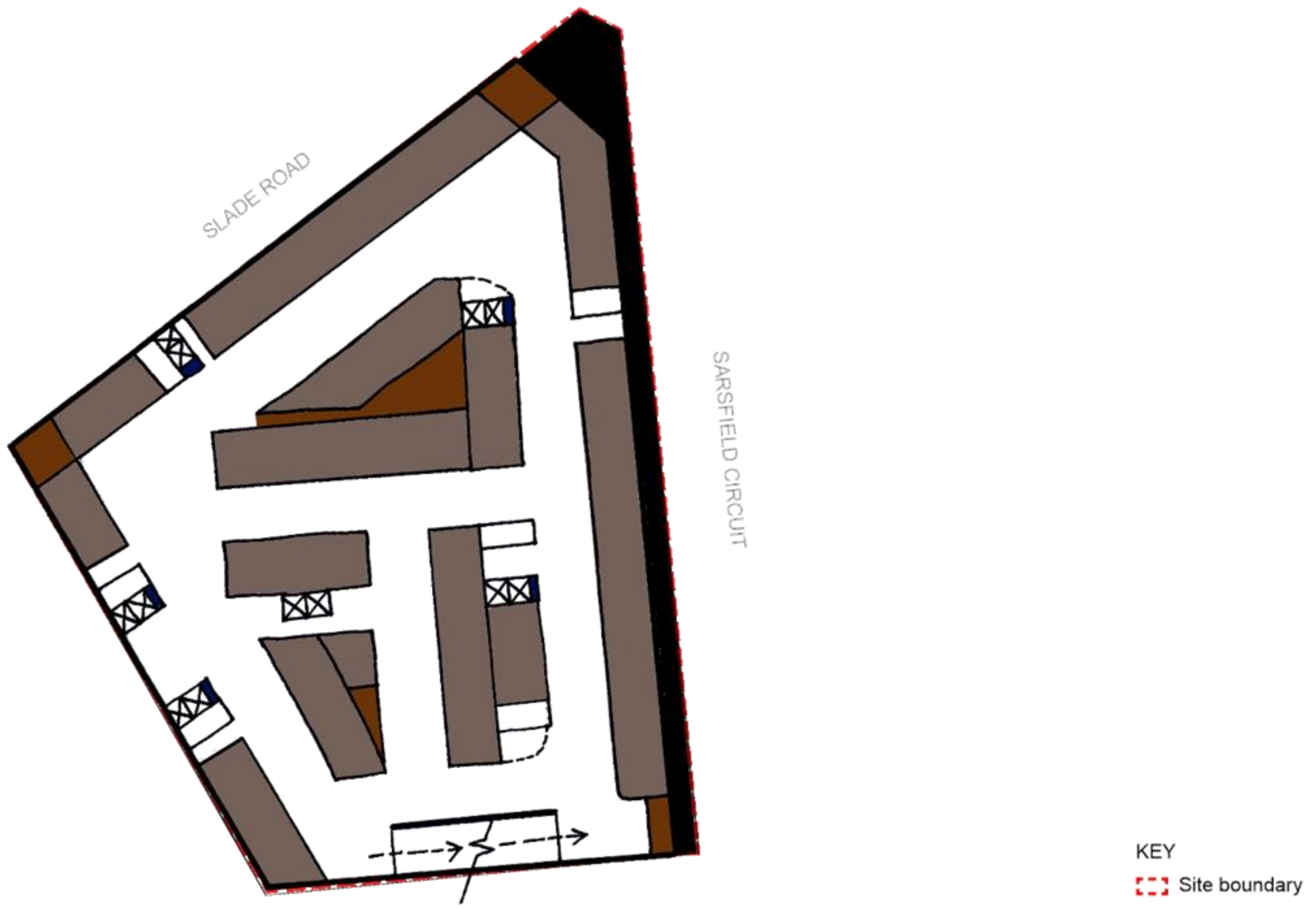

Basement Level 02

Approximately 108-110car spaces**

** Pending accessible spaces

18054 - PP - Bexley North - 187 Slade Road

Concept plans (to scale)

Prepared for: TUNBORN PTY LTD

SK-002

Revision: A by DR

Issued on 25 March 2020

SCALE: 1:500 @ A3*

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Web www.gmu.com.au

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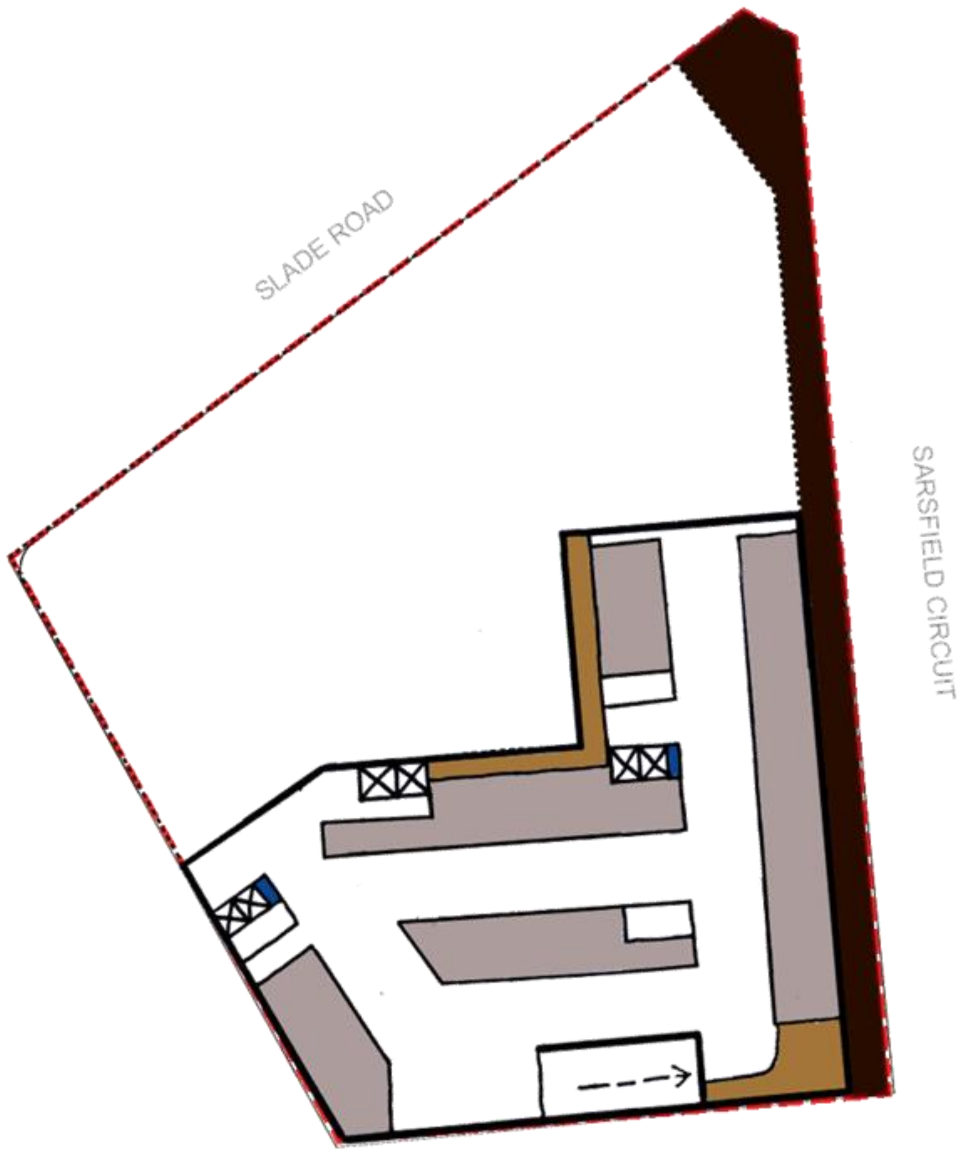

Basement Level 03

Approximately 40-42 car spaces**

** Pending accessible spaces

18054 - PP - Bexley North - 187 Slade Road

Concept plans (to scale)

Prepared for: TUNBORN PTY LTD

SK-003
Revision: A by DR
Issued on 25 March 2020

SCALE: 1:500 @ A3*

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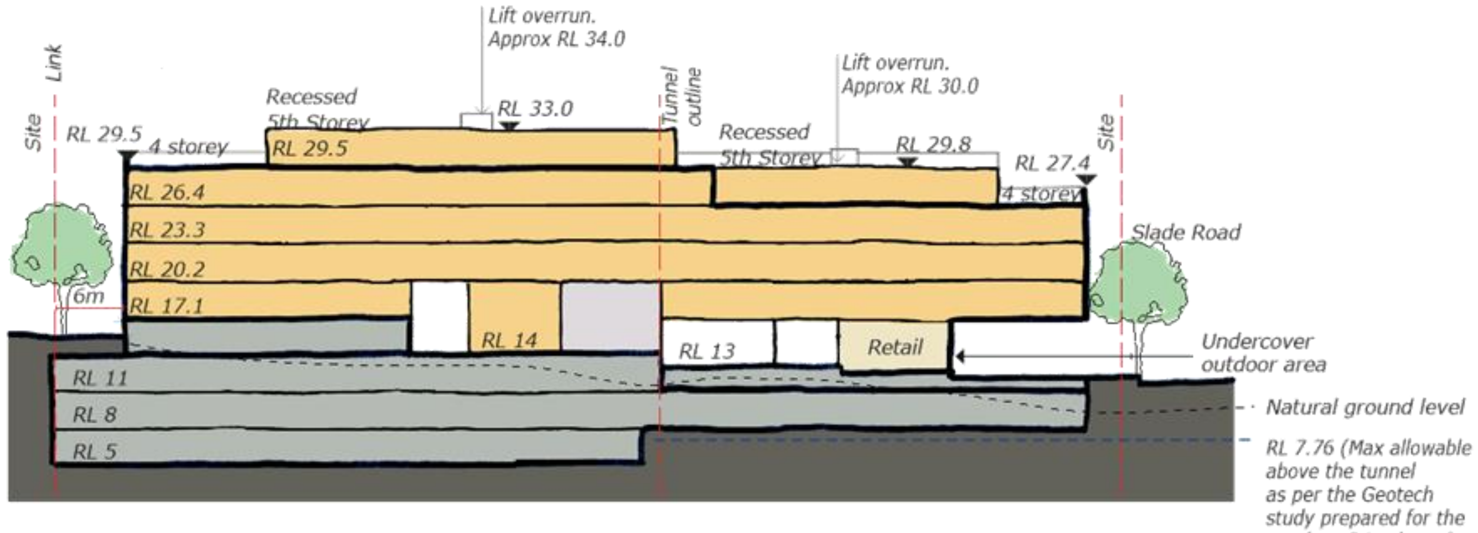
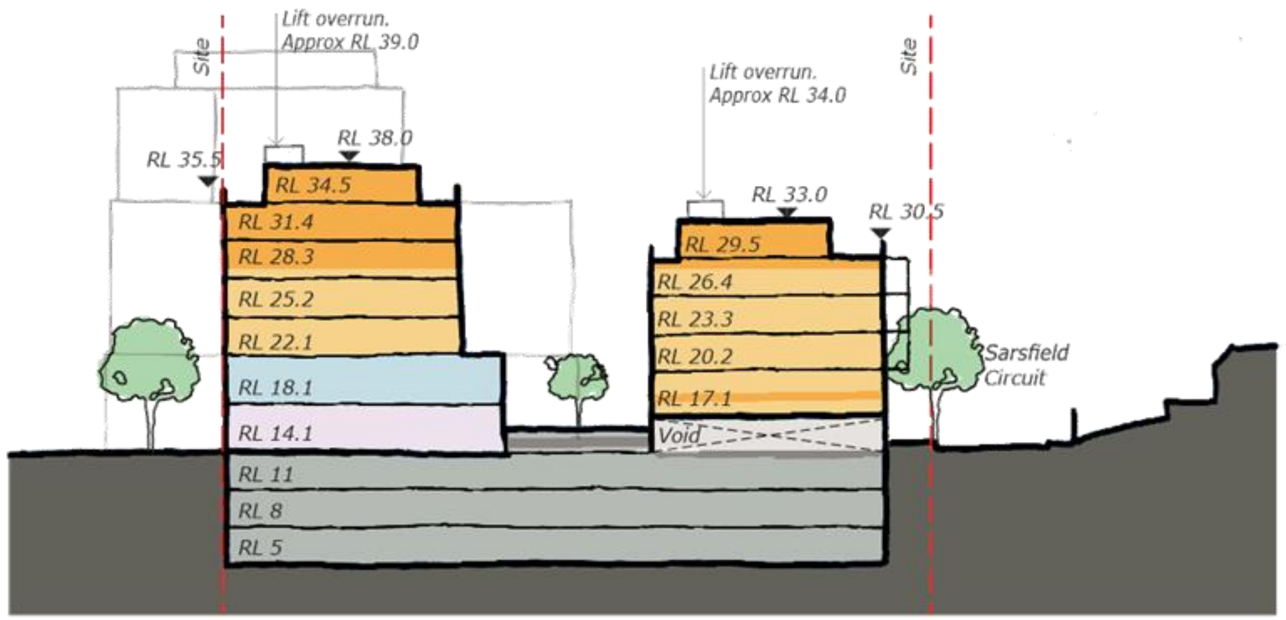


INDICATIVE SECTION a-a



INDICATIVE SECTION b-b

KEY
- Flood mitigation
- Residential
- Gym
- Pub
- Cafe
- Substation
- Basement

18054 - PP - Bexley North - 187 Slade Road
Indicative sectional studies
Prepared for: TUNBORN PTY LTD

Nominated Architect - MS Gabrielle Morrish

Level 8, 75 Miller Street
North Sydney NSW 2060
Tel (02) 8920 8388
Web www.gmu.com.au

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APPENDIX C

SIDRA Outputs

USER REPORT FOR NETWORK SITE

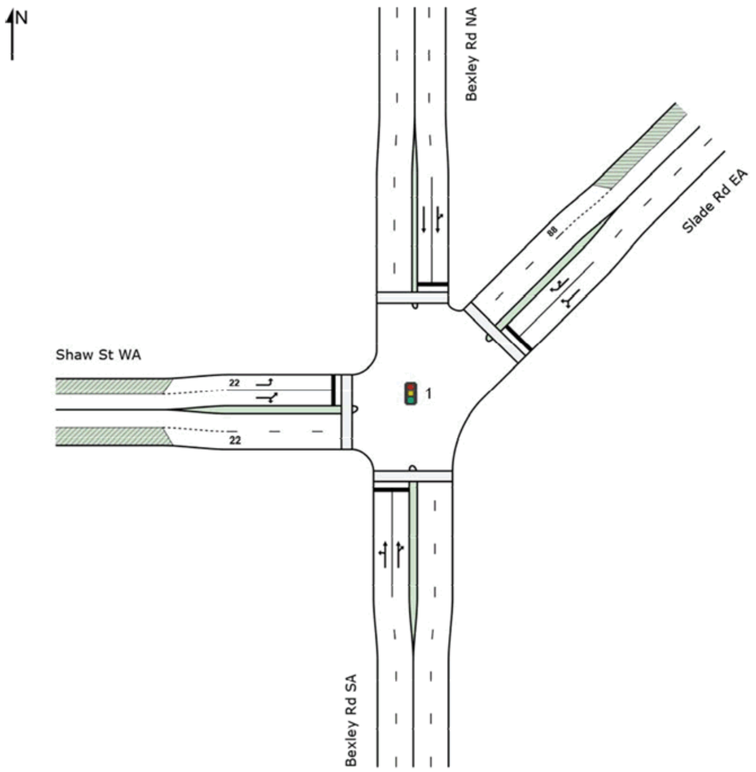
Project: 17.091m1 Traffix Bexley North Hotel PP+FU **Template: Layouts**

Site: 1 [1. AM EX Bexley Rd/ Slade Rd] **Network: 4 [1.AM_EX_Network]**

Bexley Rd/ Slade Rd
AM Peak
Existing
Site Category: -
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Site Practical Cycle Time)

Timings based on settings in the Site Phasing & Timing dialog
Phase Times determined by the program
Downstream lane blockage effects included in determining phase times
Phase Sequence: A-B-C-D
Reference Phase: Phase A
Input Phase Sequence: A, B, C, D
Output Phase Sequence: A, B, C, D

Site Layout



USER REPORT FOR NETWORK SITE

Project: 17.091m1 Traffix Bexley North Hotel PP+FU **Template: Movement_Summary**

Site: 1 [1. AM EX Bexley Rd/ Slade Rd] **Network: 4 [1.AM_EX_Network]**

Bexley Rd/ Slade Rd
AM Peak
Existing
Site Category: -
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Site Practical Cycle Time)

Timings based on settings in the Site Phasing & Timing dialog
Phase Times determined by the program
Downstream lane blockage effects included in determining phase times
Phase Sequence: A-B-C-D
Reference Phase: Phase A
Input Phase Sequence: A, B, C, D
Output Phase Sequence: A, B, C, D

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Aver. Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Bexley Rd SA														
1	L2	24	13.0	24	13.0	1.043	114.8	LOS F	15.2	110.0	1.00	1.44	1.65	14.5
2	T1	1305	4.1	1305	4.1	1.043	103.9	LOS F	15.2	110.0	1.00	1.38	1.68	7.2
3a	R1	172	3.7	172	3.7	1.043	92.0	LOS F	15.2	110.0	1.00	1.21	1.78	3.3
Approach		1501	4.2	1501	4.2	1.043	102.7	LOS F	15.2	110.0	1.00	1.36	1.69	6.8
NorthEast: Slade Rd EA														
24a	L1	113	4.7	113	4.7	0.521	52.9	LOS D	5.6	40.5	0.96	0.80	0.96	7.7
26a	R1	102	0.0	102	0.0	1.043	86.2	LOS F	14.1	100.6	0.98	1.00	1.37	17.1
26b	R3	197	3.2	197	3.2	1.043	131.7	LOS F	14.1	100.6	1.00	1.25	1.91	6.3
Approach		412	2.8	412	2.8	1.043	98.9	LOS F	14.1	100.6	0.98	1.07	1.52	9.4
North: Bexley Rd NA														
7b	L3	144	2.9	144	2.9	1.067	126.4	LOS F	31.4	226.9	1.00	1.35	1.87	3.5
8	T1	1034	4.2	1034	4.2	1.067	129.2	LOS F	37.1	268.8	1.00	1.47	1.86	3.6
Approach		1178	4.0	1178	4.0	1.067	128.9	LOS F	37.1	268.8	1.00	1.46	1.86	3.6
West: Shaw St WA														
10	L2	118	0.0	118	0.0	0.391	49.2	LOS D	3.7	25.6	0.90	0.77	0.90	24.3
10a	L1	292	1.4	292	1.4	1.097	167.9	LOS F	22.2	157.7	1.00	1.52	2.12	8.9
12	R2	33	6.5	33	6.5	1.097	169.2	LOS F	22.2	157.7	1.00	1.52	2.12	8.9
Approach		442	1.4	442	1.4	1.097	136.3	LOS F	22.2	157.7	0.97	1.32	1.80	11.1
All Vehicles		3533	3.6	3533	3.6	1.097	115.2	LOS F	37.1	268.8	0.99	1.36	1.74	6.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

USER REPORT FOR NETWORK SITE

Project: 17.091m1 Traffix Bexley North Hotel PP+FU **Template: Movement_Summary**

Site: 1 [1. PM EX Bexley Rd/ Slade Rd] Network: 1 [2.PM_EX_Network]

Bexley Rd/ Slade Rd
PM Peak
Existing
Site Category: -
Signals - Fixed Time Isolated Cycle Time = 115 seconds (Site User-Given Phase Times)

Timings based on settings in the Site Phasing & Timing dialog
Phase Times specified by the user
Phase Sequence: A-B-C-D
Reference Phase: Phase A
Input Phase Sequence: A, B, C, D
Output Phase Sequence: A, B, C, D

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Aver. Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Bexley Rd SA														
1	L2	20	10.5	20	10.5	0.911	43.0	LOS D	15.4	110.0	0.95	0.99	1.09	27.5
2	T1	1179	1.9	1179	1.9	0.911	42.9	LOS D	15.4	110.0	0.96	1.03	1.21	15.9
3a	R1	112	1.9	112	1.9	0.911	68.6	LOS E	13.7	97.2	1.00	1.18	1.67	6.2
Approach		1311	2.0	1311	2.0	0.911	45.1	LOS D	15.4	110.0	0.97	1.04	1.25	15.1
NorthEast: Slade Rd EA														
24a	L1	184	2.3	184	2.3	0.463	43.1	LOS D	6.4	45.8	0.90	0.80	0.90	9.0
26a	R1	167	0.6	167	0.6	0.926	66.6	LOS E	12.3	86.5	0.98	1.01	1.31	20.2
26b	R3	160	0.7	160	0.7	0.926	75.0	LOS F	12.3	86.5	1.00	1.06	1.42	10.4
Approach		512	1.2	512	1.2	0.926	60.8	LOS E	12.3	86.5	0.96	0.95	1.20	14.3
North: Bexley Rd NA														
7b	L3	155	1.4	155	1.4	0.911	58.0	LOS E	26.6	188.9	1.00	1.07	1.39	8.8
8	T1	1220	1.7	1220	1.7	0.911	51.4	LOS D	26.8	190.5	1.00	1.06	1.28	8.9
Approach		1375	1.7	1375	1.7	0.911	52.2	LOS D	26.8	190.5	1.00	1.06	1.30	8.9
West: Shaw St WA														
10	L2	46	0.0	46	0.0	0.194	53.6	LOS D	1.5	10.2	0.93	0.74	0.93	23.3
10a	L1	143	0.7	143	0.7	0.865	65.6	LOS E	7.1	50.2	1.00	1.01	1.33	18.1
12	R2	43	4.9	43	4.9	0.865	66.9	LOS E	7.1	50.2	1.00	1.01	1.33	18.1
Approach		233	1.4	233	1.4	0.865	63.4	LOS E	7.1	50.2	0.99	0.95	1.25	19.1
All Vehicles		3429	1.7	3429	1.7	0.926	51.5	LOS D	26.8	190.5	0.98	1.03	1.26	13.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

USER REPORT FOR NETWORK SITE

Project: 17.091m1 Traffix Bexley North Hotel PP+FU **Template: Movement_Summary**

Site: 1 [1. AM Fu EX Bexley Rd/ Slade Rd] **Network: 5 [3.AM_Fu_Network]**

Bexley Rd/ Slade Rd
AM Peak
Future
Site Category: -
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Site Practical Cycle Time)

Timings based on settings in the Site Phasing & Timing dialog
Phase Times determined by the program
Downstream lane blockage effects included in determining phase times
Phase Sequence: A-B-C-D
Reference Phase: Phase A
Input Phase Sequence: A, B, C, D
Output Phase Sequence: A, B, C, D

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total	Demand Flows HV	Arrival Flows Total	Arrival Flows HV	Deg. Satn	Average Delay	Level of Service	Aver. Back of Queue Vehicles	Aver. Back of Queue Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Bexley Rd SA														
1	L2	24	13.0	24	13.0	1.075	138.9	LOS F	15.2	110.0	1.00	1.57	1.82	12.5
2	T1	1305	4.1	1305	4.1	1.075	127.7	LOS F	15.2	110.0	1.00	1.50	1.84	6.0
3a	R1	180	3.5	180	3.5	1.075	114.8	LOS F	15.2	110.0	1.00	1.28	1.93	2.8
Approach		1509	4.2	1509	4.2	1.075	126.3	LOS F	15.2	110.0	1.00	1.47	1.85	5.8
NorthEast: Slade Rd EA														
24a	L1	113	4.7	113	4.7	0.520	52.1	LOS D	5.8	41.5	0.95	0.80	0.95	7.8
26a	R1	103	0.0	103	0.0	1.040	81.4	LOS F	14.7	105.1	0.97	0.97	1.32	17.8
26b	R3	214	3.0	214	3.0	1.040	129.8	LOS F	14.7	105.1	1.00	1.24	1.89	6.4
Approach		429	2.7	429	2.7	1.040	97.8	LOS F	14.7	105.1	0.98	1.06	1.51	9.5
North: Bexley Rd NA														
7b	L3	146	2.9	146	2.9	1.052	115.0	LOS F	29.7	215.1	1.00	1.31	1.79	3.8
8	T1	1038	4.2	1038	4.2	1.052	118.1	LOS F	35.8	259.3	1.00	1.42	1.79	3.9
Approach		1184	4.0	1184	4.0	1.052	117.7	LOS F	35.8	259.3	1.00	1.41	1.79	3.9
West: Shaw St WA														
10	L2	118	0.0	118	0.0	0.366	48.2	LOS D	3.6	25.3	0.89	0.77	0.89	24.6
10a	L1	294	1.4	294	1.4	1.062	142.7	LOS F	20.4	145.5	1.00	1.43	1.96	10.2
12	R2	33	6.5	33	6.5	1.062	144.1	LOS F	20.4	145.5	1.00	1.43	1.96	10.2
Approach		444	1.4	444	1.4	1.062	117.7	LOS F	20.4	145.5	0.97	1.25	1.67	12.5
All Vehicles		3567	3.6	3567	3.6	1.075	118.9	LOS F	35.8	259.3	0.99	1.37	1.77	6.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

USER REPORT FOR NETWORK SITE

Project: 17.091m01v02 Traffix Bexley North Hotel PP+FU **Template: Movement Summary**

Site: 1 [1. PM Fu Bexley Rd/ Slade Rd] Network: 3 [4.PM_Fu_Network]

Bexley Rd/ Slade Rd
PM Peak
Future
Site Category: -
Signals - Fixed Time Isolated Cycle Time = 120 seconds (Site Practical Cycle Time)

Timings based on settings in the Site Phasing & Timing dialog
Phase Times determined by the program
Downstream lane blockage effects included in determining phase times
Phase Sequence: A-B-C-D
Reference Phase: Phase A
Input Phase Sequence: A, B, C, D
Output Phase Sequence: A, B, C, D

Movement Performance - Vehicles

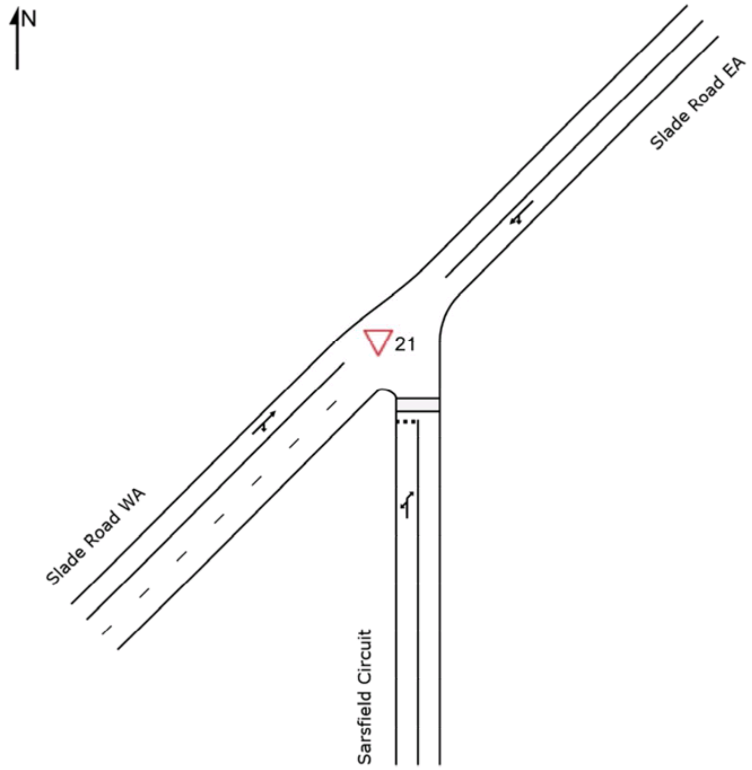
Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Aver. Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Bexley Rd SA														
1	L2	20	10.5	20	10.5	0.922	48.0	LOS D	15.4	110.0	0.98	1.03	1.14	25.9
2	T1	1179	1.9	1179	1.9	0.922	48.1	LOS D	15.4	110.0	0.99	1.08	1.28	14.6
3a	R1	128	1.6	128	1.6	0.922	74.8	LOS F	14.8	105.5	1.00	1.25	1.83	5.7
Approach		1327	2.0	1327	2.0	0.922	50.7	LOS D	15.4	110.0	0.99	1.09	1.33	13.8
NorthEast: Slade Rd EA														
24a	L1	184	2.3	184	2.3	0.463	44.2	LOS D	6.8	48.7	0.89	0.80	0.89	8.8
26a	R1	169	0.6	169	0.6	0.926	67.3	LOS E	13.3	93.9	0.97	0.99	1.28	20.1
26b	R3	177	0.6	177	0.6	0.926	76.9	LOS F	13.3	93.9	1.00	1.05	1.40	10.2
Approach		531	1.2	531	1.2	0.926	62.5	LOS E	13.3	93.9	0.95	0.94	1.19	14.0
North: Bexley Rd NA														
7b	L3	171	1.2	171	1.2	0.911	60.3	LOS E	27.7	196.2	1.00	1.06	1.41	8.5
8	T1	1225	1.7	1225	1.7	0.911	53.2	LOS D	28.2	200.6	1.00	1.05	1.28	8.6
Approach		1396	1.7	1396	1.7	0.911	54.1	LOS D	28.2	200.6	1.00	1.06	1.30	8.6
West: Shaw St WA														
10	L2	46	0.0	46	0.0	0.203	56.4	LOS D	1.5	10.7	0.93	0.74	0.93	22.6
10a	L1	146	0.7	146	0.7	0.923	76.8	LOS F	8.1	57.2	1.00	1.10	1.48	16.3
12	R2	43	4.9	43	4.9	0.923	78.2	LOS F	8.1	57.2	1.00	1.10	1.48	16.3
Approach		236	1.3	236	1.3	0.923	73.0	LOS F	8.1	57.2	0.99	1.03	1.37	17.4
All Vehicles		3489	1.7	3489	1.7	0.926	55.4	LOS D	28.2	200.6	0.99	1.05	1.30	12.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Site: 21 [2. AM EX Slade Rd/Sarsfield Circuit] **Network: 4 [1.AM_EX_Network]**

Slade Rd/Sarsfield Circuit
Existing
AM Peak
Site Category: -
Giveway / Yield (Two-Way)

Site Layout



Site: 21 [2. AM EX Slade Rd/Sarsfield Circuit] **Network: 4 [1.AM_EX_Network]**

Slade Rd/Sarsfield Circuit
Existing
AM Peak
Site Category: -
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Aver. Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Sarsfield Circuit														
1b	L3	5	0.0	5	0.0	0.011	6.7	LOS A	0.0	0.1	0.47	0.62	0.47	36.0
3a	R1	3	0.0	3	0.0	0.011	8.9	LOS A	0.0	0.1	0.47	0.62	0.47	43.2
Approach		8	0.0	8	0.0	0.011	7.5	LOS A	0.0	0.1	0.47	0.62	0.47	40.2
NorthEast: Slade Road EA														
24a	L1	21	0.0	21	0.0	0.218	4.5	LOS A	0.0	0.0	0.00	0.03	0.00	48.5
25	T1	397	2.7	397	2.7	0.218	0.0	LOS A	0.0	0.0	0.00	0.03	0.00	49.7
Approach		418	2.5	418	2.5	0.218	0.2	NA	0.0	0.0	0.00	0.03	0.00	49.6
SouthWest: Slade Road WA														
31	T1	593	2.3	552	2.3	0.293	0.0	LOS A	0.0	0.2	0.01	0.01	0.01	49.9
32b	R3	5	20.0	5	20.1	0.293	8.2	LOS A	0.0	0.2	0.01	0.01	0.01	46.9
Approach		598	2.5	557 N1	2.5	0.293	0.1	NA	0.0	0.2	0.01	0.01	0.01	49.9
All Vehicles		1024	2.5	983 N1	2.6	0.293	0.2	NA	0.0	0.2	0.01	0.02	0.01	49.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

N1 Arrival Flow value is reduced due to capacity constraint at oversaturated upstream lanes.

Site: 21 [2. PM EX Slade Rd/Sarsfield Circuit] **Network: 1 [2.PM_EX_Network]**

Slade Rd/Sarsfield Circuit
Existing
PM Peak
Site Category: -
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Aver. Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Sarsfield Circuit														
1b	L3	5	0.0	5	0.0	0.007	7.1	LOS A	0.0	0.1	0.47	0.61	0.47	36.4
3a	R1	1	0.0	1	0.0	0.007	8.4	LOS A	0.0	0.1	0.47	0.61	0.47	43.3
Approach		6	0.0	6	0.0	0.007	7.3	LOS A	0.0	0.1	0.47	0.61	0.47	38.6
NorthEast: Slade Road EA														
24a	L1	53	2.0	53	2.0	0.277	4.5	LOS A	0.0	0.0	0.00	0.05	0.00	48.3
25	T1	482	1.1	482	1.1	0.277	0.0	LOS A	0.0	0.0	0.00	0.05	0.00	49.4
Approach		535	1.2	535	1.2	0.277	0.5	NA	0.0	0.0	0.00	0.05	0.00	49.2
SouthWest: Slade Road WA														
31	T1	375	1.1	375	1.1	0.200	0.1	LOS A	0.0	0.2	0.02	0.01	0.02	49.8
32b	R3	6	0.0	6	0.0	0.200	8.0	LOS A	0.0	0.2	0.02	0.01	0.02	47.7
Approach		381	1.1	381	1.1	0.200	0.2	NA	0.0	0.2	0.02	0.01	0.02	49.7
All Vehicles		922	1.1	922	1.1	0.277	0.4	NA	0.0	0.2	0.01	0.04	0.01	49.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Site: 21 [2. AM Fu Slade Rd/Sarsfield Circuit] **Network: 5 [3.AM_Fu_Network]**

Slade Rd/Sarsfield Circuit
AM Peak
Future
Site Category: -
Giveway / Yield (Two-Way)

Movement Performance - Vehicles														
Mov ID	Turn	Demand Flows Total	HV	Arrival Flows Total	HV	Deg. Satn	Average Delay	Level of Service	Aver. Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Sarsfield Circuit														
1b	L3	23	0.0	23	0.0	0.039	7.6	LOS A	0.1	0.4	0.47	0.67	0.47	38.5
3a	R1	9	0.0	9	0.0	0.039	9.9	LOS A	0.1	0.4	0.47	0.67	0.47	47.1
Approach		33	0.0	33	0.0	0.039	8.3	LOS A	0.1	0.4	0.47	0.67	0.47	42.7
NorthEast: Slade Road EA														
24a	L1	23	0.0	23	0.0	0.219	4.5	LOS A	0.0	0.0	0.00	0.03	0.00	48.5
25	T1	397	2.7	397	2.7	0.219	0.0	LOS A	0.0	0.0	0.00	0.03	0.00	49.7
Approach		420	2.5	420	2.5	0.219	0.3	NA	0.0	0.0	0.00	0.03	0.00	49.6
SouthWest: Slade Road WA														
31	T1	593	2.3	557	2.3	0.307	0.1	LOS A	0.1	0.6	0.04	0.02	0.04	49.6
32b	R3	18	5.9	17	5.9	0.307	8.5	LOS A	0.1	0.6	0.04	0.02	0.04	49.8
Approach		611	2.4	574 N1	2.4	0.307	0.4	NA	0.1	0.6	0.04	0.02	0.04	49.6
All Vehicles		1063	2.4	1027 N1	2.5	0.307	0.6	NA	0.1	0.6	0.04	0.05	0.04	49.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

N1 Arrival Flow value is reduced due to capacity constraint at oversaturated upstream lanes.

Site: 21 [2. PM Fu Slade Rd/Sarsfield Circuit] **Network: 3 [4.PM_Fu_Network]**

Slade Rd/Sarsfield Circuit
PM Peak
Future
Site Category: -
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

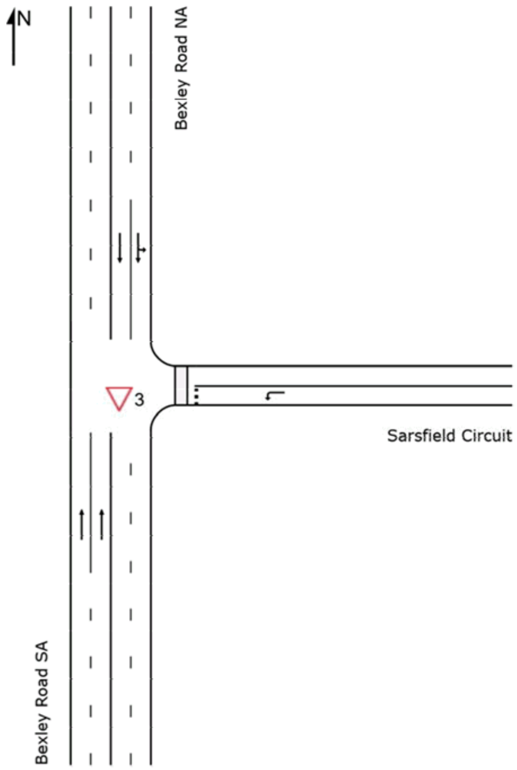
Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Aver. Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Sarsfield Circuit														
1b	L3	24	0.0	24	0.0	0.038	8.1	LOS A	0.1	0.4	0.49	0.69	0.49	38.6
3a	R1	7	0.0	7	0.0	0.038	9.7	LOS A	0.1	0.4	0.49	0.69	0.49	47.9
Approach		32	0.0	32	0.0	0.038	8.4	LOS A	0.1	0.4	0.49	0.69	0.49	42.4
NorthEast: Slade Road EA														
24a	L1	61	1.7	61	1.7	0.281	4.5	LOS A	0.0	0.0	0.00	0.06	0.00	48.3
25	T1	482	1.1	482	1.1	0.281	0.0	LOS A	0.0	0.0	0.00	0.06	0.00	49.4
Approach		543	1.2	543	1.2	0.281	0.5	NA	0.0	0.0	0.00	0.06	0.00	49.3
SouthWest: Slade Road WA														
31	T1	375	1.1	375	1.1	0.239	0.5	LOS A	0.2	1.3	0.15	0.07	0.15	48.7
32b	R3	42	0.0	42	0.0	0.239	9.0	LOS A	0.2	1.3	0.15	0.07	0.15	48.9
Approach		417	1.0	417	1.0	0.239	1.4	NA	0.2	1.3	0.15	0.07	0.15	48.7
All Vehicles		992	1.1	992	1.1	0.281	1.1	NA	0.2	1.3	0.08	0.09	0.08	48.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Site: 3 [3. AM EX Bexley Rd/Sarsfield Circuit] Network: 4 [1.AM_EX_Network]

Bexley Rd/Sarsfield Circuit
Existing
AM Peak
Site Category: -
Giveway / Yield (Two-Way)

Site Layout



Site: 3 [3. AM EX Bexley Rd/Sarsfield Circuit] **Network: 4 [1.AM_EX_Network]**

Bexley Rd/Sarsfield Circuit
Existing
AM Peak
Site Category: -
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Aver. Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Bexley Road SA														
2	T1	1501	4.2	1501	4.2	0.395	0.0	LOS A	46.6	337.6	0.00	0.00	0.00	59.9
Approach		1501	4.2	1501	4.2	0.395	0.0	NA	46.6	337.6	0.00	0.00	0.00	59.9
East: Sarsfield Circuit														
4	L2	27	3.8	27	3.8	0.035	7.5	LOS A	0.1	0.4	0.51	0.63	0.51	41.1
Approach		27	3.8	27	3.8	0.035	7.5	LOS A	0.1	0.4	0.51	0.63	0.51	41.1
North: Bexley Road NA														
7	L2	2	0.0	2	0.0	0.293	5.5	LOS A	0.0	0.0	0.00	0.00	0.00	55.6
8	T1	1177	4.3	1109	4.3	0.293	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach		1179	4.3	1111 N1	4.3	0.293	0.0	NA	0.0	0.0	0.00	0.00	0.00	59.9
All Vehicles		2707	4.2	2639 N1	4.3	0.395	0.1	NA	46.6	337.6	0.01	0.01	0.01	59.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

N1 Arrival Flow value is reduced due to capacity constraint at oversaturated upstream lanes.

Organisation: TRAFFIX PTY LTD | Created: Tuesday, 8 October 2019 9:37:26 AM
Project: T:\Synergy\Projects\17\17.091\Modelling\17.091m1 Traffix Bexley North Hotel PP+FU.sip8

Site: 3 [3. PM EX Bexley Rd/Sarsfield Circuit] **Network: 1 [2.PM_EX_Network]**

Bexley Rd/Sarsfield Circuit
Existing
PM Peak
Site Category: -
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Aver. Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Bexley Road SA														
2	T1	1311	2.0	1311	2.0	0.421	0.0	LOS A	19.0	135.0	0.00	0.00	0.00	59.9
Approach		1311	2.0	1311	2.0	0.421	0.0	NA	19.0	135.0	0.00	0.00	0.00	59.9
East: Sarsfield Circuit														
4	L2	56	1.9	56	1.9	0.086	9.0	LOS A	0.1	1.0	0.58	0.73	0.58	39.9
Approach		56	1.9	56	1.9	0.086	9.0	LOS A	0.1	1.0	0.58	0.73	0.58	39.9
North: Bexley Road NA														
7	L2	5	0.0	5	0.0	0.376	5.5	LOS A	0.0	0.0	0.00	0.00	0.00	55.6
8	T1	1442	1.9	1442	1.9	0.376	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
Approach		1447	1.9	1447	1.9	0.376	0.0	NA	0.0	0.0	0.00	0.00	0.00	59.8
All Vehicles		2814	1.9	2814	1.9	0.421	0.2	NA	19.0	135.0	0.01	0.02	0.01	58.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Site: 3 [3. AM Fu Bexley Rd/Sarsfield Circuit] **Network: 5 [3.AM_Fu_Network]**

Bexley Rd/Sarsfield Circuit
AM Peak
Future
Site Category: -
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total	Demand Flows HV	Arrival Flows Total	Arrival Flows HV	Deg. Satn	Average Delay	Level of Service	Aver. Back of Queue Vehicles	Aver. Back of Queue Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Bexley Road SA														
2	T1	1509	4.2	1509	4.2	0.398	0.0	LOS A	51.9	376.2	0.00	0.00	0.00	59.9
Approach		1509	4.2	1509	4.2	0.398	0.0	NA	51.9	376.2	0.00	0.00	0.00	59.9
East: Sarsfield Circuit														
4	L2	39	2.7	39	2.7	0.050	7.9	LOS A	0.1	0.6	0.51	0.65	0.51	42.0
Approach		39	2.7	39	2.7	0.050	7.9	LOS A	0.1	0.6	0.51	0.65	0.51	42.0
North: Bexley Road NA														
7	L2	6	0.0	6	0.0	0.298	5.5	LOS A	0.0	0.0	0.00	0.01	0.00	55.5
8	T1	1177	4.3	1124	4.3	0.298	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
Approach		1183	4.3	1130 N1	4.3	0.298	0.0	NA	0.0	0.0	0.00	0.00	0.00	59.8
All Vehicles		2732	4.2	2678 N1	4.3	0.398	0.1	NA	51.9	376.2	0.01	0.01	0.01	59.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

N1 Arrival Flow value is reduced due to capacity constraint at oversaturated upstream lanes.

Organisation: TRAFFIX PTY LTD | Created: Tuesday, 8 October 2019 9:40:09 AM
Project: T:\Synergy\Projects\17\17.091\Modelling\17.091m1 Traffix Bexley North Hotel PP+FU.sip8

Site: 3 [3. PM Fu Bexley Rd/Sarsfield Circuit] **Network: 3 [4.PM_Fu_Network]**

Bexley Rd/Sarsfield Circuit
PM Peak
Future
Site Category: -
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Aver. Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Bexley Road SA														
2	T1	1327	2.0	1327	2.0	0.448	0.0	LOS A	22.0	156.9	0.00	0.00	0.00	59.8
Approach		1327	2.0	1327	2.0	0.448	0.0	NA	22.0	156.9	0.00	0.00	0.00	59.8
East: Sarsfield Circuit														
4	L2	73	1.4	73	1.4	0.111	9.2	LOS A	0.2	1.3	0.59	0.75	0.59	40.5
Approach		73	1.4	73	1.4	0.111	9.2	LOS A	0.2	1.3	0.59	0.75	0.59	40.5
North: Bexley Road NA														
7	L2	11	0.0	11	0.0	0.377	5.5	LOS A	0.0	0.0	0.00	0.01	0.00	55.5
8	T1	1442	1.9	1442	1.9	0.377	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
Approach		1453	1.9	1453	1.9	0.377	0.1	NA	0.0	0.0	0.00	0.00	0.00	59.7
All Vehicles		2853	1.9	2853	1.9	0.448	0.3	NA	22.0	156.9	0.02	0.02	0.02	58.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Organisation: TRAFFIX PTY LTD | Created: Friday, 8 May 2020 2:29:55 PM
Project: T:\Synergy\Projects\17\17.091\Modelling\17.091m01v02 Traffix Bexley North Hotel PP+FU.sip8