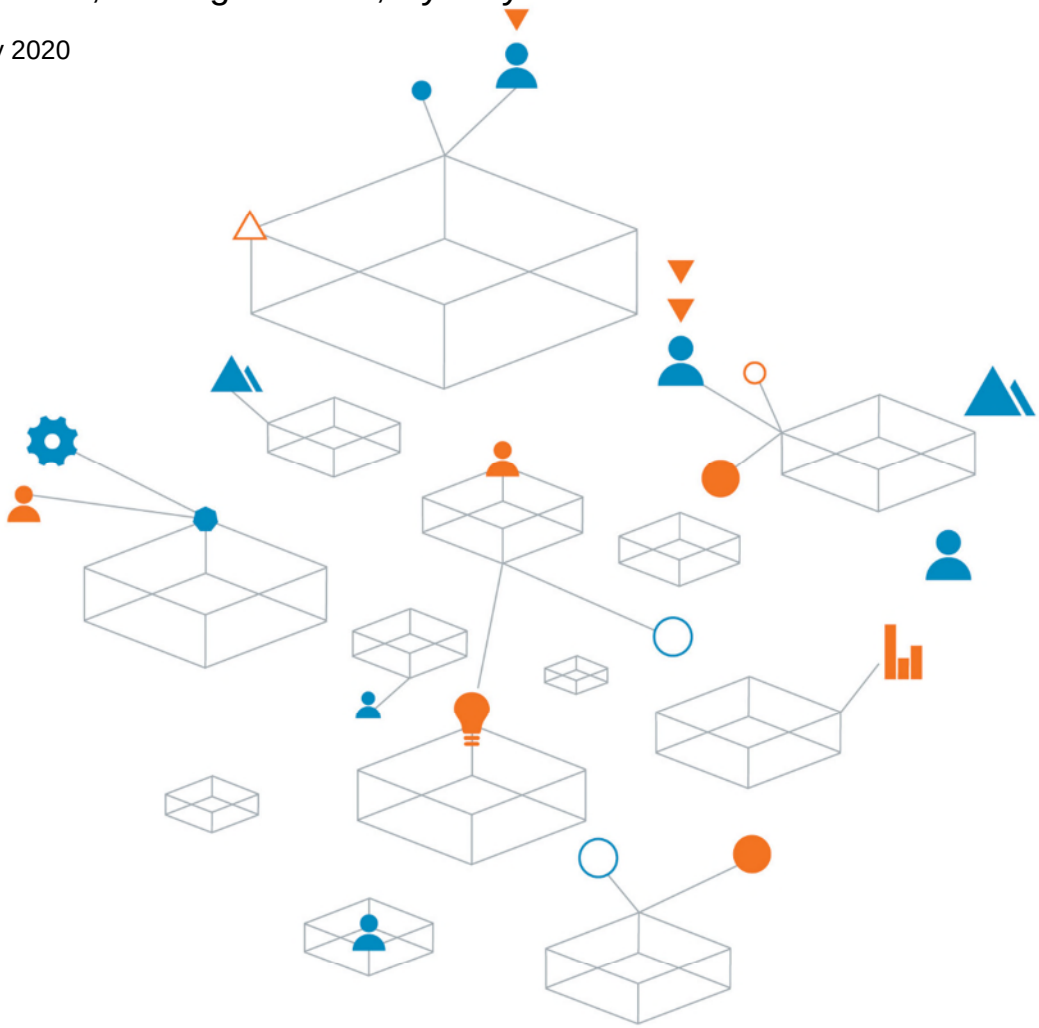
Mirvac Projects Pty Ltd

Preliminary Acid Sulfate Soil Management Plan

Harbourside Shopping Centre
Darling Drive, Darling Harbour, Sydney

3 February 2020



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Harbourside Shopping Centre

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Mirvac Projects Pty Ltd

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Table of contents

Appendices

1 Introduction

1.1. General

Coffey Services Australia Pty Ltd (Coffey) was engaged by Mirvac Projects Pty Ltd (Mirvac) to prepare a Preliminary Acid Sulfate Soil Management Plan (ASSMP) for the proposed redevelopment of the Harbourside Shopping Centre (the 'site'), which is situated on the western foreshore of Darling Harbour. The location of the site is shown in Figure 1.

The work was commissioned by Mr. Lachlan Attiwill on behalf of Mirvac. The commission was in response to a proposal submitted by Coffey dated 30th July 2018 (ref: GEOTLCOV25340AB-AA).

This report has been prepared in response to submissions received on the Concept Proposal presented in State Significant Development Application for the redevelopment of the Harbourside Shopping Centre (SSD 7874).

1.2. Proposed Development

Mirvac proposes to demolish the existing Harbourside Shopping Centre and construct a new multi-storey retail centre and residential tower. A three-level basement car park will be provided in the centre of the site with a finished floor level of -7.5mAHD. Coffey understands that the proposed development will fall within the footprint of the existing Harbourside Shopping Centre and does not require modification of the existing seawall.

Information provided to Coffey describing the proposed development concept is provided in Appendix B. These drawings show that the proposed development will include:

- Multi-storey buildings founded on bored piles extending to bedrock;
- Car parking, which may extend about 8m below ground surface (mbgs);
- Lift bases, pile caps and stair bases;
- General trenches and excavations for the purpose of infrastructure and services;
- Excavations that may be required as part of remediation and/or archaeological works;
- Excavation and construction of retention systems that provide cut-off to groundwater flow through the permeable fill and estuarine/alluvial deposits. Retention/cut-off options may comprise diaphragm wall and secant pile wall.
- Extensive dewatering involving the lowering of the water table for extended periods (months) is not anticipated during construction however, dewatering for shorter periods for the localised excavation of basement, lift pits, pile caps, infrastructure services and associated with archaeological works may be required.

This ASSMP presents a framework for the approach and methodology of ASS management at the site during the construction phase to be followed by the contactor and its subcontractors. It provides a basis for specifications for ASS management in the understanding that a site specific ASSMP will be prepared for construction.

It is envisaged that this ASSMP may require revision as site specific investigations are completed and detailed design has been undertaken.

1.3. Objectives

The objective of the ASSMP is to assess the potential to encounter ASS and reduce the potential environmental impacts associated with the disturbance of ASS within the area of the proposed works. The ASSMP is prepared in general accordance with the Acid Sulfate Soils Assessment Guidelines (Ahern et al, 1998a) and the Acid Sulfate Soils Management Guidelines (Ahern et al, 1998b) in the Acid Sulfate Soil Manual, published by the Acid Sulfate Soils Management Advisory Committee (ASSMAC). Reference has also been made to the Queensland ASS Technical Manual Soil Management Guidelines (Dear et al 2002) and the ASS Laboratory Test Methods (QASSIT 2004).

1.4. Previous Reports

Coffey has prepared the following reports in relation to the site:

- Coffey (Aug 2018); *Preliminary Site Contamination Assessment; Harbourside Shopping Centre, Darling Drive, Darling Harbour, Sydney* (Ref: GEOTLCOV25340AB-AB)
- Coffey (Sept 2016); *Preliminary Geotechnical Assessment Report; Harbourside Darling Harbour* (GEOTLCOV25340AA-AD)
- Coffey (Sept 2016b); *Preliminary Groundwater Assessment Report; Harbourside Darling Harbour* (GEOTLCOV25340AA-AE)

Mirvac provided the following reports for Coffey's consideration in the development of this ASSMP:

- Coffey (Aug 2013a); *Detailed Site Investigation Report for SSDA6 – International Convention Centre Hotel Development, Sydney International Convention, Exhibition & Entertainment Precinct* (Ref: GEOTLCOV24303AH-AD)
- Coffey (Aug 2013b); Geotechnical Investigation Report for SSDA6 – Sydney International Exhibition and Entertainment Precinct – ICC Hotel (Ref: GEOTLCOV24303AH-AH)
- Douglas Partners (June 2013); *Preliminary Geotechnical Assessment of Piles – Proposed Upgrade of Harbourside Shopping Centre, Darling Drive, Darling Harbour* (Project Ref: 73498)

The site conditions, geology and hydrogeology information included in Section 2 in this ASSMP has been reproduced from these reports.

It is noted that no investigations have been completed within the site. The only ASS sampling and analysis data available was obtained from the Coffey (2013a) report at the adjacent site.

2. Physical setting

2.1. Site Description

The site is located along the western foreshore of Darling Harbour and is occupied entirely by the Harbourside Shopping Centre. The location of the site and study boundaries is shown in Figure 1.

The site occupies an area of approximately 2ha and is bound by Darling Drive to the west, Pyrmont Bridge to the north and Darling Harbour public realm and Cockle Bay Hay Street to the east. The site layout is provided in Figure 2.

2.2. Soils and Geology

Available records indicate that the western portion of the site historically formed part of a tidal mudflat, with the eastern portion of the site was submerged within Cockle Bay. Land reclamation activities commenced in the 1860s to extend the Darling Harbour railway branch line towards the Pyrmont Bay wharves (Coffey, Aug 2018).

The fill used to form the current shoreline overlies estuarine and alluvial deposits, which are underlain by residual soil and Hawkesbury Sandstone bedrock.

Estuarine sediments (likely Holocene in age) overlying older alluvium (likely Pleistocene in age) are anticipated within the site, which are likely to have been deposited predominantly in a south-north direction consistent with the shape of Cockle Bay. The thickness of the estuarine and alluvial sediments are anticipated to increase in an easterly direction.

Due to their age difference and depositional history, Holocene and Pleistocene sediments often exhibit very different characteristics. The lower Pleistocene sediments tend to be more stiff and dense in nature and exhibit orange and brown hues owing to exposure and oxidation during falls in sea-level. The upper Holocene sediments tend to be softer and looser in nature, and typically grade from dark grey to black in colour, often with organics and shell fragments.

It is possible that these estuarine and alluvial sediments are absent, or at least of negligible thickness given the disturbance associated with historic reclamation activities and maritime freight operations.

2.3. Hydrogeology

Given the proximity of the site to Darling Harbour and the local stratigraphy, it is expected that groundwater beneath the site will be saline and tidally influenced in fill material, with a net gradient towards the Cockle Bay. Standing water levels recorded in monitoring wells installed to the southeast of the site ranged from 0.4m to 0.6mAHD.

2.4. General Subsurface Profile

Previous investigations installed seventeen boreholes within areas to the south and southwest of the site (Coffey, Aug 2013a). A summary of the ground conditions recorded within these boreholes is presented in Table 2.1.

Table 2.1: Summary of ground conditions to the south and west of the site

Unit	Depth to Top of Unit (mbgs)	Approx. Unit Thickness	Material Description
Fill	0m	0.4m to 3.9m	Asphalt and concrete paving overlying FILL with the consistency of sand and gravelly sand: fine to coarse grained, brown, orange and grey, gravel is fine to coarse. FILL thickness increased toward Cockle Bay (east).
Estuarine/ Alluvium Sediments	Observed in discrete horizons at 2.5m and 3.0m	0.4m to 0.7m	SAND: Medium to coarse, dark grey and brown, with some shells and a trace of clay and roots. Typically observed as loose to medium dense, and moist.
Residual Soil	0.6m to 3.4m	0.2m to 1.5m	Silty SAND: fine to coarse, orange brown mottled grey, with a trace of fine to medium sandstone gravel. Typically observed as medium dense to dense.

Unit	Depth to Top of Unit (mbgs)	Approx. Unit Thickness	Material Description
Sandstone	0.8m to 4.1m. Generally deepest at the southern boundary	Not proven	SANDSTONE: Fine to medium grained, orange brown mottled pale grey. Ranges from highly weathered to fresh with dark grey interlaminated shale seams up to 1m thick.

Indicative geological cross sections through the site presenting the inferred sub-surface conditions are presented within Appendix D.

2.5. Acid Sulfate Soil Occurrence

The DLWC (1997) 1:25,000 scale ASS risk map shows the site as disturbed terrain, which they describe as "*Disturbed terrain may include filled areas, which often occur during reclamation of low lying swamps for urban development. Other disturbed terrain includes areas which have been mined or dredged, or have undergone heavy ground disturbance through general urban development or construction of dams or levees. Soil investigations are required to assess these areas for acid sulfate soil potential."*

With reference to the Acid Sulfate Soil (ASS) Risk Map available in the Australian Soil Resource Information System (ASRIS), the site is noted as 'Disturbed Terrain' which relates to the historic reclamation of low lying areas along the Darling Harbour foreshore for port facilities in the mid-1800s.

The ASRIS map indicated that there was a high probability of ASS or Potential ASS in sediments in Darling Harbour and Sydney Harbour. There is evidence that the site and surrounding area has been reclaimed using harbour sediments, possibly along with other sources of fill material. Therefore it is possible that the some of the fill material at the site could contain ASS or Potential ASS.

3. Coastal acid sulfate soils

3.1. Background

Coastal ASS are commonly found in low lying coastal floodplains, estuaries, rivers and creeks. They are naturally occurring sediments rich in iron sulfides that form sulfuric acid when exposed to oxygen. Coastal ASS can include **potential** ASS (PASS) and **actual** ASS (AASS).

PASS are soils which contain iron sulfides or sulfidic material. In their undisturbed state, PASS may exhibit a pH of 4 or greater, and may be slightly alkaline. When exposed to air, the sulfides in PASS oxidise and can release significant quantities of acid. Following oxidation, the pH of these soils may fall considerably below pH 3.5.

AASS are highly acidic soils resulting from the oxidation of iron sulfides or sulfidic material present in the soil profile. AASS are formed through the disturbance of PASS, which may be a result of either natural disturbances (i.e. regional fall in groundwater levels which exposes PASS to oxygen) or human disturbances (i.e. excavating PASS, dewatering and/or dredging). AASS are typically characterised by pale yellow mottles, coating of soils with jarosite and pH of 4 or less.

3.2. Existing Laboratory Results

As noted above, no investigations have been completed within the site to confirm the presence of ASS. Investigation data and laboratory screening test results from the ICC Hotel development site located to the south and southwest of the site is summarised in Table 3.1 (Coffey Aug 2013a). The location of the boreholes relative to the site are shown on Figure 2.

Table 3.1: ASS Screening Results

Borehole Reference_ Sample Depth	Stratum	Field pH	pH_{FOX}	Reaction Description
BH202_0.6-0.7m	Residual Soil	8.2	5.8	Low
BH203_1.8-2.0	Residual Soil	7.9	5.4	Low
BH206_1.1-1.4	Residual Soil	8.9	6.9	Low
BH204A_2.8-2.9	Fill	7.2	2.2	Low
BH204A_3.8	Fill	6.7	2.0	Low
BH204A_3.9	Alluvium	7.3	2.6	Volcanic
BH204A_4.0-4.1	Alluvium	7.5	5.5	High

Notes:
1. Field Peroxide Reaction Descriptions are qualitative descriptions provided by the laboratory. These descriptions are provided to indicate the strength of reaction between soils and peroxide, and hence the presence of unoxidised sulfides.

No samples showed field pH (pH_F) less than 4. Soil in water showing pH below 4 can be an indication of AASS.

The laboratory results for field pH (pH_F) and pH after oxidation (pH_{FOX}) indicated that sample BH204A from a depth of 3.9m to 4.1m indicated a high likelihood for the presence of ASS given:

a) the samples were alluvium being dark grey silty Sand with some shells;

b) The difference between the pH_F and the pH_{FOX} values; and

c) The vigorous chemical reactions that were observed during testing.

The investigation data also shows a large difference between the pH_F and pH_{FOX} values reported in the deeper fill materials within BH204A, which may also be indicative of potential acid sulfate soils (PASS).

Based on these results and the site geology, it was assessed that PASS is likely to be present within the site where estuarine/alluvial soils are present.

3.3. Summary of ASS Risk

The following summary of ASS risk is based on the current level of knowledge regarding the soil profiles, and the development of a site specific ground model including bored piles to bedrock.

3.3.1. Fill Material

In consideration of the historic uses of the site (Coffey, 2018a), the composition of fill material is expected to be variable across the site. However, historical information suggests that some of the fill materials may comprise dredged sediments from Cockle Bay. It is unclear when these sediments were placed as fill and there is a risk that these dredged sediments may be ASS. Two samples of fill from

BH204A that was screened using the ASS field screening test indicated that deeper fill material at this location may comprise PASS. Fill materials encountered in other bores positioned to the southwest of the site did not exhibit the characteristics of dredged harbour sediments, although further investigation is required to assess this.

The risk of encountering ASS within the fill is related to the time the sediments were placed and hence the length of time that oxidation could have occurred and the height of groundwater in the fill which would tend to slow down the oxidation process.

It is considered likely that pockets of fill material may be encountered which have some stored acidity and will need to be managed as ASS.

Given the uncertainties associated with the placement and occurrence of dredged sediments the fill material will require check testing during excavation (refer to Sections 4.5 and 4.6), and if the laboratory results indicate that stored acidity is present, then they will require management in accordance with this ASSMP.

3.3.2. Estuarine and Alluvium Deposits

The alluvium and estuarine deposits are expected to increase in thickness in an easterly direction across the site. The estuarine soils generally comprise very soft to firm clays and very loose to loose sand, dark grey to black in colour. Estuarine soils are often characterised by organic and/or sulfurous odours. The alluvium generally comprises firm to very stiff clay and dense sand, grey and brown, often with red or orange mottling.

Estuarine alluvial deposits have a higher probability of being PASS and the limited laboratory analysis available generally supports this. Investigation records from land to the southwest indicate that the estuarine deposits are not consistently present, and that estuarine soils are not shown on all logs. It would be expected that estuarine soils would exist within former tidal creeks (prior to infilling) and as a thin layer over older alluvium.

3.3.3. Residual Soils and Weathered Sandstone

Residual soils weathered from Hawkesbury Sandstone, and weathered sandstone are not coastal ASS, and therefore do not require management under this ASSMP.

3.3.4. Summary

Based on the review of the available geological information plus the laboratory results from investigation data from adjoining land, the risk of ASS is considered to be highest in the estuarine alluvial soils. There is the potential for encountering ASS within the deeper fill materials. As such, these soils will require management in accordance with this ASSMP if excavated or disturbed.

Residual soil and weathered bedrock materials are not ASS and therefore do not require management under this ASSMP.

Localised dewatering may be required, and prolonged dewatering has the potential to expose ASS to oxidation and produce acidic water, and procedures will be required to manage these risks.

The probability of ASS being encountered during the various construction activities is outlined in Table 3.3 below.

Table 3.2 – Probability of Encountering ASS

Construction Activity	Probability of Encountering ASS
Boring pile foundations	High probability of encountering ASS. Piles will extend through estuarine soils. There is also a low to moderate probability of encountering pockets of fill which are ASS.
Car park excavation to 6mbgs (approx. -3mAHD)	The basement is expected to extend through the fill and estuarine alluvial soils on site, requiring these materials to be removed. There is a high probability of encountering ASS within this excavation.
Excavation of pile caps, lift bases and stair bases.	Localised excavation in areas outside of the basement footprint may extend to depths that encounter deeper fill and/or estuarine alluvium that classify as ASS.
Trenches and excavations for infrastructure and services.	Likely to be required across most of the site extending through shallow fill material at depths less than 1.5mbgs. Based on available data, there is a low likelihood of encountering pockets of fill which are ASS where trenches and excavation extends to depths of circa 1.5mbgs. Where here the infrastructure/services excavations extend beyond depths of say 3mbgs, there is a high probability of encountering ASS. Should directional drilling/under-boring be proposed for installation of services beyond the boundary of the basement, these would likely encounter ASS.
Excavations for remediation and/or archaeological purposes.	The depth of proposed remediation/archaeological excavations is not known. Where the remediation/archaeological excavations extend beyond the depth of fill, there is a high probability of encountering ASS.
Excavation/retention systems.	The depth of proposed excavation/retention systems is not known although will likely need to socket into the underlying bedrock. As such, there is a high probability of encountering pockets of fill and estuarine deposits which are ASS.

It is anticipated that material which has been excavated, may be managed in the following ways:

- Disposed to landfill - this material will require treatment and management. Guidance on the management and treatment of excavated soils is provided in Section 4.8 below;
- Re-used on site after long-term stockpiling - this material will require treatment and management. Guidance on the management and treatment of excavated soils is provided in Section 4.8 below;
- Re-used on site, under the water table, after short to medium term stockpiling – there is a reduced need to treat these soils as they will not be exposed for long time periods, and will be returned to below the water table. Guidance on the management of these soils is provided in Section 4.9 below.

4. Management plan and procedures for Acid Sulfate Soils

4.1. General

The monitoring and management of ASS will be the responsibility of the Contractor who will prepare a site-specific ASSMP based on the actual construction scenario and using the framework provided by this preliminary ASSMP. The site-specific ASSMP will require review and approval by Department of Planning and Infrastructure as part of the overall project approval and subsequent Development Applications (where relevant).

It is noted that sampling completed as part of assessments prepared for the adjoining land does not conform with the NSW (1998) ASS Manual where it is recommended that samples are collected from the site and field screened at 0.5m intervals (vertically), and selected samples tested in the laboratory for further assessment (SCR). Future sampling and analysis is required to improve confidence on the location and depth of ASS and liming rates to manage these materials effectively. The results, including liming rates (if applicable) should be incorporated into the site-specific ASSMP.

The following general management procedures are considered applicable for the following activities:

- Spoil generated from bored piles extending to bedrock.
- Excavations for construction of basement car parks, which extend to an elevation of circa -7.5mAHD.
- Excavations for lift bases, pile caps and stair bases.
- General trenches and excavations for the purpose of infrastructure and services.
- Excavations that may be required as part of remediation and/or archaeological works.
- Excavation and retention systems.
- Localised dewatering of the above excavations.

Extensive dewatering involving the lowering of the water table for extended periods (months) is not currently anticipated during construction, therefore detailed management measures for dewatering has not been provided. The general management procedures are:

a) Appointment of an appropriately qualified person to manage the ASS issues during the earthwork activities and prepare an induction for staff undertaking earthworks on this project.

b) Undertake regular monitoring (screening) of deeper fill material, and the alluvium and estuarine soils to assess the potential presence of ASS during excavation activities;

c) Undertake regular surface water and groundwater monitoring during localised dewatering to assess if the surface water or groundwater has been impacted by oxidation of ASS;

d) Manage the materials that are assessed to potentially be ASS through temporary stockpiling and treatment with lime to neutralise sulphuric acid produced via oxidation.

e) Assess options for water that requires disposal.

These procedures are further discussed in the following sections.

In the event that extensive dewatering involving the lowering of the water table for extended periods (months) is required, detailed management measures for dewatering will need to be assessed.

4.2. Preparation of a Site-Specific ASSMP

The Contractor will be responsible for preparation of a site-specific ASSMP based on the actual construction scenario.

The site-specific ASSMP will need to use the framework provided in this general ASSMP, including information on:

- The results of the additional sampling and analysis (as per Section 4.4), if carried out;
- Training, roles and responsibilities;
- Management of excavated soils;
- Treatment and monitoring of acid sulfate soils, including liming rates;
- Management of temporary stockpiles;
- Management of dewatering water, including liming rates;
- Options for re-use and/or disposal of soils;
- Options for disposal of water;
- Monitoring and reporting requirements.

4.3. Training, Roles and Responsibilities

The earthworks contractor will appoint an appropriately trained person who is responsible for managing the ASS issues during the earthwork activities.

This person should be familiar with:

- Council and other relevant statutory requirements;
- Recognition of ASS materials;
- ASS testing and treatment procedures;
- Onsite management of ASS materials, including implementing management procedures.

The classification of ASS materials during construction should be carried out by personnel trained in the identification of ASS and be based on visual classification and the field screening test. If required, a suitably qualified Environmental Consultant could be engaged to assist or train the Contractor in the identification of ASS.

4.4. Additional Assessment

The 1998 ASS Manual states that for sites covering an area of 1 to 2 hectares, samples should be collected from a minimum of 6 sampling locations, with soil samples collected at 0.5m intervals at each

location. Samples should be collected to a depth of 1m below the proposed depth of disturbance, or refusal on bedrock.

As no site specific investigation has been completed to date, additional sampling and analysis is required to satisfy these guidelines. The sampling and analysis can be undertaken as part of investigations proposed to assess the contamination status of the site and/or geotechnical investigations to inform the design of the proposed development. The investigation should aim to improve confidence on the location and depth of ASS and liming rates. This data should be incorporated into a site-specific ASSMP to be prepared and implemented on site.

4.5. Visual Classification

The preliminary visual checking of potential ASS will be based on material type, colour and consistency. Dark grey and black, very soft to soft, occasionally firm clays and sandy clays and dark grey to grey, very loose to loose clayey sands and sands will be classified as suspected acid sulfate soils.

The site soils comprise fill materials, overlying alluvial and estuarine soils. There is a potential for the fill material to contain pockets of dredged sediments, which may be ASS. The alluvial soils are generally unlikely to be ASS and would comprise stiffer clays and denser sands, and are typically brown, grey and mottled orange in colour. Where significant interbedding is observed and the visible classification is inconclusive, the material should be classified as suspected acid sulfate soils.

4.6. Screening Test Classification and pH Monitoring

A screening test using hydrogen peroxide (H_2O_2) will be performed regularly on the excavated soils. The peroxide screening test will be undertaken based on Appendix I of the ASSMAC (1998) Acid Sulfate Soils Manual (Ahern et al, 1998a). Soils that record a pH of below 4, following oxidation with H_2O_2, will be managed as ASS.

Based on the results of pH monitoring, visual assessment and peroxide screening, selected soils samples (at a minimum rate of 10% of screened samples) will be sent for laboratory analysis using the chromium reducible suite (Scr) method (or similar) to confirm the peroxide screening test results to confirm the required liming rate.

4.7. Management of Excavated Soil During Construction

Table 4.1 below summarises the required management/treatment of soils for the various construction activities, and frequency of check testing and validation sampling, and the field and laboratory analysis required. More detailed information on how to carry out the recommended treatment, and the requirements of sampling and analysis are provided in Sections 4.8 and 4.9.

The probability of ASS being encountered during the various construction activities is outlined in Table 3.2.

From the review of the development plans, it is assessed that material which will be excavated, will not be returned to the excavation. The possible exceptions to this are soils excavated from infrastructure/services trenches, and remediation/archaeological excavations. The material excavated for remediation/archaeological purposes is not expected to be returned to the excavation within a short to medium time frame, and therefore will require treatment similarly to other excavated soils.

The soils excavated from the infrastructure/services trenches may be able to be returned to below the water table within the trench within a short timeframe, reducing the need to treat these soils.

Table 4.1 – Management/Treatment of ASS for Various Construction Activities

Construction Activity	Treatment/Management Method^	Check Testing Frequency and Analysis	Validation Sampling and Analysis
Boring pile foundations	It is considered impractical to attempt to separate the soil cuttings that could contain ASS, from the soil cuttings that are not ASS. It is also considered that the non-ASS cuttings and cementitious grout could act as a sufficient buffer to neutralise the ASS present, provided the ratio of ASS to non ASS is greater than 3:1. As a precaution samples of the soil cuttings should be tested to assess if there is a need for additional neutralisation by liming. If liming is required, the procedures in Section 4.8 should be carried out.	One sample per 250m^3 to be analysed using the screening test. If the screening tests indicate cuttings are ASS, then 10% of samples should be tested using the S_{CR} test to check the liming rate.	If liming is carried out, validation sampling will be required. This would comprise one sample per 250m^3 to be analysed using the field screening test.
Car park excavation.	A soil retention system is required to be installed to enable the basement excavation to achieve the target depth, and prevent groundwater inflow. The retention system would be installed in advance of the basement excavation works to negate the need for extensive dewatering. Once the retention system has been constructed, suspected ASS shall be placed in the treatment area. Check testing is required to assess if the soil is ASS, and confirm liming rates. Depending on the results of check testing, the soil will be treated with lime as per the procedures in Section 4.8.	One sample per 250m^3 to be analysed using the screening test. If the screening tests indicate cuttings are ASS, then 10% of samples should be tested using the S_{CR} test to check the liming rate.	If liming is carried out, validation sampling will be required. This would comprise one sample per 250m^3 to be analysed using the field screening test.
Excavation of pile caps, lift bases and stair bases.	The soils will need to be placed in the treatment area. Check testing is required to assess if the soil is ASS, and confirm liming rates. Depending on the results of check testing, the soil will be treated with lime as per the procedures in Section 4.8.	One sample per 250m^3 to be analysed using the screening test. If the screening tests indicate cuttings are ASS, then 10% of samples should be tested using the S_{CR} test to check the liming rate.	If liming is carried out, validation sampling will be required. This would comprise one sample per 250m^3 to be analysed using the field screening test.
Trenches and excavations for infrastructure and services.	Depending on the method of installation, two management/treatment options are possible. ***Soils from excavation of trenches:*** The soils will need to be placed in the treatment area. Check testing is required to assess if the soil is ASS, and confirm liming rates. Depending on the results of check testing, the soil will be treated with lime as per the procedures in Section 4.8. ***Soils from directional drilling / under-boring:*** Based on experience with similar under-boring work the drilling technique will most likely include wash boring using a bentonite slurry and casing to prevent the hole from collapsing. It is considered impractical to attempt to separate the soil cuttings that could contain ASS, from the bentonite slurry. It is also considered that the bentonite slurry would act as a sufficient buffer to neutralise ASS. As a precaution samples of the slurry should be tested to assess if there is a need for additional neutralisation by liming.	One sample per 250m^3 to be analysed using the screening test. If the screening tests indicate cuttings are ASS, then 10% of samples should be tested using the S_{CR} test to check the liming rate.	If liming is carried out, validation sampling will be required. This would comprise one sample per 250m^3 to be analysed using the field screening test.

Construction Activity	Treatment/Management Method^	Check Testing Frequency and Analysis	Validation Sampling and Analysis
Excavations for remediation and/or archaeological purposes.	The soils will need to be placed in the treatment area. Check testing is required to assess if the soil is ASS, and confirm liming rates. Human health precautions may need to be implemented to protect construction workers in accordance with any approved human health and environmental risk assessment. The scope of such measures requires further assessment and is beyond the scope of this document. Depending on the results of check testing, the soil will be treated with lime as per the procedures in Section 4.8.	One sample per 250m^3 to be analysed using the screening test. If the screening tests indicate cuttings are ASS, then 10% of samples should be tested using the S_{CR} test to check the liming rate.	If liming is carried out, validation sampling will be required. This would comprise one sample per 250m^3 to be analysed using the field screening test.
Excavation/retention systems.	The soils will need to be placed in the treatment area. Check testing is required to assess if the soil is ASS, and confirm liming rates. Depending on the results of check testing, the soil will be treated with lime as per the procedures in Section 4.8.	One sample per 250m^3 to be analysed using the screening test. If the screening tests indicate cuttings are ASS, then 10% of samples should be tested using the S_{CR} test to check the liming rate.	If liming is carried out, validation sampling will be required. This would comprise one sample per 250m^3 to be analysed using the field screening test.

Notes:
^The treatment/management method outlined in this table requires review following the completion of the additional assessment recommended in Section 4.4. The further assessment would aim to confirm if soils proposed to be excavated are ASS or non-ASS, and the liming rate. This would reduce the need for check testing and potentially the extent of treatment required.

4.8. Treatment of ASS

4.8.1. Treatment Pad and Liming Methodology

Excavated soils will be placed in a specially prepared treatment pad for treatment via application of lime to the soil. The type and amount of lime to be applied should be such that a neutralising value (NV) of 100 can be achieved. The NV should be identified prior to mixing. NV relates to the purity of the lime and an NV of 100 is required to ensure that the lime is effective in neutralising the potential acid. Fine powdered agricultural lime ($CaCO_3$) generally has an NV of 90% to 100% whilst other manufactured forms of lime can have an NV as low as 80%. Where NV is below 100, the factor of safety, hence the amount of lime will have to be adjusted accordingly.

The design of the treatment pad should be in general accordance with Figure 4, page 24, of Dear et al (2002) presented in Appendix D. The following procedures (or other equivalent) should be undertaken for the treatment pad and liming:

- The treatment pad should be located at least 40m from Cockle Bay. The area should be appropriately bunded and provision made to collect run-off water.
- Spreading of the soil in thin (<200mm) layers on impervious pads within the boundary of the site works.
- A guard layer of neutralising agents should be provided at the base of the pad prior to the addition of ASS; and
- Addition of lime by hand or light weight truck followed by mixing, using light weight rotovators or excavator. The amount of lime to be added needs to be established as part of the Additional Assessment recommended in Section 4.4.
- The amount of lime to be kept on site for emergencies will be assessed by the Contractor.

4.8.2. Lime Register and pH

In order to demonstrate that appropriate quantities of lime have been used, a lime register shall be maintained by the Contractor. The register shall list the amount of lime delivered to the site, verified by delivery dockets, and where the lime has been used. The lime usage shall quantify areas limed and soil volumes treated, liming rates and quantities of lime used. The amount of lime to be kept on-site for emergencies will be assessed by the Contractor.

Observations of the limed material will be made by an experienced ASS consultant who will also assess the lime register. Monitoring of pH will be carried out at least weekly prior to re-use of the material.

Readings of pH at or above background, in conjunction with the lime register and observations of mixing, can be used as verifiable performance indicators.

4.8.3. Validation of Treated ASS

In order to demonstrate that the treatment of the ASS has been effective sampling and analysis of the soil will be required. The sampling and analysis will comprise:

- Collection of samples at the following frequencies:
  - one sample per 250m^3 for volumes up to 5,000m^3;

  - one sample per 500m^3 for volumes up to 10,000m^3;
  - one sample per 1,000m^3 for volumes greater than 10,000m^3;
- Screening of the samples as per Appendix I of the ASSMAC (1998) ASS Manual;
- Analysis of at least 10% of samples using the chromium reducible sulfur (S_{CR}) test by a NATA accredited laboratory;

Where the results indicate that the treatment has not been effective, further liming will be required.

Once successfully limed and validated this material could be used on site as general fill provided it is placed above the water table and does not pose unacceptable risks to human health or the environment. It is assumed further information on the re-use and disposal of soil from a contamination perspective will be provided in a remedial action plan (RAP) or construction environment management plan (CEMP).

Alternatively, the limed material can be disposed off site to landfill once appropriately classified. If the material is proposed to be disposed to landfill, sampling and analysis of the soil for contaminants of concern may be required. The soil can then be classified in accordance with the NSW EPA (2014) Waste Classification Guidelines.

4.9. Spoil to be Returned to Below Groundwater Level

The excavated soil classifying as PASS, and not actual ASS, from trenches for infrastructure/services may be able to be returned to at or below the groundwater level within a short (<24hours) timeframe, where such soil also meets the on-site reuse criteria established by a RAP or CEMP. Where this is possible, it is not proposed to treat the excavated material but to excavate, temporarily stockpile and monitor this material for pH. The excavated material can then be used to backfill the trench to at or below the groundwater level where practicable and acceptable to the relevant utility provider. The decision to reuse material in such a manner will be to Mirvac's discretion.

4.9.1. Temporary Stockpiling

The types of material that are likely to be encountered during trenching for services are expected to range from clays (fine textured) to sands (coarse textured). Reference should be made to Table 4 of Dear et al (2002), presented in Appendix D, for appropriate timeframes for short to medium term stockpiling depending on the actual material types encountered. The site specific ASSMP is to detail how stockpiling will be minimised by preparing a detailed earthworks strategy that documents:

- The timing and volumes of soil to be stockpiled and returned to the trench;
- Temporary stockpile locations;
- Measures to prevent potential impacts relating to the oxidation of ASS on surface water and groundwater.

Medium term stockpiling timeframes should conform to Table 5 of Dear et al (2002) (Appendix D). Where stockpiling exceeds these limits or pH monitoring indicates that oxidation is occurring, these soils will be removed to the specially prepared liming pad and treated as per Section 4.8.

The following management plan should be followed where ASS is placed in a medium term stockpile area:

- Soils will be stockpiled at least 40m from Cockle Bay. The soil stockpiles will be bunded, and placed on strong impermeable plastic sheeting, and provision made for collection of surface runoff and appropriate sediment, erosion and dust controls;
- The stockpiles will be kept moist to help slow the oxidation process;

- A supply of fine grained agricultural lime (with a neutralisation factor of at least 97%) will be kept on site during construction work. The amount of lime to be kept on site will be sufficient to provide emergency liming of existing stockpiles on site (see Section 5).
- The stockpiles will also be observed for obvious signs of oxidation, such as jarosite staining;
- Monitoring of the stockpiles and associated run-off water will be carried out for the duration of the work by personnel trained in the identification of ASS. The monitoring will include:

  Soil

  - The stockpiles will be observed for obvious signs of oxidation, such as jarosite staining;
  - Soil samples will be collected from stockpiles at a frequency of one per 250m^3 and tested in the field for pH;
  - If the pH results indicate acidification is occurring (i.e. pH is below 4) then the soil will need to managed and treated as per Section 4.8. The soil can then be re-used on site or disposed to landfill as per Section 4.8.3.

  Water

  - If surface run-off water is collected, then a water sample must be tested in the field for pH;
  - If the pH results indicate the water is acidic (i.e. pH is below 4), then the procedures in Section 4.11 should be implemented.

4.9.2. Backfilling of Trench

Material in the temporary stockpiles will be placed back within the trench within four days of excavation provided there is no evidence of oxidation. This material must be placed below the groundwater level.

4.10. Management of ASS During Directional Drilling/Under-Boring

Directional drilling or under-boring may be used for installation of some underground infrastructure or services. Based on experience with similar underboring work the drilling technique will most likely include wash boring using a bentonite slurry and casing to prevent the hole from collapsing.

The slurry material is usually directed to a sump during drilling and recycled as the borehole advances. At the completion of drilling, the slurry waste should be classified and disposed of to a licensed landfill. It is considered impractical to attempt to separate the soil cuttings that could contain ASS, from the bentonite slurry. It is also considered that the bentonite slurry would act as a sufficient buffer should the slurry dry out. As a precaution a sample of the slurry should be tested to assess if there is a need for additional neutralisation.

4.11. Dewatering During Construction

Localised dewatering will be required during the construction of the basement. The extent of dewatering, and associated drawdown of areas surrounding the basement will be minimised through the sequence of construction. A soil retention system is required to be installed to enable the basement excavation to achieve the target depth, and prevent groundwater inflow. The retention system would be installed in advance of the basement excavation works to minimise the need for extensive dewatering.

Localised dewatering during excavations in areas outside of the basement footprint is considered to represent a low risk of ASS oxidation for the following reasons:

- Prolonged drawdown is not expected due to the localised nature of the dewatering (i.e. small excavation areas only). If draw-down is likely, then further consideration of the impacts this will have will be required in the site specific ASSMP;
- Excavations would most likely be carried out progressively in small areas. The length of time for dewatering within each area should be measured in days/weeks and is not considered to be sufficient time for significant oxidation to occur;

It should be noted that actual construction details are not known at this stage and may vary from that assumed above. Dewatering and mitigation strategies will be provided by the Contractor in line with the broad framework outlined in this general ASSMP. Prolonged lowering of the groundwater table (months) would enhance oxidation of the potential ASS in the area and eventually cause harm once the groundwater returned to pre-construction levels. As a precaution, groundwater and surface water monitoring is recommended and outlined in the following sections.

Should acidification of water occur, the following general procedures should be followed:

- Water is to be placed in an acid-resistant holding tank or pond, and samples collected to assess the pH, electrical conductivity, chloride sulfate ions, and heavy metals;
- Lime will be added to the water at a rate assessed from the results of the testing;
- Following treatment with lime, the water will be sampled and tested again for pH, electrical conductivity, chloride sulfate ions and heavy metals;
- The results of the water testing must be compared to the results of baseline monitoring of receiving bodies (i.e. Cockle Bay). If the water results are similar to the results of the baseline monitoring of the receiving body, then the water will be considered suitable for disposal to the receiving body, or to stormwater drains that discharge into the receiving body. Permission from the relevant regulatory authority (i.e. NSW Office of Water or Council) must be obtained before disposal;
- If the water is not suitable for disposal in the environment, the water must either be treated to become suitable for disposal to the environment (i.e. use of a pH dosing equipment), or be removed and disposed by a licensed liquid waste contractor;

Ata this stage, it is assumed that the RAP or CEMP would provide information on the management, treatment and disposal of water from a contamination perspective.

4.12. Groundwater and Surface Water Monitoring

A groundwater and surface water monitoring system will be required to confirm that impacts from potential oxidation of ASS are being appropriately managed.

Nearby drains and groundwater monitoring wells should be monitored for pH and electrical conductivity. The frequency of testing should be assessed based on the construction timetable and the length of time each areas of excavation remains open.

Baseline data should be collected from existing drains and groundwater wells prior to the commencement of excavations. Baseline data should include laboratory analysis of samples for pH, electrical conductivity, chloride and sulfate ions, and heavy metals.

4.13. Monitoring Testing and Reporting

Monitoring testing and reporting of soil and groundwater will be carried out in accordance with industry standards. Monitoring and testing of surface water will be carried out in accordance with the relevant sections of the National Water Quality Management Strategy. In particular the following guidelines will be referenced and used where appropriate:

- ASS Management Advisory Committee (1998); ASS Manual.
- NEPC (2013); National Environment Protection (Assessment of Site Contamination) Measure 1999 (the 'ASC NEPM')
- NSW EPA (2014); Waste Classification Guidelines.
- Australian and New Zealand Guidelines for the Protection of Fresh and Marine Waters (2000); and
- Australian Guidelines for Water Quality Monitoring and Protection (2000).

4.13.1. Soil Monitoring Programme

The following soil monitoring programme should be carried out during excavation and pile boring:

- Visual assessment and pH monitoring of stockpiled material (minimum one field test per 250m^3);
- Visual assessment and pH monitoring of temporary stockpiles for signs of oxidation of ASS (minimum one field test per 250m^3);
- Visual assessment of backfilling operations (if soil is re-used on site) to assess that ASS is placed appropriately within the excavations/trenches;
- Laboratory analysis of selected soil samples for Scr and comparison to ASS Action Criteria;
- Laboratory analysis of soil for contaminants of concern, and comparison to the appropriate landuse criteria in ASC NEPM (NEPC, 2013) and/or the Waste Classification Guidelines (NSW EPA 2014). Further information on the re-use and disposal of soil from a contamination perspective will be provided in the RAP or CEMP;
- Reporting of the results of pH monitoring, visual assessment and laboratory results.

4.13.2. Water Quality Monitoring Programme

The following water monitoring programme should be carried out during dewatering activities:

- Baseline sampling of surface water bodies where water will be discharged to, either directly or indirectly (i.e. via stormwater). Samples should be collected in accordance with the guidelines noted above;
- Laboratory analysis of baseline samples for pH, electrical conductivity (EC), chloride sulfate and heavy metals, and other potential contaminants of concern as discussed in the detailed remediation action plan;
- Monitoring of groundwater and surface water during dewatering activities including field parameters EC, temperature, redox and pH;
- Reporting of the baseline results prior to dewatering commencing;
- Reporting of the monitoring of field parameters in groundwater and surface water. A comparison of monitoring results to thresholds and/or baseline data will be made. Should results exceed the threshold and/or baseline data, then the contingency procedures in Section 5 should be implemented. Other factors to be included in reporting are the areas of excavation affected, volume of stockpiled material and length of time dewatering is carried out.

5. Contingency Plan

An initial contingency plan is outlined in Table 5.1, listing potential events relating to ASS that may arise during construction and actions that will be undertaken if unexpected conditions occur.

Table 5.1: Contingency Plan

Unexpected Condition	Action
ASS encountered where not expected.	Emergency liming of soil to be carried out. Where emergency liming is required and additional laboratory testing results are not readily available, the liming of ASS may be carried out at a rate of about 20kg lime per tonne of soils. The emergency liming rate is a temporary measure to lower the immediate risk to the environment and may not be sufficient for complete neutralisation.
Severity of ASS encountered is higher than expected (i.e. potential to generate more acid).	Carry out chromium reducible sulphur testing of the soil, using a NATA accredited laboratory, to confirm liming rate. Additional liming of soil is to be carried out (as per Section 4.8.1), and validation testing (as per Section 4.8.3) conducted to check liming has effectively neutralised acid.
Accumulated water from dewatering is observed to be acidified (i.e. pH <4).	Emergency liming of water is to be carried out. Where emergency liming of water is required either from dewatering or run-off from stockpiles, and laboratory testing results are not available, liming of acidic water may be carried out at a rate such that residual lime is present and the pH of the water is not less than 6. The emergency liming rate is a temporary measure to lower the immediate risk to the environment and may not be sufficient for complete neutralisation.
Validation samples fail criteria.	Carry out additional liming of soil.
Identification of unexpected contaminated materials or archaeological finds during excavations.	Refer to construction environment management plan, or remedial action plan (for contamination). An environmental consultant or archaeologist may be required to assess the material and provide management measures.
Other	Other unexpected events which may affect the outcome of the investigation would be notified to the client, and other relevant parties. At that time potential actions to address the unexpected event will be assessed and presented.

6. Conclusion

Based on the information provided to describe the development concept, it is understood that the proposed scheme will introduce a mix of land uses into a multi-storey development with a three storey basement. New infrastructure services (including diversions and augmentations) will be provided to service the new development. Other excavations may also be required associated with remediation and archaeological works.

Coffey has assessed the development scheme in the context of the potential to encounter acid sulfate soils on the site and have concluded that where such soils are encountered through the undertaking

of the proposed development works, that they can be adequately managed utilising industry standard design and construction techniques and practices to prevent unacceptable environmental impacts and render the site suitable for its intended use.

Given the limited information currently available to describe ground conditions within the site, this document represents a preliminary ASSMP. As site-specific investigations are completed, and detailed design information becomes available, a detailed ASSMP will be developed and included within the Detailed Stage 2 Development Application.

7. Limitations

This ASSMP is prepared based on the current level of understanding of the site and the proposed development. It should be reviewed and updated progressively as detailed design is known, and work is completed. It is assumed that a site specific ASSMP will be developed by the successful contractor using management procedures of this ASSMP as a framework. This ASSMP will be superseded once a site specific ASSMP has been prepared and approved.

The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of this site at all points.

This plan has been prepared based on preliminary information regarding acid sulfate soils at the site based on borehole information, and limited laboratory testing from adjoining land. The actual subsurface conditions encountered during the project could differ from that relied on for this report.

This plan does not address geotechnical or contamination issues.

References

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Coffey (Aug 2013a); *Detailed Site Investigation Report for SSDA6 – International Convention Centre Hotel Development, Sydney International Convention, Exhibition & Entertainment Precinct* (Ref: GEOTLCOV24303AH-AD)

Coffey (Aug 2013b); Geotechnical Investigation Report for SSDA6 – Sydney International Exhibition and Entertainment Precinct – ICC Hotel (Ref: GEOTLCOV24303AH-AH)

Dear SE, Moore NG, Dobos SK, Watling KM and Ahern CR (2002) *Queensland Acid Sulfate Soil Technical Manual - Soil management Guidelines Version 3.8*

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Douglas Partners (June 2013); *Preliminary Geotechnical Assessment of Piles – Proposed Upgrade of Harbourside Shopping Centre, Darling Drive, Darling Harbour* (Project Ref: 73498)

National Environmental Protection Council (2013) *National Environmental Protection (Assessment of Site Contamination) Measure 1999, Schedule B (1) – Guideline on the Investigation Levels for Soil and Groundwater*

Important information about your **Coffey** Environmental Report

Introduction

This report has been prepared by Coffey for you, as Coffey's client, in accordance with our agreed purpose, scope, schedule and budget.

The report has been prepared using accepted procedures and practices of the consulting profession at the time it was prepared, and the opinions, recommendations and conclusions set out in the report are made in accordance with generally accepted principles and practices of that profession.

The report is based on information gained from environmental conditions (including assessment of some or all of soil, groundwater, vapour and surface water) and supplemented by reported data of the local area and professional experience. Assessment has been scoped with consideration to industry standards, regulations, guidelines and your specific requirements, including budget and timing. The characterisation of site conditions is an interpretation of information collected during assessment, in accordance with industry practice.

This interpretation is not a complete description of all material on or in the vicinity of the site, due to the inherent variation in spatial and temporal patterns of contaminant presence and impact in the natural environment. Coffey may have also relied on data and other information provided by you and other qualified individuals in preparing this report. Coffey has not verified the accuracy or completeness of such data or information except as otherwise stated in the report. For these reasons the report must be regarded as interpretative, in accordance with industry standards and practice, rather than being a definitive record.

Your report has been written for a specific purpose

Your report has been developed for a specific purpose as agreed by us and applies only to the site or area investigated. Unless otherwise stated in the report, this report cannot be applied to an adjacent site or area, nor can it be used when the nature of the specific purpose changes from that which we agreed.

For each purpose, a tailored approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible quantify, risks that both recognised and potential contamination pose in the context of the agreed purpose. Such risks may be financial (for example, clean up costs or constraints on site use) and/or physical (for example, potential health risks to users of the site or the general public).

Limitations of the Report

The work was conducted, and the report has been prepared, in response to an agreed purpose and scope, within time and budgetary constraints, and in reliance on certain data and information made available to Coffey.

The analyses, evaluations, opinions and conclusions presented in this report are based on that purpose and scope, requirements, data or information, and they could change if such requirements or data are inaccurate or incomplete.

This report is valid as of the date of preparation. The condition of the site (including subsurface conditions) and extent or nature of contamination or other environmental hazards can change over time, as a result of either natural processes or human influence. Coffey should be kept appraised of any such events and should be consulted for further investigations if any changes are noted, particularly during construction activities where excavations often reveal subsurface conditions.

In addition, advancements in professional practice regarding contaminated land and changes in applicable statues and/or guidelines may affect the validity of this report. Consequently, the currency of conclusions and recommendations in this report should be verified if you propose to use this report more than 6 months after its date of issue.

The report does not include the evaluation or assessment of potential geotechnical engineering constraints of the site.

Interpretation of factual data

Environmental site assessments identify actual conditions only at those points where samples are taken and on the date collected. Data derived from indirect field measurements, and sometimes other reports on the site, are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions.

Variations in soil and groundwater conditions may occur between test or sample locations and actual conditions may differ from those inferred to exist. No environmental assessment program, no matter how comprehensive, can reveal all subsurface details and anomalies. Similarly, no professional, no matter how well qualified, can reveal what is hidden by earth, rock or changed through time.

The actual interface between different materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of a suitably qualified and experienced environmental consultant through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other unrecognised features encountered on site. Coffey would be pleased to assist with any investigation or advice in such circumstances.

Recommendations in this report

This report assumes, in accordance with industry practice, that the site conditions recognised through discrete sampling are representative of actual conditions throughout the investigation area. Recommendations are based on the resulting interpretation.

Should further data be obtained that differs from the data on which the report recommendations are based (such as through excavation or other additional assessment), then the recommendations would need to be reviewed and may need to be revised.

Report for benefit of client

Unless otherwise agreed between us, the report has been prepared for your benefit and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendation and should make their own enquiries and obtain independent advice in relation to such matters.

Coffey assumes no responsibility and will not be liable to any other person or organisation for, or in relation to, any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report.

To avoid misuse of the information presented in your report, we recommend that Coffey be consulted before the report is provided to another party who may not be familiar with the background and the purpose of the report. In particular, an environmental disclosure report for a property vendor may not be suitable for satisfying the needs of that property's purchaser. This report should not be applied for any purpose other than that stated in the report.

Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, a suitably qualified and experienced environmental consultant should be retained to explain the implications of the report to other professionals referring to the report and then review plans and specifications produced to see how other professionals have incorporated the report findings.

Given Coffey prepared the report and has familiarity with the site, Coffey is well placed to provide such assistance. If another party is engaged to interpret the recommendations of the report, there is a risk that the contents of the report may be misinterpreted and Coffey disowns any responsibility for such misinterpretation.

Data should not be separated from the report

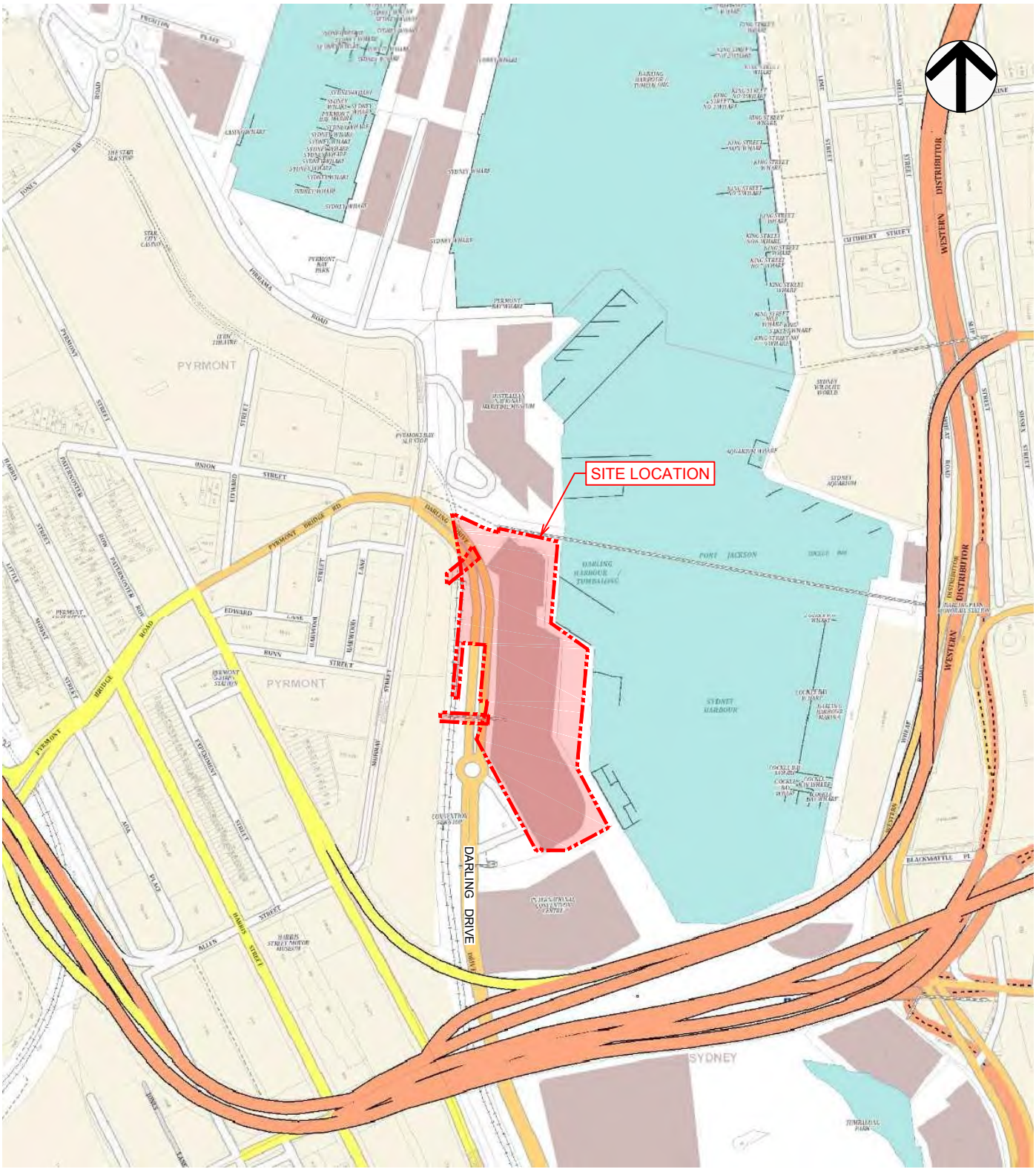
The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists or engineers based on their interpretation of field logs, field testing and laboratory evaluation of samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

This report should be reproduced in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

Responsibility

Environmental reporting relies on interpretation of factual information using professional judgement and opinion and has a level of uncertainty attached to it, which is much less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. As noted earlier, the recommendations and findings set out in this report should only be regarded as interpretive and should not be taken as accurate and complete information about all environmental media at all depths and locations across the site.

Appendix A – Figures



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Scale (metres) 1:5000

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drawn	ML / AW
approved	-
date	6 / 08 / 18
scale	AS SHOWN
original size	A4

coffey
A TETRA TECH COMPANY

client: MIRVAC PROJECTS PTY LTD

project: HARBOURSIDE SHOPPING CENTRE
DARLING HARBOUR, SYDNEY, NSW

title: SITE LOCATION PLAN

project no: 754-GEOTLCOV25340AB-AB | figure no: FIGURE 1 | rev: A

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GARAGE STORAGE AREA
SHIPPING CONTAINER STORAGE AREA
PYRMONT BRIDGE
SYDNEY LIGHT RAIL CORRIDOR
CONVENTION CENTRE STATION
LOADING DOCK ACCESS AREA
COCKLE BAY
NOVOTEL HOTEL AND PUBLIC CARPARK
HARBOURSIDE SHOPPING CENTRE
DARLING DRIVE
ICC HOTEL
DARLING HARBOUR PUBLIC REALM
BH209
R20-BH102
BH201
BH201A
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BH203
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DRAFT

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

LEGEND

- APPROXIMATE SITE BOUNDARY
- SITE PHOTOGRAPH AND DIRECTION
- PREVIOUS INVESTIGATION LOCATIONS (COFFEY AUG 2013a)

10 0 10 30 50

Scale (metres) 1:1000

drawn	ML / AW
approved	-
date	6 / 08 / 18
scale	AS SHOWN
original size	A3

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A TETRA TECH COMPANY

client: MIRVAC PROJECTS PTY LTD

project: HARBOURSIDE SHOPPING CENTRE
DARLING HARBOUR, SYDNEY, NSW

title: SITE LAYOUT PLAN

project no: 754-GEOTLCOV25340AB-AB | figure no: FIGURE 2 | rev: A

Appendix B – Proposed Development Concept

Summary

Mirvac had previously lodged State Significant Development (SSD) Development Application (DA) for the redevelopment of the Harbourside Shopping Centre (Harbourside) (SSD 7874).

The SSD DA was publicly exhibited for a period of 62 days from 15 December 2016 to 14 February 2017. During this time, ten (10) submissions were received from government agencies and City of Sydney Council and over 140 submissions were received from the general public.

Proposed Amended Development

Since exhibition of the proposal and given the nature and range of submissions made from agencies and the pubic, Mirvac has reviewed the overall approach and elements of the Concept Proposal. This has accordingly led to developing an Amended Concept Proposal. The final Amended Concept Proposal includes substantial amendments made by Mirvac pursuant to Clause 55 of the Environmental Planning & Assessment Regulation, in the main to address matters raised in the submissions and deliver an overall significantly improved outcome on the site and for the broader Darling Harbour precinct.

The following key amendments have been made to the proposal:

Relocation of the Tower

The tower element of the Concept Proposal has been relocated from the north of the site to the centre of the site (the widest part of the site) to allow for an increased setback from the heritage listed Pyrmont Bridge, improved relationship to the waterfront and ICC Hotel, to minimise view impacts from 50 Murray Street, together with reducing overshadowing impacts on the public domain and improved solar amenity to the northern end of the retail centre.

Reduction in Height of the Tower

The height of the tower has also been reduced from 166.35mAHD to 153.75mAHD. The reduction in the height will minimise overshadowing impacts to the public domain as well better relate to the height of the ICC Hotel.

Reduction in Height of the Podium

A portion of the podium height at its northern extent has been partly reduced from 30.5mAHD to 25mAHD. The reduction in height provides for improved view sharing from 50 Murray Street.

Removal of Tower ‘Tail’ element

As part of the relocation of the tower and refinement of the podium, the stepped form of the lower tower element has now been removed. This design move has been made in order to again improve views from adjacent buildings from the west.

Building Footprint of the Tower

The building footprint of the tower has increased in width, to accommodate the floorspace from the reduction in height of the tower and removal of the ‘tail’.

Gross Floor Area / Land Use Mix

The amended proposal retains the same overall 87,000sqm of GFA, however there is a minor adjustment in the split between non-residential and residential:

- Non-residential uses floor space – 49,000sqm; and

- Residential uses floor space – 38,000sqm

In response to market demand and the focus of local and regional strategic planning policies, it is proposed for the podium to include both retail and commercial land uses. Indicatively, comprising approximately 23,000sqm of commercial net lettable area and 15,000sqm of retail gross lettable area.

The podium enables large campus sized commercial floor plates that are favoured by large multinational tech, finance and professional services companies.

Apartment numbers

As a result of a review of the mix and sizing of apartments, there is a minor reduction in the indicative number of apartments, from 364 to 357. Note, this yield is on the 'Indicative Design' only and will be subject to future design development and a Stage 2 DA. This Stage 1 DA only seeks approval for land uses and the building envelope comprising a total of 87,000sqm GFA.

Car Parking Spaces

The extent of the basement will remain the same but will extend over three levels, providing a minor increase of car parking spaces. As above, this is based on the 'Indicative Design' only.

A more detailed and comprehensive description of the amended proposal is contained in the Response to Submissions and Amended Concept Proposal prepared by Ethos Urban.

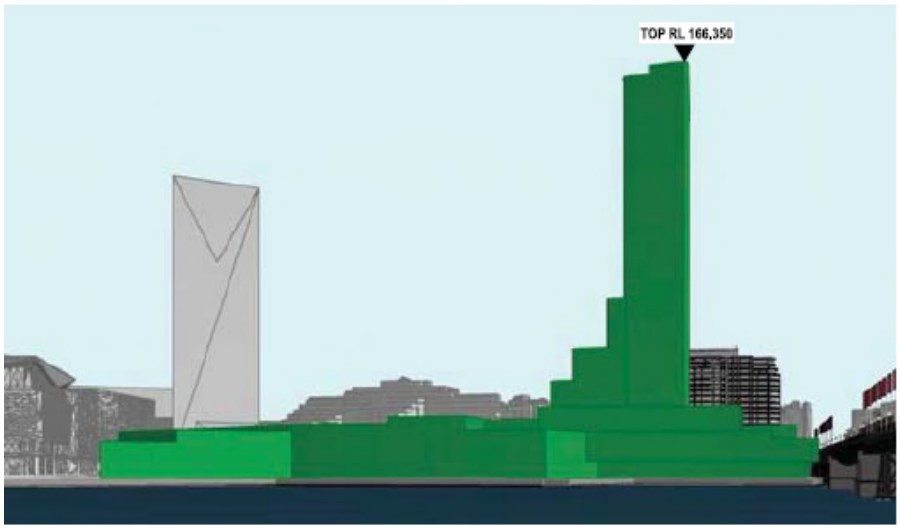


Figure 1 Original submitted Concept Proposal

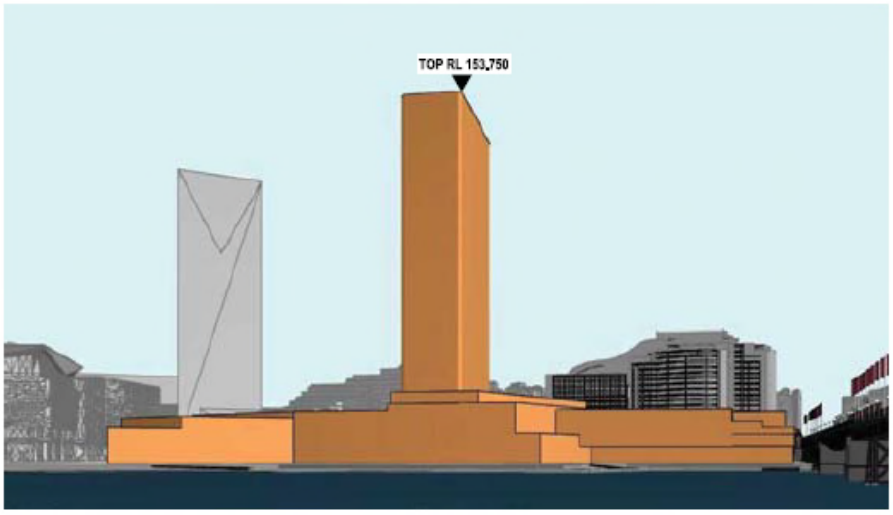


Figure 2 Amended Concept Proposal

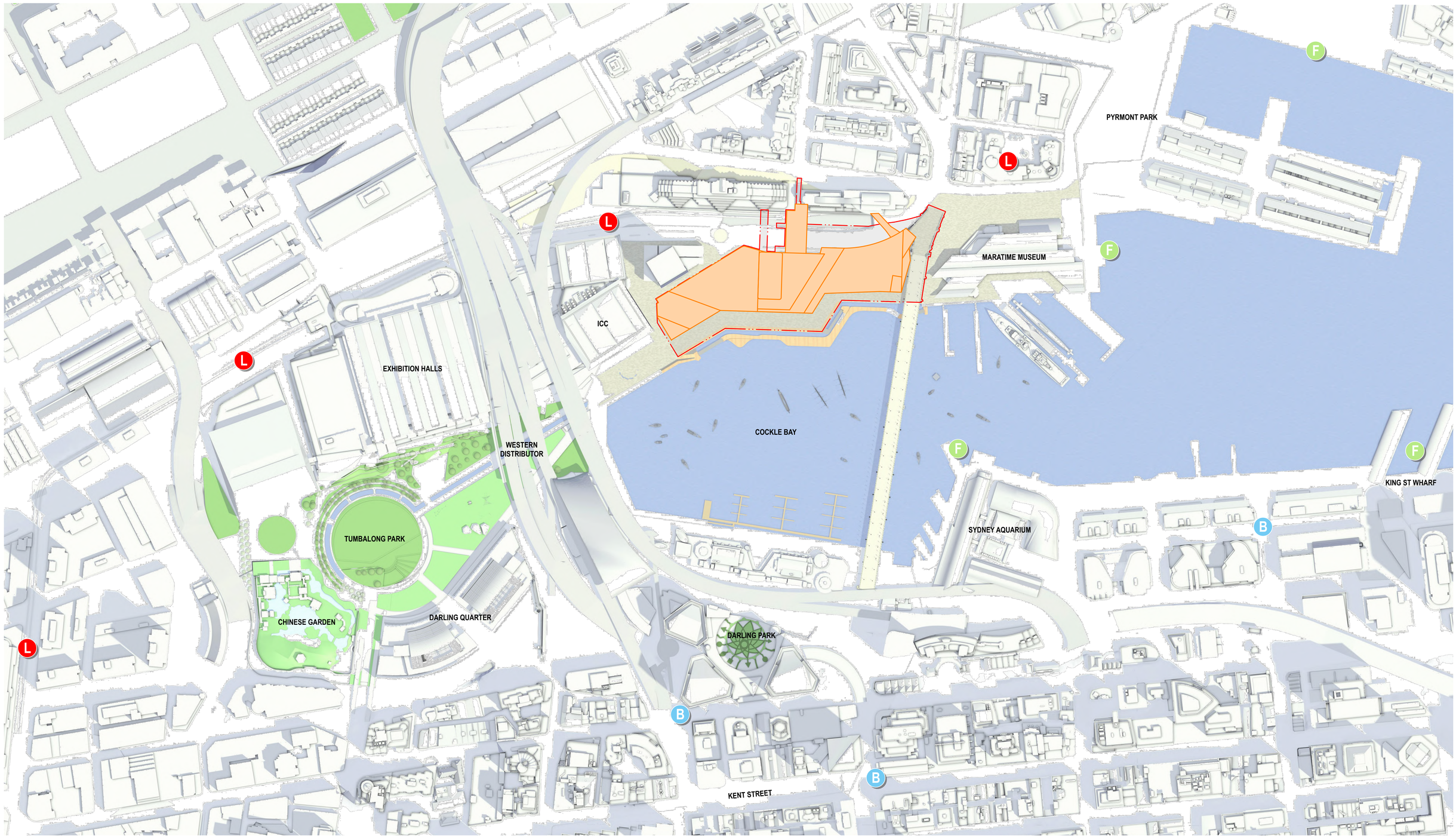
Landscaped Open Space and Public Domain

All of the key concepts and public benefits as originally proposed are retained under the amended Concept Proposal, with the addition of further landscaping opportunities on the northern rooftop extent of the retail podium, further enhancing views and outlook from 50 Murray Street.

The final Concept Proposal seeks approval for the following key components and development parameters:

- Demolition of existing site improvements, including the Harbourside Shopping Centre, pedestrian bridge link across Darling Drive, obsolete monorail infrastructure, and associated tree removal;
- A network of open space areas and links generally as shown within the Public Domain Concept Proposal, to facilitate re-integration of the site into the wider urban context;
- Building envelopes;
- Land uses across the site, non-residential and residential uses;
- A maximum total Gross Floor Area (GFA) across the Harbourside site of 87,000m^2 for mixed use development (49,000sqm non-residential and 38,000sqm residential development);
- Basement car parking;
- Car parking rates to be utilised in subsequent detailed (Stage 2) Development Applications);
- Urban Design and Public Realm Guidelines to guide future development and the public domain; and
- Strategies for utilities and services provision, drainage and flooding, and ecological sustainable development.

STAGE 1 DA HARBOURSIDE



BOUNDARY LEGEND

- PROPOSED SSDA 1 BOUNDARY
- WATERFRONT & PYRMONT BRIDGE SETBACKS
- ENVELOPE EXTENT

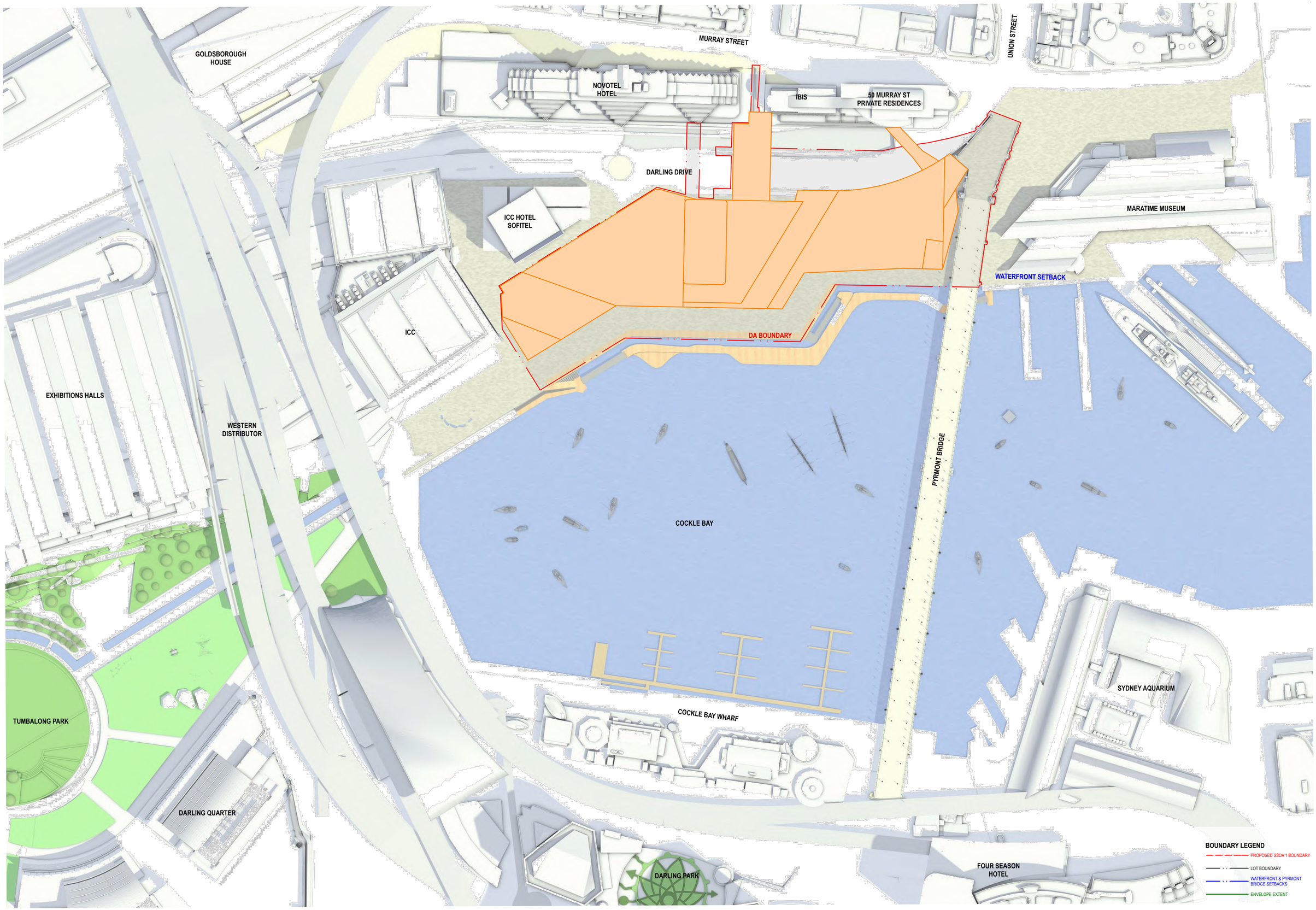
0 20 50 100m

Location Plan

Mirvac - Harbourside

1:2000 @ A1 29/1/20

For Information **SSDA1-001**

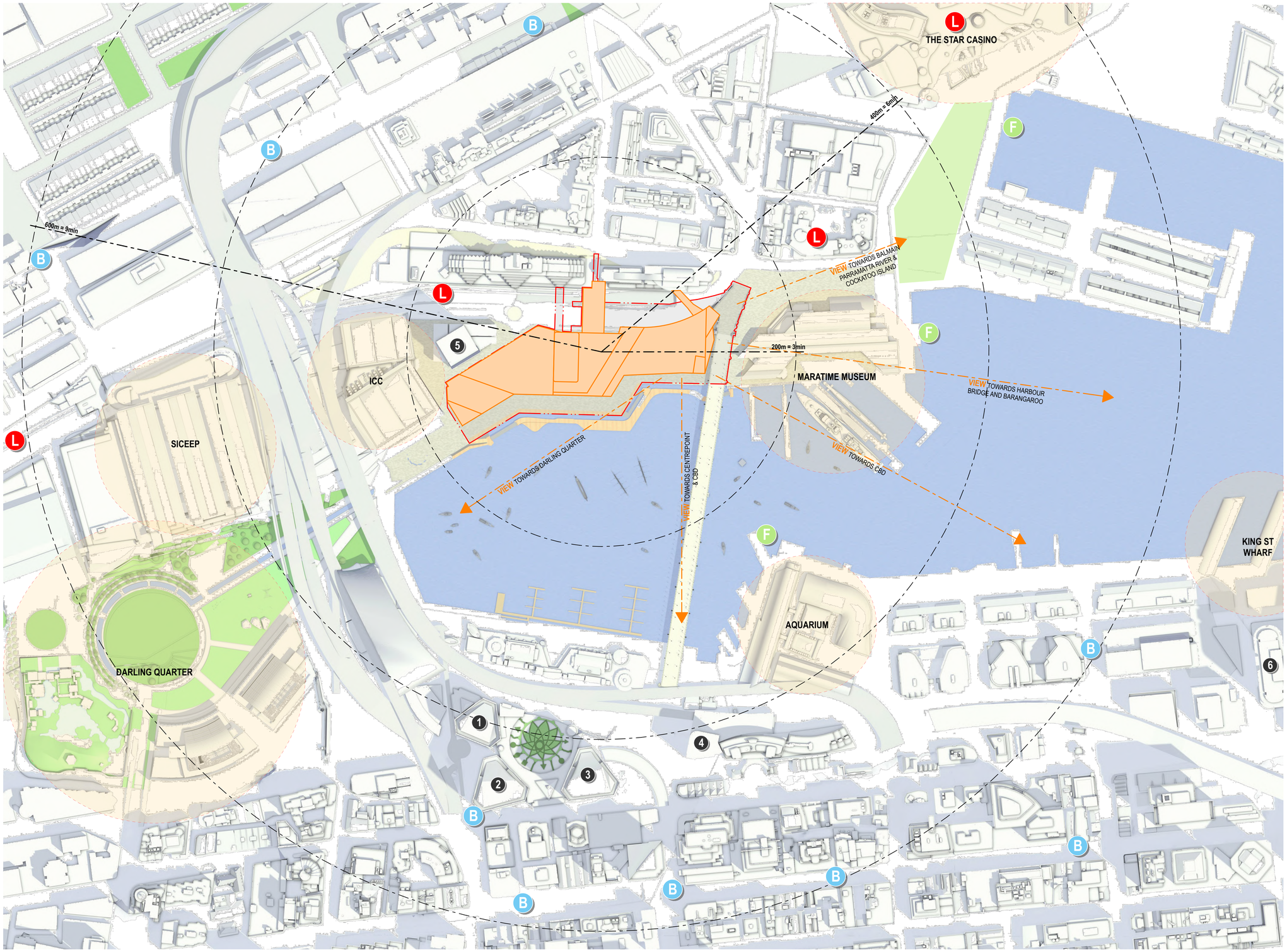


Context Plan

Mirvac - Harbourside

1:1000 @ A1 29/1/20

For Information **SSDA1-002**



LEGEND

- DA BOUNDARY
- ENVELOPE EXTENT
- ENVELOPE EXTENT
- GREEN PUBLIC SPACES
- CULTURAL NODES
- PROXIMITY - WALKING TIMES
- VIEWS

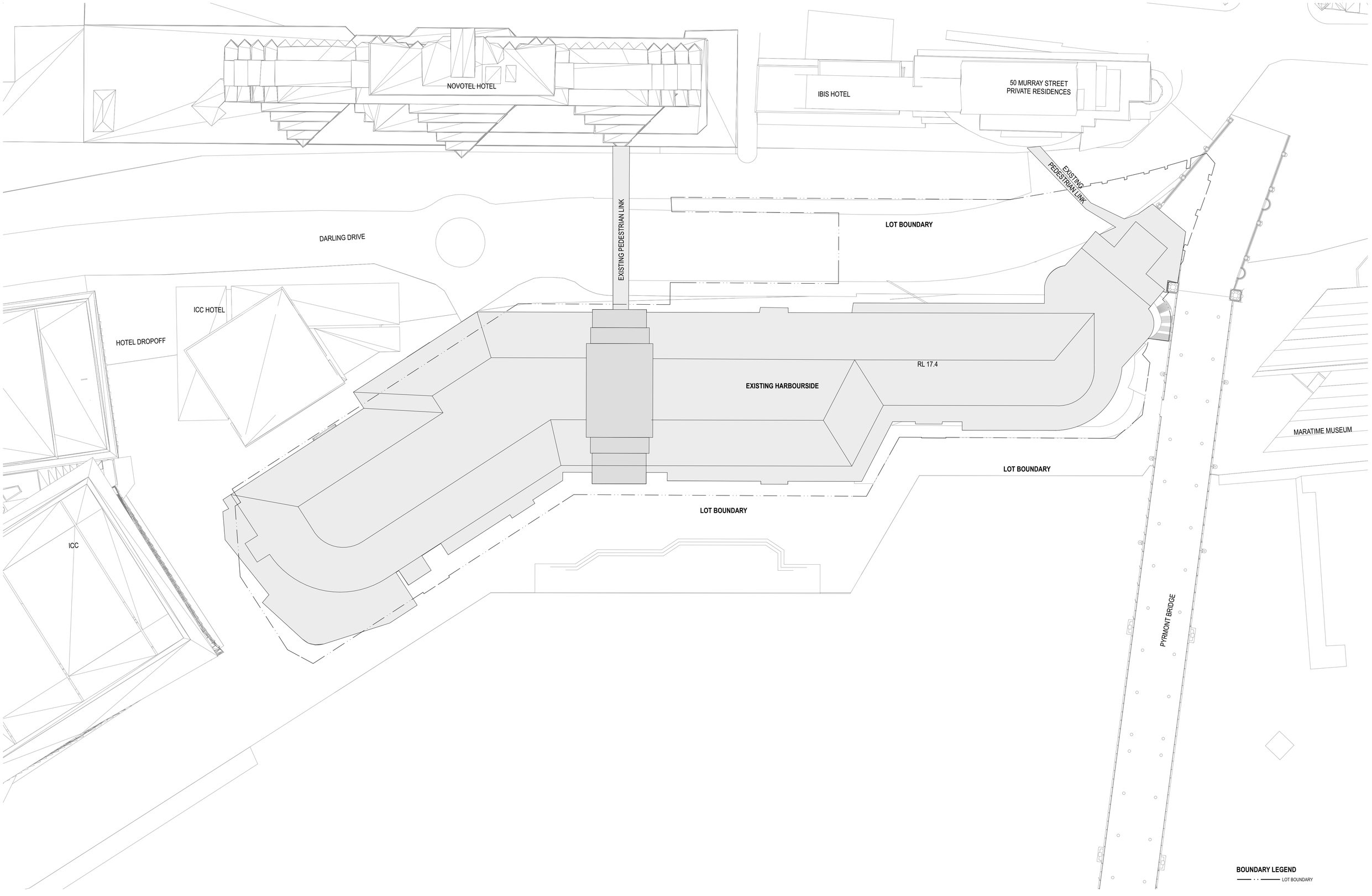
PUBLIC TRANSPORTATION

- F — FERRY WHARF
- T — TRAIN STATION
- L — LIGHT RAIL
- B — BUS STOP

CONTEXT

NEIGHBOURING TOWERS GREATER THAN AHD 80

1. DARLING TOWER 3 - RL 90.0
2. DARLING TOWER 2 - RL 130.0
3. DARLING TOWER 1 - RL130.0
4. FOUR POINTS - RL 93.6
5. ICC HOTEL SOFITEL - RL 133.550
6. C5 - RL 168.0



Existing Site Plan

Mirvac - Harbourside

0 5 10 20m

1:500 @ A1

29/1/20

For Information

SSDA1-004

NOVOTEL HOTEL

IBIS HOTEL

50 MURRAY STREET

ICC HOTEL SOFITEL

U/S 14.000

U/S 15.500

DA BOUNDARY BRIDGE CONNECTION

DA BOUNDARY BRIDGE CONNECTION

DA BOUNDARY EXTENT BUNN ST TERRACE

DA BOUNDARY EXTENT BUNN ST BRIDGE

DA BOUNDARY GROUND

DA BOUNDARY GROUND

DA BOUNDARY EXTENT GROUND

DA BOUNDARY EXTENT GROUND

DA BOUNDARY EXTENT MONORAIL LINK

25.000

21.750

17.500

ENVELOPE UNDER DARLING DRIVE

OUTLINE OF TOWER ENVELOPE
SEE DRAWING SSDA1-101 ENVELOPE PLAN - TOWER

E 333400
N 6250650

E 333400
N 6250700

25.000

31.000

26.500

16.650

23.100

14.000

20.500

15.500

E 333450
N 6250700

DA BOUNDARY

DA BOUNDARY

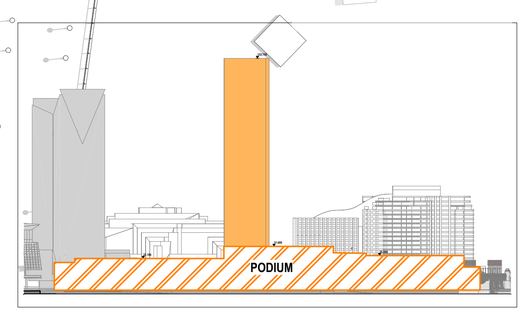
DA BOUNDARY

DA BOUNDARY

DA BOUNDARY EXTENT GROUND

BOUNDARY LEGEND

- PROPOSED STAGE 1 DA BOUNDARY
- LOT BOUNDARY
- BASEMENT ENVELOPE EXTENT



0 1 2 5m

1:100 @ A1

29/1/20

Envelope Plan - Podium

Mirvac - Harbourside

SSDA1-100

NOVOTEL HOTEL

IBIS HOTEL

50 MURRAY STREET

ICC HOTEL SOFITEL

DARLING DRIVE

DA BOUNDARY BRIDGE CONNECTION

DA BOUNDARY BRIDGE CONNECTION

DA BOUNDARY EXTENT BUNN ST BRIDGE

DA BOUNDARY EXTENT BUNN ST BRIDGE

DA BOUNDARY GROUND

DA BOUNDARY GROUND

DA BOUNDARY MEMORIAL LINK

DA BOUNDARY EXTENT GROUND

DA BOUNDARY EXTENT GROUND

DA BOUNDARY

DA BOUNDARY

DA BOUNDARY

DA BOUNDARY

PODIUM ENVELOPE BELOW
SEE DRAWING SSDA1-100
ENVELOPE PLAN - PODIUM

RL 153.750

53,200

12,000

BOUNDARY LEGEND

PROPOSED STAGE 1 DA BOUNDARY

LOT BOUNDARY

TOWER

0 5 10 20m

Envelope Plan - Tower

Mirvac - Harbourside

1:500 @ A1

29/1/20

For Information

SSDA1-101

DA BOUNDARY EXTENT GROUND

DA BOUNDARY GROUND

DA BOUNDARY GROUND

DA BOUNDARY

DA BOUNDARY EXTENT GROUND

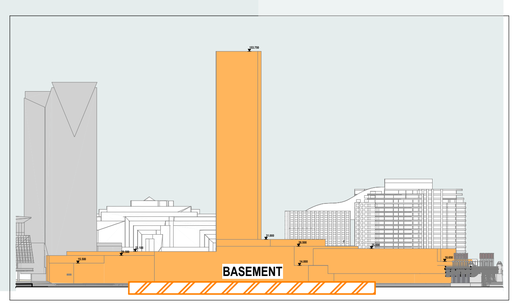
DA BOUNDARY

DA BOUNDARY

BOUNDARY LEGEND

LOT BOUNDARY

WATERFRONT & PYRMONT BRIDGE SETBACKS



0 5 10 20m

Envelope Plan - Basement

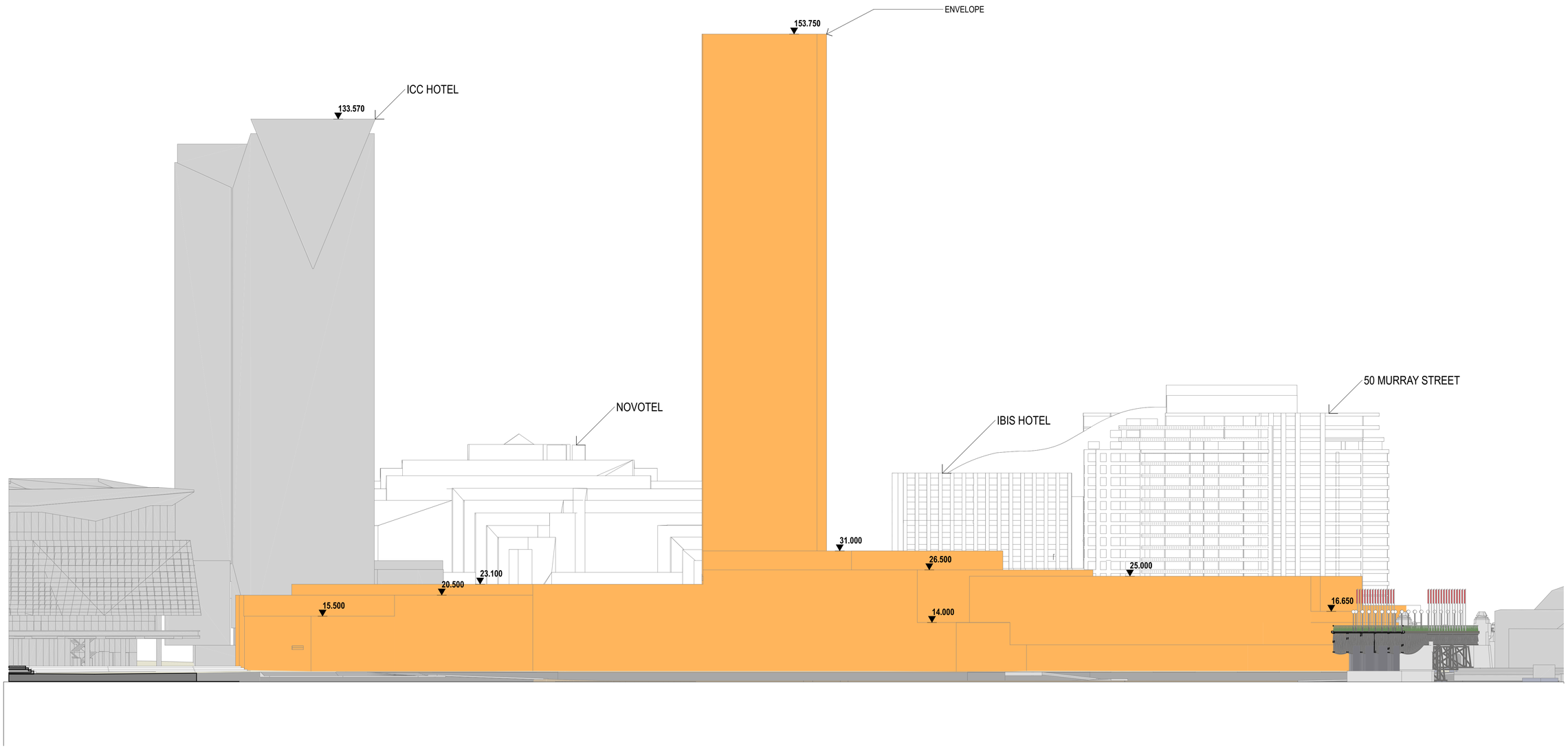
Mirvac - Harbourside

1:500 @ A1

29/1/20

For Information

SSDA1-102



Envelope East Elevation

Mirvac - Harbourside

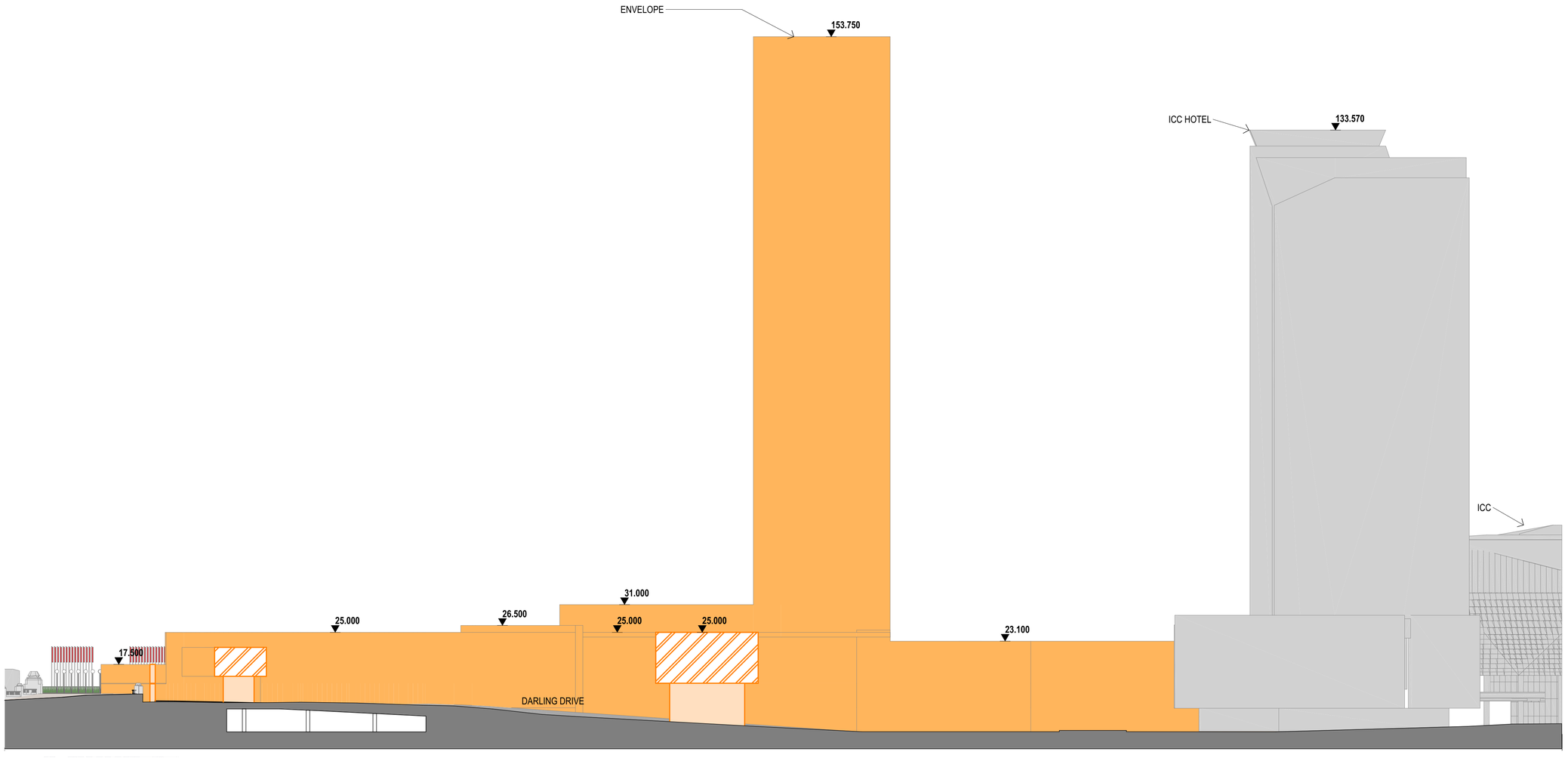
0 5 10 20m

1:500 @ A1

29/1/20

For Information

SSDA1-103



Envelope West Elevation

Mirvac - Harbourside

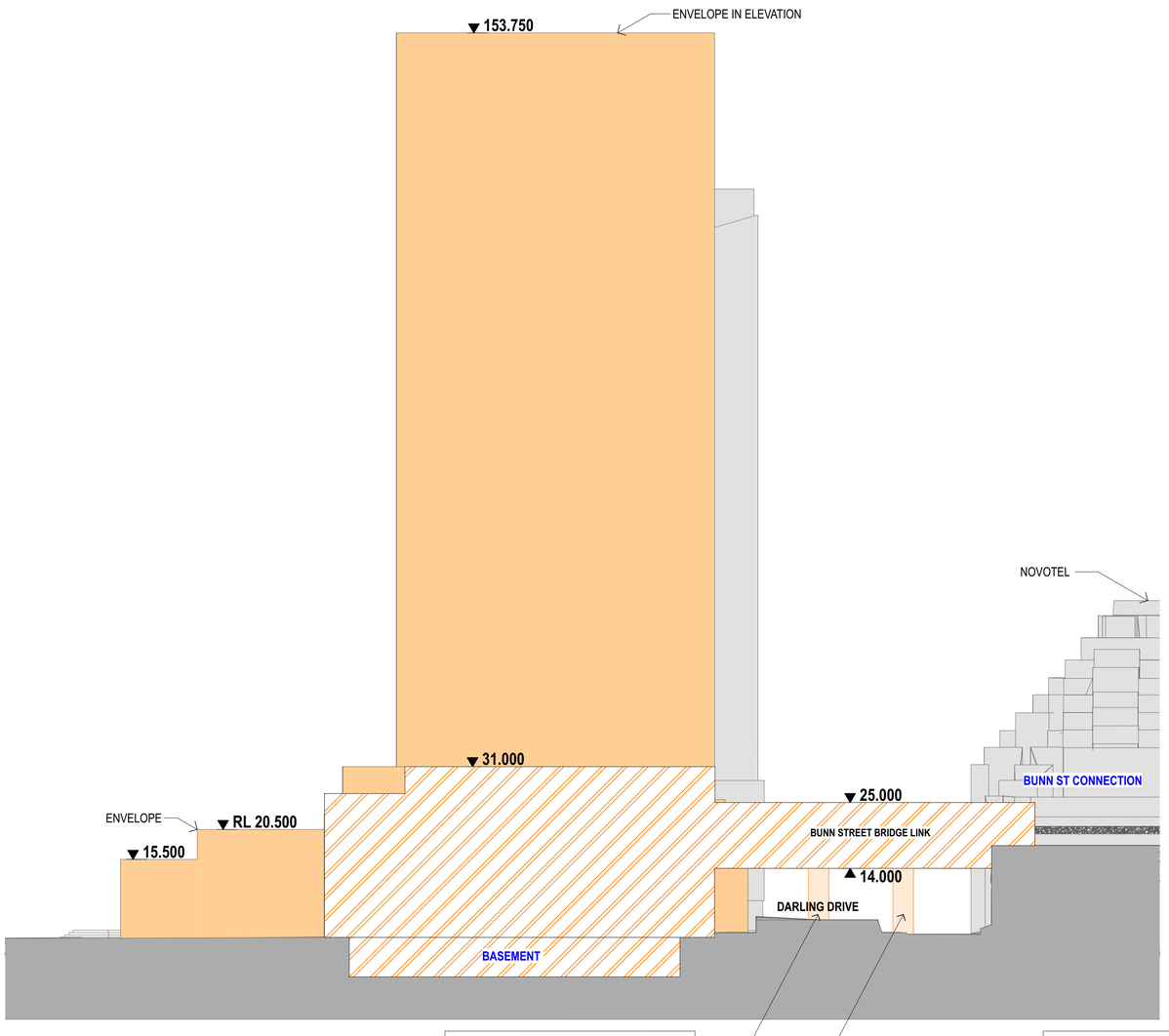
0 5 10 20m

1:500 @ A1

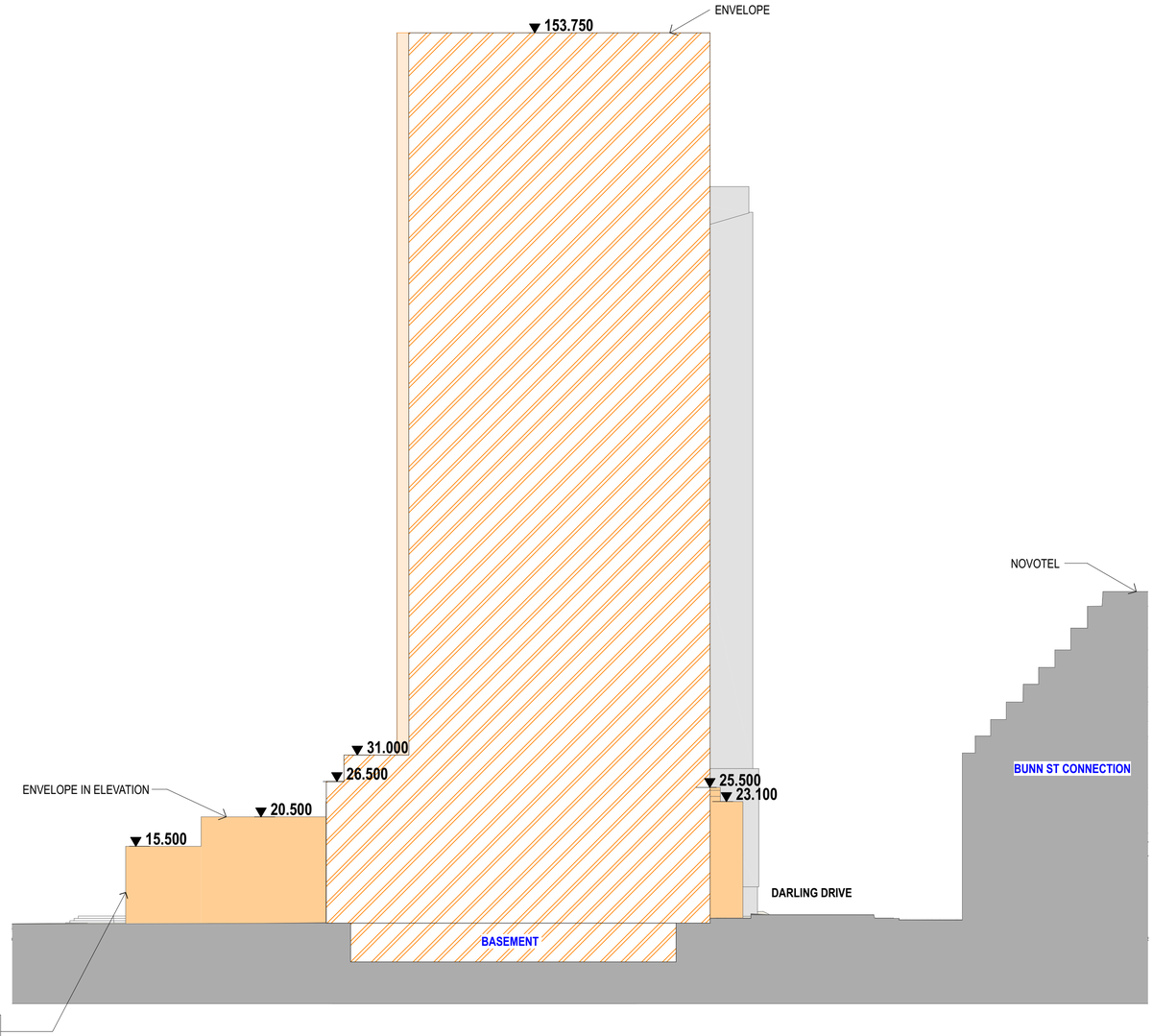
29/1/20

For Information

SSDA1-104



SECTION ENVELOPE Section 1
1:500



SECTION ENVELOPE SECTION 2
1:500

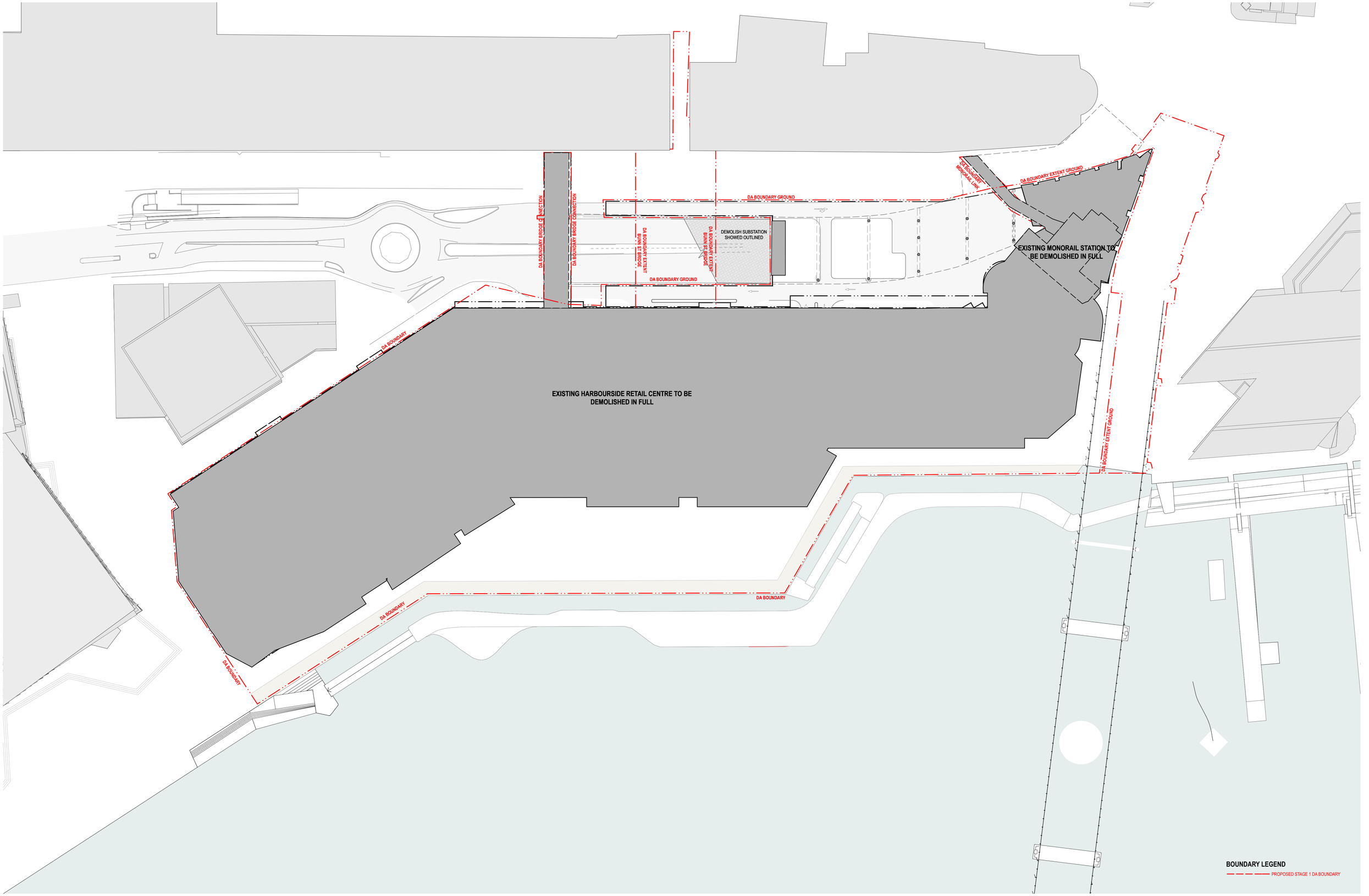
Envelope Cross Sections

Mirvac - Harbourside

0 5 10 20m

1:500 @ A1 29/1/20

For Information **SSDA1-105**



Demolition Plan - Existing Harbourside & Monorail Station

Mirvac - Harbourside

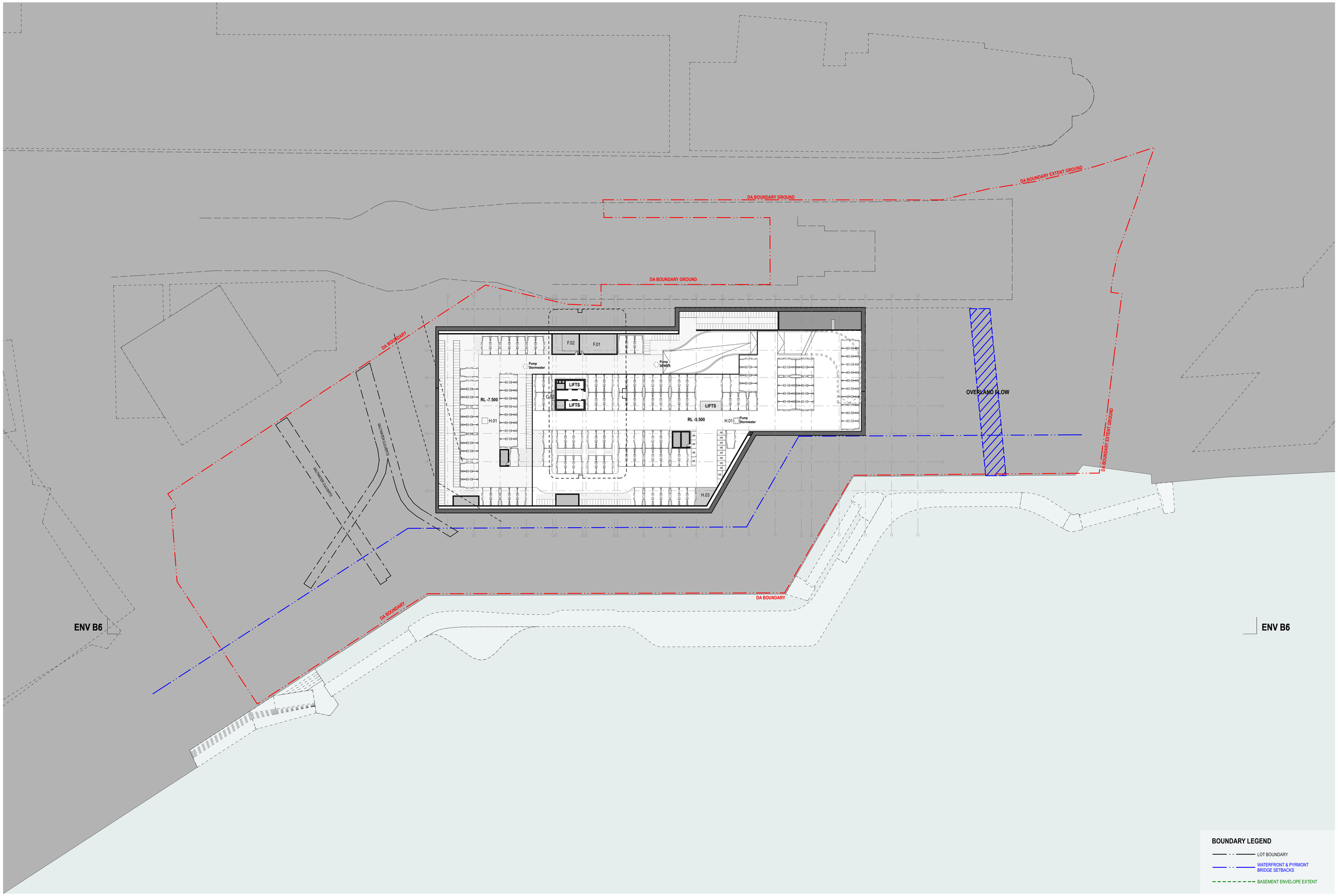
0 5 10 20m

1:500 @ A1

29/1/20

For Information

SSDA1-200



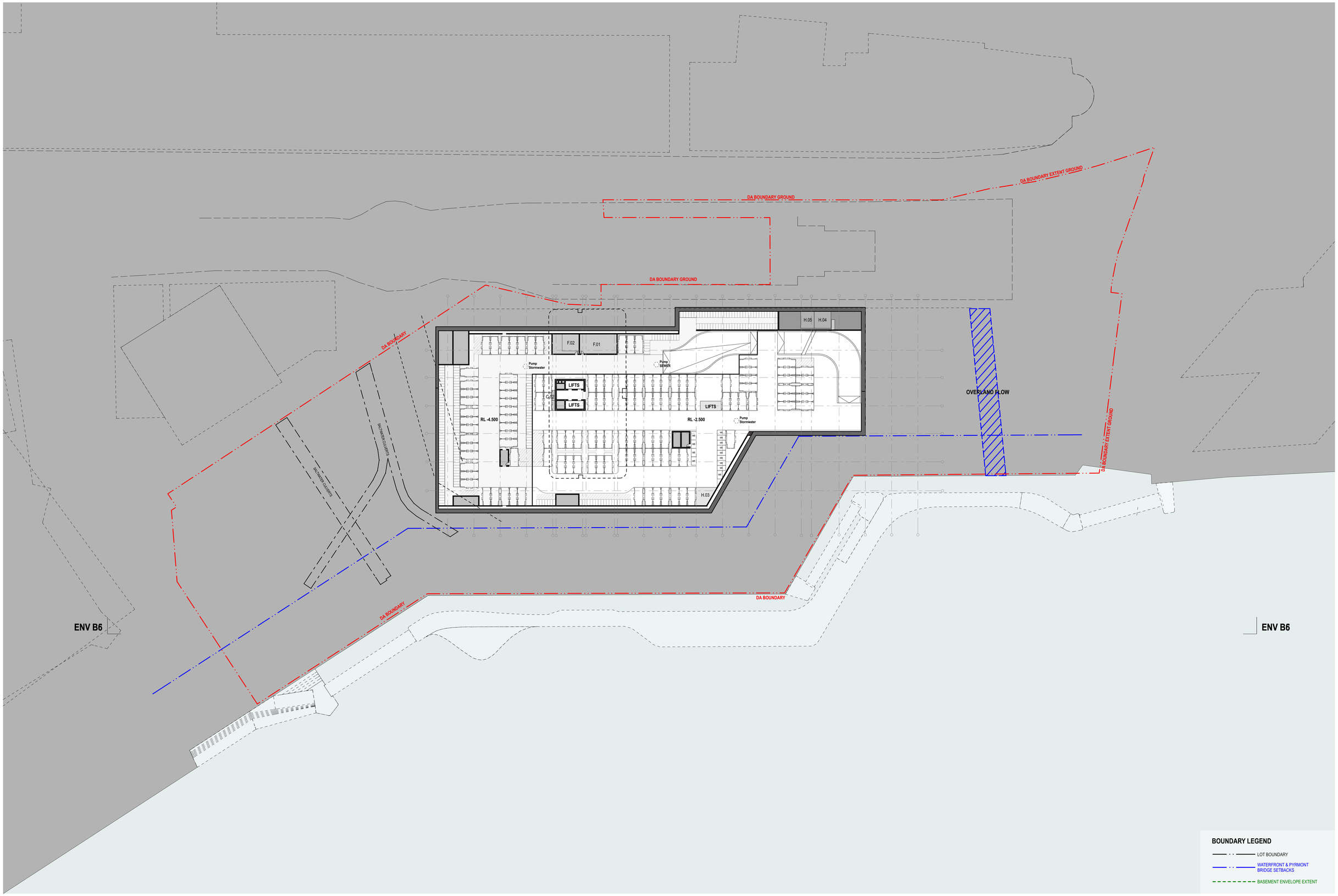
Indicative Plan Only - B3

Mirvac - Harbourside

0 5 10 20m

1:500 @ A1 29/1/20

For Information **SSDA1-300**



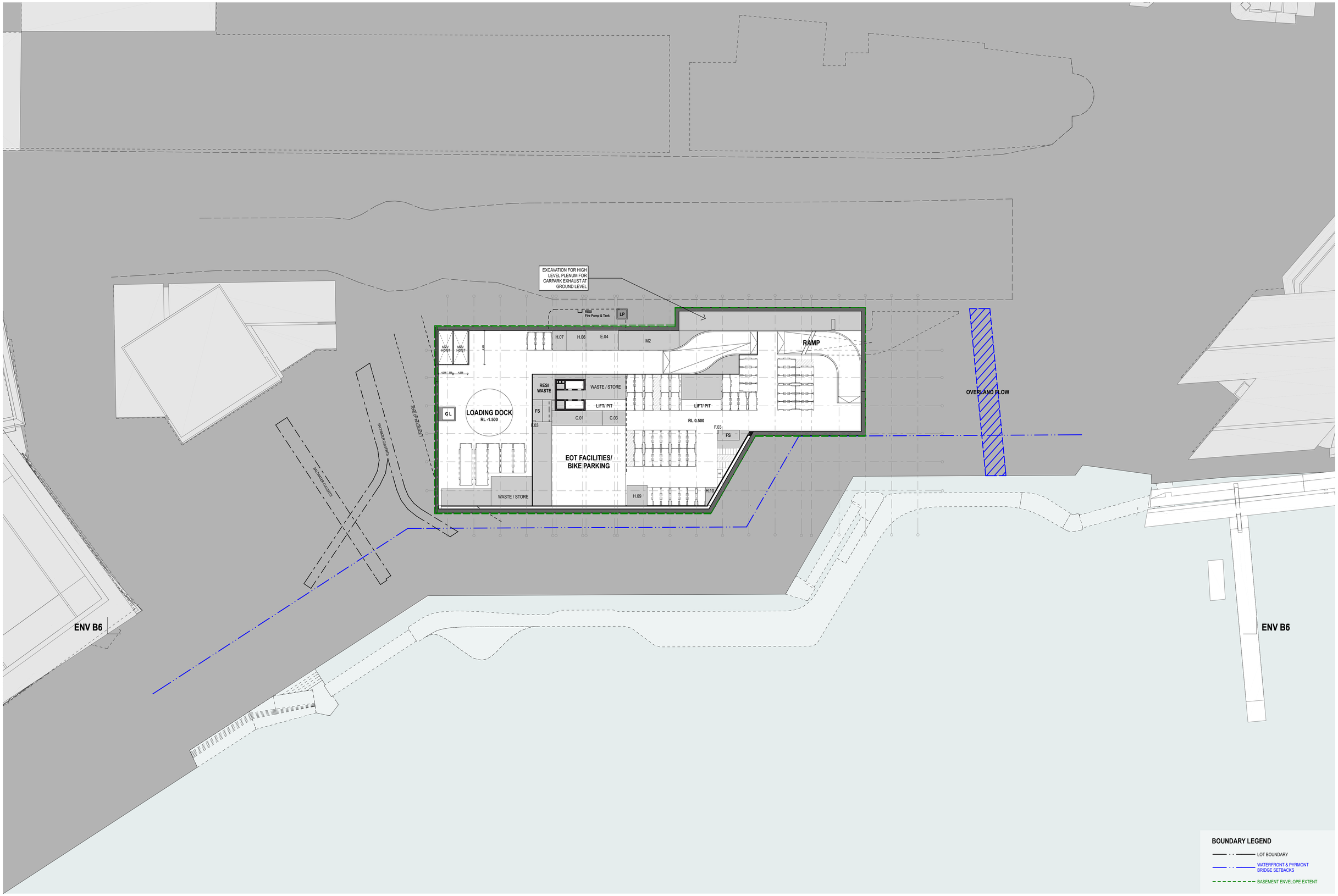
Indicative Plan Only - B2

Mirvac - Harbourside

0 5 10 20m

1:500 @ A1 29/1/20

For Information **SSDA1-301**



Indicative Plan Only - B1

Mirvac - Harbourside

0 5 10 20m

1:500 @ A1 29/1/20

For Information **SSDA1-302**

DA BOUNDARY

DA BOUNDARY BRIDGE CONNECTION

DA BOUNDARY BRIDGE CONNECTION

DA BOUNDARY GROUND

DA BOUNDARY GROUND

DA BOUNDARY EXTENT GROUND

DA BOUNDARY BRIDGE LINK

DA BOUNDARY EXTENT GROUND

LOADING DOCK

LIFTS

LIFT

FS

GL

BFS

RESI LOBBY

COMMERCIAL LOBBY

G.01

G.02

G.03

G.04

G.05

G.06

G.07

G.08

G.09

G.10

G.11

G.12

G.13

G.14

G.15

G.16

G.17

G.18

G.19

G.20

G.21

G.22

G.23

G.24

G.25

G.26

G.27

G.28

G.29

G.30

G.31

G.32

G.33

G.34

G.35

G.36

G.37

PROPOSED ENVELOPE

PROPOSED ENVELOPE

DA BOUNDARY

DA BOUNDARY

DA BOUNDARY

ENV B6

RETAIL

COMMERCIAL

RESIDENTIAL

0 5 10 20m

1:500 @ A1

29/1/20

For Information

SSDA1-303

Indicative Plan Only - Ground Floor Retail

Mirvac - Harbourside

DA BOUNDARY
DA BOUNDARY BRIDGE CONNECTION
DA BOUNDARY BRIDGE CONNECTION
DA BOUNDARY GROUND
DA BOUNDARY GROUND
DA BOUNDARY MONORAIL LINK
DA BOUNDARY EXTENT GROUND
DA BOUNDARY EXTENT ON PYRMONT BRIDGE
DA BOUNDARY EXTENT ON PYRMONT BRIDGE
DA BOUNDARY EXTENT GROUND
DA BOUNDARY EXTENT ON PYRMONT BRIDGE
DA BOUNDARY
DA BOUNDARY
DA BOUNDARY

1.01
1.02
1.03
1.04
1.05
1.06
1.07
1.08
1.09
1.10
1.11
1.12
1.13
1.14

G L
LIFTS
LIFT
ON-FLOOR PLANT
AMENITIES
FS
LOBBY
C/GL
AWC

ENV B6

RETAIL
COMMERCIAL
RESIDENTIAL

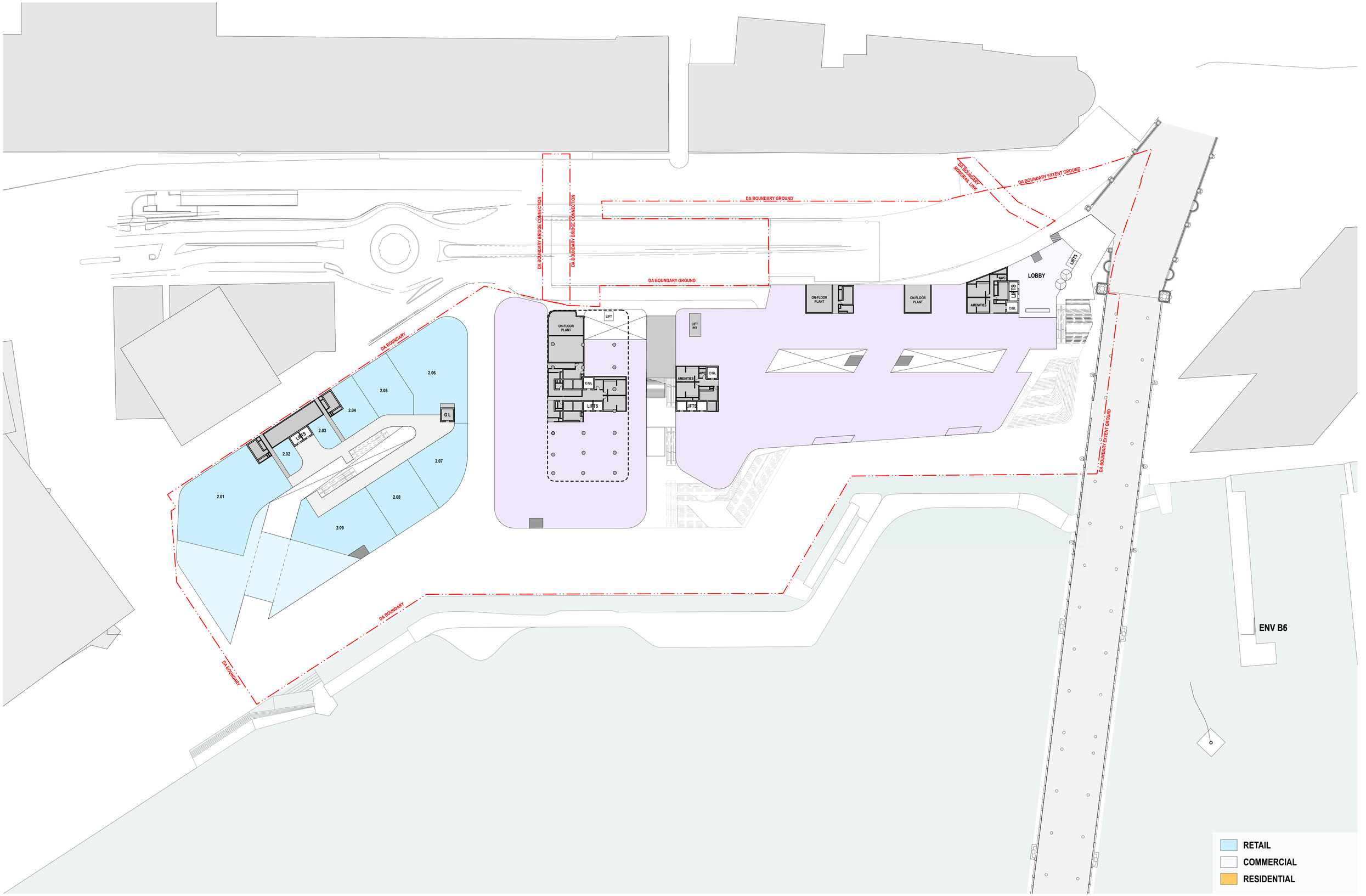
Indicative Plan Only - Level 1 Retail / Commercial

Mirvac - Harbourside

0 5 10 20m

1:500 @ A1 29/1/20

For Information **SSDA1-304**



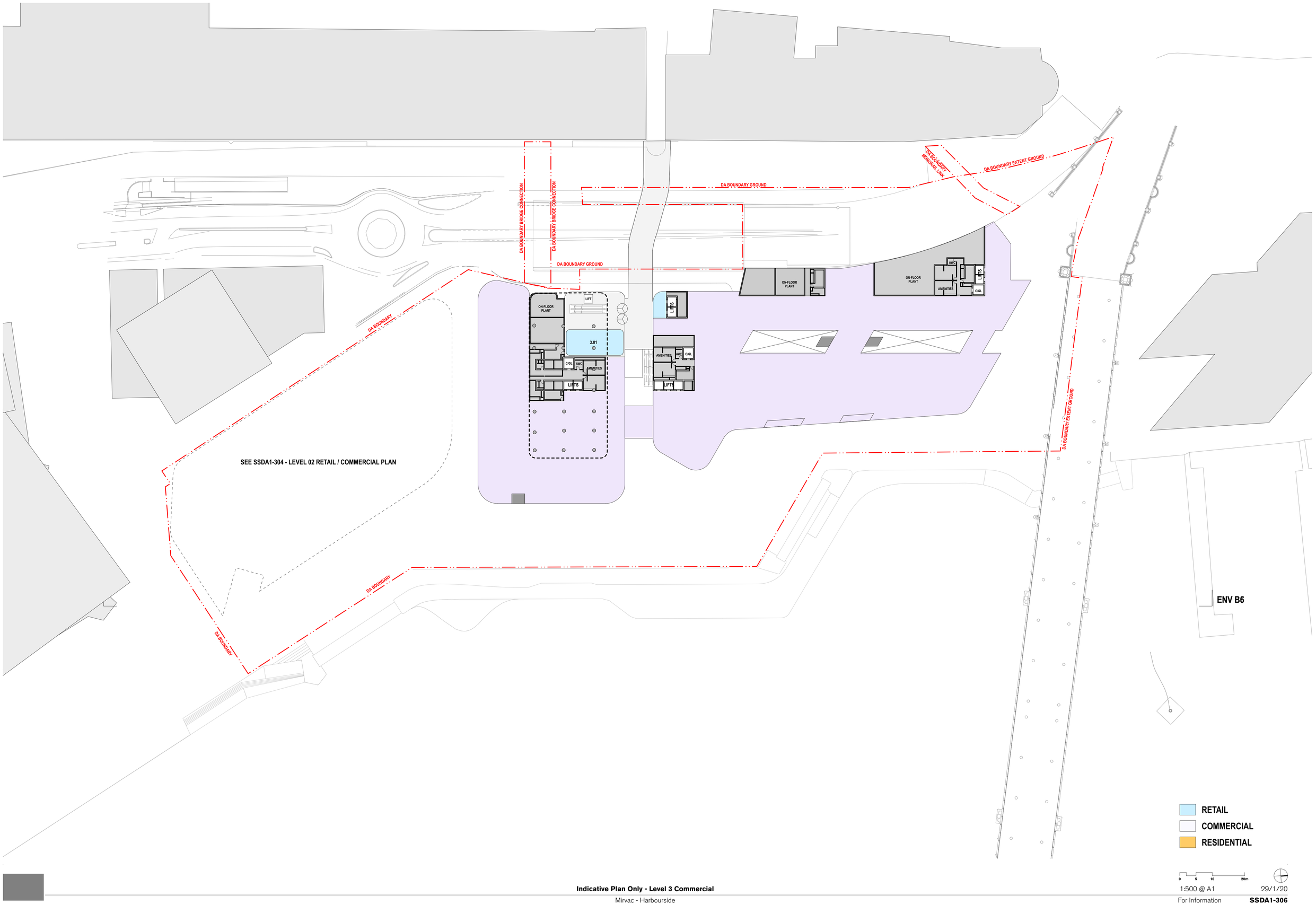
Indicative Plan Only - Level 2 Retail / Commercial

Mirvac - Harbourside

0 5 10 20m

1:500 @ A1 29/1/20

For Information **SSDA1-305**

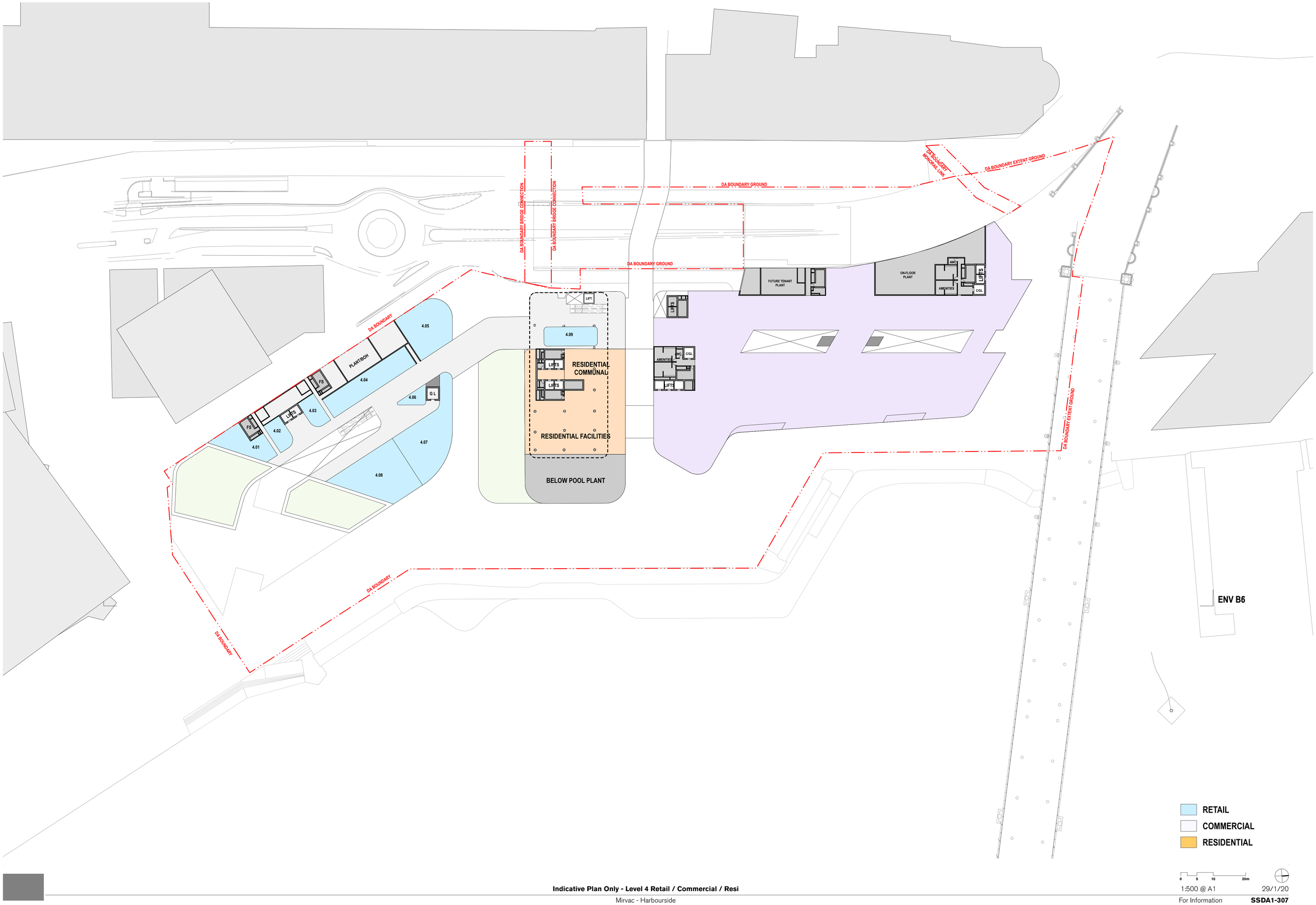


Indicative Plan Only - Level 3 Commercial

Mirvac - Harbourside

1:500 @ A1 29/1/20

For Information **SSDA1-306**

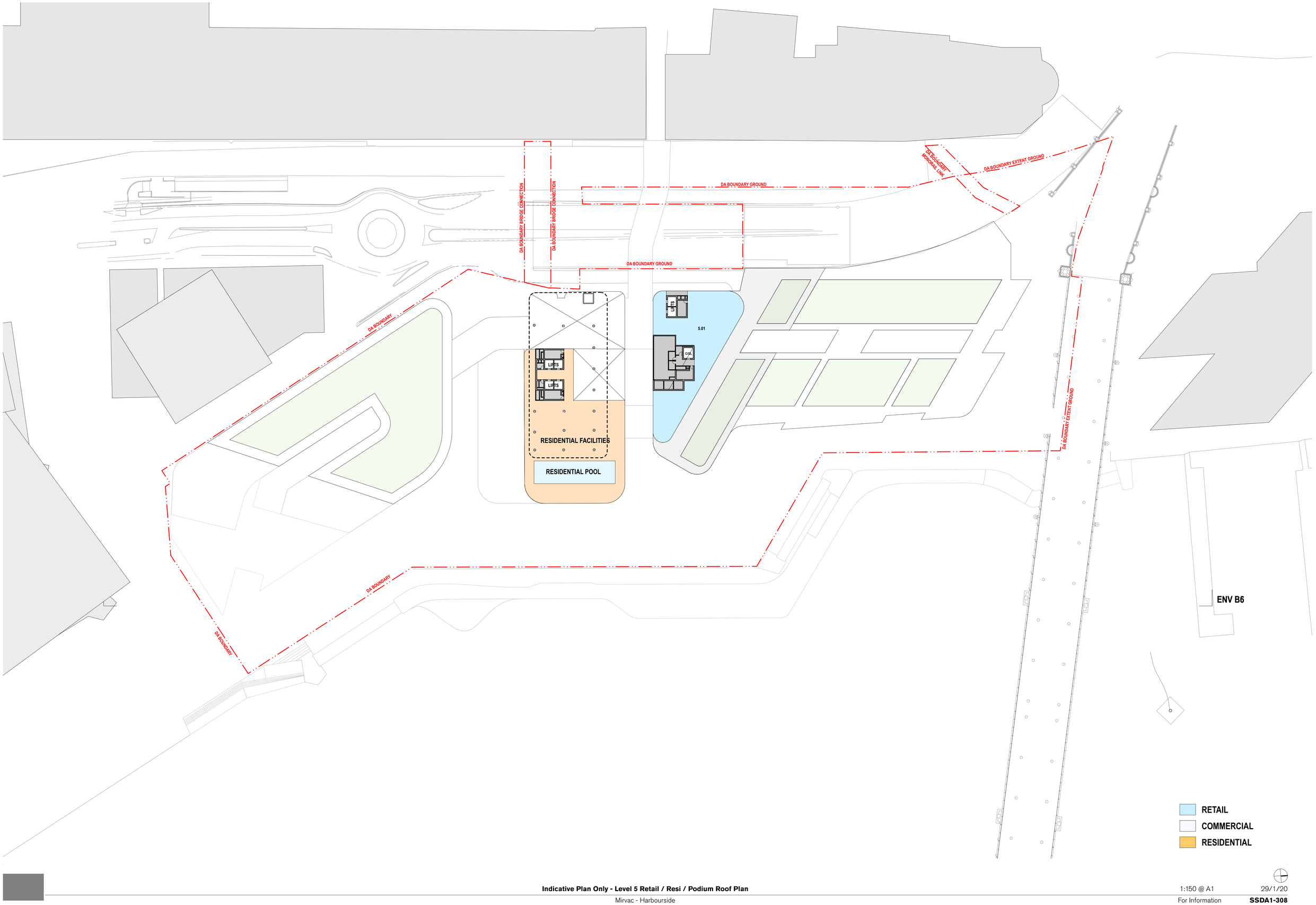


Indicative Plan Only - Level 4 Retail / Commercial / Resi

Mirvac - Harbourside

1:500 @ A1 29/1/20

For Information **SSDA1-307**



Indicative Plan Only - Level 5 Retail / Resi / Podium Roof Plan

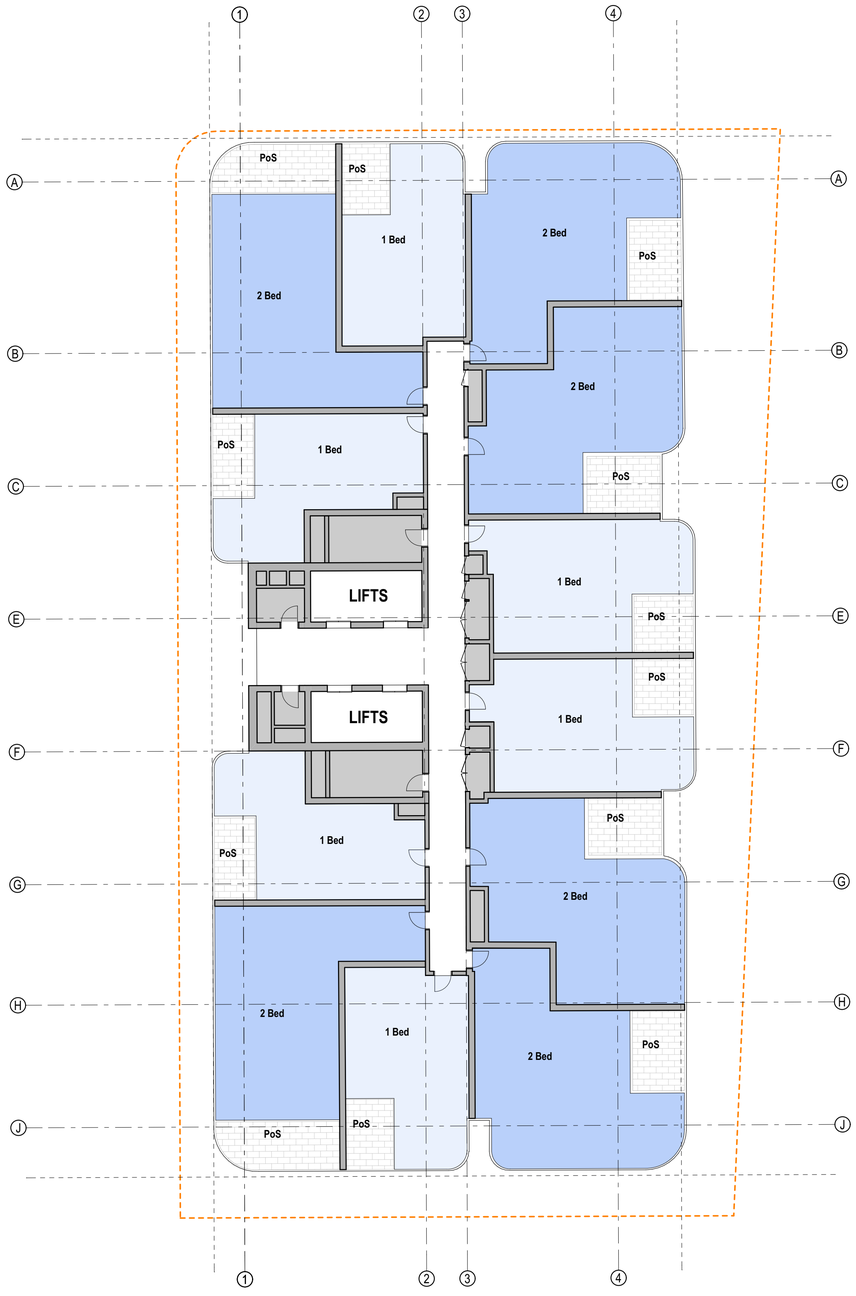
Mirvac - Harbourside

1:150 @ A1

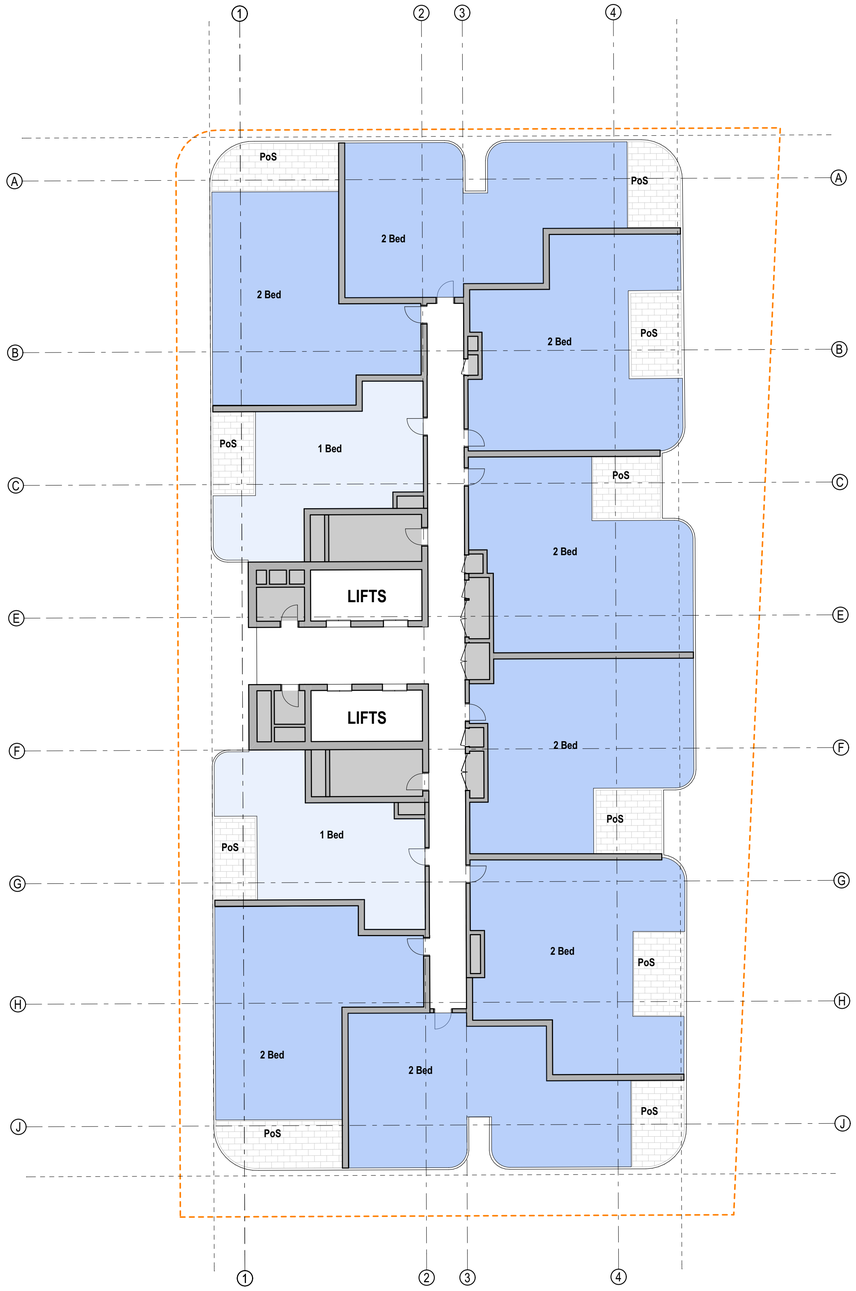
29/1/20

For Information

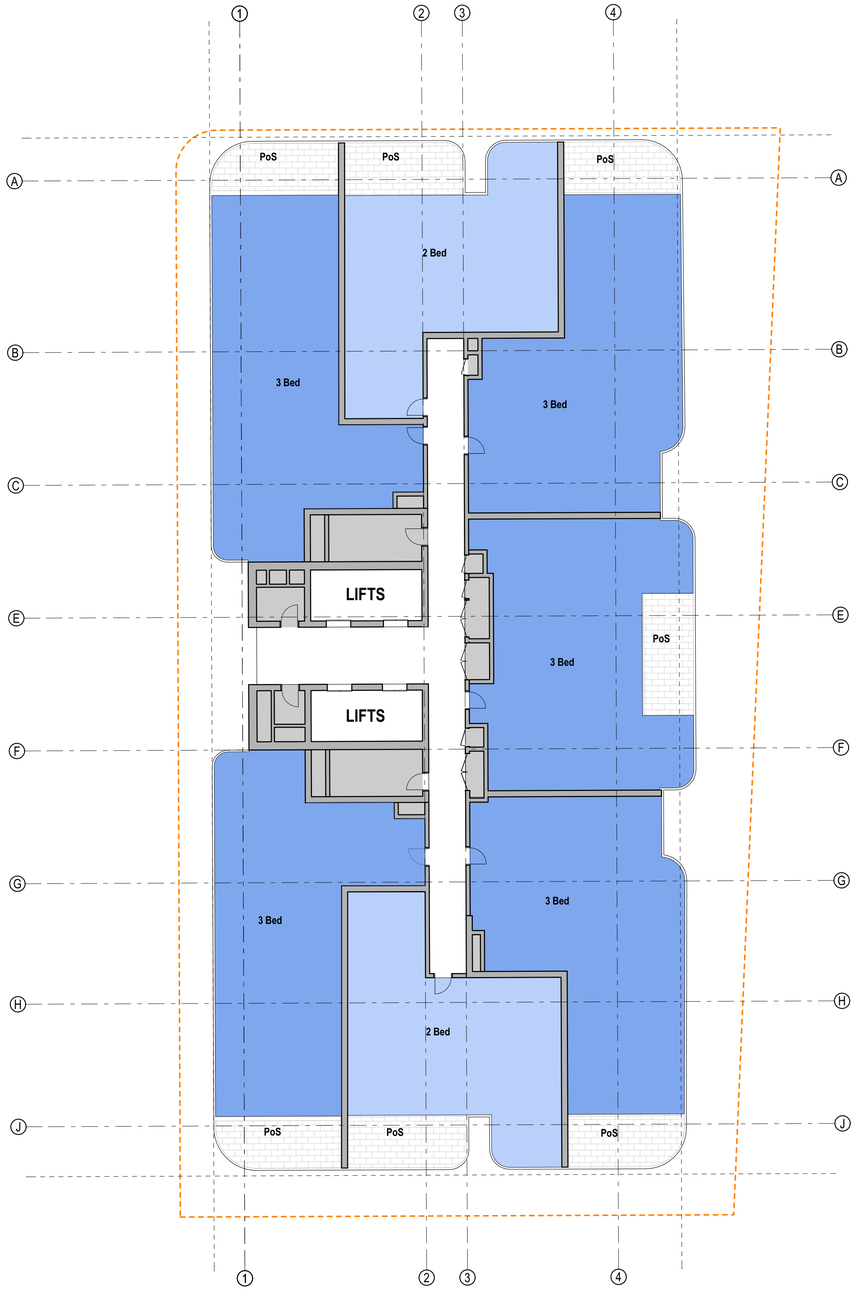
SSDA1-308



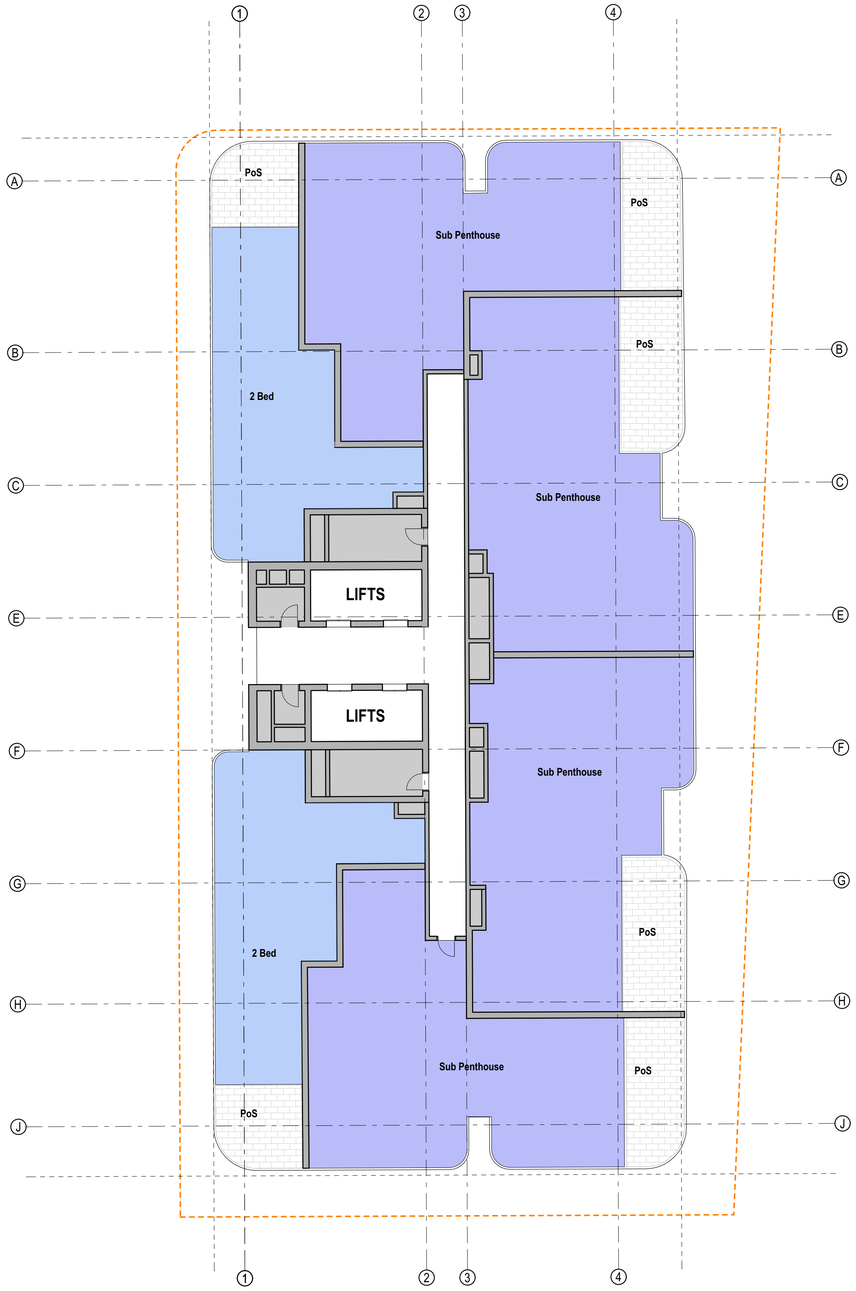
1 PLAN 1B Typical
1:150



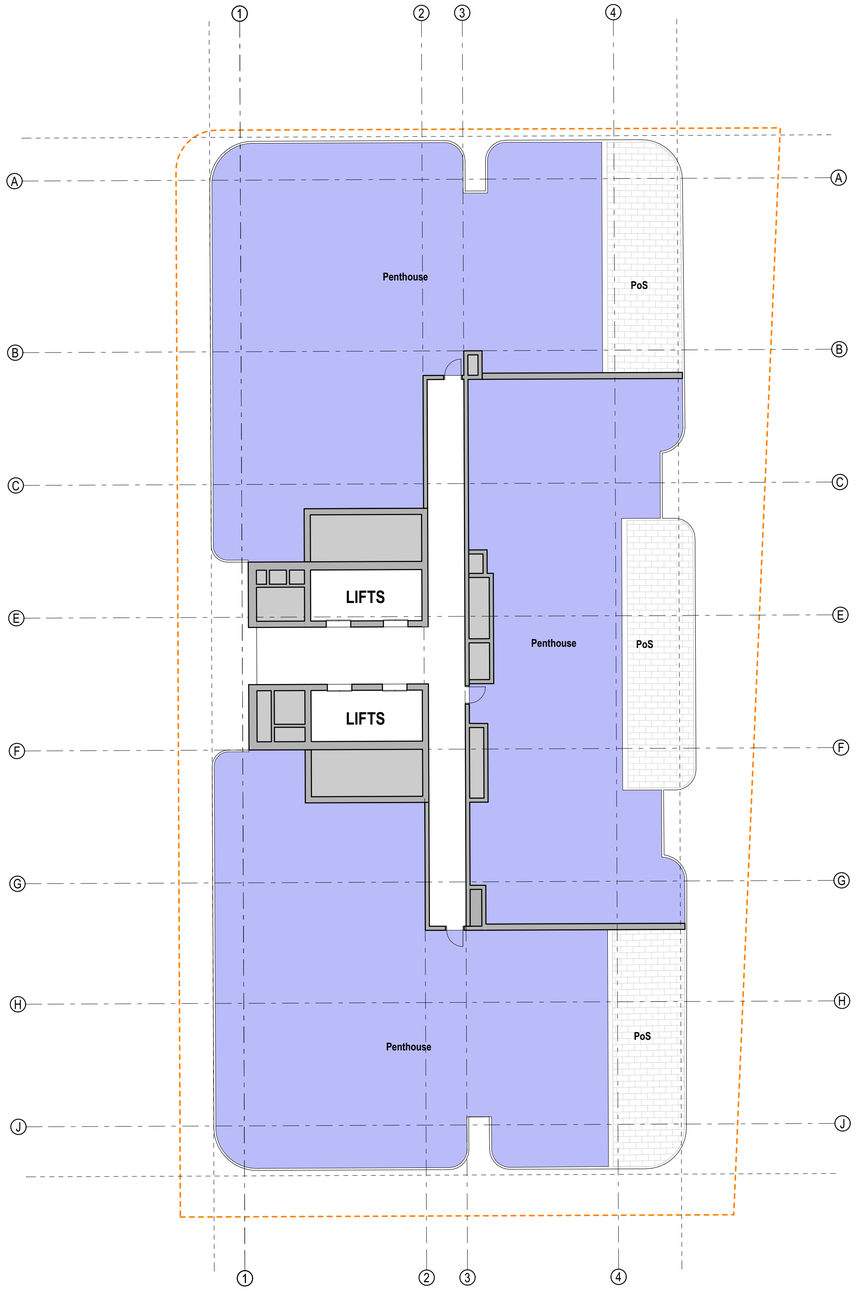
1 PLAN 2B Typical
1:150



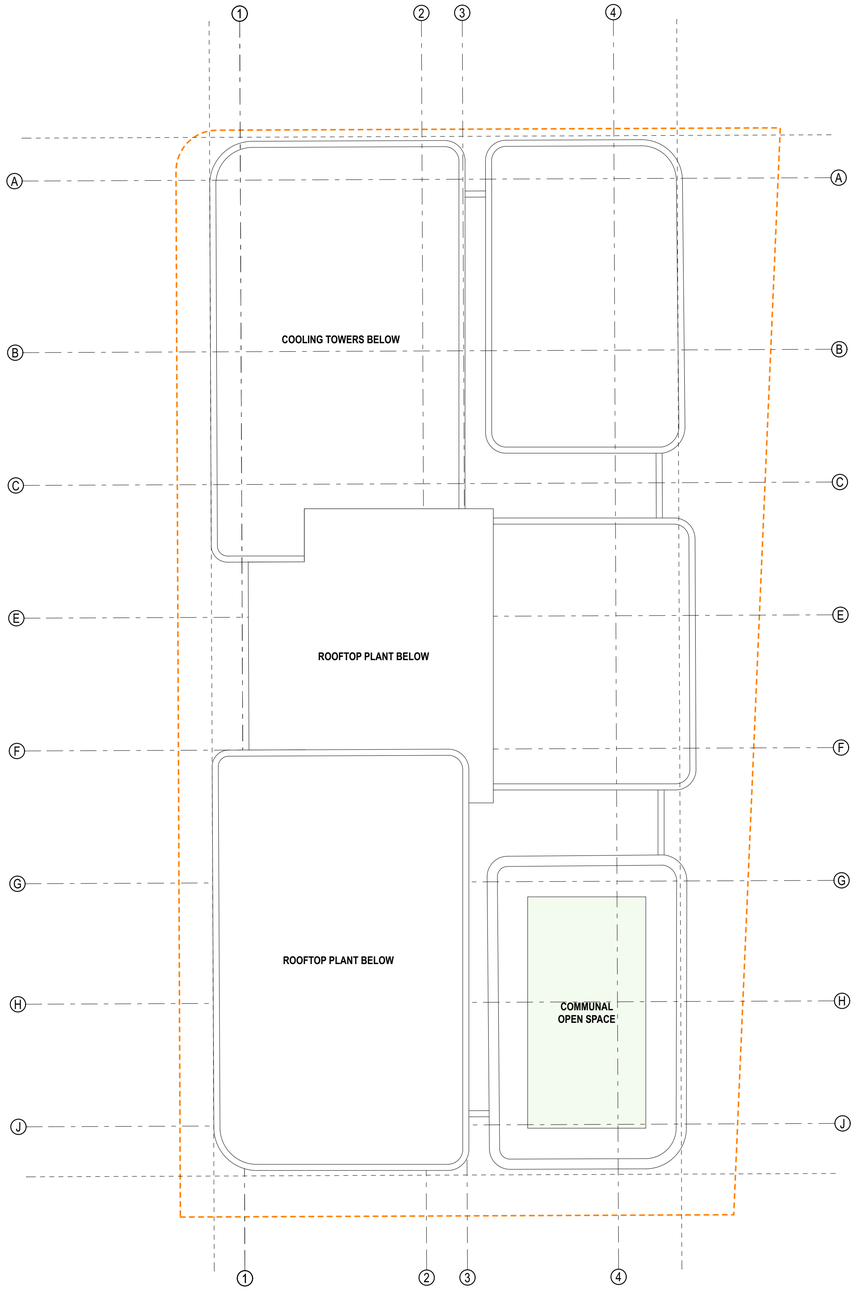
1 PLAN 3B Typical
1:150



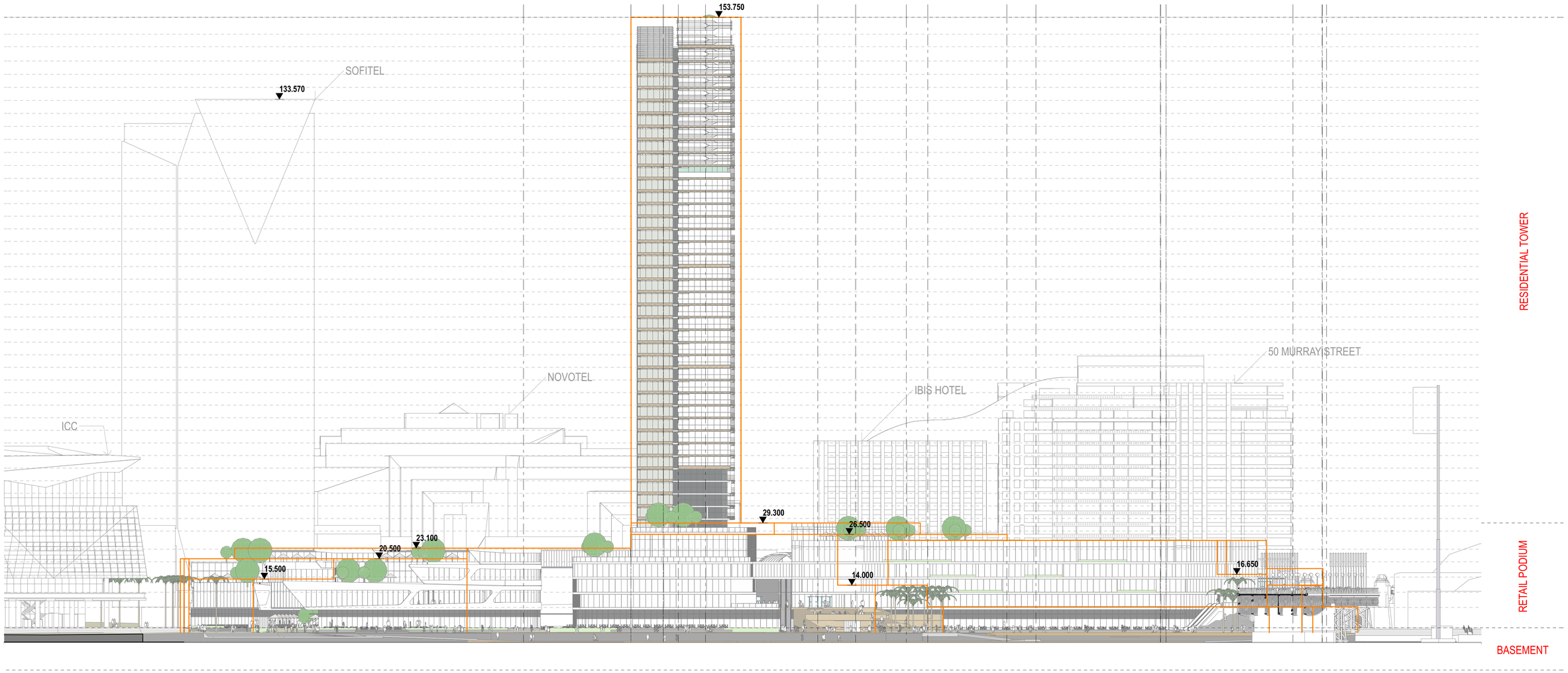
1 PLAN Sub Penthouse
1:150



1 PLAN Penthouse
1:150



1 PLAN Roof Plan
1:150



BOUNDARY LEGEND

ENVELOPE EXTENT

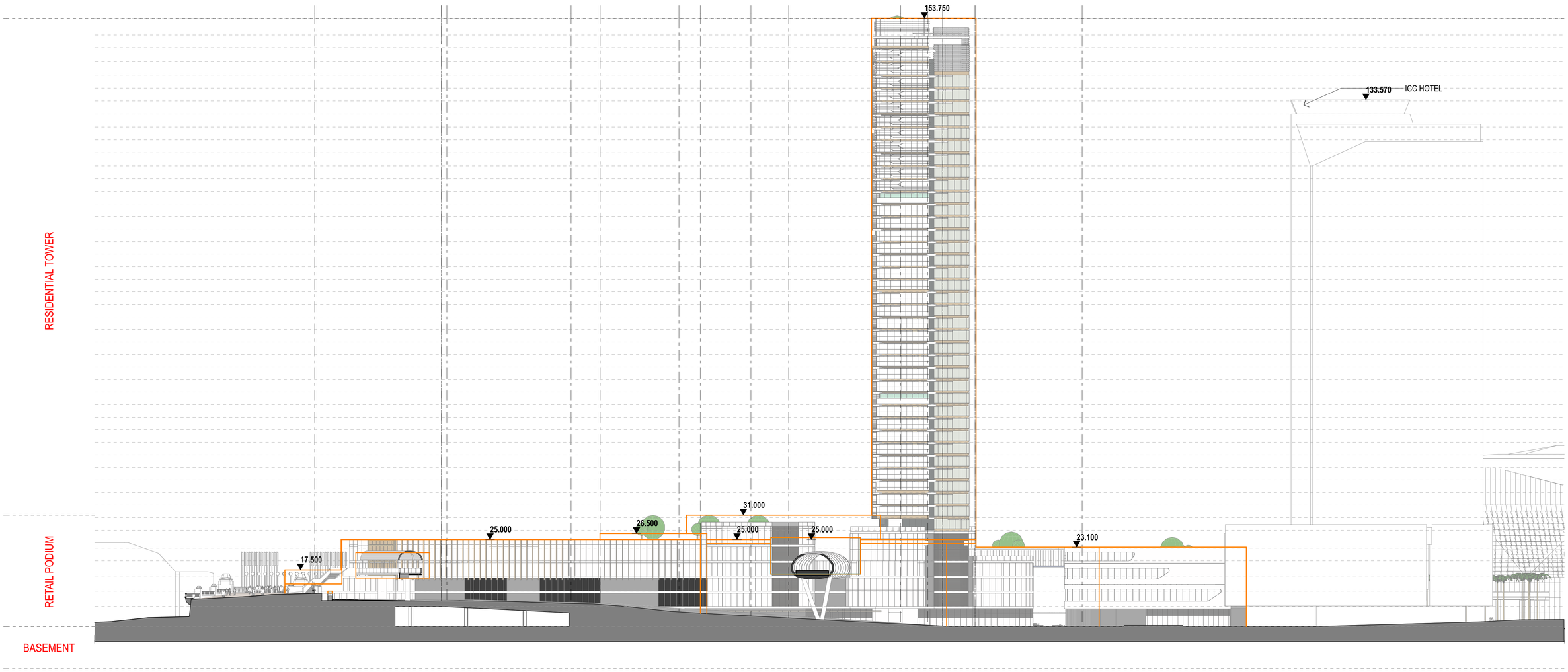
0 5 10 20m

Indicative Elevation Only - East

Mirvac - Harbourside

1:500 @ A1 29/1/20

For Information **SSDA1-315**



BOUNDARY LEGEND

ENVELOPE EXTENT

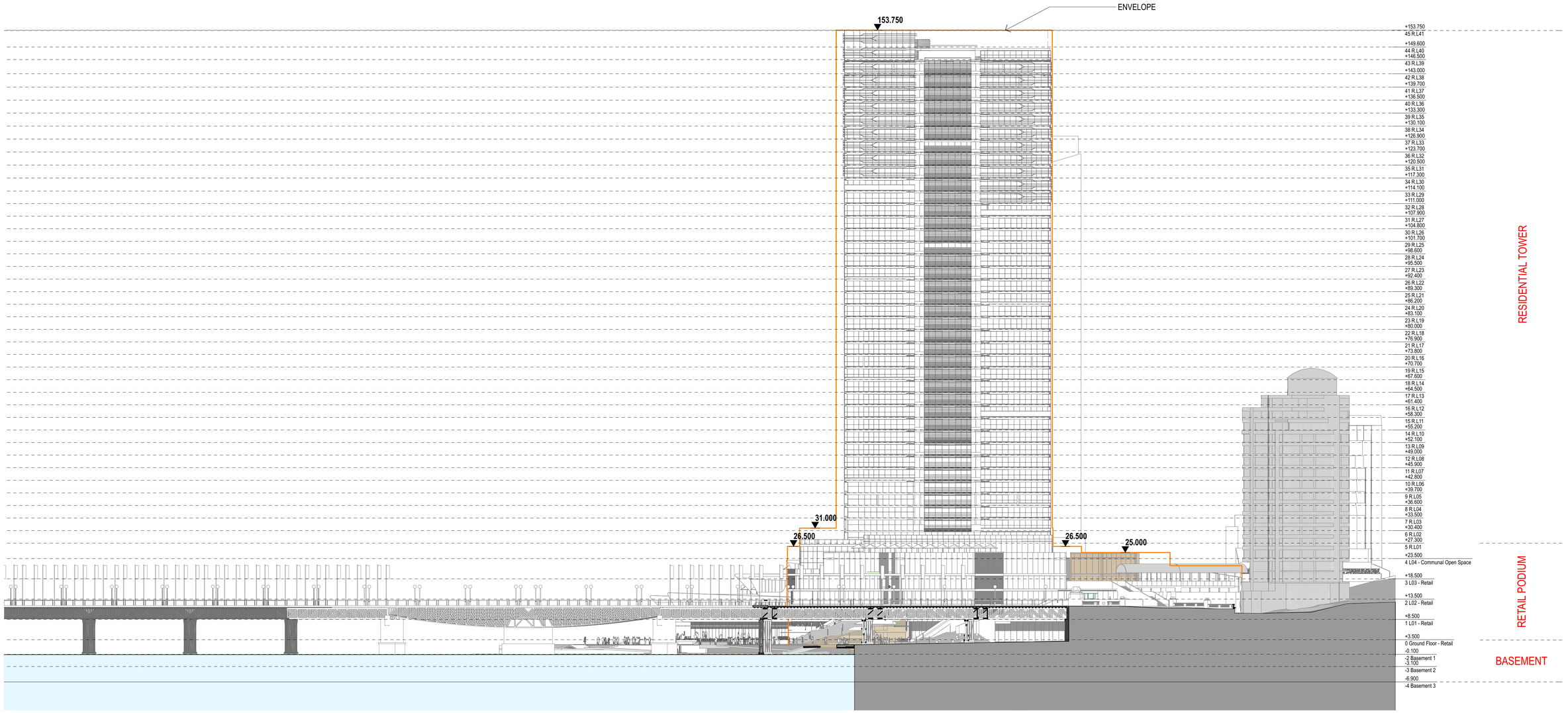
0 5 10 20m

Indicative Elevation Only - West

Mirvac - Harbourside

1:500 @ A1 29/1/20

For Information **SSDA1-316**



BOUNDARY LEGEND

ENVELOPE EXTENT

0 5 10 20m

Indicative Elevation Only - North

Mirvac - Harbourside

1:500 @ A1 29/1/20

For Information **SSDA1-317**

Appendix C – Indicative Geological Sections

coffey

Computations

project no: GEOTLCOV25340AA

sheet 1 of 3

client:

principal:

project: HARBOURSIDE

location:

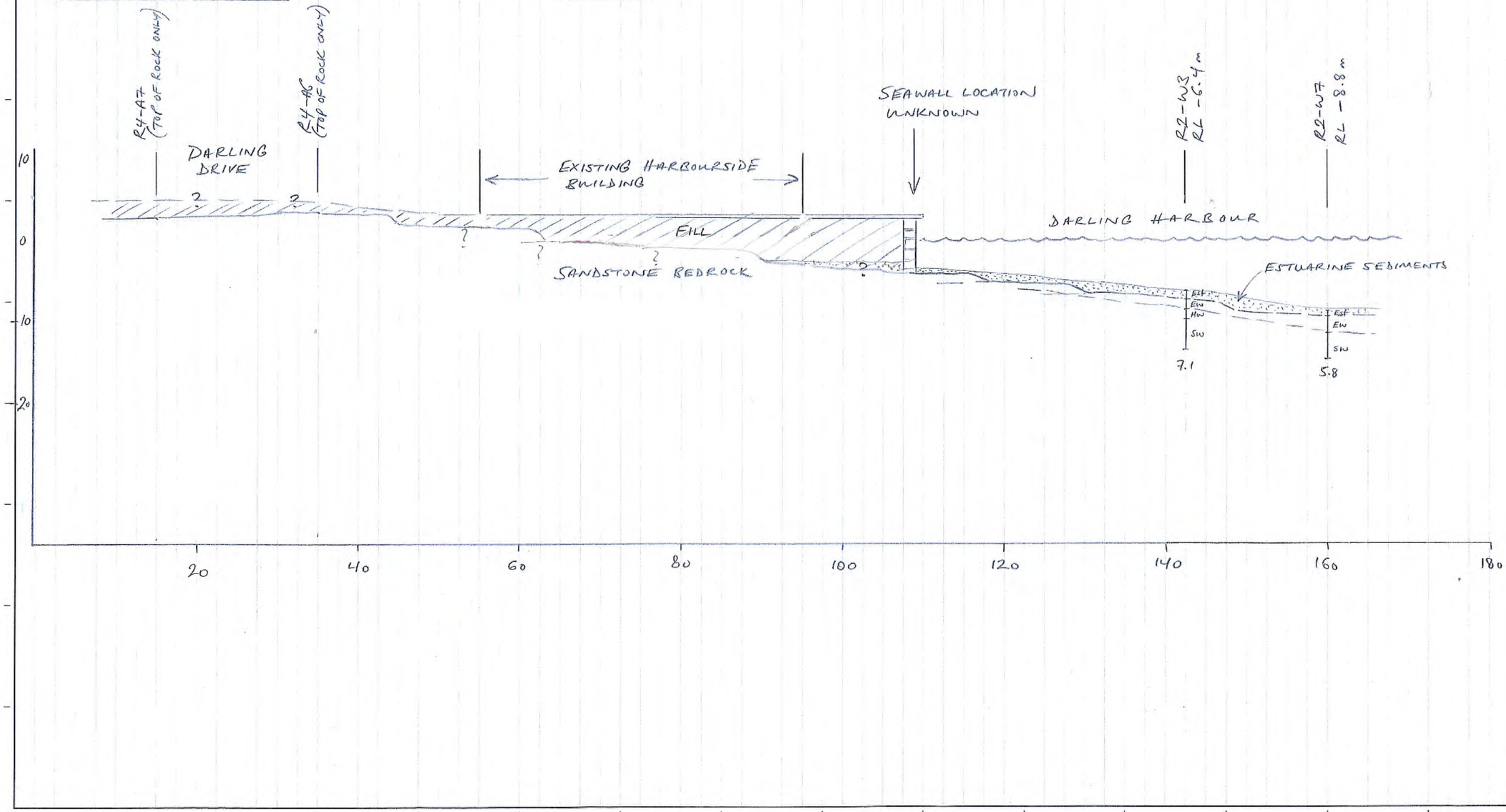
office: CHATS

date: 18/02/2016

by: MF

checked:

SECTION A - A'



64210/07-06

coffey

Computations

project no: GEOTLCOV25240AA

sheet 2 of 3

client:

principal:

project: HARBOURSIDE

location:

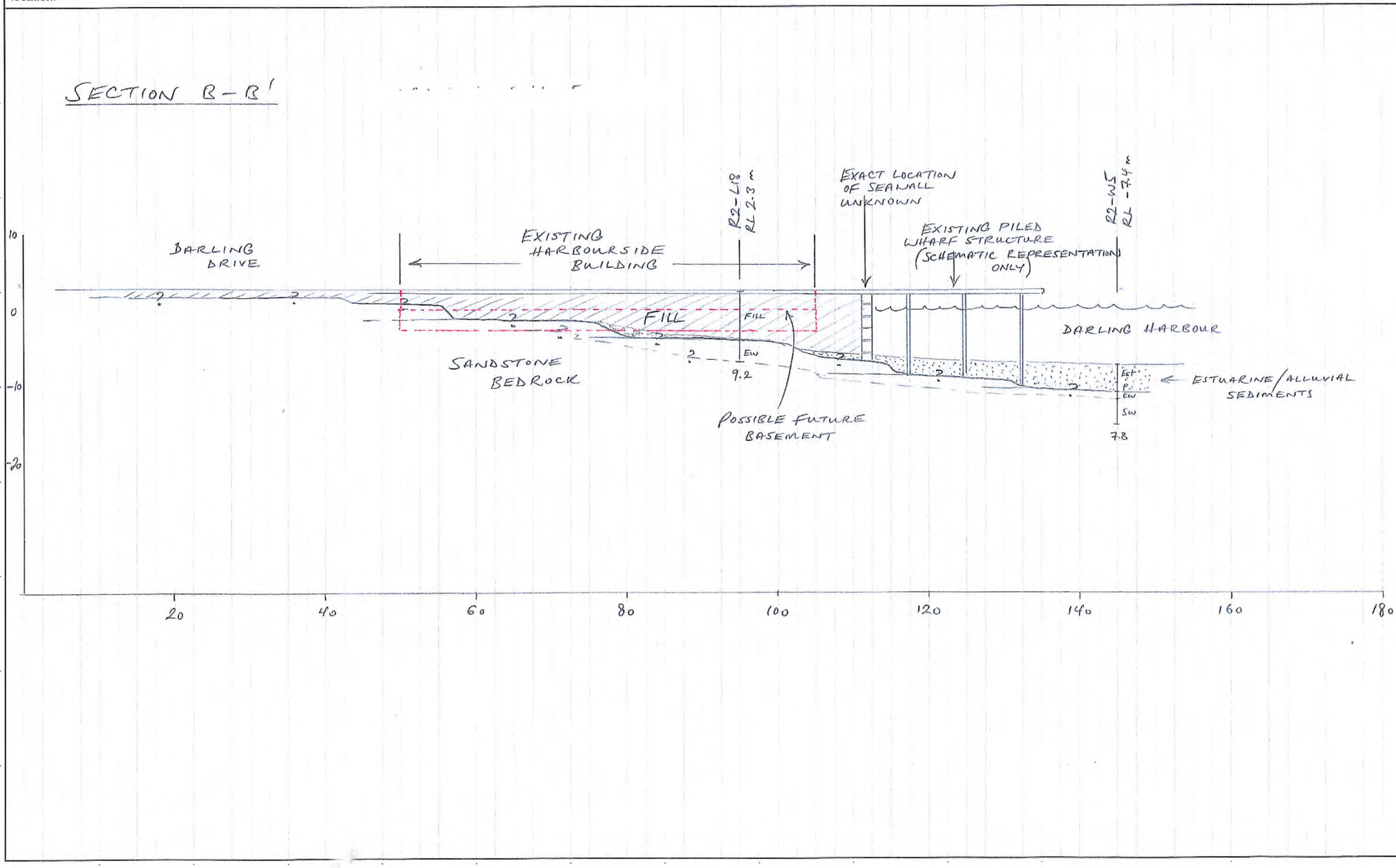
office: CHATS

date: 18/02/2016

by: MF

checked:

SECTION B-B'



64210 / 07-06

coffey

Computations

project no: GEOTLCOV25340AA sheet 3 of 3

client:

principal:

project: HARBOURSIDE

location:

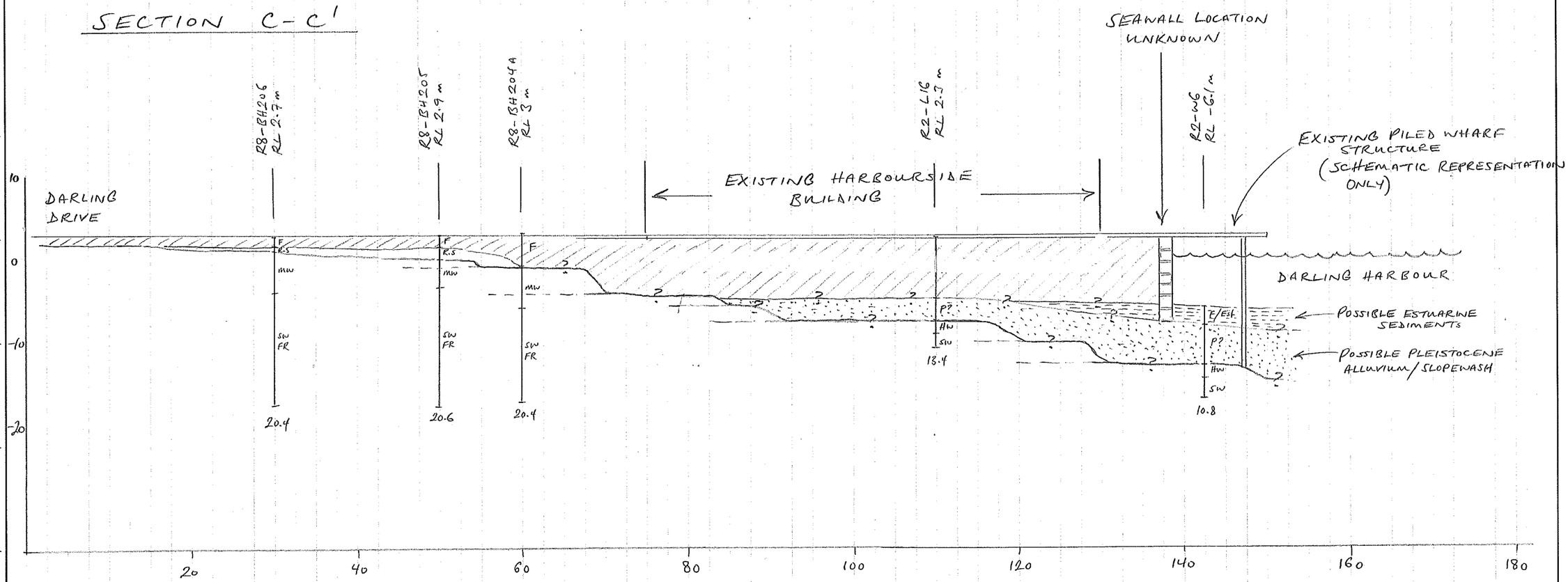
office: CHATS

date: 18/02/2016

by: MF

checked:

SECTION C-C'



64210 / 07-06

Appendix D – Information from Dear et.al. (2002)

The guard layer should be employed as a precaution to neutralise acidity that has not been adequately treated during the soil neutralisation process.

The rate of neutralising agent used in the guard layer will depend on the final treatment pile height, existing and potential acidity of the sediments, and the soil texture. The rate may need to be increased where the receiving environmental values warrant higher protection. The rate may also need to be increased to enable a neutralising agent to be incorporated in situations where significant delays occur in drying soils due to soil texture or climatic conditions.

Note: Reapplication of the guard layer may be necessary under temporary treatment pads, if the guard layer is disturbed or removed with the treated soil.

Soil treatment

Soils may be neutralised on a temporary treatment pad or alternatively the soils may be neutralised as they are placed permanently. Essentially, treatment of the soils is the same process whether it is performed on a temporary treatment pad, or on a treatment pad in their permanent location. Treating soils on a temporary treatment pad may promote better mixing of the neutralising agent with the soil as the soils and agent may be further mixed as they are moved. However, there is the added expense of double handling of the soil.

ASS Tip 16 – Depth of soil

If wet materials are being placed, shrinkage may be allowed for. To allow for shrinkage, layers of greater depth may be initially placed.

Ultimately it is up to the contractor to ensure that they have appropriate equipment to incorporate the neutralising agent to the depth of fill.

Acid sulfate soil material should be placed on top of the guard layer in 150 to 300 mm thick layers on the treatment pad, to allow drying. The appropriate amount of neutralising agent, including the calculated safety factor should be spread once the ASS are sufficiently dry. The ASS may require reworking several times to achieve adequate mixing of the neutralising agent and/or drying of the soil. The treated layer will require Phase 3 sampling (ie. verification analysis) to confirm whether appropriate amounts of the neutralising agent have been incorporated into the soil, which should be subsequently compacted before treatment of the next layer commences, or when moved to the permanent placement area if initially mixed on temporary treatment pads.

Guard layers may need to be applied between each compacted ASS layer as a precaution in environmentally sensitive areas, areas with high levels of sulfides or where soils are difficult to mix.

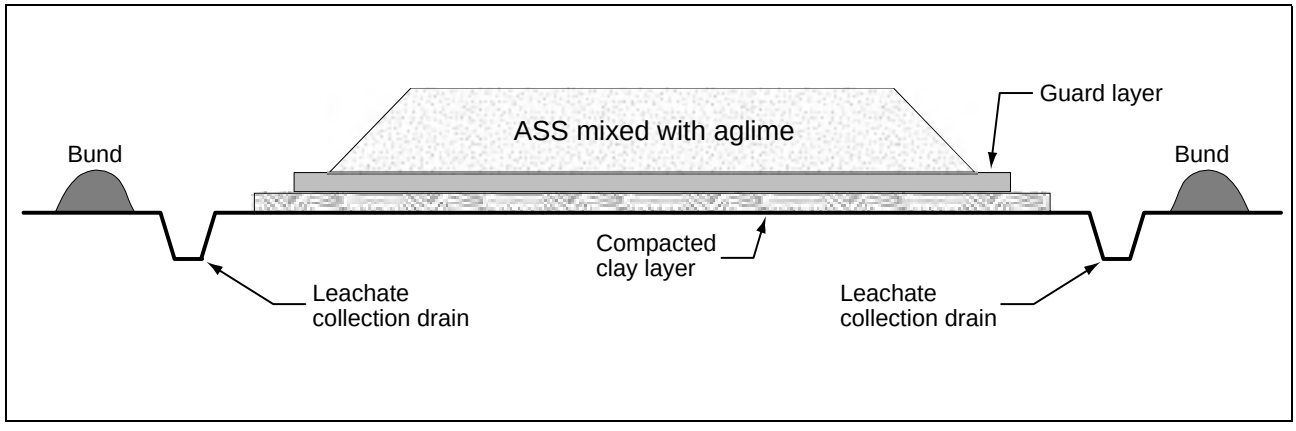


Figure 4. Schematic cross-section of a treatment pad, including a compacted clay layer, guard layer, leachate collection system and containment with bunding.

11.1.2 *Management considerations*

Stockpiling untreated ASS should be minimised by preparing a detailed earthworks strategy that documents the timing of soil volumes to be moved, treatment locations and capacity of those areas to accept materials. Stockpiling may mean double-handling and increased earthmoving costs. It is important to account for risk from wet weather and plan for other contingencies.

Short-term stockpiles

The recommended maximum time period for which soils can be temporarily stockpiled without treatment is detailed in Table 4.

Table 4. Indicative maximum periods for short-term stockpiling of untreated ASS.

Type of Material		**Duration of stockpiling**	
Texture range (McDonald *et al*. 1990)	Approx clay content (%)	Days	Hours
Coarse texture Sands to loamy sands	≤5	Overnight	18 hours
Medium texture Sandy loams to light clays	5–40	2½ days	70 hours
Fine texture Medium to heavy clays and silty clays	≥40	5 days	140 hours

At some sites these figures may be too conservative, and in some circumstances not conservative enough (eg. during hot weather some sands may begin to oxidise within a matter of hours). It is recommended that appropriate operational delay times be determined (preferably well prior to the creation of the stockpile) for the specific circumstances. The use of a guard layer under the short-term stockpiles may be warranted under certain circumstances.

The total volume of material that is placed in short-term stockpiles should not exceed 20% of a day's total extraction.

Note: These timeframes do not apply to monosulfidic black oozes. These materials should not be stockpiled without a risk assessment, and the implementation of strict environmental management protocols.

Medium-term stockpiles

Situations where it is necessary to stockpile untreated ASS for moderate periods will need to be justified to the relevant administrating agency. Management to reduce the oxidation of sulfides and the collection and treatment of all leachate and runoff water will need to be implemented during the stockpiling period. The maximum time period for which soils can be temporarily stockpiled in the medium-term is listed in Table 5.

Table 5. Indicative maximum periods for medium-term stockpiling of untreated ASS.

Type of Material		**Duration of stockpiling**	
Texture range (McDonald *et al*. 1990)	Approx clay content (%)	Days	Weeks
Coarse texture Sands to loamy sands	≤5	14 days	2 weeks
Medium texture Sandy loams to light clays	5–40	21 days	3 weeks
Fine texture Medium to heavy clays & silty clays	≥40	28 days	4 weeks

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