Project No: S20047

27 November 2020

Deicorp
Level 4, 161 Redfern Street
REDFERN NSW 2016

Attention: Mr G Colbran

Dear Greg,

FIVE-WAYS, CROWS NEST
PLANNING PROPOSAL
STRUCTURAL ENDORSEMENT LETTER

BG&E Pty Limited, being chartered consulting engineers and members of Consult Australia, hereby confirm that this practice has carried out a structural review of Turner Architectural drawings dated 25 November 2020 for the Five-Ways Development located at Crows Nest.

The structural review was carried out which also included the review of EIAustralia Geotechnical Investigation Report E24770.G03 1 October 2020, to assess the feasibility of the design with respect to the advice provided in BG&E Concept Report-Planning Proposal dated 29/05/2020.

The proposed design includes deleting a single 36 storey tower and adding twin 18 storey towers. We note that the basement excavation remains unchanged from what was previously reviewed.

Based on our review we confirm that the advice previously provided in BG&E Concept Report-Planning Proposal dated 29/05/2020 is still valid. BG&E endorses the proposed Turner Architectural drawings dated 25th November 2020.

We trust this above is sufficient for its intended purpose.

Yours sincerely,

VINCE BETRO
Associate Director- Buildings Lead NSW

Enc.
Turner Architect Drawings dated 25th November 2020
BG&E Concept Report-Planning Proposal dated 29/05/2020

Sydney *Office*—

Level 2, 8 Windmill Street, Sydney NSW 2000
P / +61 2 9770 3300 *E /* info@bgeeng.com
bgeeng.com—

BG&E Pty Limited
ABN / 67 150 804 603

FALCON ST

PUBLIC WALK

PUBLIC WALK

PACIFIC HWY

ALEXANDER ST

ALEXANDER LN

Sydney Metro Protection 1st Reserve

Sydney Metro Protection 1st Reserve

Retail
99.2

Commercial
& Residential
Lobby
98.0

Retail
98.2

Retail
97.2

Retail
97.8

Retail
113.9

Retail
97.2

Retail
96.1

Retail
97.0

Retail
96.3

RL +99.02
RL +98.75
RL +98.43
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RL +97.60
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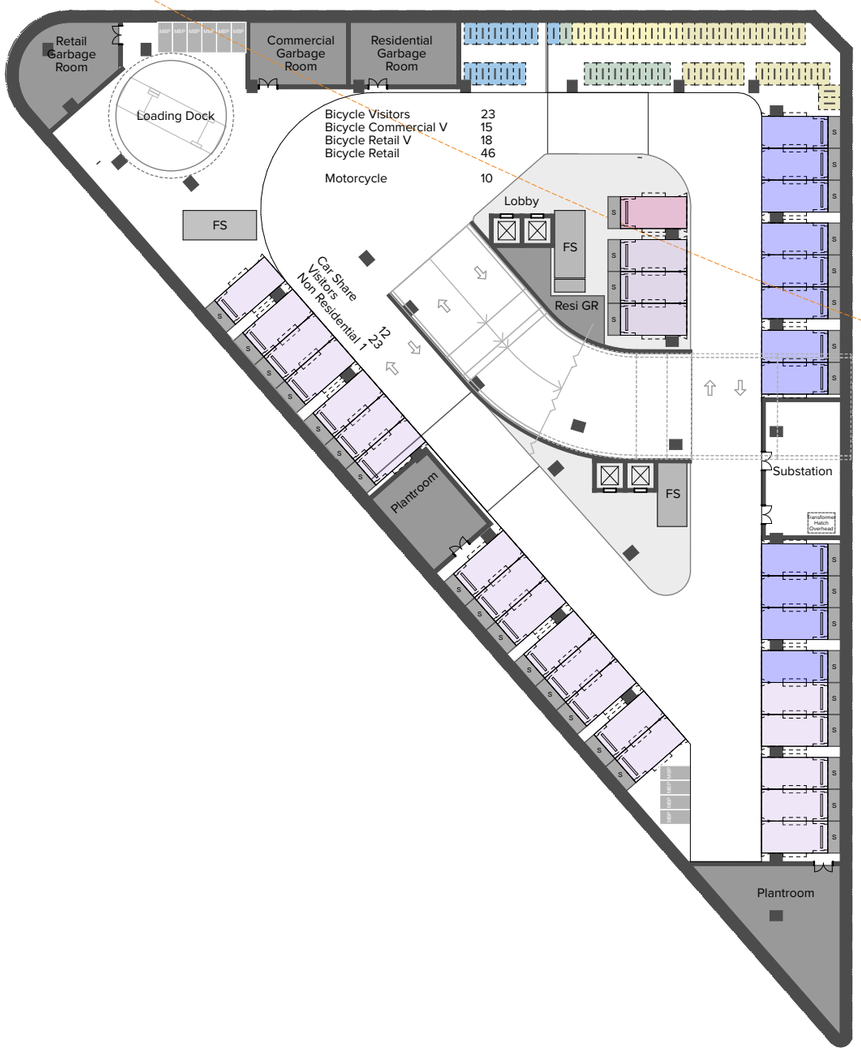
RL +98.99
RL +99.11
RL +99.14

TURNER

Ground Level

25 November 2020

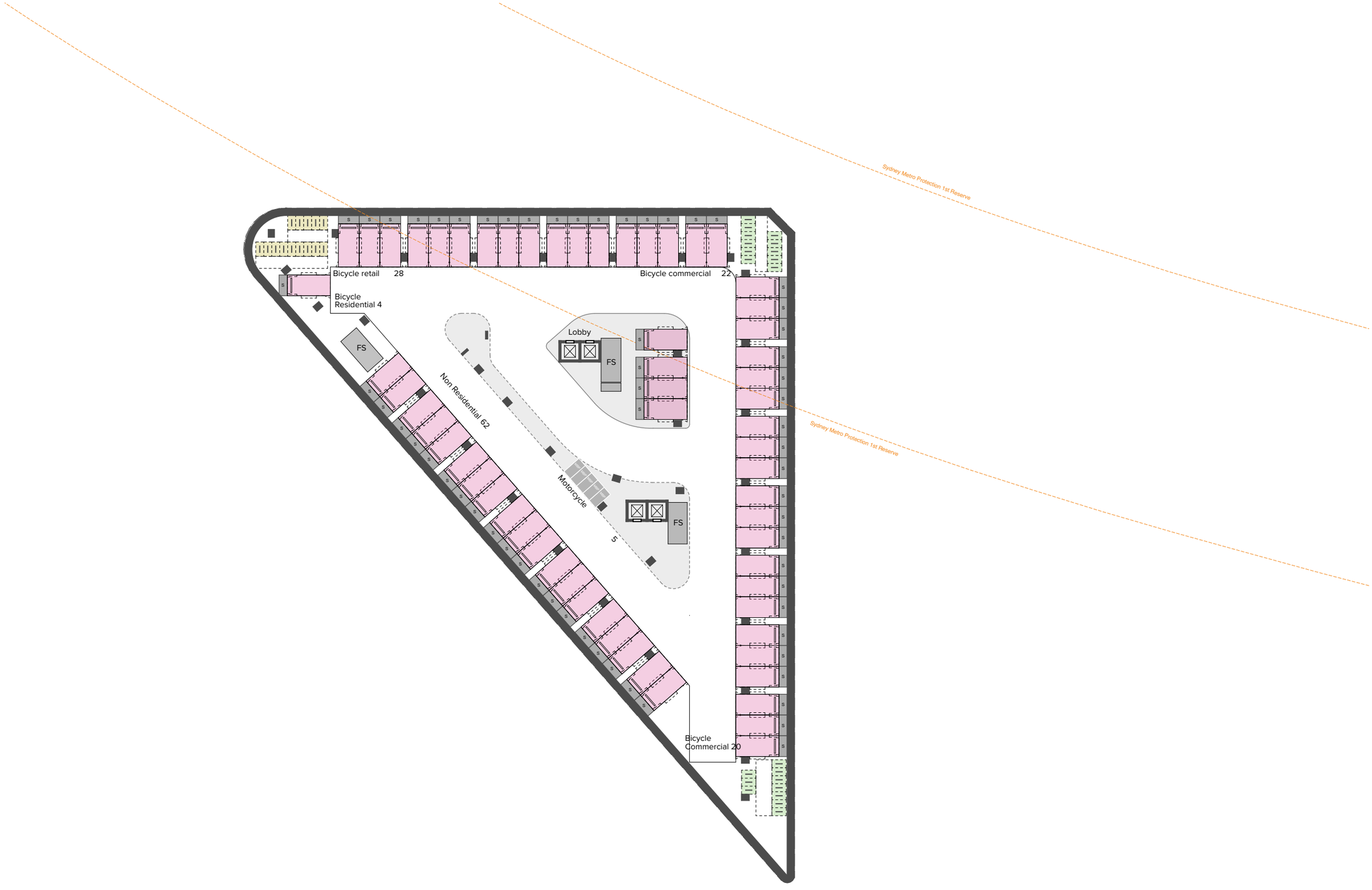


- Residential
- Residential Adaptable
- Car Share
- Residential Visitors
- Non Residential
- Bicycle Residents
- Bicycle Residents Visitors
- Bicycle Commercial
- Bicycle Commercial Visitors
- Bicycle Retail
- Bicycle Retail Visitors

TURNER

Basement 01

25 November 2020



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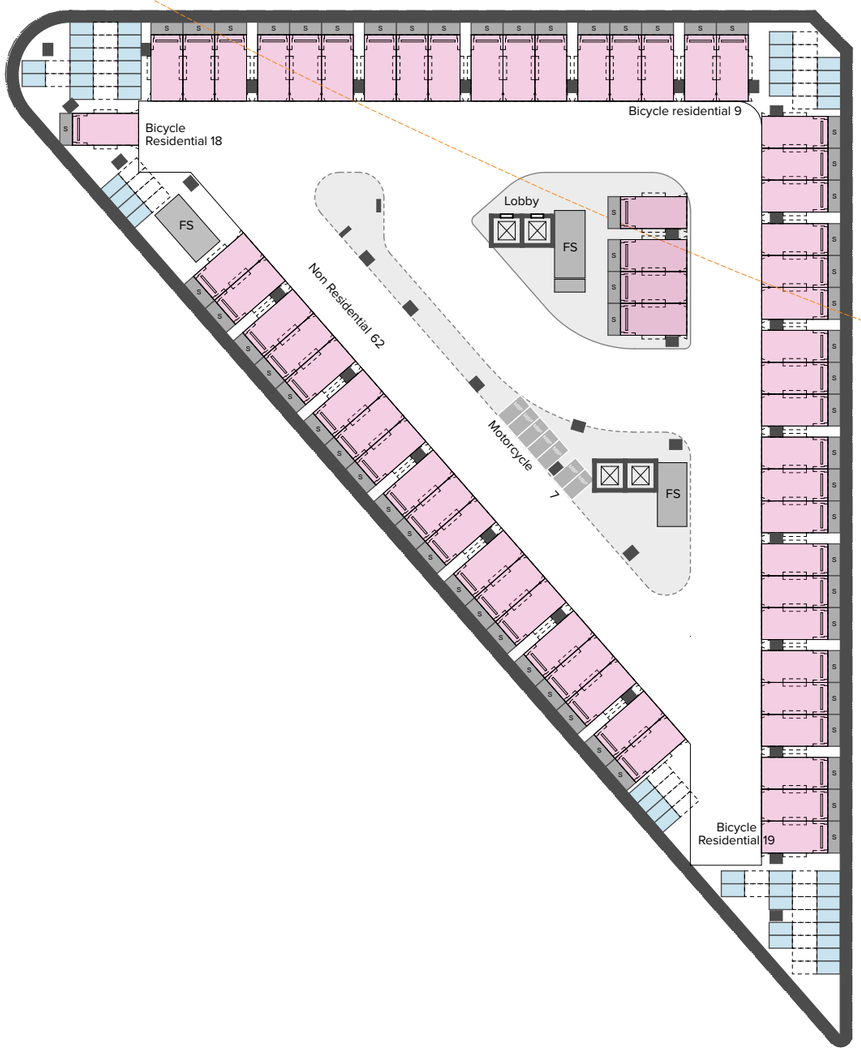
TURNER

Basement 02

25 November 2020



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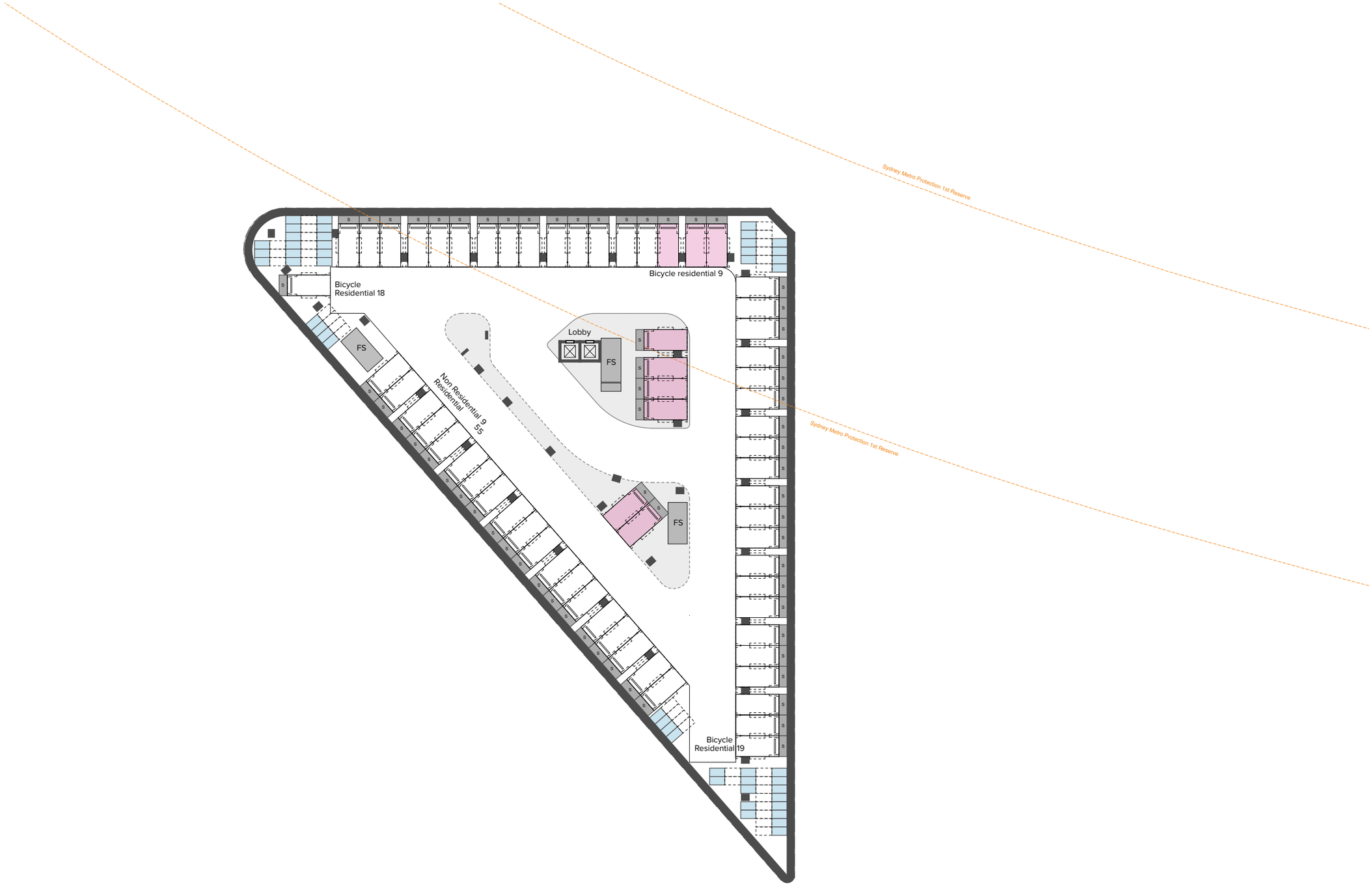
TURNER

Basement 03

25 November 2020



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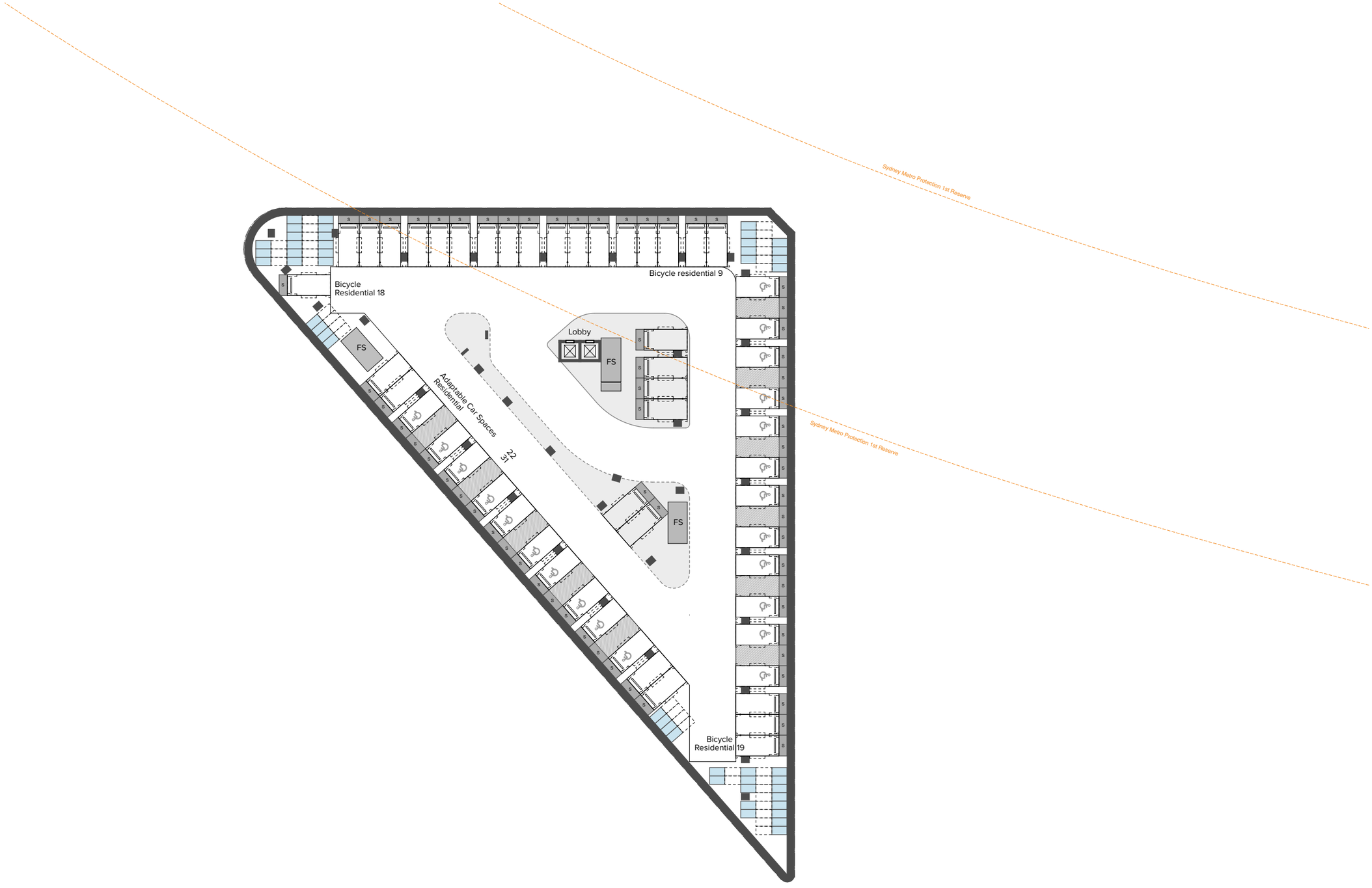
- Bicycle Retail Visitors

TURNER

Basement 04

25 November 2020



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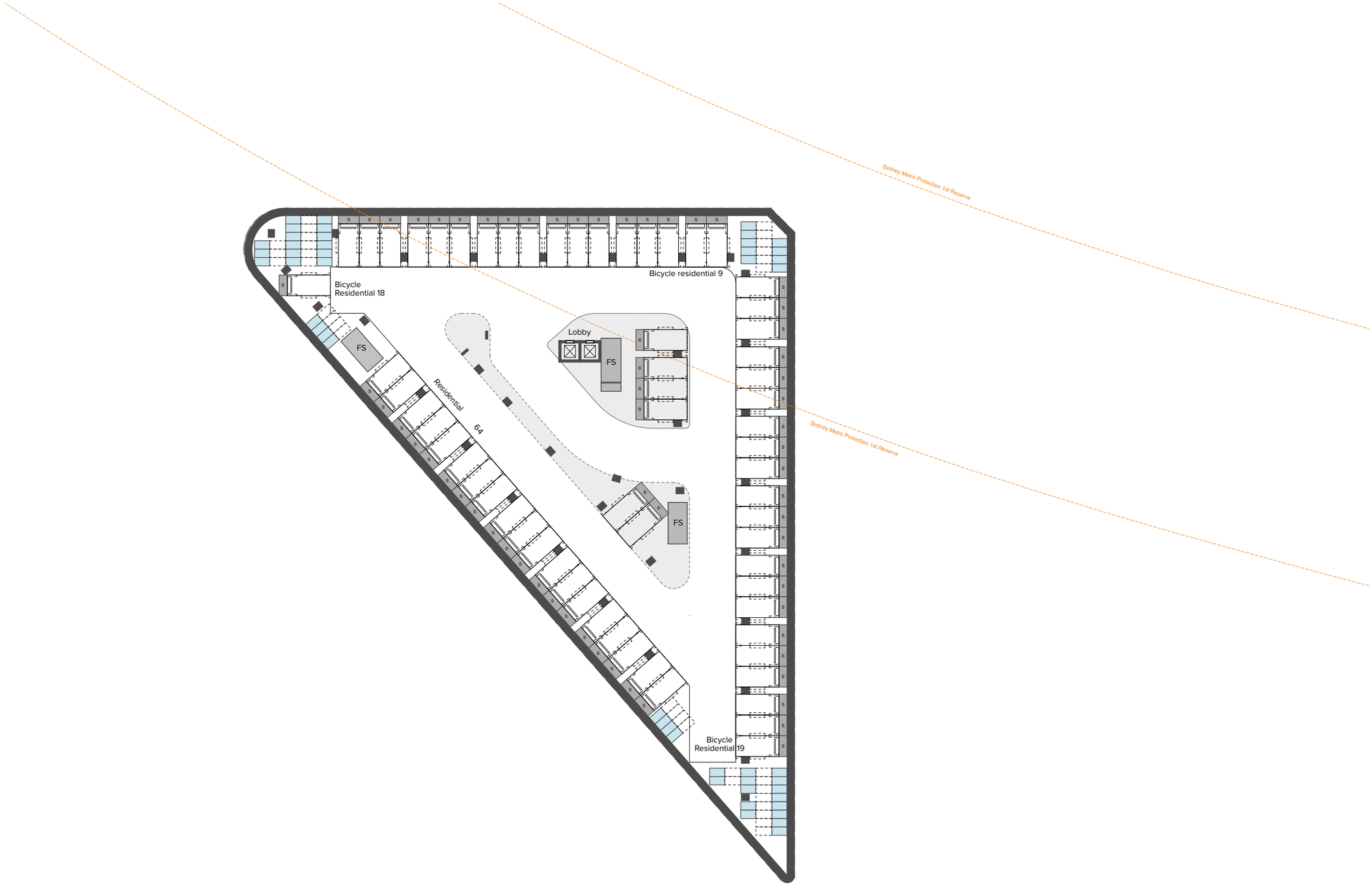
- Bicycle Retail
- Bicycle Retail Visitors

TURNER

Basement 05

25 November 2020



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- Residential Adaptable
- Car Share
- Residential Visitors
- Non Residential
- Bicycle Residents
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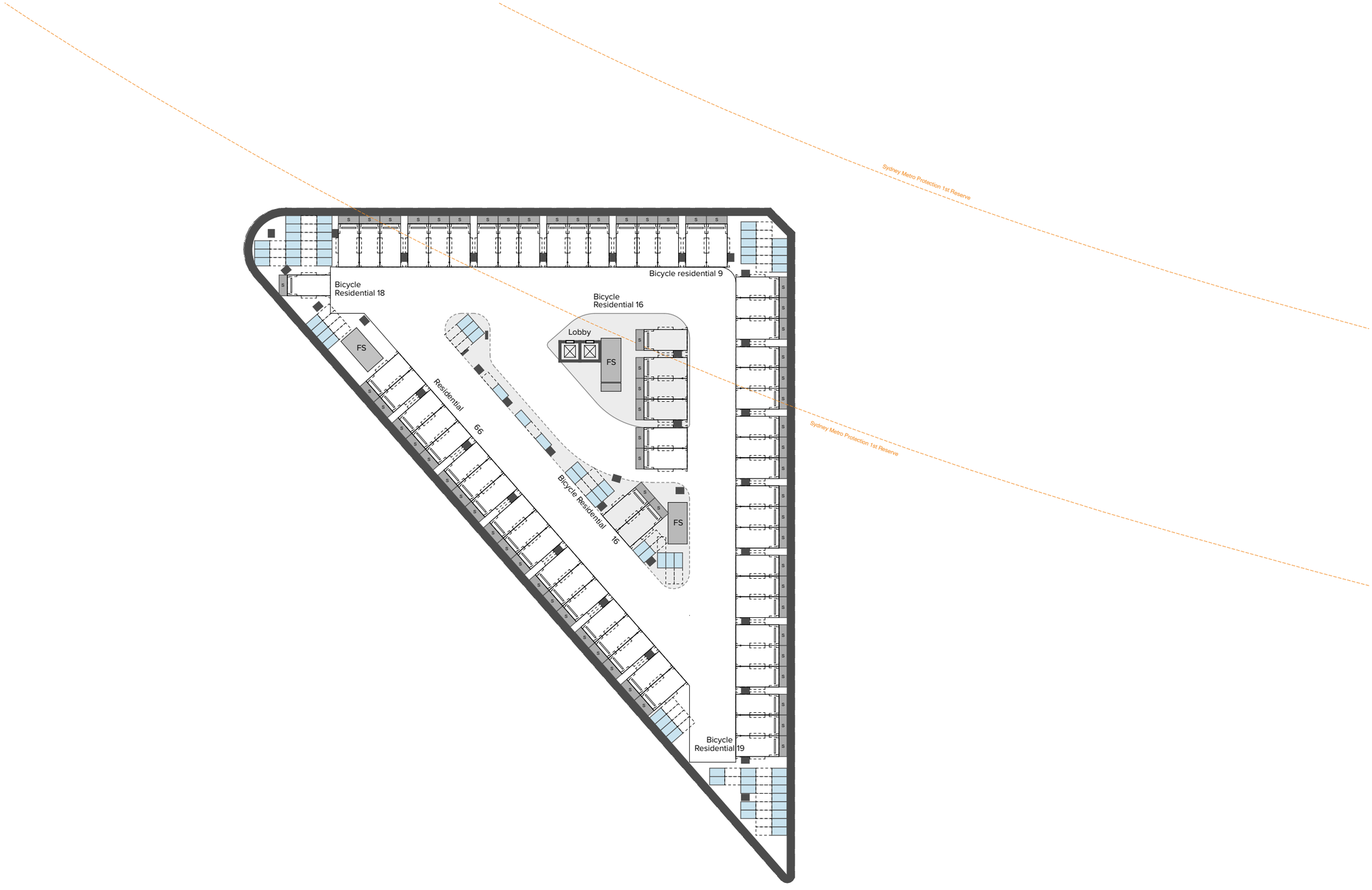
- Bicycle Commercial
- Bicycle Commercial Visitors
- Bicycle Retail
- Bicycle Retail Visitors

TURNER

Basement 06

25 November 2020



- Residential
- Residential Adaptable
- Car Share
- Residential Visitors
- Non Residential
- Bicycle Residents
- Bicycle Residents Visitors
- Bicycle Commercial
- Bicycle Commercial Visitors
- Bicycle Retail
- Bicycle Retail Visitors

TURNER

Basement 07

25 November 2020

	North Sydney DCP Requirements	Provided
Residential		
1 Bed - 34 Apartments	17	
2 Bed - 176 Apartments	176	
3 Bed - 23 Apartments	23	
Total - 233 Apartments	216	216
Residential Adaptable	10% of total Apartments	23 (Included in total residential)
Car Share	Not required	12
Residential Visitors	23	23
Non Residential	134	134
Total Car Spaces	**385**	**385**

NOTE: Calculated at 10%

Bicycle Residents	233	233
Bicycle Residents Visitors	23	23
Bicycle Commercial	41	41
Bicycle Commercial Visitors	15	15
Bicycle Retail	73	73
Bicycle Retail Visitors	18	18
Total Bicycles	**404**	**404**
Motorcycles	**22**	**22**

NOTE: In Basement 7 there are currently 30 extra car spaces if required

FALCON ST

Commercial
105.5

PACIFIC HWY

ALEXANDER ST

ALEXANDER LN

TURNER

Level 01

25 November 2020

TURNER

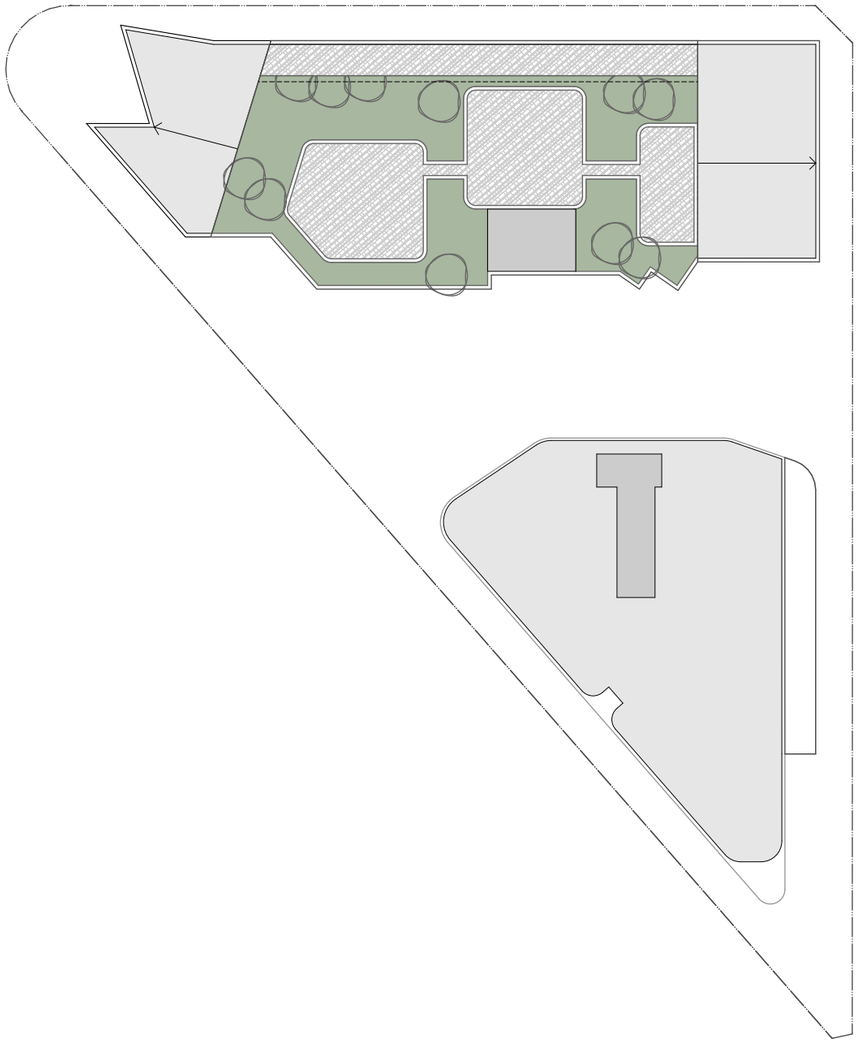
Level 02

25 November 2020

TURNER

Level 03 Podium

25 November 2020



TURNER

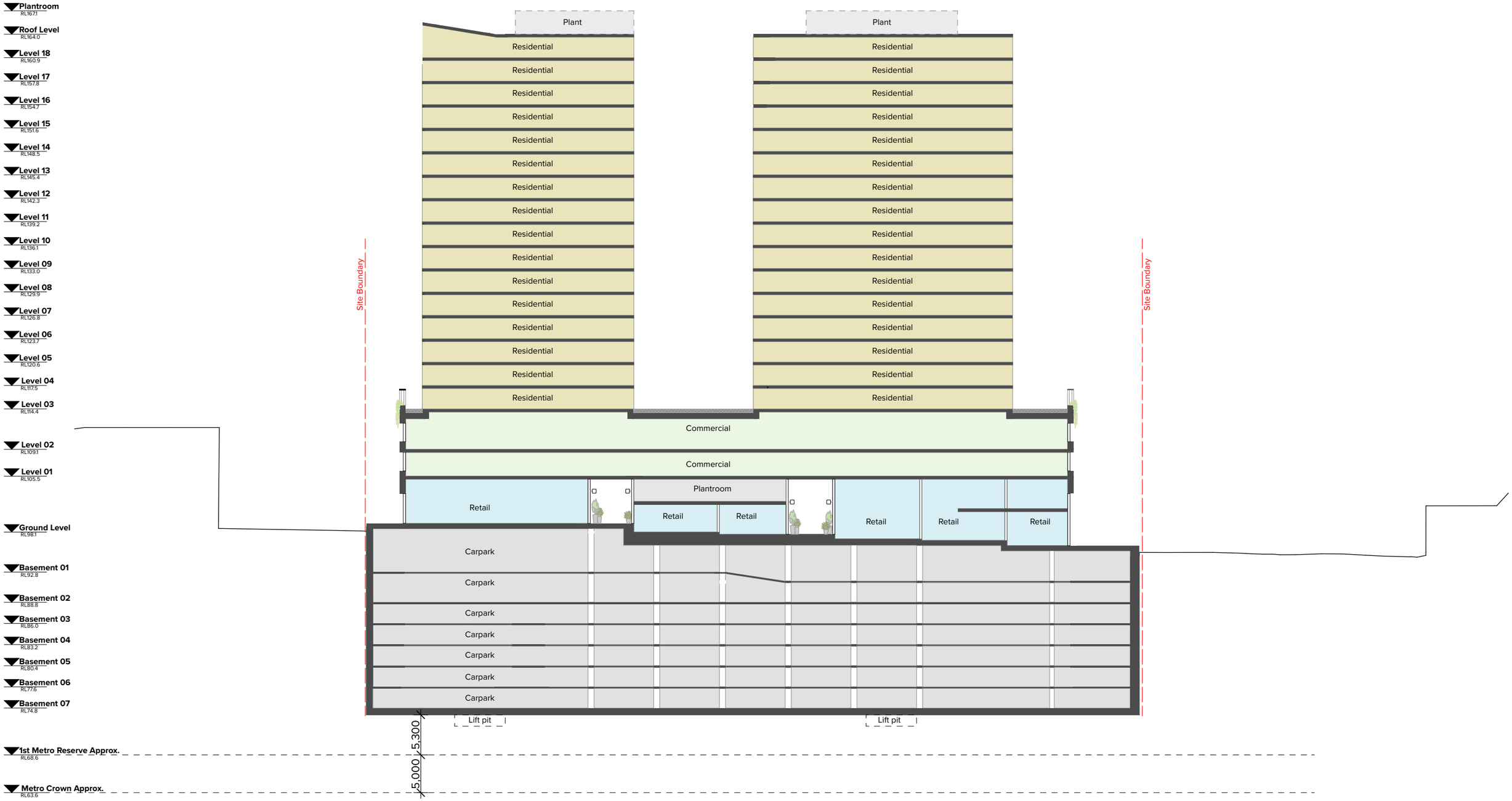
Roof Level

25 November 2020

TURNER

Typical Level

25 November 2020



TURNER

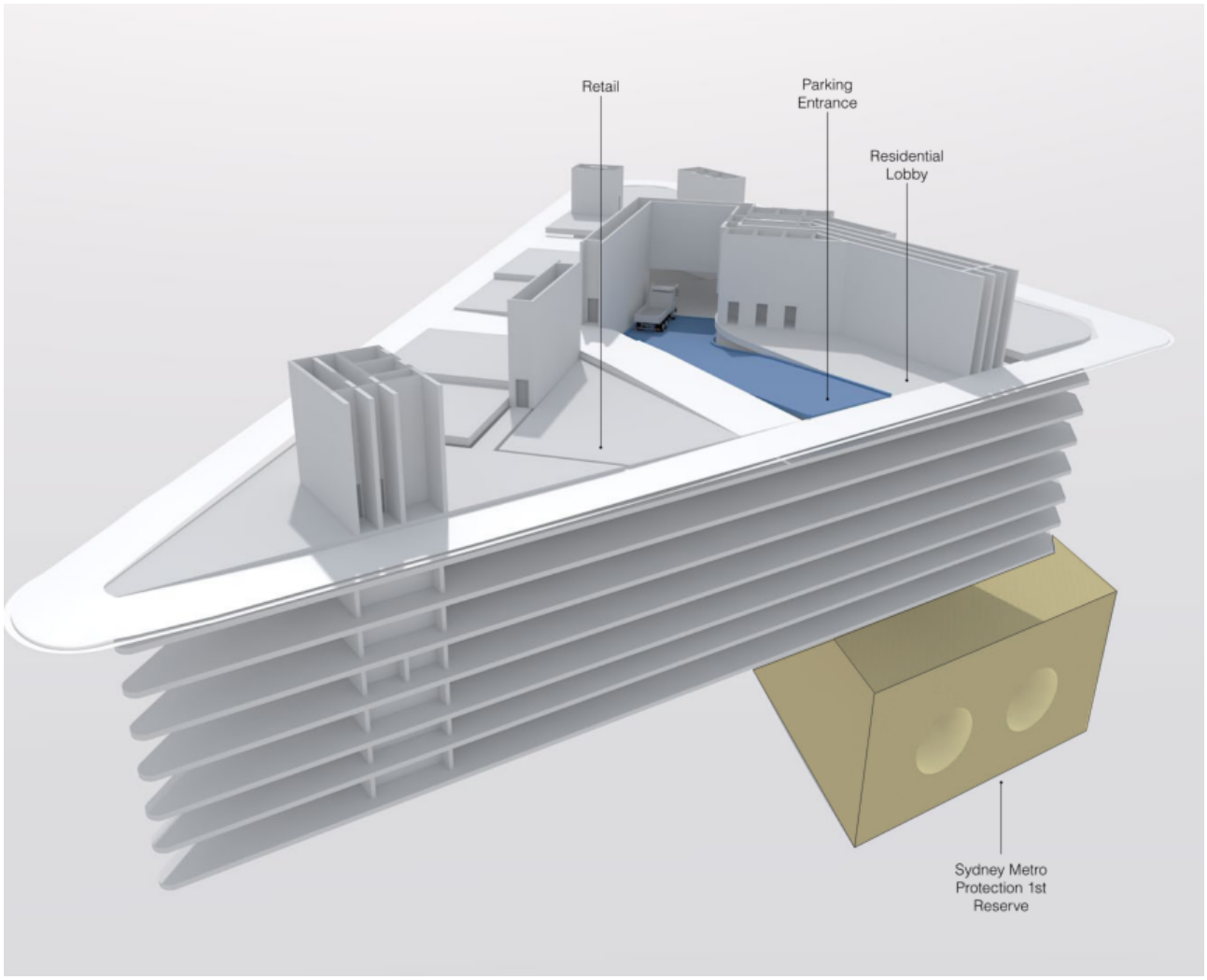
Section AA 1:500

25 November 2020

FIVE-WAYS

Crows Nest —

Concept Report – Planning Proposal



FOR / Structural Engineering Services

CLIENT / Deicorp

DOCUMENT NO / S20047-BGE-RPT-001 REV / B DATE / 29/05/2020

bgeeng.com—

CONTENTS

Document *Control*

Revision	Date	Description	Prepared	Reviewed	Approved
A	06/05/2020	Draft- For Information	VB		
B	29/05/2020	For Information	VB	JC	

1 INTRODUCTION

The subject site is bound by Falcon St, Pacific Highway and Alexander Street in Crows Nest. Currently the site is occupied by residential and commercial buildings. Sydney Metro Tunnels are also located below the site.

The proposed development consists of a 36 storey residential tower over a 7 level basement. The first 6 levels of the buildings are proposed to be dedicated to retail and commercial with the remaining floors being residential.

The proposed developments extents into the 2nd Reserve of the Sydney Metro Tunnels.

1.1 Background

BG&E is familiar with the subject site. A previous commission from the previous owners included a feasibility study on a 40 and 60 storey tower option with a full basement excavation over the existing Sydney Metro tunnels.

BG&E is also working on the Sydney Metro Tunnel Station Excavation (TSE) Package which includes the assessment of building structures along the tunnel alignment after the tunnels had been excavated and constructed.

1.2 Reference Documents

This report has drawn on the information provided in the following documents:

- Turner Silvester Fuller Architectural Drawings Refer Appendix A
- Douglas Partners Report No. Project 86645.01 dated 19th March 2019 R.002 Rev0JH.
- Douglas Partners Letter No. Project 86645.02 dated 29th May 2020
- Transport Assest Standards Authority Standard, Developments near Rail Tunnels- T-HR-CI-12051-ST v2 November 2018.
- Sydney Metro Underground Corridor Protection Technical Guidelines- NWRLSRT-PBA-SRT-TU-REP-000008 rev 1 dated 16 October 2017.

1.3 Site Description

The development site in Crows Nest is bound by Falcon St on the northern side, Pacific Highway on the western side and Alexander Street on the eastern side. Currently the site is occupied by residential and commercial buildings and consists of 19 separate lots. The site also has the Sydney Metro Tunnels pass underneath the North Eastern corner of the site.

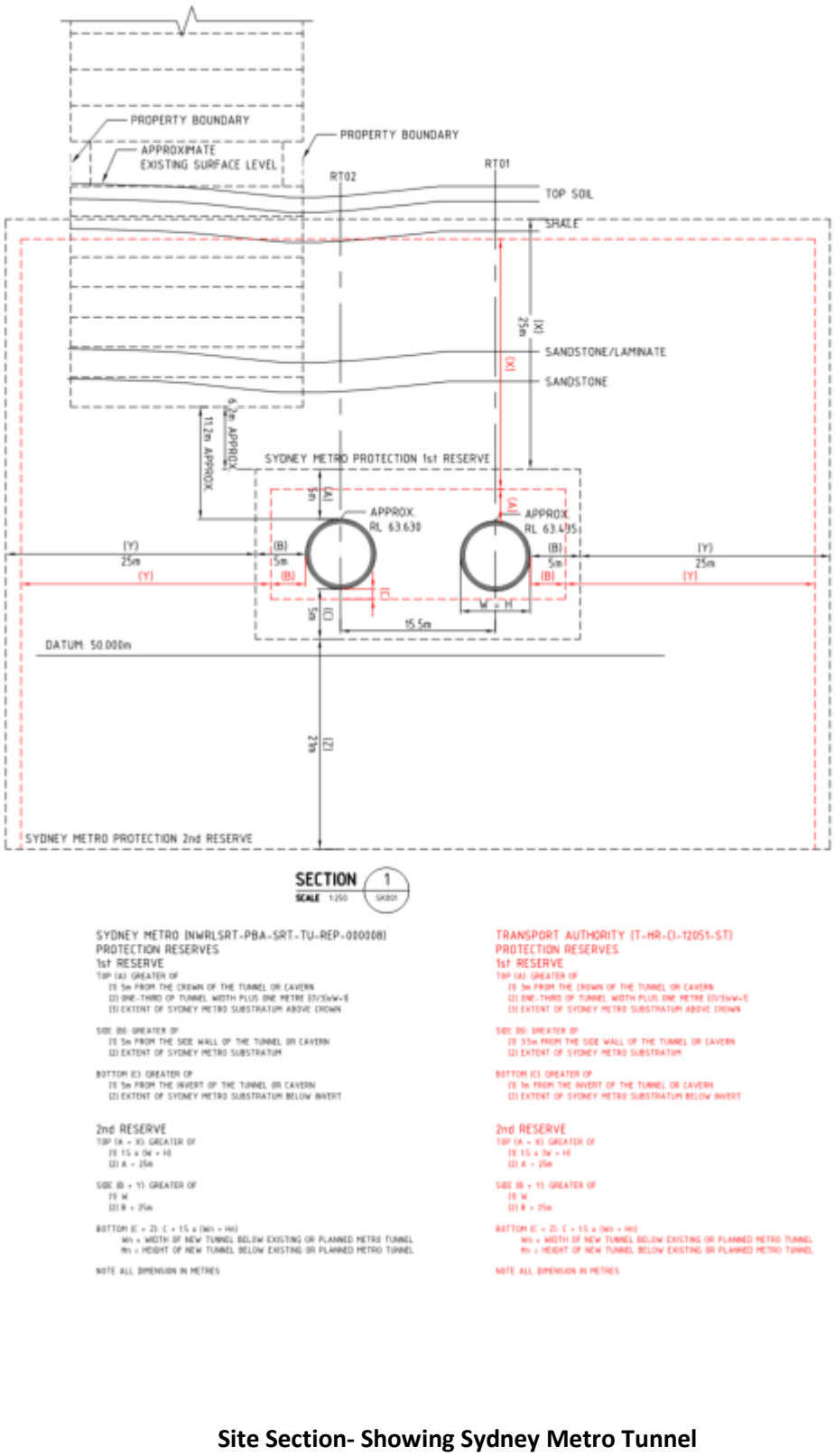
Site Plan

See below a site plan which indicates the Sydney Metro 1st and 2nd Reserve Easements based on the following two documents;

- Transport Assest Standards Authority Standard, Developments near Rail Tunnels- T-HR-CI-12051-ST v2 November 2018.
- Sydney Metro Underground Corridor Protection Technical Guidelines- NWRLSRT-PBA-SRT-TU-REP-000008 rev 1 dated 16 October 2017.

There are two documents that have been produced that outline easements for tunnels in Sydney. The above two documents both indicate easements which are slightly different. For the purposes of this report BG&E has taken the worst case scenario which is outlined in the Sydney Metro Technical Guidelines.

Site Plan- Showing Sydney Metro Tunnel Easements



Site Section- Showing Sydney Metro Tunnel Easements

1.4 Sydney Metro Tunnels

The existing Sydney Metro twin tunnels located under the site have a crown that is approximately 30m below the natural ground surface.

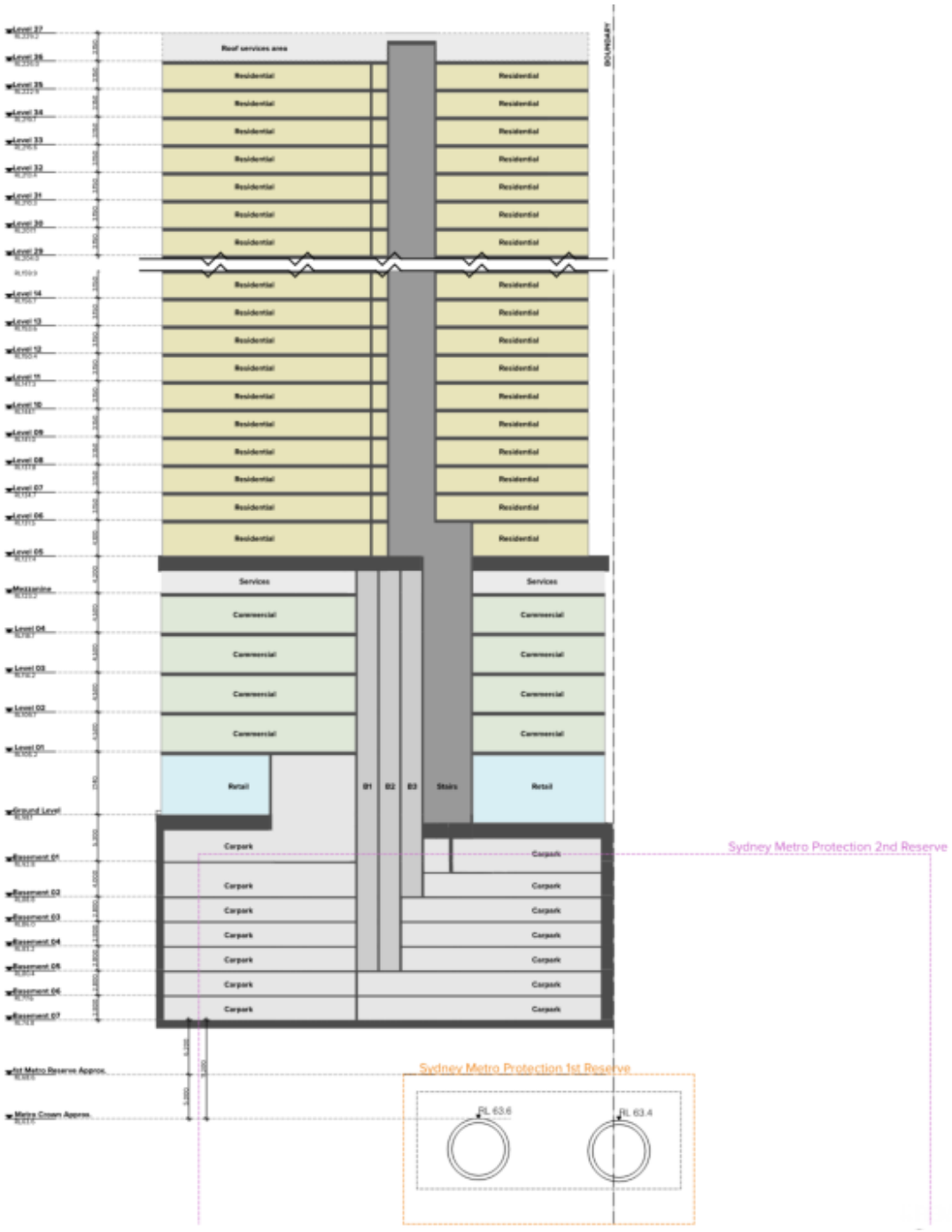
The tunnel liner in the area under the site is a nominal 260mm thick fibre reinforcement element.

Reference is made to BG&E drawings SK001 rev C dated 28/05/20 and SK002 Rev C 28/05/20 which indicates the tunnels and the relationship with the proposed development.

The sub-terrain geotechnical conditions of the site include topsoil and clay for the first few metres with shale and sandstone located below that. Reference is made to Douglas Partners Geotechnical Engineering Report for more detailed information, Refer Appendix D.

2 PROPOSED STRUCTURE

The proposed development consists of a 36 storey residential tower over a 7 level basement. The first 6 levels of the buildings are proposed to be dedicated to retail and commercial with the remaining floors being residential.



Overall Site Section

As mentioned earlier in this report, BG&E has previously done some work on this site and has provided advice on building loads for columns and core walls directly over and adjacent to the rail corridor for a 60 storey high-rise building.

These loads are what Douglas Partners based their advice on in Report No. Project 86645.01 dated 19th March 2019 R.002 Rev0JH. We have since reviewed those loads and given that the building is now only 36 levels and not 60 levels they loads can be reduced approximately 40%.

In determining loads we have made some assumptions of structural grids, depths, finishes and façade based on similar type building. Live loads are as per code requirements. We have also made a high level assessment on winds loads.

We also provided a section through the tunnels and proposed building indicating the location and position of tunnels relative to the proposed building basement. BG&E drawings SK001 rev C dated 28/05/20 and SK002 Rev C 28/05/20.

Following is a summary of the proposed structural framework for the proposed building. Also refer to Appendix B for Structural Sketches.

2.1 Retention Walls

The basement construction will require the removal of significant amount of material and the installation of a retention wall around the perimeter of the site.

The retention walls will consist of either a contiguous piled wall or a soldier piled wall with shotcrete infill panels. It is anticipated that two rows of temporary anchors will be required to restrain the retention walls.

Permission to install temporary anchors into neighbouring properties, Council or RMS property would need be obtained.

Installing temporary anchors into Sydney Metro Reserves will also be necessary, it would appear that anchors into the 2nd reserve are unavoidable.

2.2 Foundations

Foundations typically will consist of pad footings supporting columns and raft slabs supporting lifts, stair and shear walls. Where foundations are located over or adjacent to twin tunnels there may be a requirement to install piles rather than have high level pad footings which will be dependent on the impact of the building on the tunnel lining.

2.3 Columns

Columns will consist typically of reinforced concrete columns.

2.4 Walls

Stair and lift walls will consist of reinforced concrete walls. The proposed structural concept positions main tower cores predominately outside the Sydney Metro 1st Reserve.

2.5 Slabs

Suspended floor slabs will generally consist of post tensioned two way flat plates. Slab thicknesses will typically be 200mm however heavier loaded slabs on the lower levels and basements will need to be thicker.

2.6 Basement Slab

Basement 7 slab will consist of a concrete slab on grade.

2.7 Roof

Roof slab structure will also generally consist of post tensioned two way flat plates. Slab thicknesses will typically be approximately 230-250mm due to heavier loads.

3 GEOTECHNICAL

3.1 Geotechnical Modelling

The previous information on columns and wall loading was provided to Douglas Partners to allow a preliminary numerical analysis model to be created to assess the impact of the excavation of basement and loads for the proposed structure over on the rail tunnels as noted above.

Refer to Douglas Partners Report No. Project 86645.01 dated 19th March 2019 R.002 Rev0JH.

3.2 Geotechnical Conclusion

The previous geotechnical modelling for the proposed 60 storey building indicates that the net effect of excavation works and construction works of the proposed building over and adjacent the tunnel marginally complies with the requirements the Transport Asset Standards Authority Standard, Developments near Rail Tunnels T-HR-CI-12051-ST, version 2, November 2018. Overall displacements are slightly less than the 10mm allowable in the standard, with differential movements very close to 0.5mm/m and 1:2000 allowable. It would appear that the current scheme which has a column load reduction of up to 40% would be an improvement on the previously analysed scheme. Further analysis is however required on the impact of the reduced rock stratum over the tunnel.

3.3 Outcome

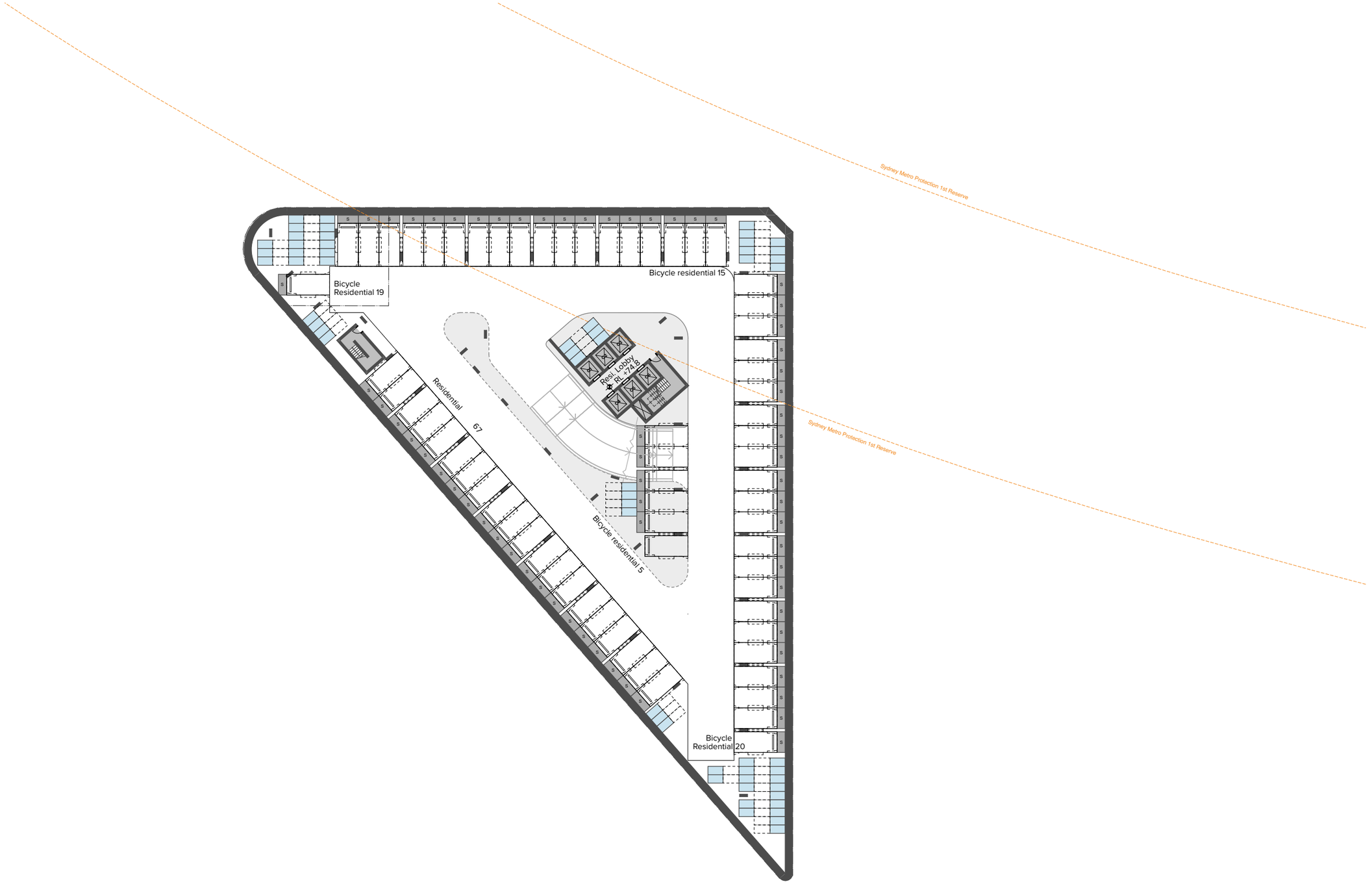
The current geotechnical modelling suggests that the current stepped basement scheme with a 60 storey building marginally complies with the Sydney Metro deflection limits for the rail tunnel lining. In our opinion the current scheme of a 36 level tower is feasible and requires further detailed analysis from a geotechnical engineer to assess the impact on the tunnel lining with reduced tower column loads and reduced rock stratum over tunnels of 11.2m.

4 RECOMMENDATIONS

- The structural input provided to date is very preliminary and is based on some educated assumptions and engineering judgement. Our recommendations moving forward post planning proposal would be to do some detailed structural analysis on vertical and lateral loads at foundation level which will more than likely improved the accuracy of the loads provided by BG&E to date.
- Lateral Analysis – Further detailed studies to be carried out.
- Engage with Wind consultant – Lateral Loads for Building of this height will be governed by wind hence a reduction in wind loads with the assistance of a wind consultant is crucial.
- Carrying out site specific geotechnical investigation to obtain more accurate geotechnical parameters for modelling.
- Geotechnical Investigation of existing site ground conditions must also be carried in the future prior to further advancement of a 3D geotechnical numerical model.
- Geotechnical parameters assumed to date in modelling may change with more detailed investigation which may change results.
- Update 3D geotechnical numerical analysis model with updated geotechnical parameters, structural loading and rock stratum over the tunnels.
- Douglas Partners have indicated that Sydney Metro will interrogate the geotechnical modelling analysis and results which may require possible changes to the modelling which may adversely affect the results and approval of the proposed development.
- Commence engagement with Sydney Metro to obtain feedback on current scheme and establish a pathway to obtaining approval from Sydney Metro. Updating Sydney Metro along the way during approval process is also highly recommended to ensure that they are providing feedback along the way.

APPENDIX A

Architectual Drawings



- Residential
- Residential Adaptable
- Car Share
- Residential Visitors
- Non Residential
- Bicycle Residents
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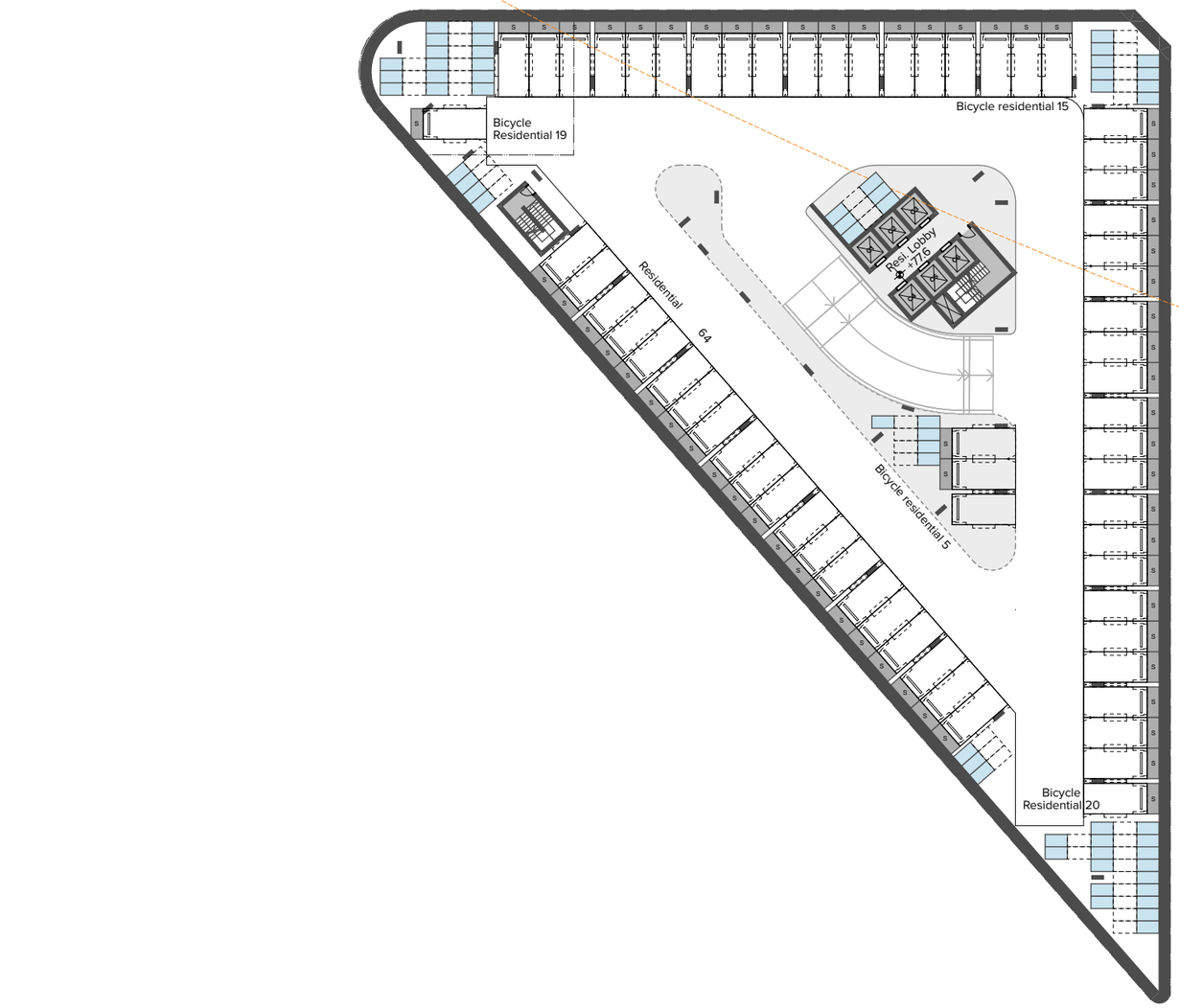
- Bicycle Commercial Visitors
- Bicycle Retail
- Bicycle Retail Visitors

TURNER SILVESTERFULLER

Basement 07

PP-110-008 1:500, 1:200 @ A3

0 5 10 15m



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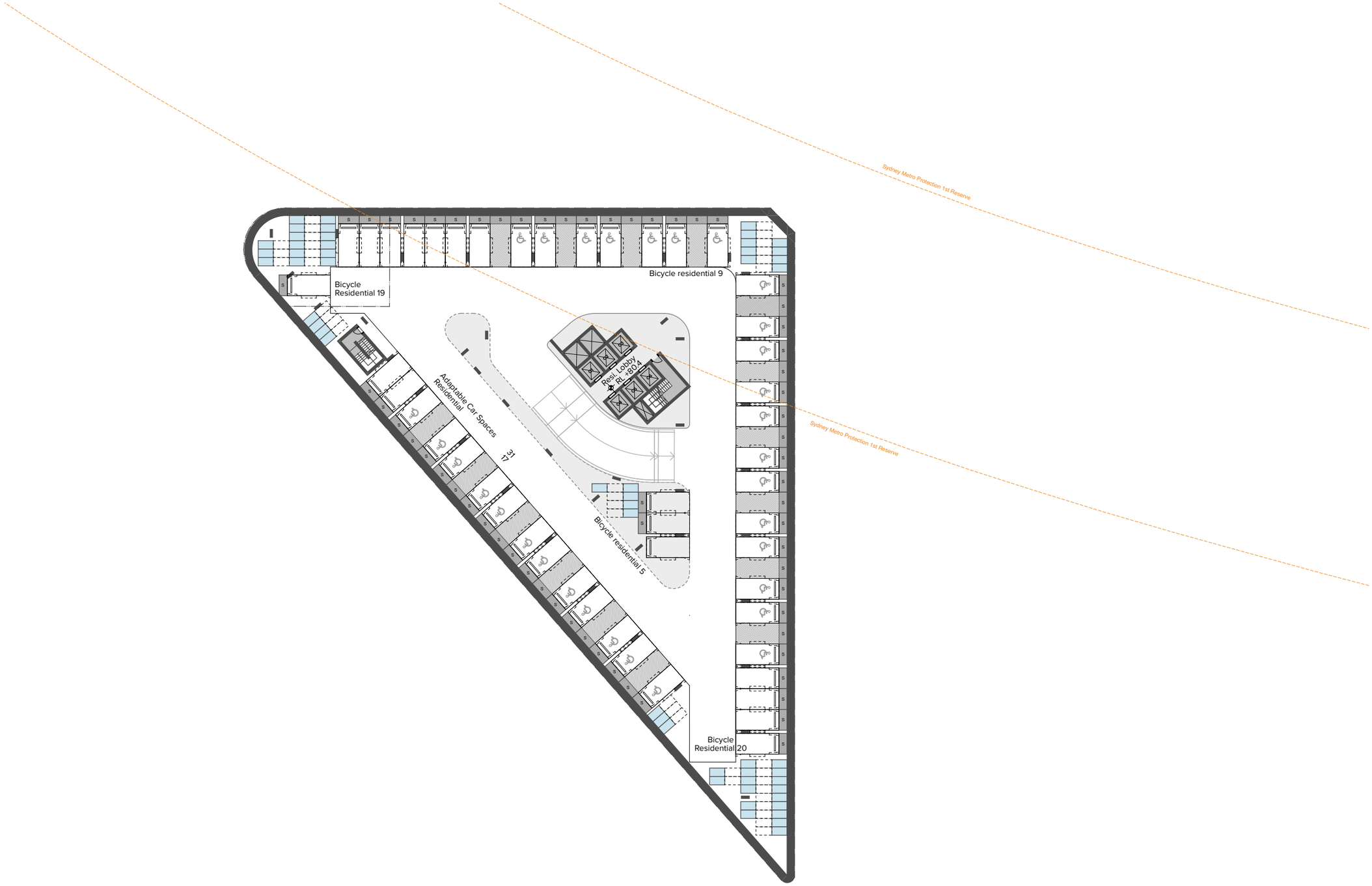
TURNER SILVESTERFULLER

Basement 06

PP-110-007 1:500, 1:200 @ A3

0 5 10 15m



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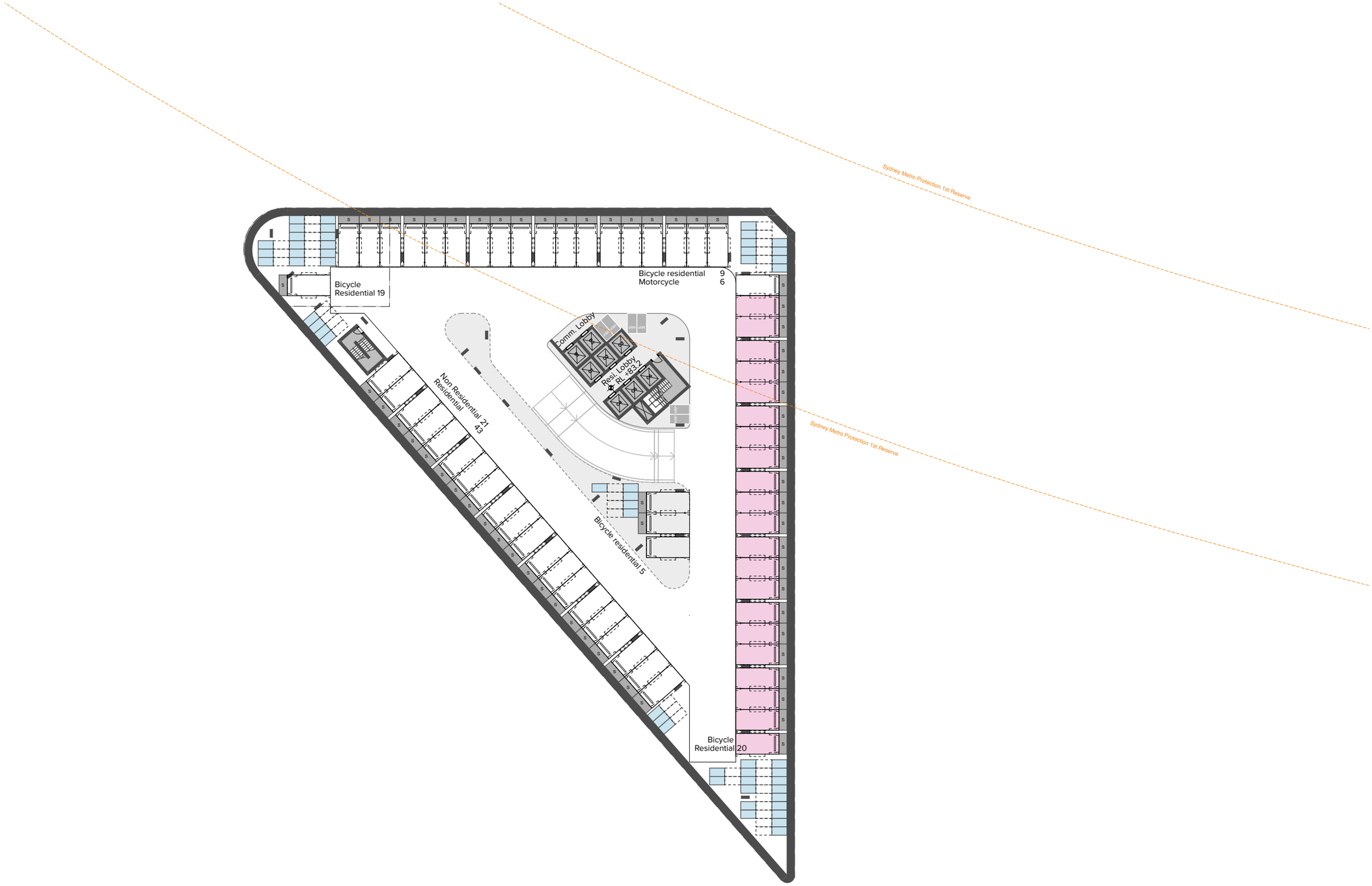
TURNER SILVESTERFULLER

Basement 05

PP-110-006 1:500, 1:200 @ A3

0 5 10 15m



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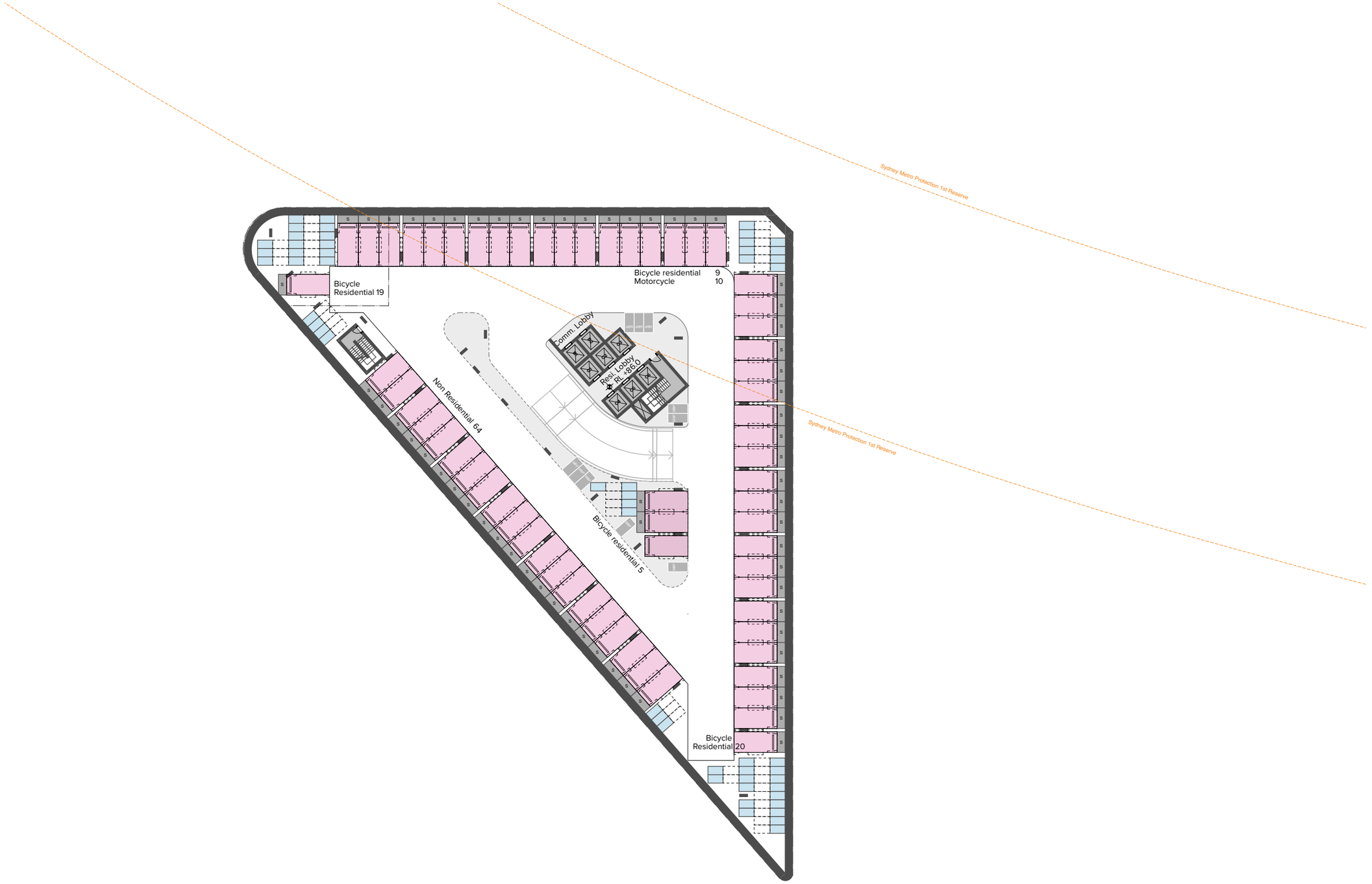
TURNER SILVESTERFULLER

Basement 04

PP-110-005 1:500, 1:200 @ A3

0 5 10 15m



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TURNER SILVESTERFULLER

Basement 03

PP-110-004 1:500, 1:200 @ A3

0 5 10 15m

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TURNER SILVESTERFULLER

Basement 02

PP-110-003 1:500, 1:200 @ A3

0 5 10 15m

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- Residential Adaptable
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- Bicycle Commercial
- Bicycle Commercial Visitors
- Bicycle Retail
- Bicycle Retail Visitors

TURNER SILVESTERFULLER

Basement 01

PP-110-002 1:500, 1:200 @ A3

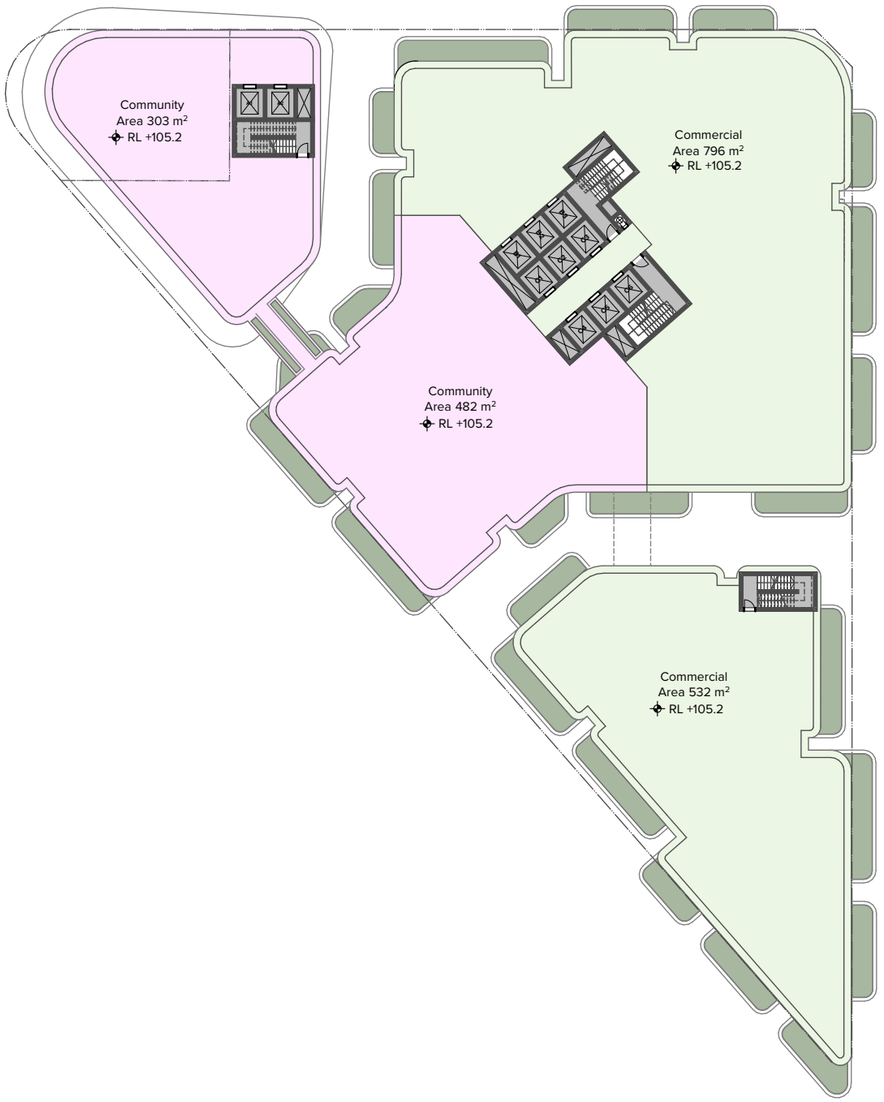
0 5 10 15m

TURNER SILVESTERFULLER

Ground Level

PP-110-001 1:500 @ A3

0 5 10 15m



NOTE

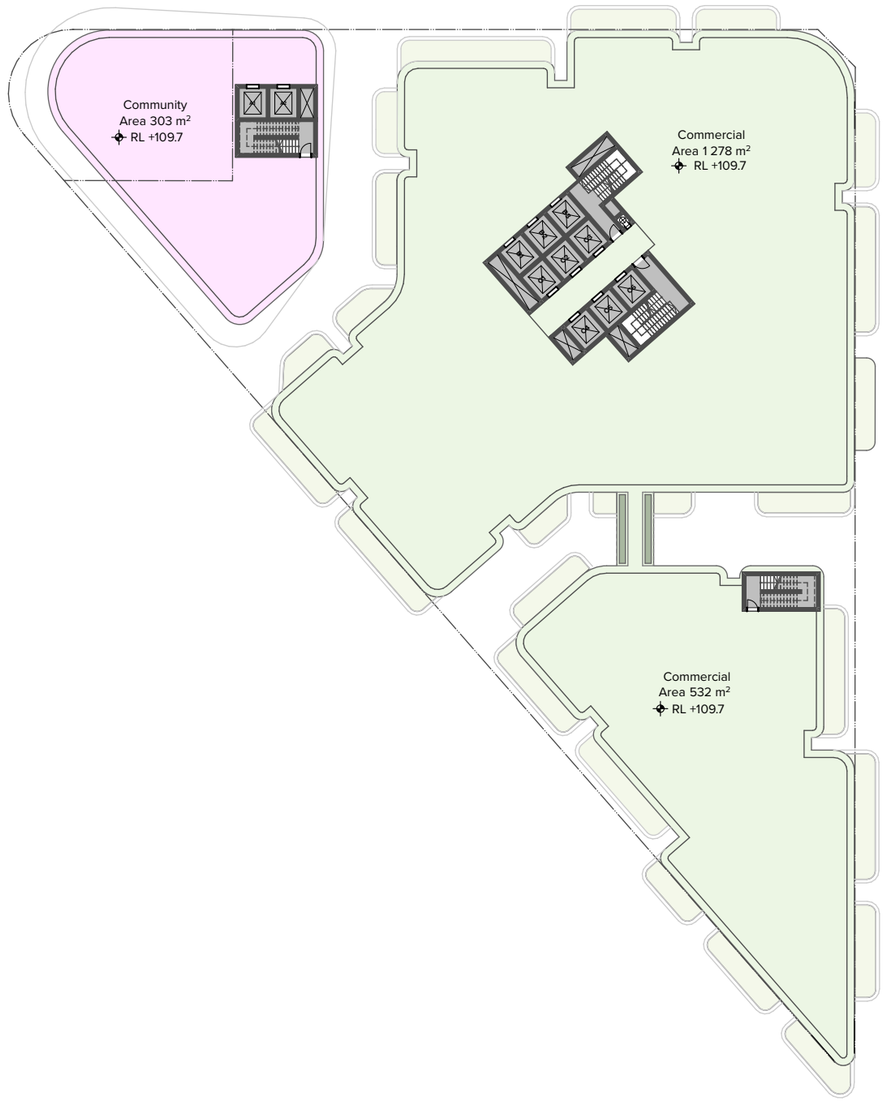
Area of Southern Tenancy With Lifts:	498m²
Area Lost to Inclusion of Lifts:	31m²

TURNER SILVESTERFULLER

Level 01

PP-110-010 1:500 @ A3

0 5 10 15m



TURNER SILVESTERFULLER

Level 02

PP-110-020 1:500 @ A3

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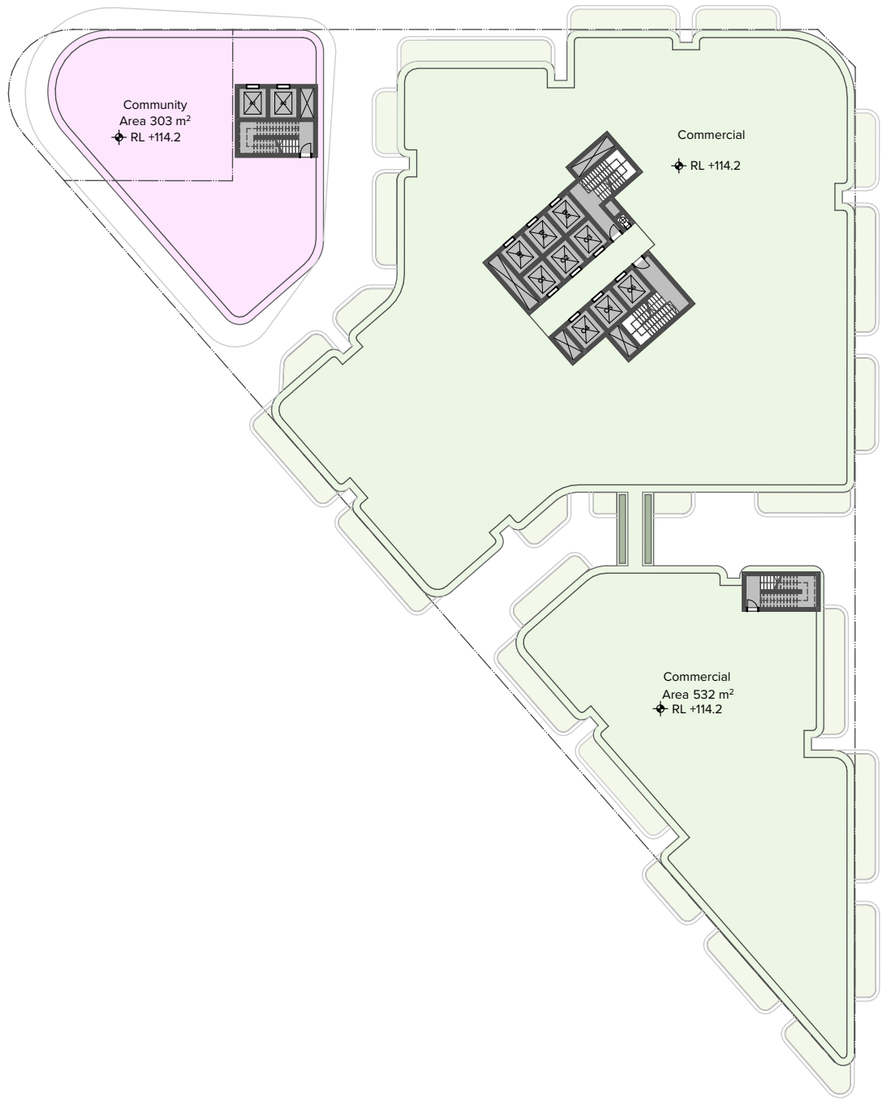

TURNER SILVESTERRELLEF

Level 03

PP-110-030 1:500 @ A3

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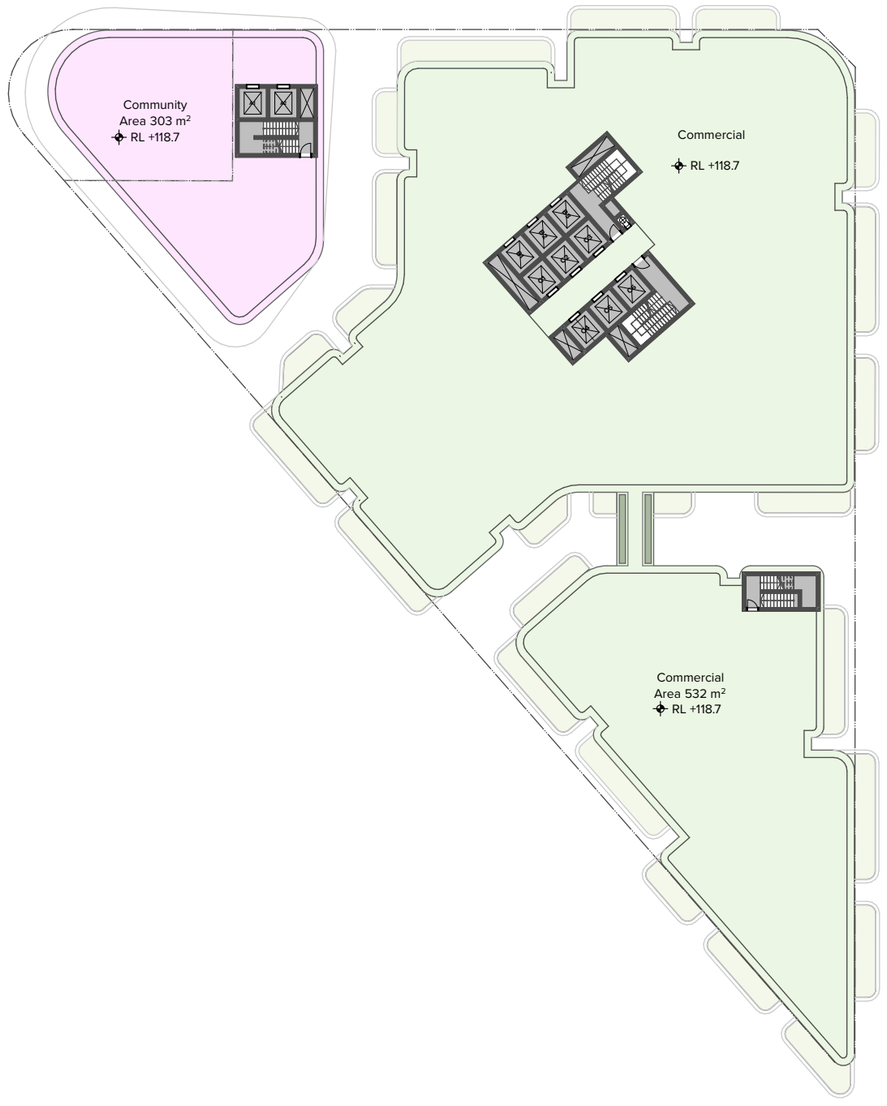


NOTE

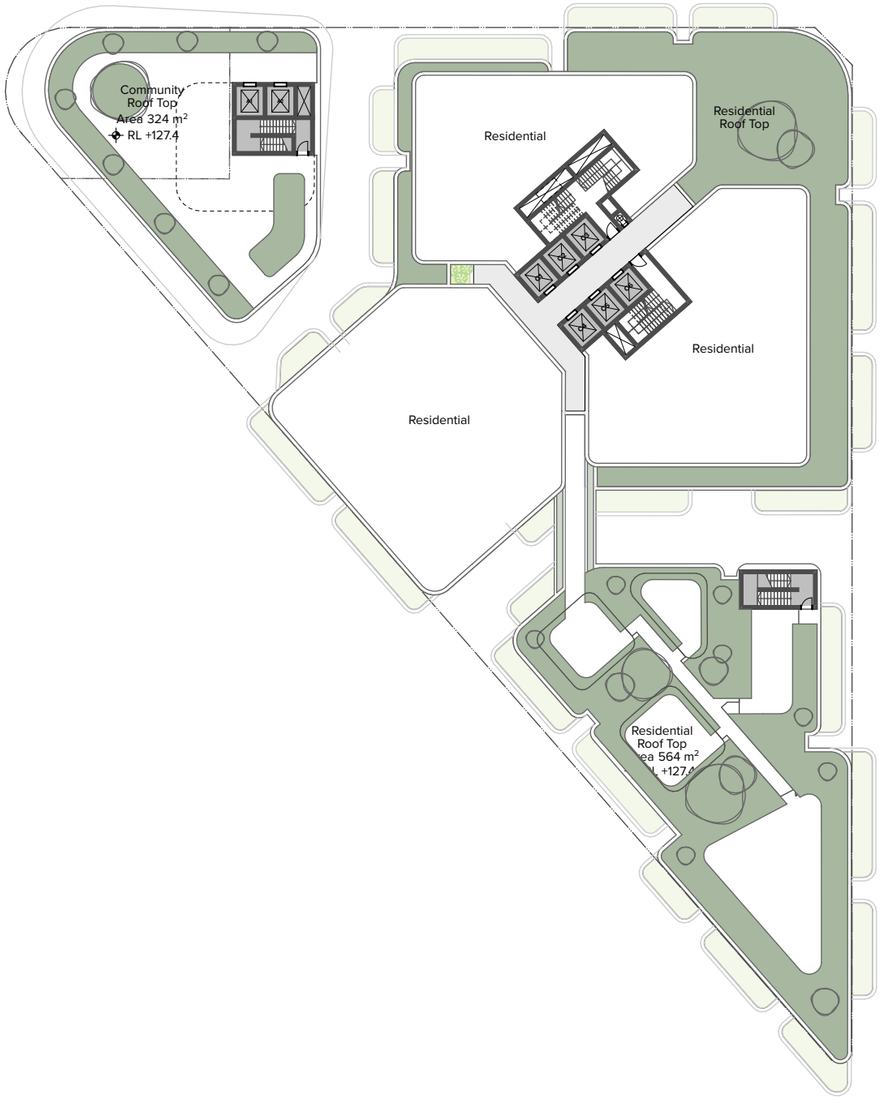
Area of Southern Tenancy With Lifts:	498m²
Area Lost to Inclusion of Lifts:	31m²

TURNER SILVESTERFULLER

Level 04

PP-110-040 1:500 @ A3

0 5 10 15m

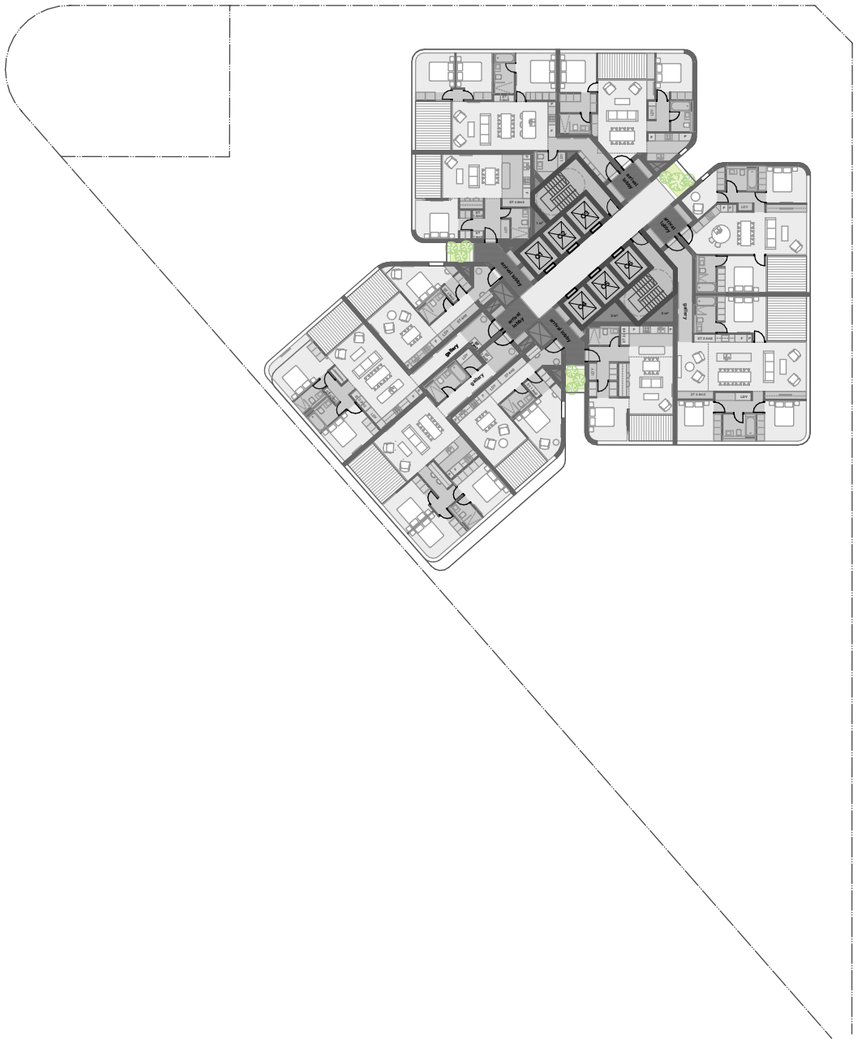


TURNER SILVESTER FULLER

Level 05

PP-110-050 1:500 @ A3

0 5 10 15m

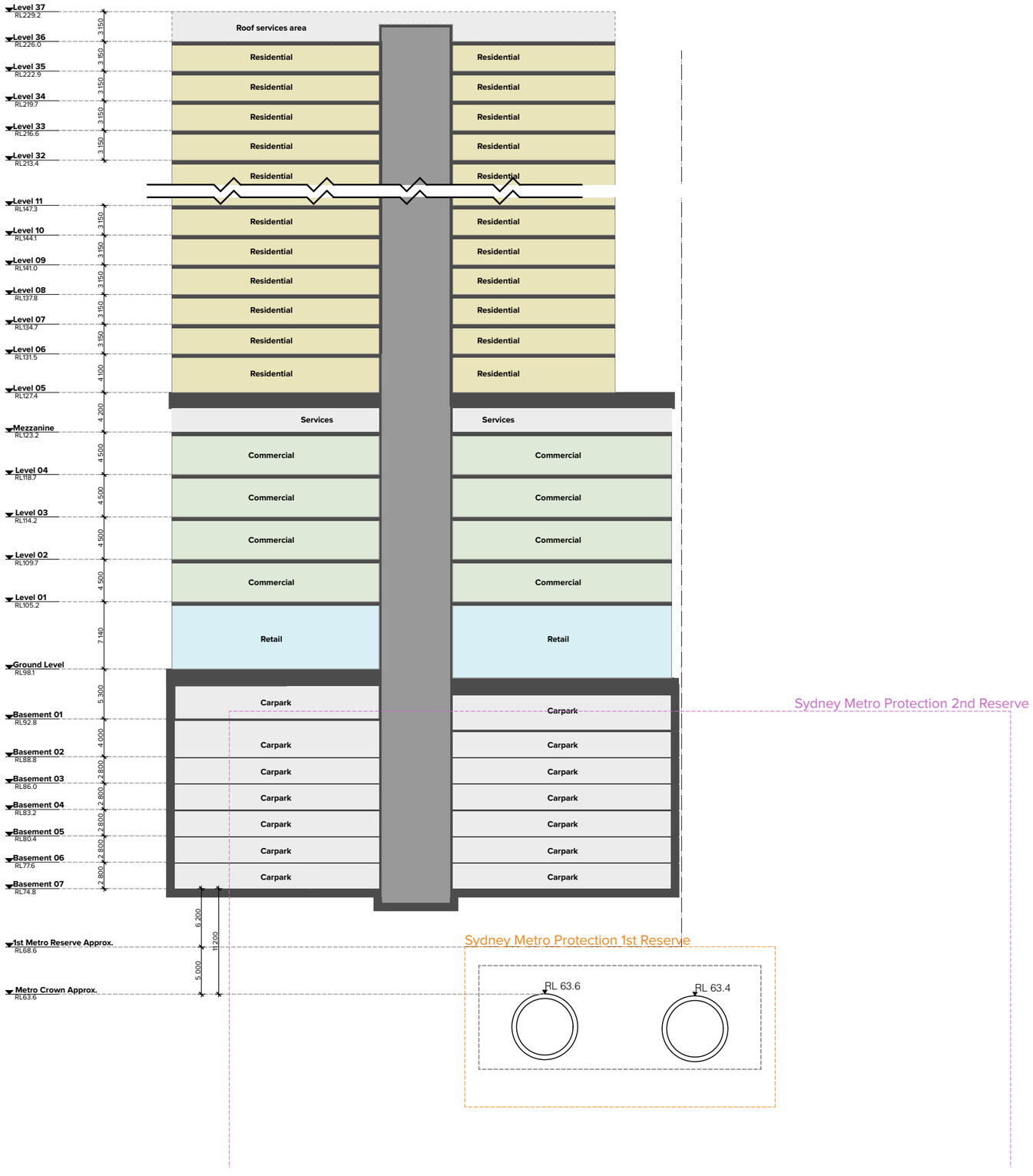


TURNER SILVESTERFULLER

Typical Level

PP-110-060 1:500 @ A3

0 5 10 15m



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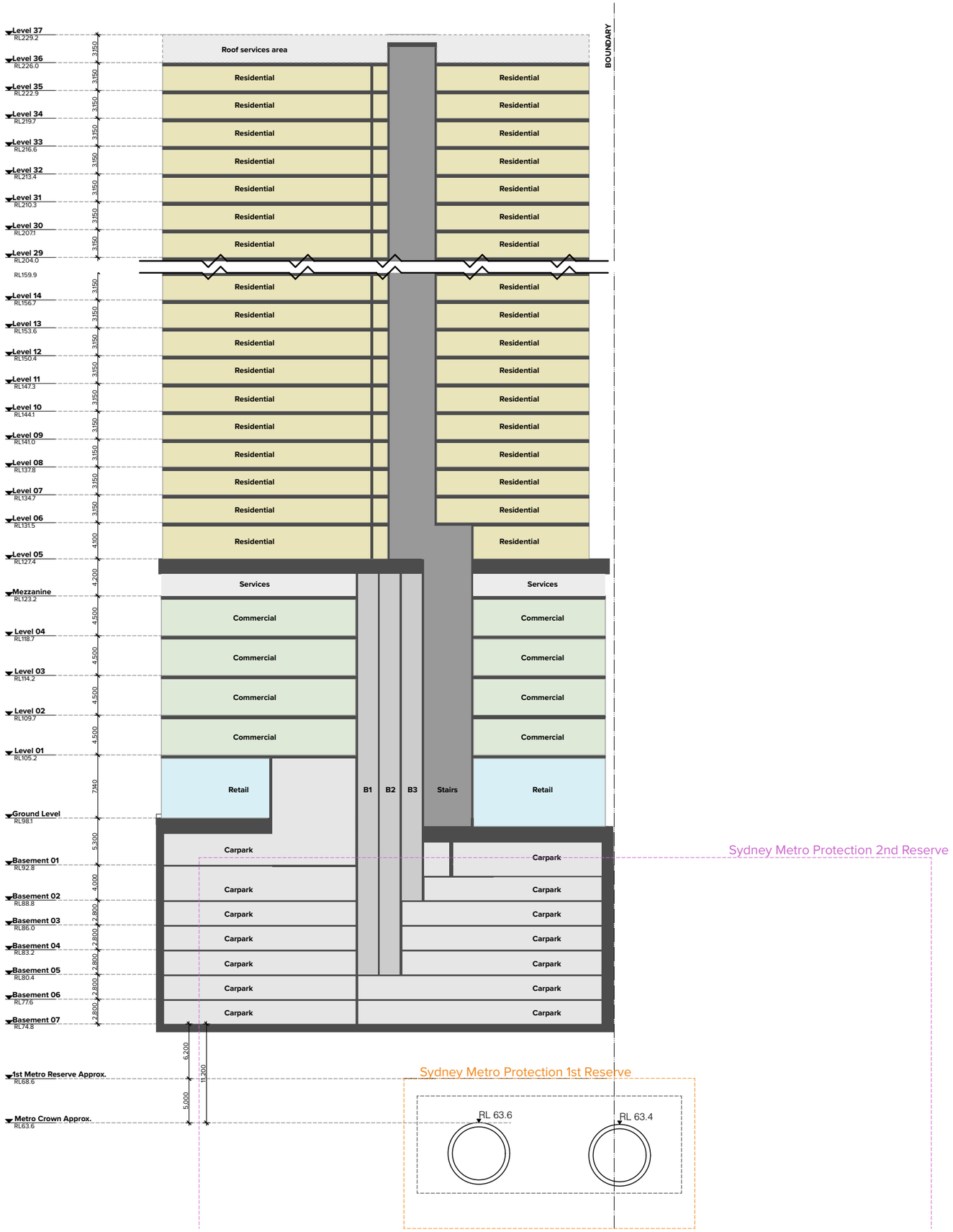
Heights Strategy

PP-310-001 1:500 @ A3

0 5 10 15m

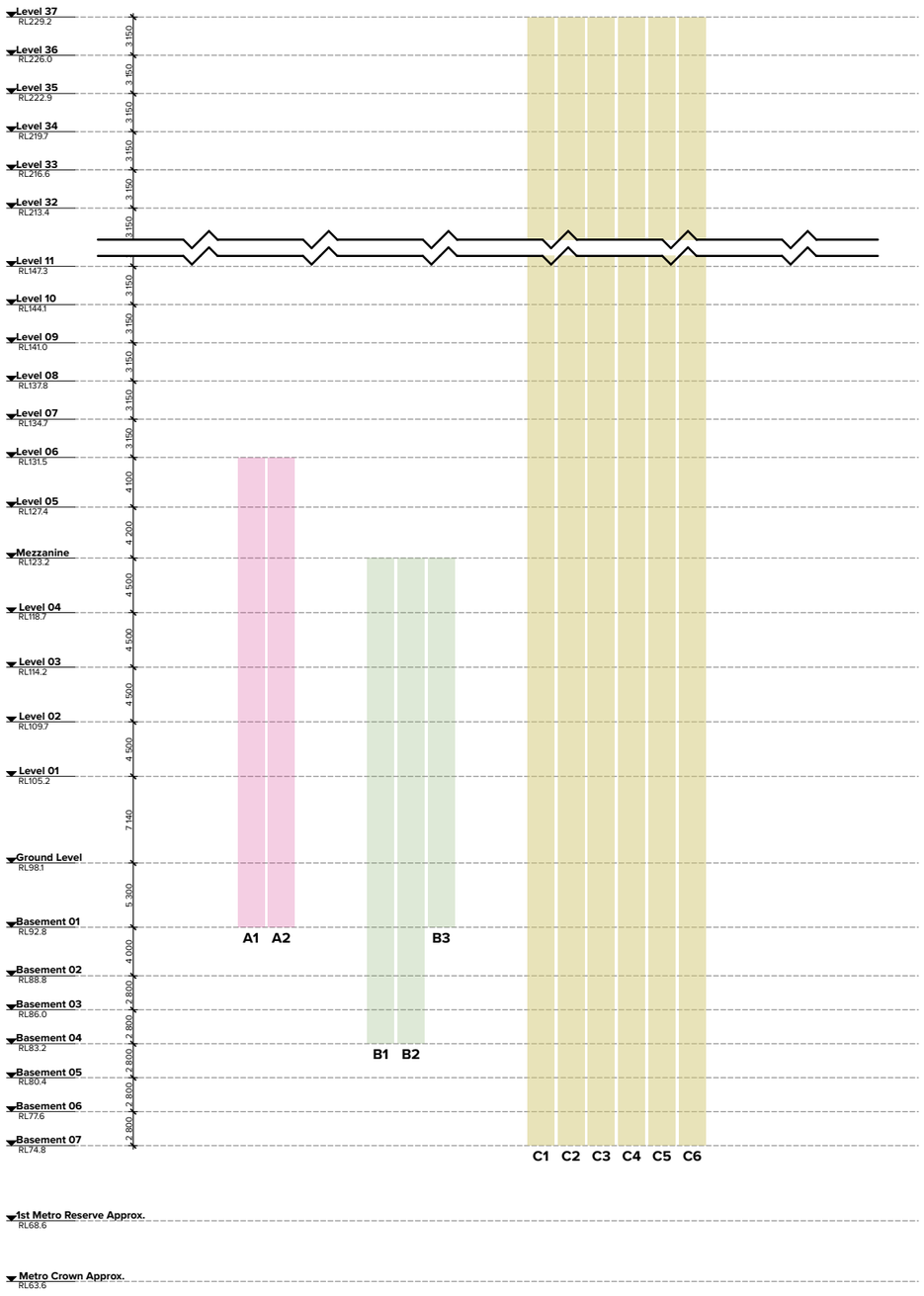


TURNER SILVESTERFULLER

Core Section

PP-310-002 1:500 @ A3

0 5 10 15m



TURNER SILVESTERFULLER

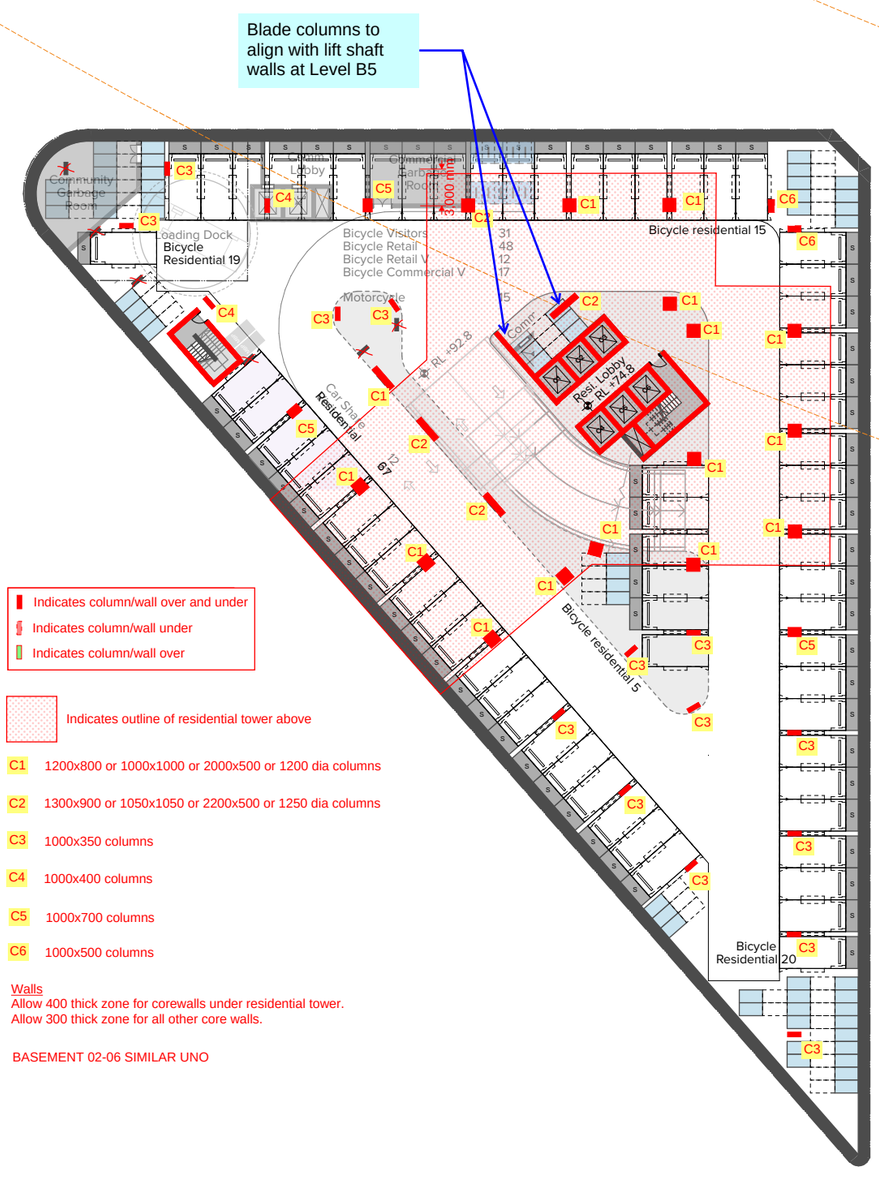
Lifts Strategy

PP-310-003 1:500 @ A3

0 5 10 15m

APPENDIX B

Structural Sketches



Indicates column/wall over and under

Indicates column/wall under

Indicates column/wall over

Indicates outline of residential tower above

C1 1200x800 or 1000x1000 or 2000x500 or 1200 dia columns

C2 1300x900 or 1050x1050 or 2200x500 or 1250 dia columns

C3 1000x350 columns

C4 1000x400 columns

C5 1000x700 columns

C6 1000x500 columns

Walls
Allow 400 thick zone for corewalls under residential tower.
Allow 300 thick zone for all other core walls.

BASEMENT 02-06 SIMILAR UNO

- Residential
- Residential Adaptable
- Car Share
- Residential Visitors
- Non Residential
- Bicycle Residents
- Bicycle Residents Visitors
- Bicycle Commercial
- Bicycle Commercial Visitors
- Bicycle Retail
- Bicycle Retail Visitors

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Preliminary

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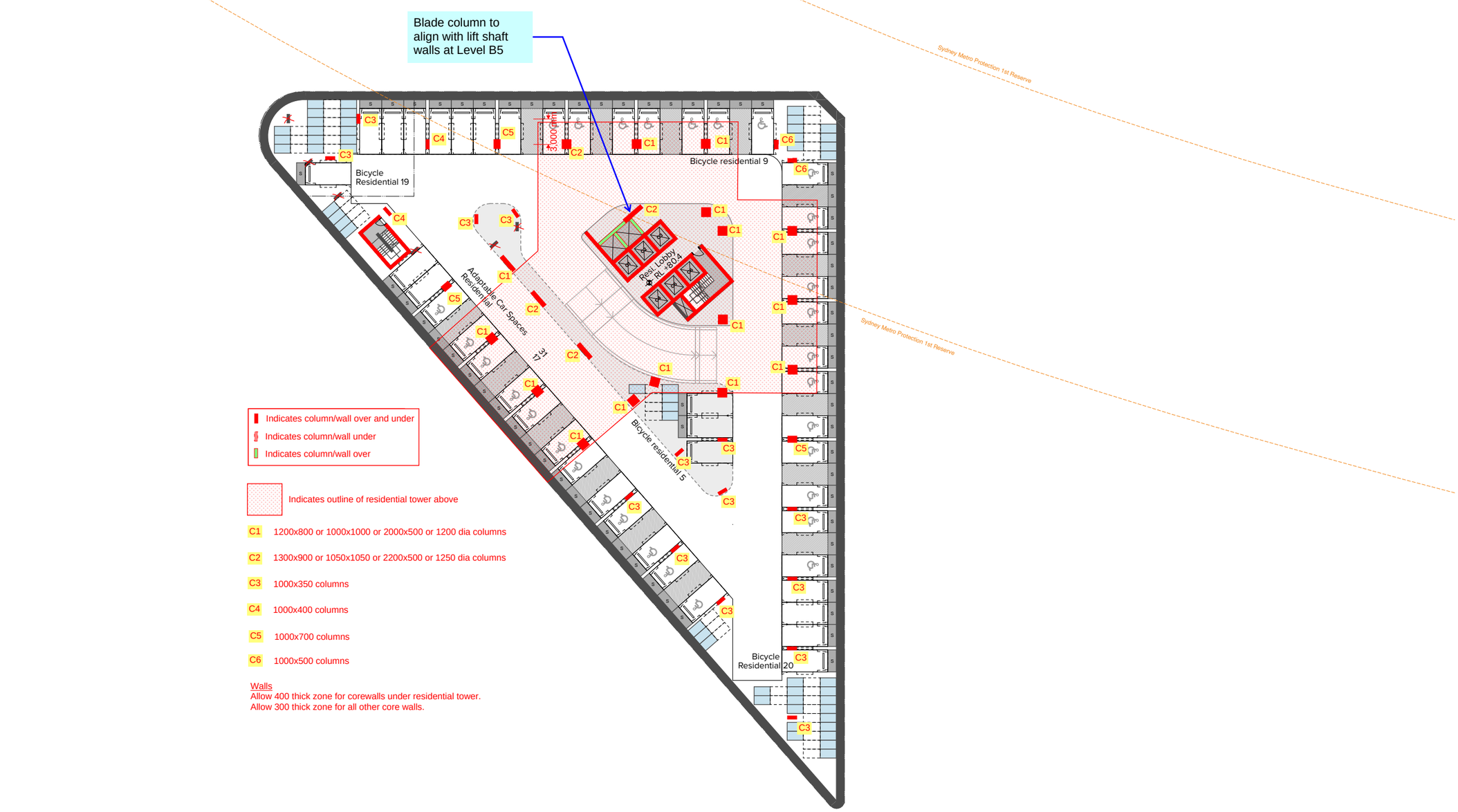
BG&E

Basement 07

PP-110-008 1:500, 1:200 @ A3

BASEMENT 02-06 SIMILAR UNO



Indicates column/wall over and under

Indicates column/wall under

Indicates column/wall over

Indicates outline of residential tower above

C1 1200x800 or 1000x1000 or 2000x500 or 1200 dia columns

C2 1300x900 or 1050x1050 or 2200x500 or 1250 dia columns

C3 1000x350 columns

C4 1000x400 columns

C5 1000x700 columns

C6 1000x500 columns

Walls
Allow 400 thick zone for corewalls under residential tower.
Allow 300 thick zone for all other core walls.

- Residential
- Residential Adaptable
- Car Share
- Residential Visitors
- Non Residential
- Bicycle Residents
- Bicycle Residents Visitors
- Bicycle Commercial
- Bicycle Commercial Visitors
- Bicycle Retail
- Bicycle Retail Visitors

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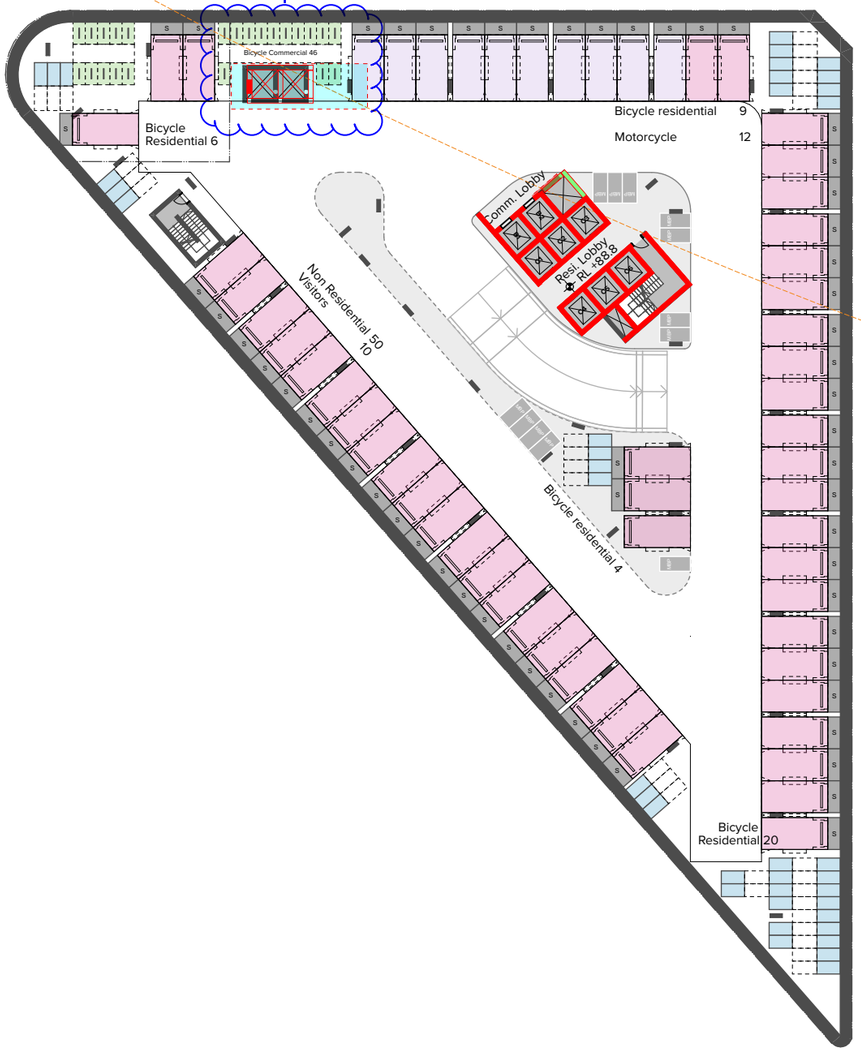
BG&E

Basement 05

PP-110-006 1:500, 1:200 @ A3

0 5 10 15m

Lift core to be transferred at B1. Walls at B2 to be non-load bearing block work with column centred over/under wall as shown. Allow for 500 deep band beam to support lift pit.



- Residential
- Residential Adaptable
- Car Share
- Residential Visitors
- Non Residential
- Bicycle Residents
- Bicycle Residents Visitors
- Bicycle Commercial
- Bicycle Commercial Visitors
- Bicycle Retail
- Bicycle Retail Visitors

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Preliminary

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BG&E

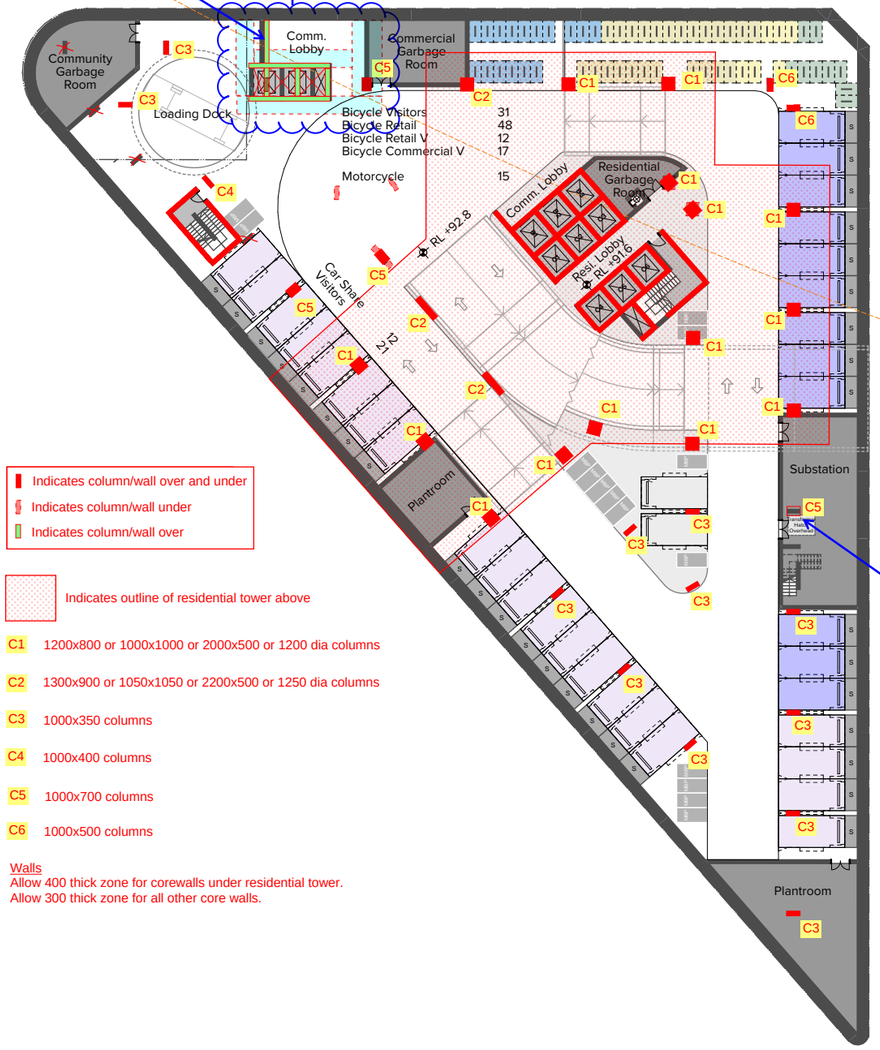
Basement 02

PP-110-003 1:500, 1:200 @ A3

0 5 10 15m

Lift core to be transferred at B1. Move service shaft to western side of core. Walls at B2 to be non-load bearing block work with column centred under wall as shown.

Full height transfer wall at B1 aligned with column below



Sydney Metro Protection 1st Reserve

Sydney Metro Protection 1st Reserve

Column inside substation. Architect to confirm if acceptable. If not possible, transfer beam will be required on B1 with potential impact on B2 clearances.

Indicates column/wall over and under

Indicates column/wall under

Indicates column/wall over

Indicates outline of residential tower above

C1 1200x800 or 1000x1000 or 2000x500 or 1200 dia columns

C2 1300x900 or 1050x1050 or 2200x500 or 1250 dia columns

C3 1000x350 columns

C4 1000x400 columns

C5 1000x700 columns

C6 1000x500 columns

Walls
Allow 400 thick zone for corewalls under residential tower.
Allow 300 thick zone for all other core walls.

- Residential
- Residential Adaptable
- Car Share
- Residential Visitors
- Non Residential
- Bicycle Residents
- Bicycle Residents Visitors
- Bicycle Commercial
- Bicycle Commercial Visitors
- Bicycle Retail
- Bicycle Retail Visitors

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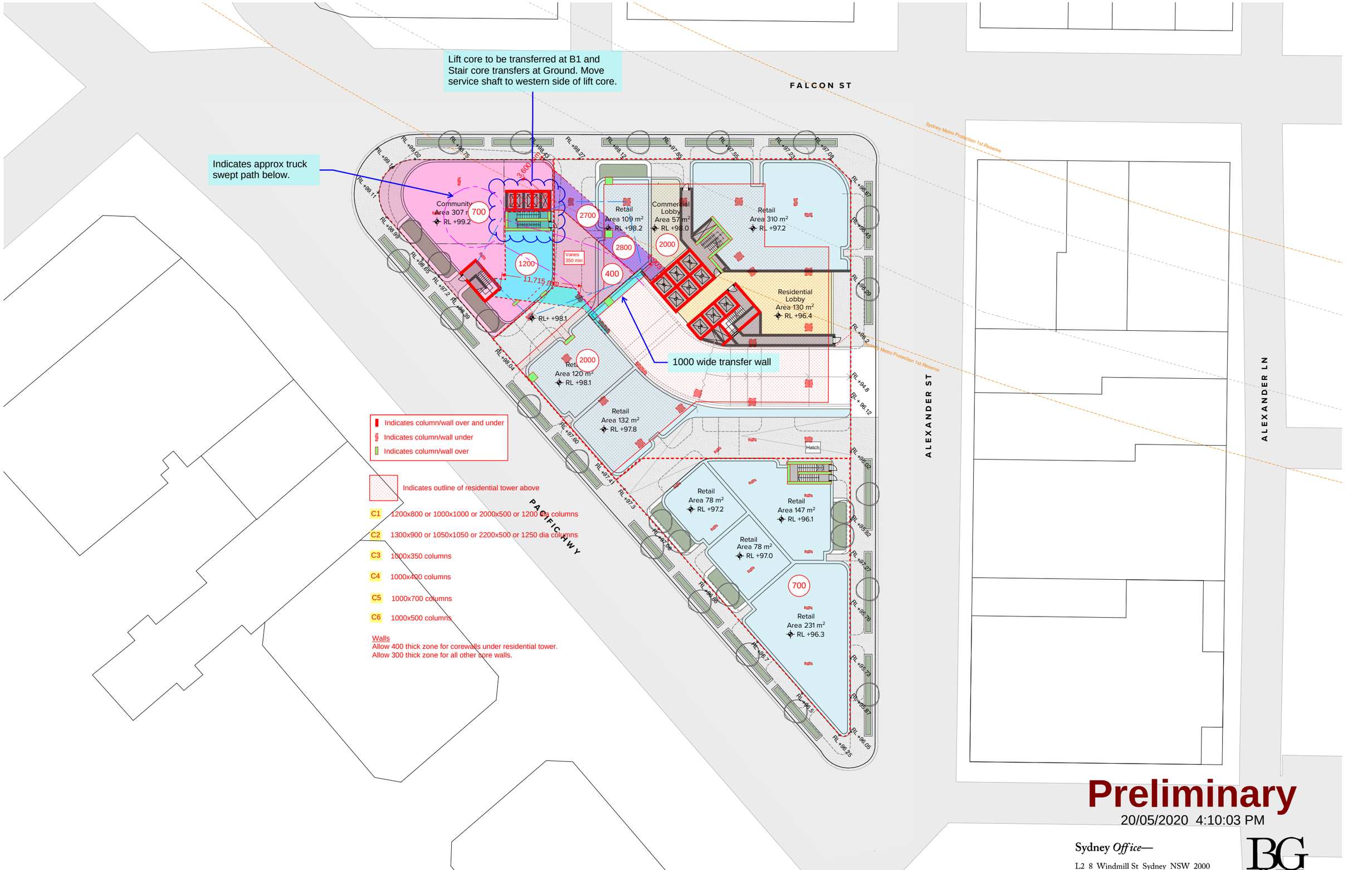
BG&E

Basement 01

PP-110-002 1:500, 1:200 @ A3

0 5 10 15m



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Ground Level

PP-110-001 1:500 @ A3

0 5 10 15m

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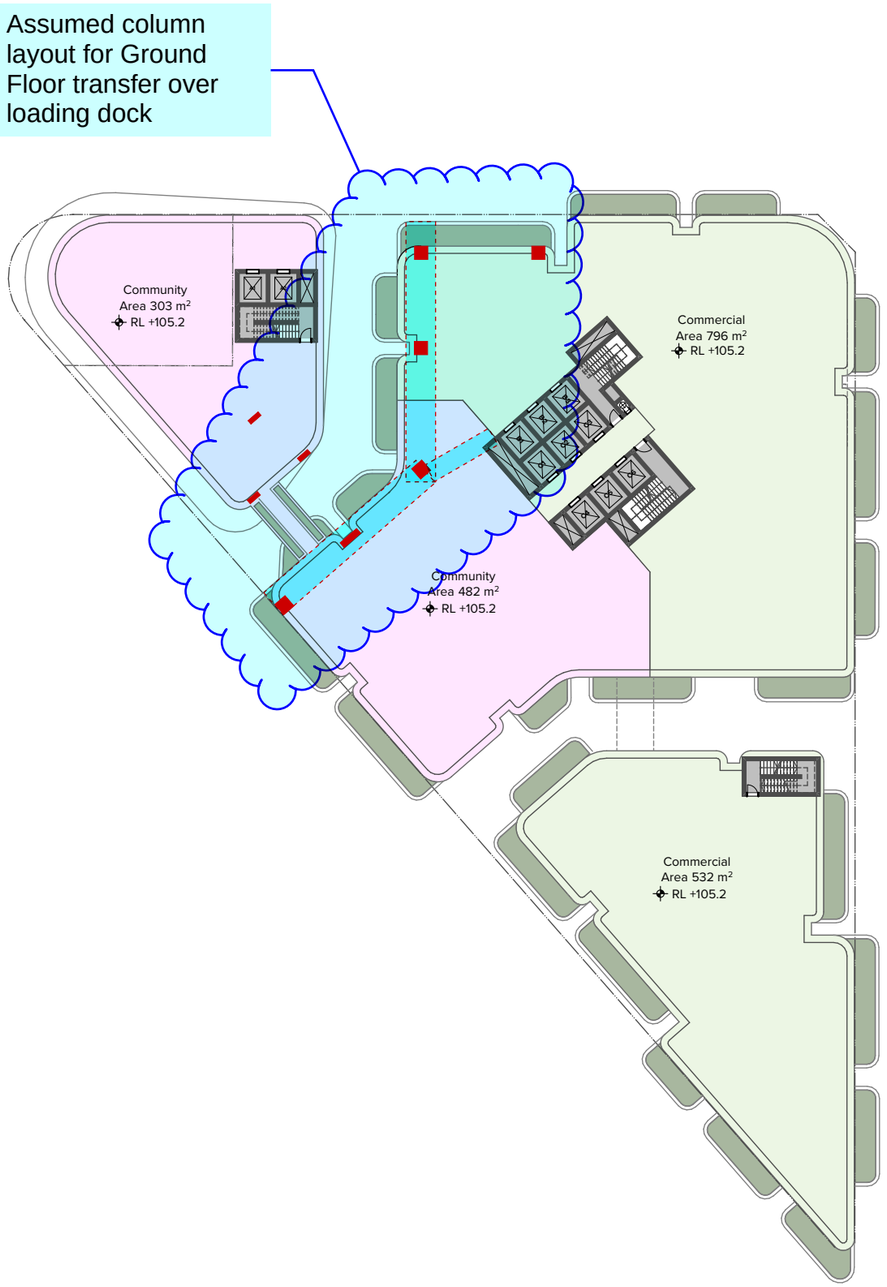

NOTE

Area of Southern Tenancy With Lifts:	498m²
Area Lost to Inclusion of Lifts:	31m²

TURNER SILVESTER FULLER

Preliminary

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BG&E

Level 01

PP-110-010 1:500 @ A3

0 5 10 15m

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BG&E

Preliminary
6/05/2020 3:04:33 PM

Podium Concepts
Level 05

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BG&E

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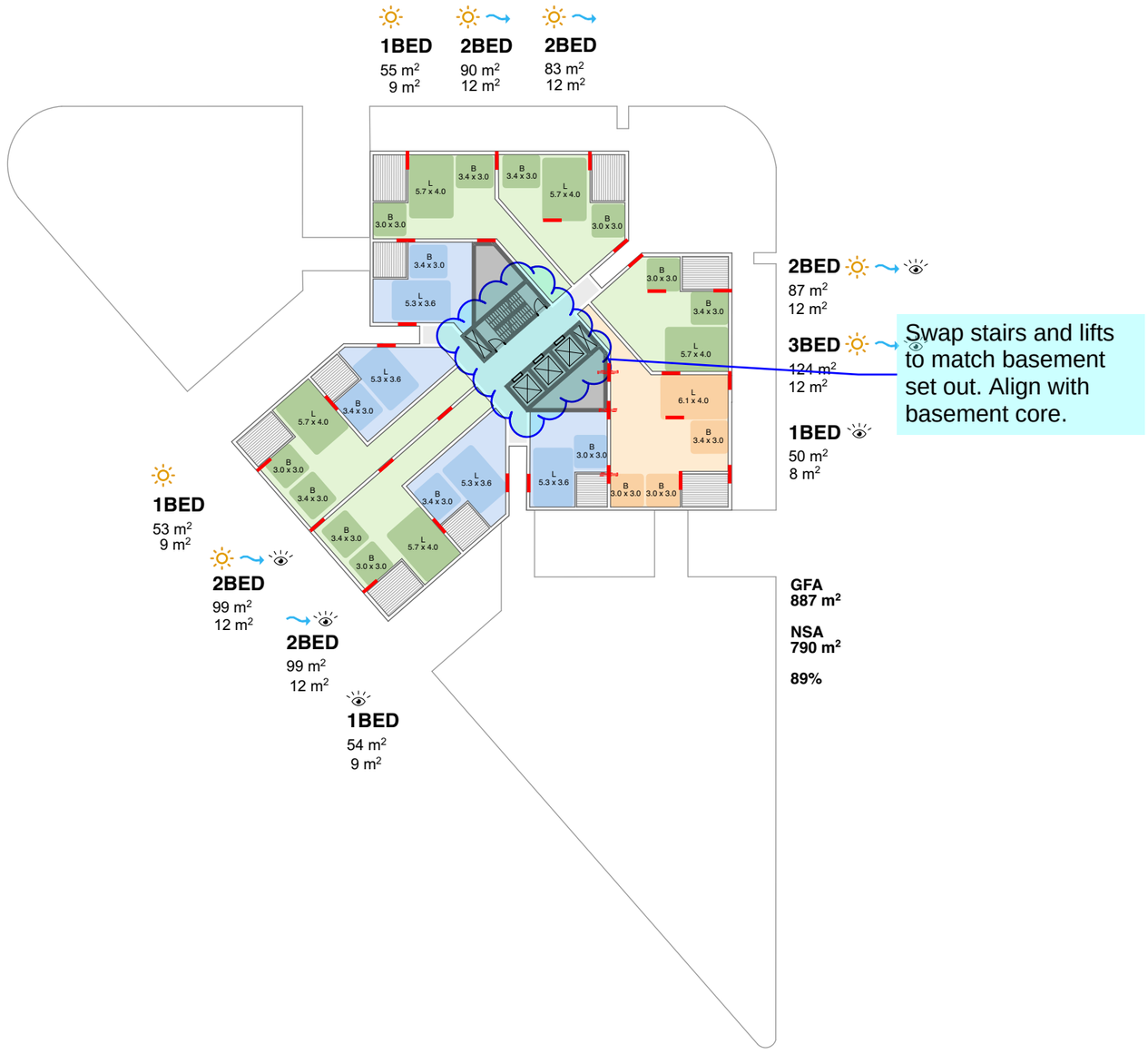
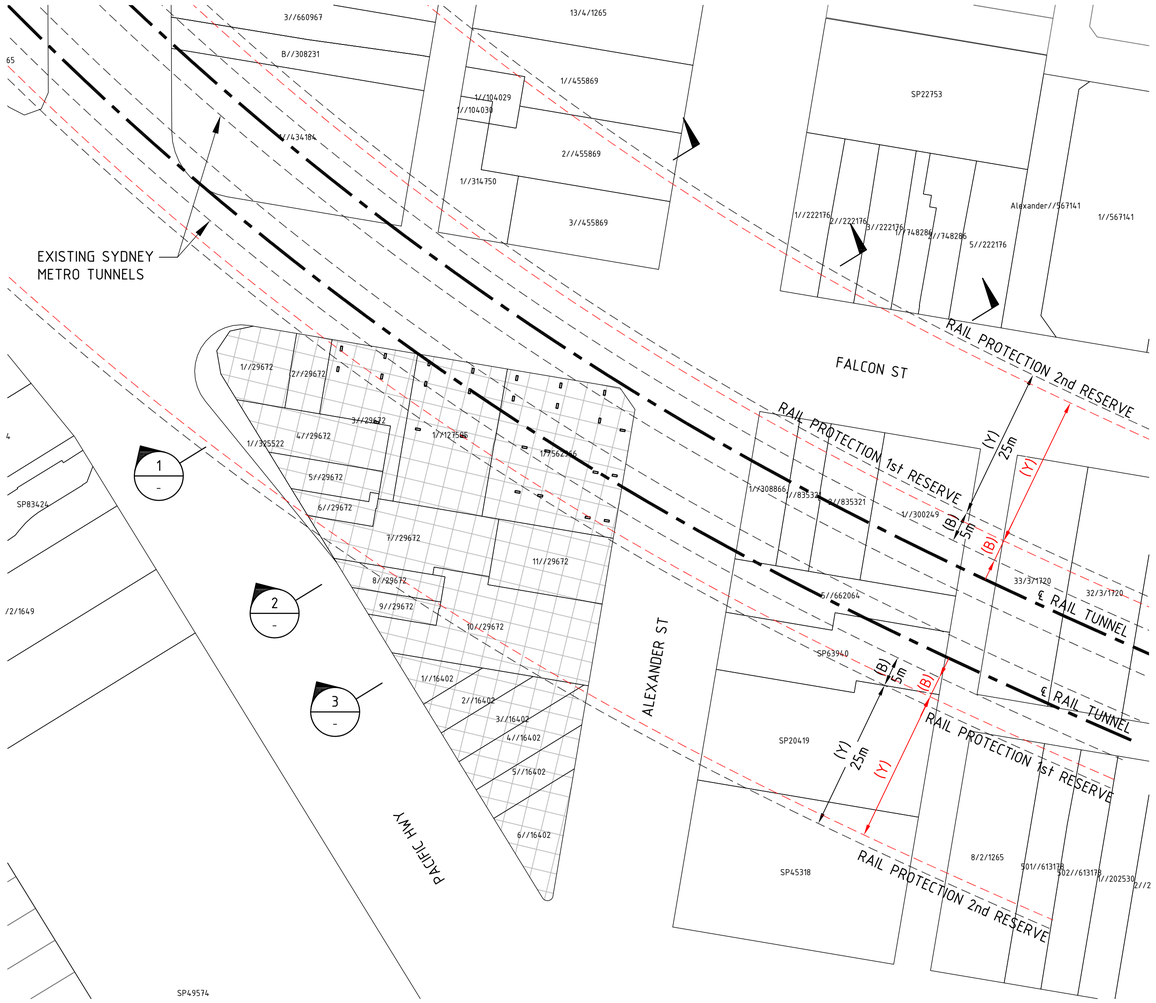


Plans
Typical

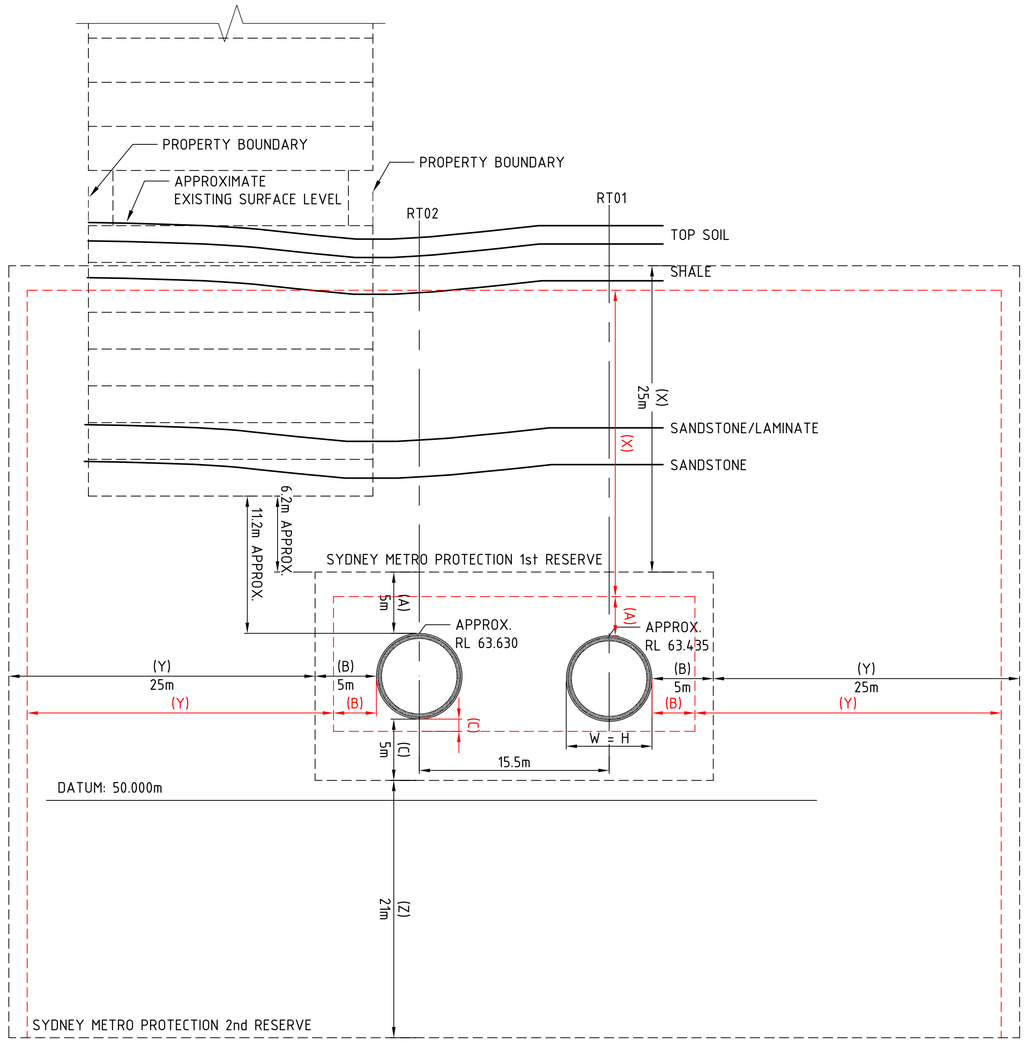
APPENDIX C

BG&E- Sydney Metro Interaction Drawings



SITE PLAN

SCALE 1:500



SECTION 1

SCALE 1:250 — SK001

SYDNEY METRO (NWRLSRT-PBA-SRT-TU-REP-000008) PROTECTION RESERVES

1st RESERVE

TOP (A): GREATER OF
- (1) 5m FROM THE CROWN OF THE TUNNEL OR CAVERN
- (2) ONE-THIRD OF TUNNEL WIDTH PLUS ONE METRE [(1/3)xW+1]
- (3) EXTENT OF SYDNEY METRO SUBSTRATUM ABOVE CROWN

SIDE (B): GREATER OF
- (1) 5m FROM THE SIDE WALL OF THE TUNNEL OR CAVERN
- (2) EXTENT OF SYDNEY METRO SUBSTRATUM

BOTTOM (C): GREATER OF
- (1) 5m FROM THE INVERT OF THE TUNNEL OR CAVERN
- (2) EXTENT OF SYDNEY METRO SUBSTRATUM BELOW INVERT

2nd RESERVE

TOP (A + X): GREATER OF
- (1) 1.5 x (W + H)
- (2) A + 25m

SIDE (B + Y): GREATER OF
- (1) W
- (2) B + 25m

BOTTOM (C + Z): C + 1.5 x (Wn + Hn)
- Wn = WIDTH OF NEW TUNNEL BELOW EXISTING OR PLANNED METRO TUNNEL
- Hn = HEIGHT OF NEW TUNNEL BELOW EXISTING OR PLANNED METRO TUNNEL

NOTE ALL DIMENSION IN METRES

TRANSPORT AUTHORITY (T-HR-CI-12051-ST) PROTECTION RESERVES

1st RESERVE

TOP (A): GREATER OF
- (1) 3m FROM THE CROWN OF THE TUNNEL OR CAVERN
- (2) ONE-THIRD OF TUNNEL WIDTH PLUS ONE METRE [(1/3)xW+1]
- (3) EXTENT OF SYDNEY METRO SUBSTRATUM ABOVE CROWN

SIDE (B): GREATER OF
- (1) 3.5m FROM THE SIDE WALL OF THE TUNNEL OR CAVERN
- (2) EXTENT OF SYDNEY METRO SUBSTRATUM

BOTTOM (C): GREATER OF
- (1) 1m FROM THE INVERT OF THE TUNNEL OR CAVERN
- (2) EXTENT OF SYDNEY METRO SUBSTRATUM BELOW INVERT

2nd RESERVE

TOP (A + X): GREATER OF
- (1) 1.5 x (W + H)
- (2) A + 25m

SIDE (B + Y): GREATER OF
- (1) W
- (2) B + 25m

BOTTOM (C + Z): C + 1.5 x (Wn + Hn)
- Wn = WIDTH OF NEW TUNNEL BELOW EXISTING OR PLANNED METRO TUNNEL
- Hn = HEIGHT OF NEW TUNNEL BELOW EXISTING OR PLANNED METRO TUNNEL

NOTE ALL DIMENSION IN METRES

REV	DATE	DESCRIPTION	RVD
C	28.05.2020	ISSUED FOR INFORMATION	AL
B	05.05.2020	ISSUED FOR INFORMATION	AL
A	28.02.2019	ISSUED FOR INFORMATION	AL

REVISIONS

CLIENT: Z:\Corel Company Logos\Deicorp.jpg

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PROJECT: SLIMLINES CROWS NEST

STATUS: ISSUED FOR INFORMATION — NOT TO BE USED FOR CONSTRUCTION

DRAWN	DESIGNED	CHECKED	APPROVED
AL	VB	JC	-

DATUM	GRID	SCALE	PROJECT No.	DRAWING No.	REV.
		AS SHOWN AT A1 SIZE	S19073	SK001	C

TITLE: SYDNEY METRO TUNNEL INTERACTION SHEET 1

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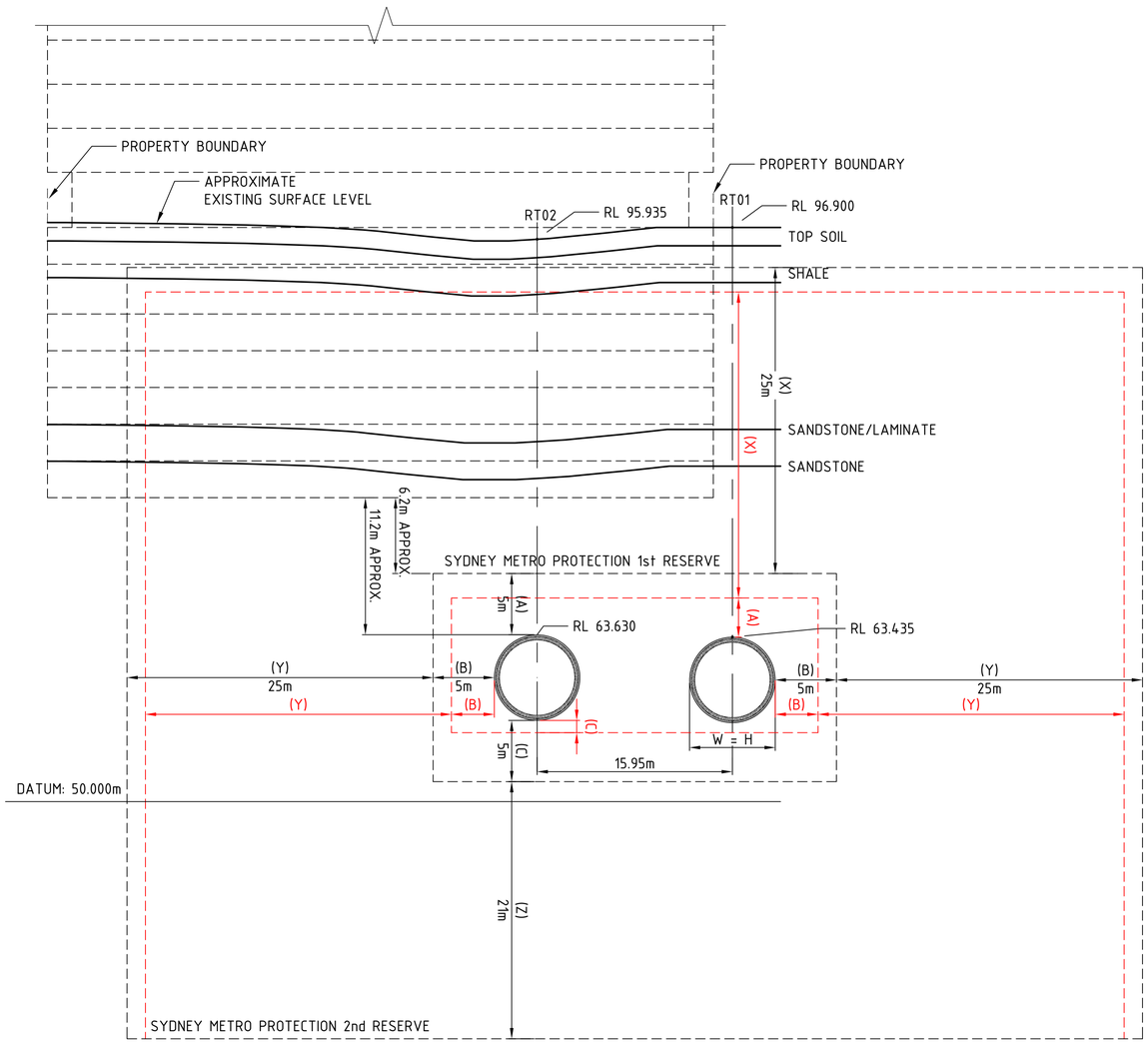
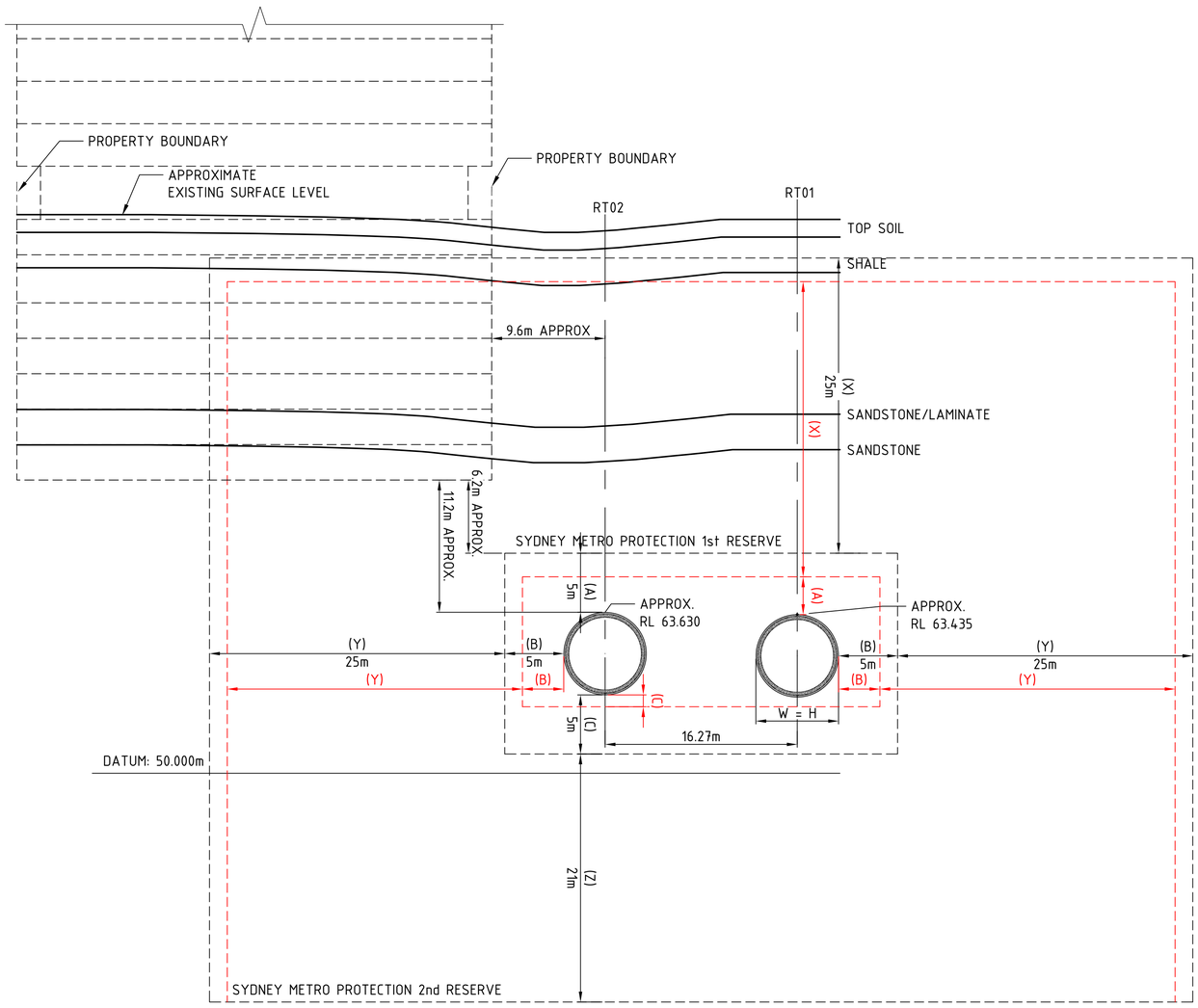


SECTION 2
SCALE 1:250 SK001



SECTION 3
SCALE 1:250 SK001

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B	05.05.2020	ISSUED FOR INFORMATION	AL
A	28.02.2019	ISSUED FOR INFORMATION	AL

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PROJECT
SLIMLINES
CROWS NEST

STATUS
ISSUED FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

DRAWN	DESIGNED	CHECKED	APPROVED
AL	VB	JC	–

DATUM	GRID	SCALE	
		AS SHOWN	AT A1 SIZE

TITLE
SYDNEY METRO TUNNEL
INTERACTION SHEET 2

PROJECT No.	DRAWING No.	REV.
S19073	SK002	C

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APPENDIX D

Geotechnical Letter

APPENDIX E

Previous Geotechnical Report

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Eastern Property Alliance
Level 1, 34-36 Oxford Street
Darlinghurst NSW 2010

Project 86645.01
19 March 2019
R.002.Rev0
JH

Attention: Brone Roze

Email: broneroze@gmail.com

Dear Sirs

Report on Preliminary Numerical Modelling Assessment
Proposed Mixed Use Development
Corner Falcon Street, Pacific Highway and Alexander Street, Crows Nest

1. Introduction

This report presents the results of a preliminary analysis to assess the impact that the proposed mixed use development may have on the proposed Sydney Metro tunnels. The analysis was commissioned by Mr Brone Roze of Eastern Property Alliance Pty Ltd and was undertaken in accordance with Douglas Partners Pty Ltd's (DP) proposal SYD181205 dated 26 February 2019.

This preliminary analysis follows on from a previous analysis described in DP Report 86645.01.R.001.Rev1, dated 12 March 2019 and has included the following changes:

- Introduced additional column loads (i.e. the green rectangles representing columns under shear / outrigger walls, as marked by BG&E, dated 13 March 2019);
- Introduced the building core load for the North Tower as nominated by BG&E, applied 3 m below the lowest basement level; and
- Dropped the level of the upper basement and applied the column loads within the upper basement to the top of sandstone. The shale in the model at the upper basement level is unlikely to be suitable to support the high column loads and therefore the loads have been transferred to the top of the assumed sandstone layer.

The property has a triangular shape and is bounded by Falcon Street on the northern side, Pacific Highway on the western side and Alexander Street on the eastern side. Currently the area is occupied by residential and commercial buildings. The proposed development will comprise mixed commercial/residential, 40 and 60 level buildings with 4 to 6 levels of basement, which extend into the 2nd reserve of the Sydney Metro tunnels. A three dimensional numerical analysis was therefore carried out to assess the effect that the new footing loads and basement are likely to have on the tunnels.

Numerical modelling was undertaken using the *FLAC3D* computer program to assess the changes in stress and the displacements associated with the excavation and construction works.

2. Numerical Analysis

2.1 Inputs

The geological model for the site has been developed from the findings of the geotechnical desktop study carried out for the site, which was based on a number of geotechnical investigations for projects nearby.

The following geological profile was used for the model:

- Unit 1: Filling and clay/shaly clay to 4.0 m depth, overlying;
- Unit 2: Siltstone/shale and laminite (Ashfield Shale formation), generally slightly weathered, fractured, low to medium strength with zones of extremely low and very low strength to a depth of 12 m, overlying
- Unit 3: Sandstone (Mittagong Formation and Hawkesbury Sandstone), fresh, slightly fractured, medium to high strength, to the base of the model.

To model the materials a plastic (Mohr-Coulomb) constitutive model was used. The material properties assumed for the analyses are shown in Table 1.

Table 1: Geotechnical Material Properties

Properties	Units	Unit 1: Soil/Filling	Unit 2: Ashfield Shale	Unit 3: Hawkesbury Sandstone
Unconfined compressive strength	MPa	-	8	25
Density	kN/m^3	20	22	24
Poisson's ratio	-	0.3	0.25	0.2
Young's Modulus (mass)	MPa	10	500	2500
Cohesion	kPa	2	350	2400
Frictional angle	degrees	25	35	44

Pells' 2002 in situ stress was used within the medium to high strength sandstone. The in situ stress was downgraded within the shale.

A groundwater table was not considered in the analysis.

Structural loads were provided by BG&E in the sketch titled "Prelim Markup of Lower Basement Foundations Rev2, dated 13 March 2019" as shown on the attached drawings and represent loads for the 60 level building. The loads were applied as pressures directly to the grid.

The following sequence was adopted for the modelling:

1. Set up geology, geometry and in-situ stress conditions and run to equilibrium;
2. Excavate the Sydney Metro Tunnels, run to equilibrium - **Stage 0**;
3. Reset displacements, excavate the basement and run to equilibrium – **Stage 1**;
4. Apply foundation loads and run to equilibrium - **Stage 2**.

2.2 Results

Plots of displacement at Stage 2 are attached to this report. The model indicates that excavation is likely to result in maximum displacements within the rock surrounding the tunnel of up to 8 mm after construction. Most of this displacement is vertical, with up to 3 mm upwards movement during excavation and 8 mm downwards movement during construction. Horizontal displacements reached a maximum of <1 mm. The entire tunnel is generally displaced vertically upwards during excavation and then vertically downwards during construction, after the full building loads were applied. The maximum differential displacement within the tunnel lining in any plane is very close to 0.5 mm/m or 1:2000.

3. Conclusion

The model indicates that the net effect of excavation and construction of the proposed development on the tunnel marginally complies with the requirements of the Transport Asset Standards Authority Standard, Developments near Rail Tunnels, reference T-HR-CI-12051-ST, version 2, November 2018. Overall displacements of the tunnel are predicted to be slightly less than the 10 mm allowable in the Asset Standard, with differential movements very close to 0.5 mm/m or 1:2000 allowable in the Asset Standard.

It must be noted that Sydney Metro will review and interrogate modelling results and inputs, and changes to the modelling and results may be required which may adversely affect approvals.

It is also noted that the preliminary modelling is based on an assumed soil/rock profile. Investigation will be required for detailed design and planning and this may indicate a deeper and/or weaker rock profile which will also result in changes to the predicted impacts.

The above suggests that the current stepped basement scheme with a 60 storey building marginally complies with the Sydney Metro deflection limits.

The typical Sydney Metro Protection Reserves are shown below (taken from our previous desktop report). The BG&E section provided suggests a First Reserve of 5 m around the tunnels. In some areas Sydney Metro nominate a Sydney Metro Substratum that can extend more than 5 m above the tunnels (for instance at Artarmon). This distance is considered as the First Reserve. This should be checked with Sydney Metro as it has potential to extend the First Reserve closer to and within the proposed basement and footings.

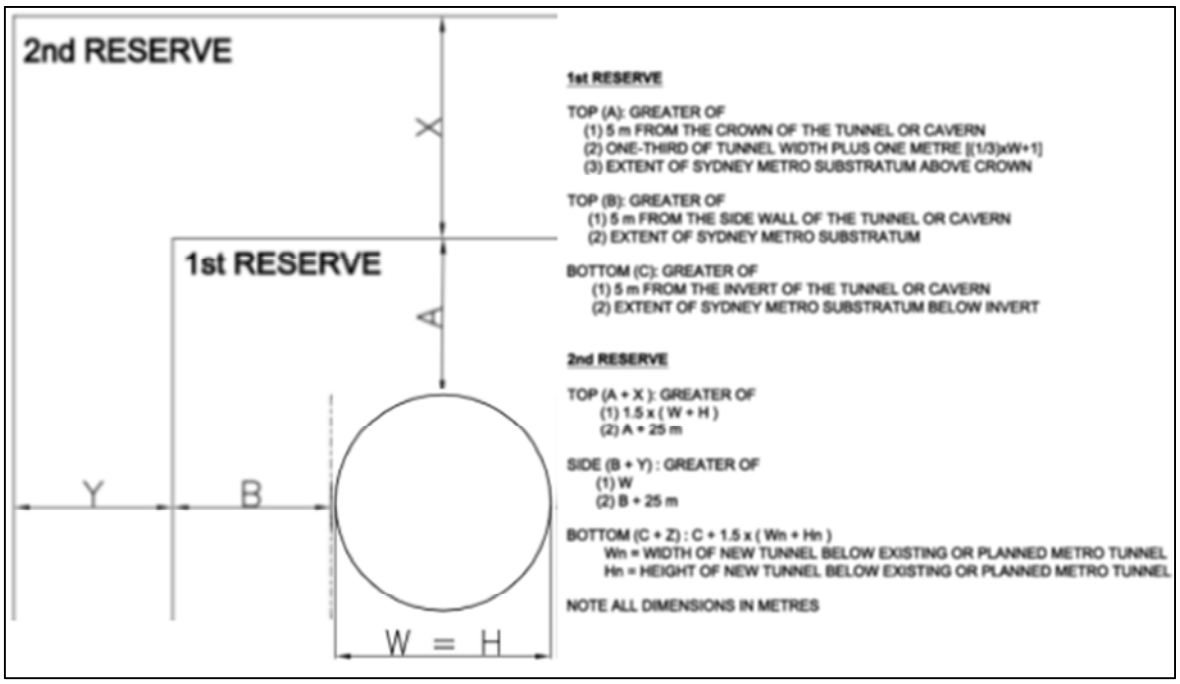

Figure 1 – Sydney Metro Protection Reserves (extract from TfNSW document)

4. Alternative Options

It is understood that the following alternative schemes are also being considered;

Alternative 1 - 60 storeys (high-rise option) with full basement excavation.

Alternative 2 - 40 storeys (mid-rise option) with two fewer basement levels.

Based on the modelling carried out for the current stepped basement scheme with a 60 storey building, it is considered that Alternative 1 is unlikely to comply with the deflection criteria nominated by Sydney Metro. This option will apply to loads closer to the tunnels and will increase deflections. There is an opportunity to carry out detailed investigations and modelling with refined (reduced building loads) during detailed design to try and justify this option, but it is consider that there is a high risk that this option will not be justified and/or would not be approved by Sydney Metro.

Alternative 2 with a reduced basement depth and reduced building loads should result in reduced deflections and impacts on the tunnels. As a guide, it is anticipated that maximum deflections at the tunnels for this option may be in the order of 5 mm (assuming building loads are reduced by 33%). This option obviously has the lowest risk in terms of approval from Sydney Metro.

5. Limitations

Douglas Partners (DP) has prepared this report for this project at the corner of Falcon Street, Pacific Highway and Alexander Street, Crows Nest in accordance with DP's proposal SYD181205 dated 27 November 2018 and acceptance received from Brone Rose dated 26 February 2019. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Eastern Property Alliance Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes on the same or other sites or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires a risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Yours faithfully
Douglas Partners Pty Ltd

Reviewed by

Joel Huang
Associate

John Braybrooke
Senior Consultant

Scott Easton
Principal

Attachments: Notes About This Report
Numerical Analysis Results

References:

Bertuzzi, R and Pells, P.J.N (2002), Geotechnical Parameters of Sydney Sandstone and Shale, Australian Geomechanics, Vol 37(5), December 2002.

Oliveira, D.A.F (2014), An Alternative View on Geotechnical Parameters for Tunnel Design in Sydney, Australian Geomechanics, Vol 49(3), September 2014.

Pells, P.J.N (2002), Developments in the Design of Tunnels and Caverns in the Triassic Rocks of the Sydney Region, Int J Rock Mech and Min Sci, 39:569-587.

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Attachment A

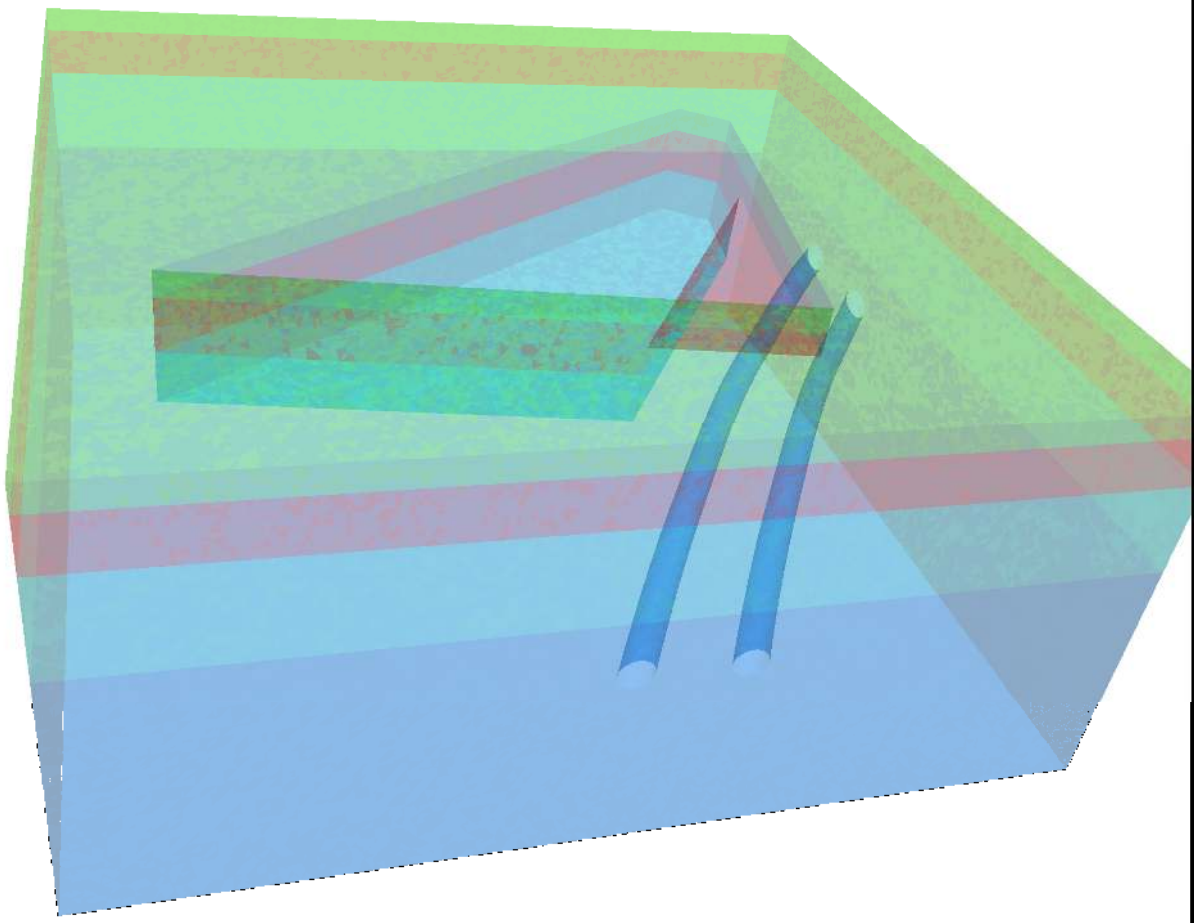
Numerical Analysis Results

FLAC3D 5.01

Zone

Colorby: Group Any

- botSS2
- toppSS2
- topshale
- topsoil



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Geotechnics / Environment / Groundwater

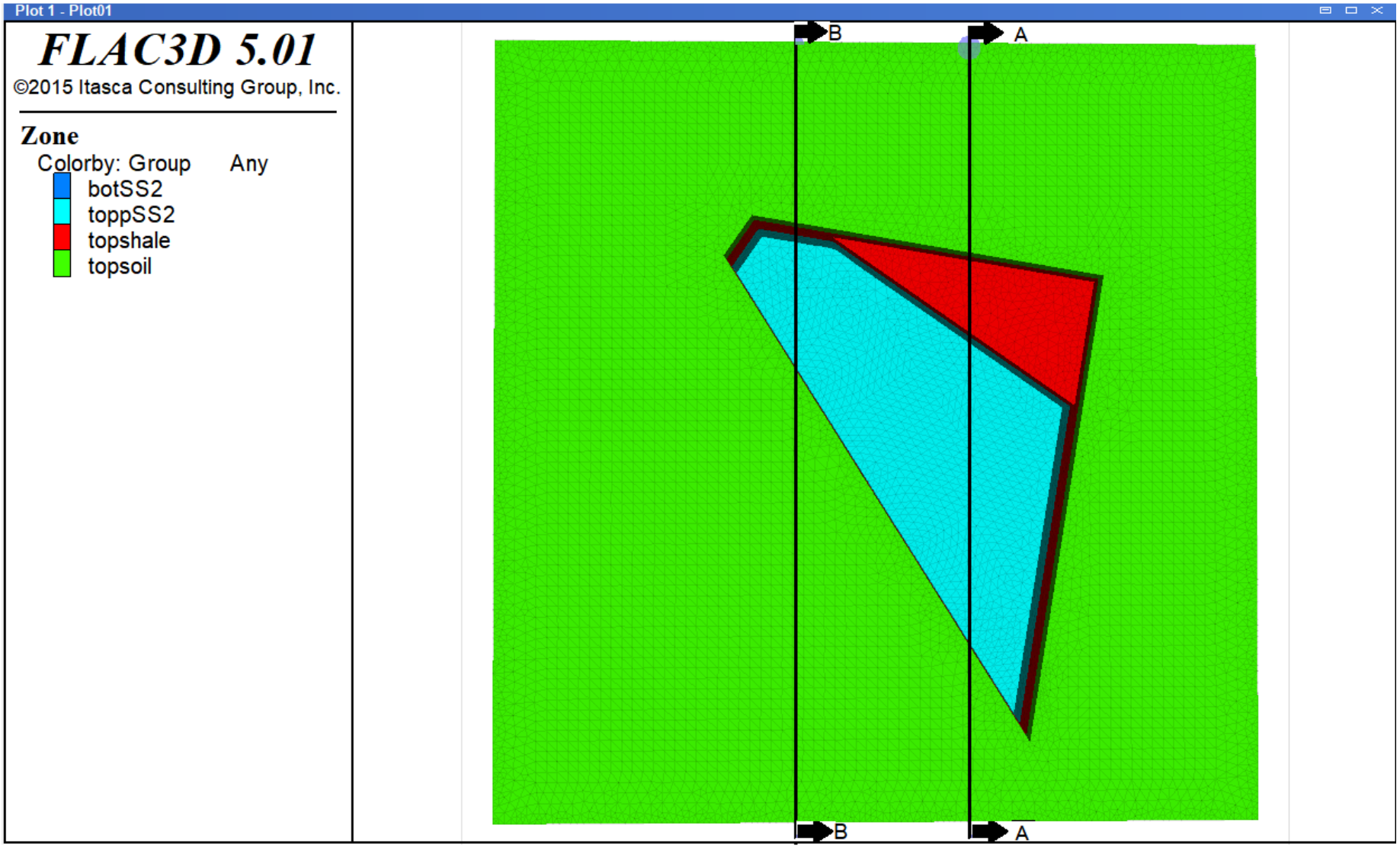
CLIENT:	Eastern Property Allaince
OFFICE:	Sydney
DATE:	18 Mar 2019

FLAC3D Model Geometry

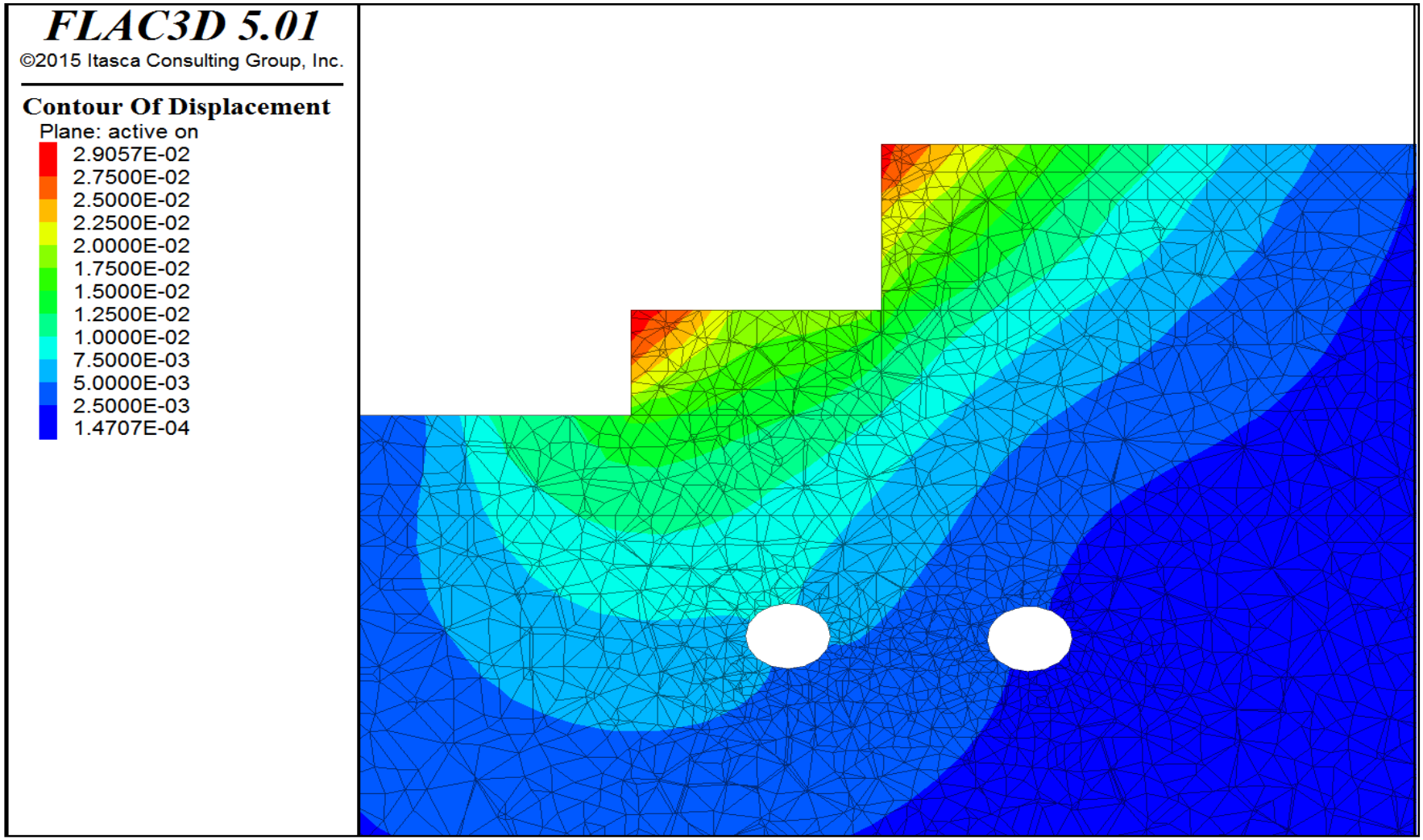
Modelling of Basement/Tunnel Interaction

Corner Falcon St, Pacific Hwy and Alexander St, Crows Nest

PROJECT No:	86645.01
Plot No:	NM1
REVISION:	2

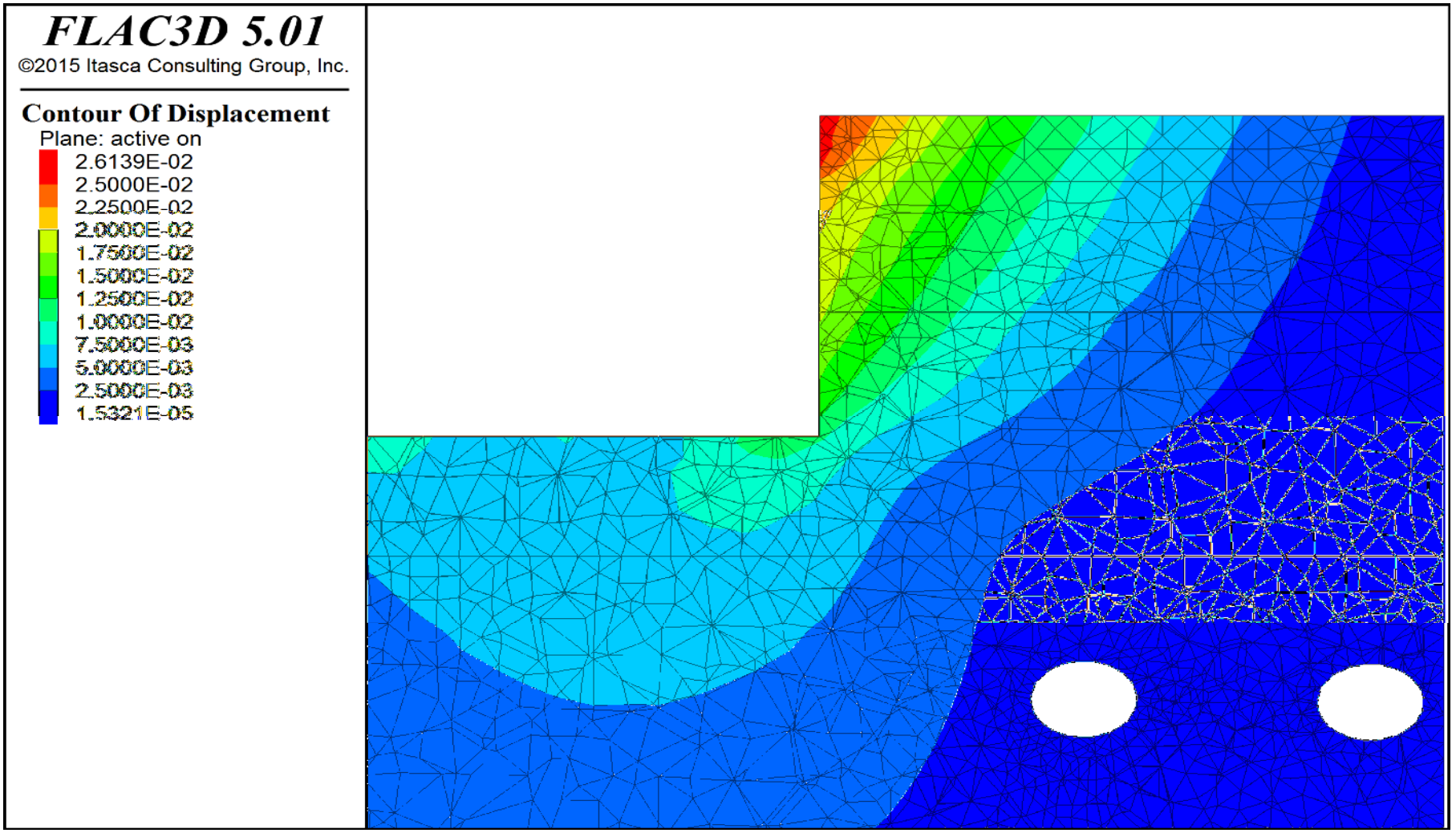


Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Eastern Property Allaince	**Sections considered for displacement outputs**	PROJECT No: 86645.01
	OFFICE: Sydney	**Modelling of Basement/Tunnel Interaction**	Plot No: NM2
	DATE: 18 Mar 2019	**Corner Falcon St, Pacific Hwy and Alexander St, Crows Nest**	REVISION: 2



Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Eastern Property Allaince	**Contours of Displacement (Stage 2)**	PROJECT No:	86645.01
OFFICE: Sydney	**Modelling of Basement/Tunnel Interaction**	Plot No:	NM3
DATE: 18 Mar 2019	**Corner Falcon St, Pacific Hwy and Alexander St, Crows Nest**	REVISION:	2



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Eastern Property Allaince	**Contours of Displacement (Stage 2)**	PROJECT No: 86645.01
	OFFICE: Sydney	**Modelling of Basement/Tunnel Interaction**	Plot No: NM4
	DATE: 18 Mar 2019	**Corner Falcon St, Pacific Hwy and Alexander St, Crows Nest**	REVISION: 2

Assumed locations Shear and Outrigger walls in the tower levels overlaid for reference.

Preliminary Tower Core Raft Footing denoted in Green.
Core Foundation Loads:
Ultimate: 1.2G + Wind + 0.4Q = 300,000kN

Preliminary column positions assuming that the Upper Basement layout is typical for all car park basement levels - denoted by rectangles.
Only columns within the approx zone of influence of the tunnel have been shown.
Preliminary loads on column foundations:
Pink Rectangles:
Dead Load = 28,400 kN
Live Load = 6,500 kN
Blue Rectangles:
Dead Load = 40,500 kN
Live Load = 9,300 kN
Green Rectangles (Columns under shear/outrigger walls):
1.2G + Wind + 0.4 Q = 100,500 kN

Lateral Load Assumptions:
Towers are separated by a Building Movement Joint
Preliminary wind loads calculated using AS1170.2

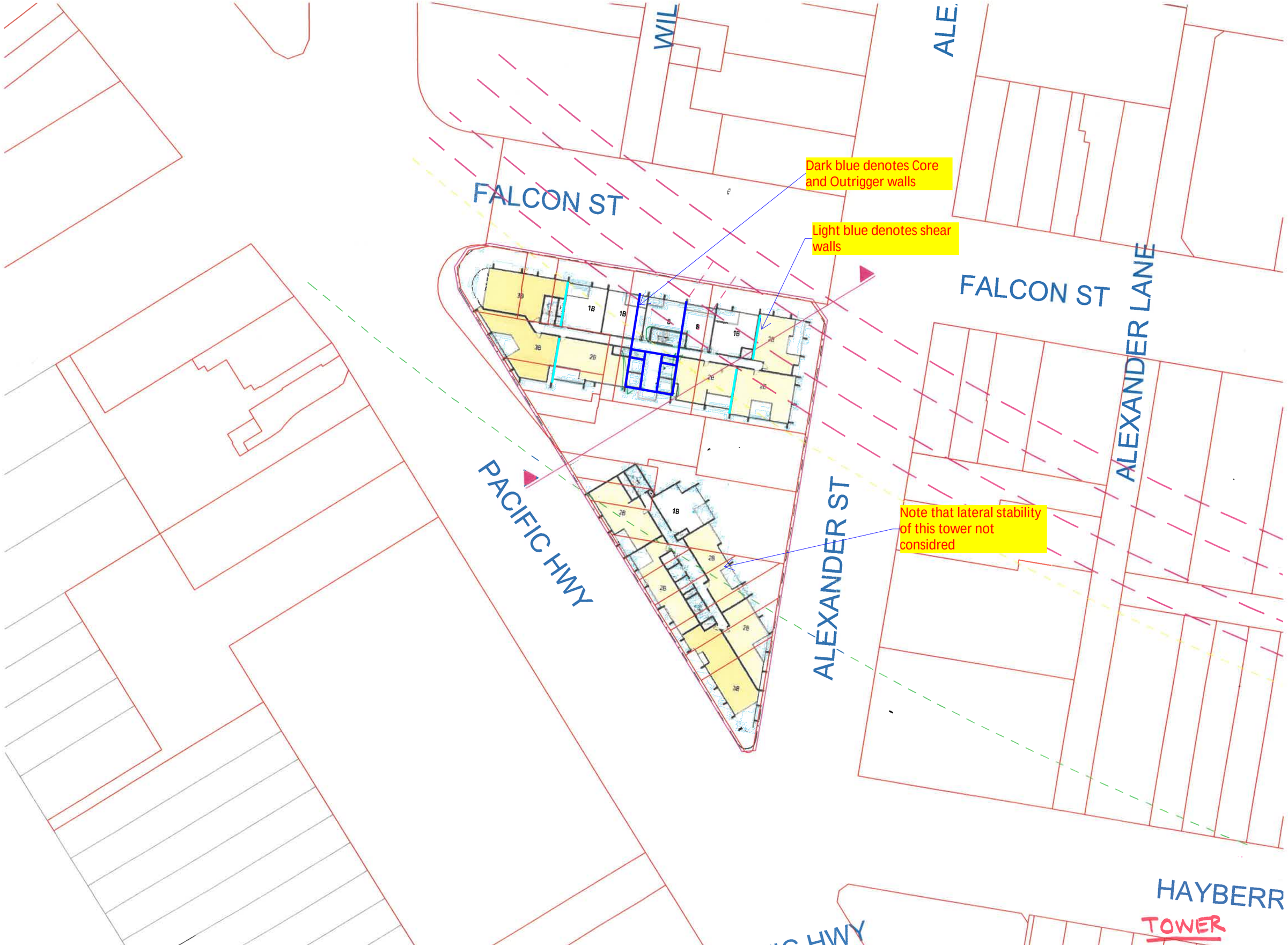
Wind Load Parameters:
Annual Probability of exceedance = 1:500
Region: A2
Terrain Category: East, West, South =3; North = 4
C(dyn) = 1.0; A dynamic wind analysis will need to be assessed by a wind consultant

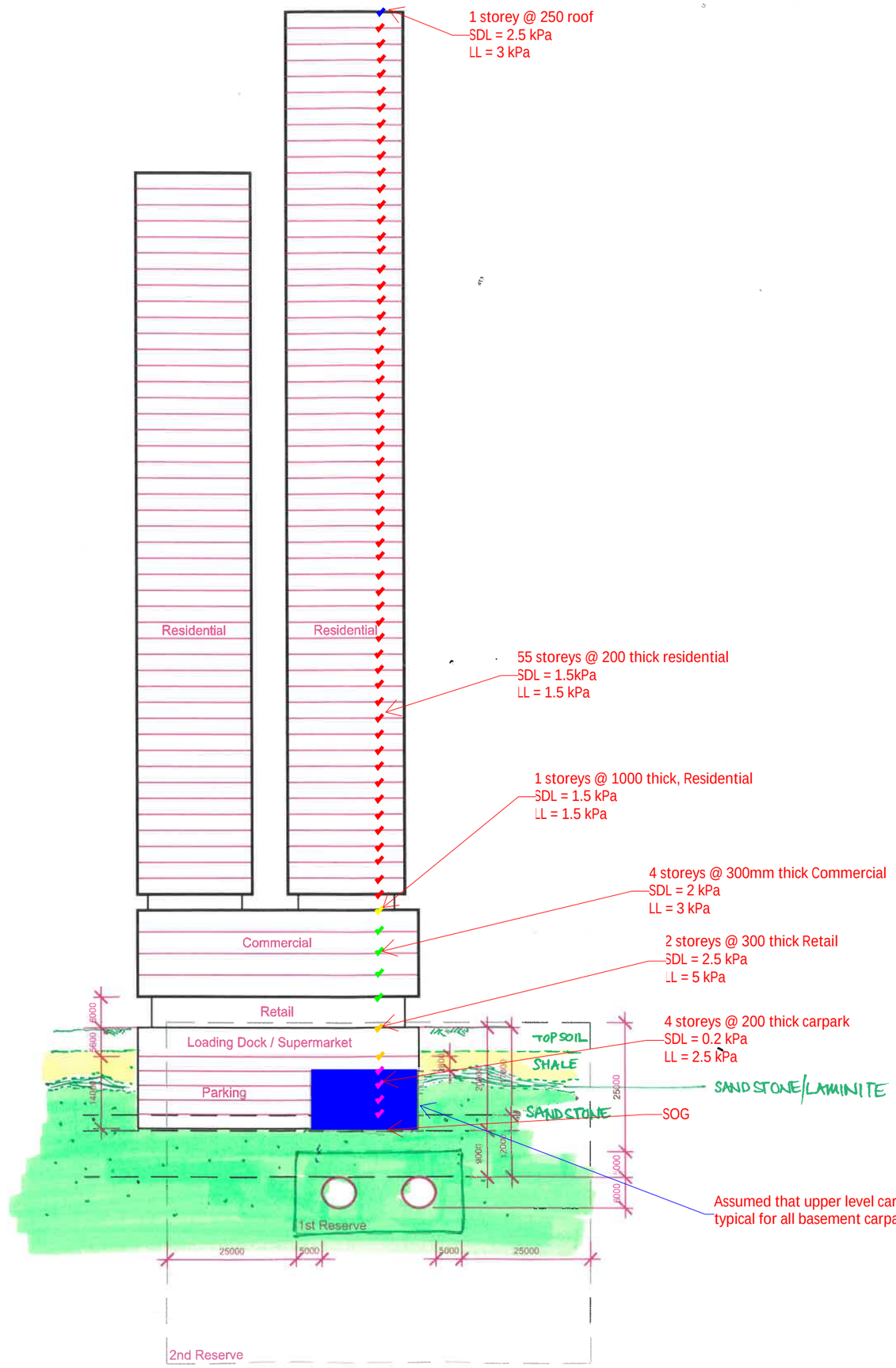
FOR THIS EXERCISE BG&E HAVE ASSUMED THAT THE UPPER BASEMENT LAYOUT WILL BE APPLIED TO ALL BASEMENT CARPARK LEVELS.

BG&E PRELIM MARKUP OF LOWER BASEMENT FOUNDATIONS 13.03.19 (Rev 2)

LOWER & UPPER BASEMENT LEVELS
~~UPPER BASEMENT~~

FALCON ST
PACIFIC HWY
ALEXANDER ST
LIFT TO NORTH TOWER
RAMP UP
LIFT TO RETAIL/ COMMERCIAL FLOORS
LIFT TO SOUTH TOWER


FALCON ST
FALCON ST
ALEXANDER LANE
PACIFIC HWY
ALEXANDER ST
HAYBERR
TOWER
Dark blue denotes Core and Outrigger walls
Light blue denotes shear walls
Note that lateral stability of this tower not considred


1 storey @ 250 roof
SDL = 2.5 kPa
LL = 3 kPa
Residential
Residential
55 storeys @ 200 thick residential
SDL = 1.5kPa
LL = 1.5 kPa
1 storeys @ 1000 thick, Residential
SDL = 1.5 kPa
LL = 1.5 kPa
4 storeys @ 300mm thick Commercial
SDL = 2 kPa
LL = 3 kPa
2 storeys @ 300 thick Retail
SDL = 2.5 kPa
LL = 5 kPa
4 storeys @ 200 thick carpark
SDL = 0.2 kPa
LL = 2.5 kPa
Commercial
Retail
Loading Dock / Supermarket
Parking
TOPSOIL
SHALE
SAND STONE/LAMINITE
SANDSTONE
SOG
Assumed that upper level carpark layout is typical for all basement carpark levels
1st Reserve
2nd Reserve
25000
5000
5000
25000

SECTION

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

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

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

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

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

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

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.