Attachment K – Arboricultural Impact Appraisal, Prepared by Naturally Trees, dated September 2017

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Arboricultural Impact Appraisal and Method Statement

73-75 Gardeners Road
Eastlakes, NSW

Prepared for
Sydney Water

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15 September 2017

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Summary

Sydney Water have engaged Architectus to prepare a Master Plan for land at 73-75 Gardeners Road, Eastlakes for the purposes of informing a Planning Proposal which seek to amend the current planning controls for the site to allow residential development and supporting land uses.

Sydney Water are in the process of divesting surplus land to allow redevelopment and improved utilisation of this land within the Sydney Metropolitan area. For the subject sites, due to their location within the wider context of Eastlakes, it is proposed to seek their rezoning to allow for residential development or other appropriate supporting land uses.

In order to test and demonstrate the suitability of the site for the proposed land uses, a master plan has been prepared by Architectus and considered by Naturally Trees. This master plan identifies that the site should be developed for residential with supporting land uses such as small scale shops, retail or similar uses. The proposal will enable the future redevelopment of both sites resulting in approximately 750 units, 1,417 parking spaces and a range of building heights between 6-14 storeys. No approval is sought for the master plan at this stage as it simply seeks to evidence that the proposed changes to the planning controls are appropriate.

Any future development of the site will be subject to future development applications lodged with Council. Our review of the master plan has identified that the site is suitable for the proposed land uses as residential and supporting land uses including supporting commercial / retail uses.

Twenty-seven high category trees and seventy-six low category trees are affected by the proposed master plan. However, a comprehensive landscaping scheme to mitigate these losses can be proposed as part of any subsequent detailed design Development Application following the amendment of the proposed planning controls. The proposed master plan may adversely affect a further sixty-one high category trees and thirty-two low category trees if appropriate protective measures are not taken. However, this report identifies adequate precautions to protect the retained trees as part of any future subsequent Development Application for the site under the proposed planning controls. The assessment of the master plan identifies that the site is appropriate for residential development with regards impact on trees, subject to detailed design and further assessment as part of any future development application.

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Appendices

1. INTRODUCTION

1.1 **Instruction:** I am instructed by Architectus Sydney to inspect the tree population at 73-75 Gardeners Road, Eastlakes and to provide an arboricultural report to consider a master plan which informs a planning proposal which seeks amendments to the current planning controls for the site to permit residential development. This report investigates the impact of the proposed development on trees and provides the following guidelines for appropriate tree management and protective measures:

- a schedule of the relevant trees to include basic data and a condition assessment;
- an appraisal of the impact of the proposal on trees and any resulting impact that has on local character and amenity;
- a preliminary arboricultural method statement setting out appropriate protective measures and management for trees to be retained

1.2 **Purpose of this report**: This report provides an analysis of the impact of the development proposal on trees with additional guidance on appropriate management and protective measures. Its primary purpose is for the council to review the tree information in support of the planning submission and use as the basis for issuing a planning consent or engaging in further discussions towards that end. Within this planning process, it will be available for inspection by people other than tree experts so the information is presented to be helpful to those without a detailed knowledge of the subject.

1.3 **Qualifications and experience:** I have based this report on my site observations and the provided information, and I have come to conclusions in the light of my experience. I have experience and qualifications in arboriculture, and include a summary in Appendix 1.

1.4 **Documents and information provided:** Architectus Sydney provided me with copies of the following documents:

- Survey Plan, Dwg No. 150721 (Sheets 1 to 7), by Linker Surveying dated 4 August 2015;
- Survey Plan, Dwg No. 118382500 (Sheets 1 to 2), by Cardno dated 25 May 2017; and
- Draft Master Plan by Architectus Sydney.

1.5 **Scope of this report:** This report is concerned with one hundred and ninety-six trees located within, and adjacent to, the subject site. It takes no account of other trees, shrubs or groundcovers within the site unless stated otherwise. It includes a preliminary assessment based on the site visit and the documents provided, listed in 1.4 above.

2. THE LAYOUT DESIGN

2.1 **Tree AZ method of tree assessment:** The TreeAZ assessment method determines the worthiness of trees in the planning process. TreeAZ is based on a systematic method of assessing whether individual trees are important and how much weight they should be given in management considerations. Simplistically, trees assessed as potentially important are categorised as '**A**' and those assessed as less important are categorised as '**Z**'. Further explanation of TreeAZ can be found in Appendix 3.

In the context of new development, all the Z trees are discounted as a material constraint in layout design. All the A trees are potentially important and they dictate the design constraints. This relatively simple constraints information is suitable for use by the architect to optimise the retention of the best trees in the context of other material considerations.

2.2 Site visit and collection of data

2.2.1 **Site visit:** I carried out an unaccompanied site visit on 11 August 2015 and again on 6 July 2017. All my observations were from ground level and I estimated all dimensions unless otherwise indicated. Aerial inspections, root or soil analysis, exploratory root trenching and internal diagnostic testing was not undertaken as part of this assessment. I did not have access to trees on other private properties and have confined observations of them to what was visible from within the property. The weather at the time of inspection was clear and dry with good visibility.

2.2.2 **Brief site description:** 73-75 Gardeners Road is located in the residential suburb of Eastlakes (refer figure 1). The site is on the southern side of the road and surrounded by residential development to the north and a golf course to the south. 73 Gardeners road is currently occupied by a Sydney Water Depot and 75 Gardeners road previously was occupied by a retail nursery centre which has since been demolished. A variety of ornamental, coniferous and indigenous trees are scattered throughout the site and around the site boundaries.

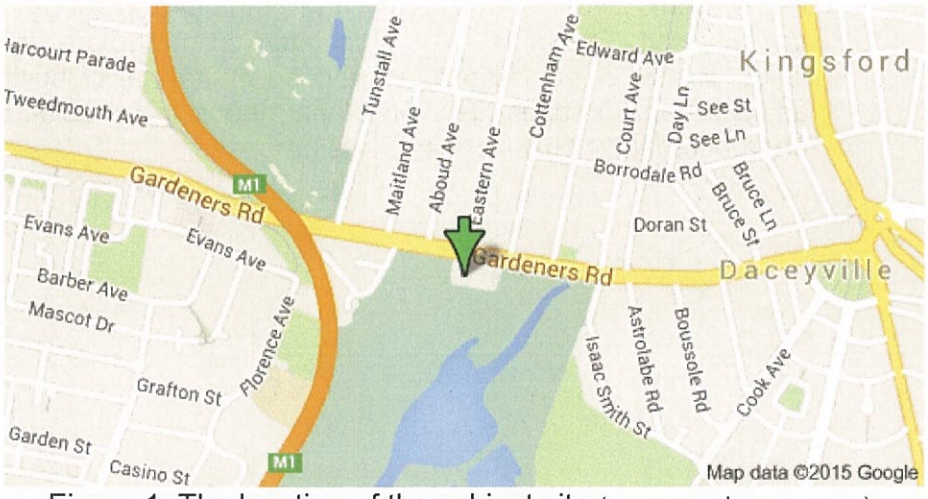

Figure 1: The location of the subject site (www.googlemaps.com).

2.2.3 **Collection of basic data:** I inspected each tree and have collected information on species, height, diameter, maturity and potential for contribution to amenity in a development context. I have recorded this information in the tree schedule included, with explanatory notes, in Appendix 2. Each tree was then allocated to one of four categories (AA, A, Z or ZZ), which reflected its suitability as a material constraint on development.

2.2.4 **Identification and location of the trees:** I have illustrated the locations of the significant trees on the Tree Management Plan (Plan TMP01) included as Appendix 8. This plan is for illustrative purposes only and it should not be used for directly scaling measurements.

2.2.5 **Advanced interpretation of data:** Australian Standard *Protection of trees on development sites* (AS4970-2009), recommends that the trunk diameter measurement for each tree is used to calculate the tree protection zone (TPZ), which can then be interpreted to identify the design constraints and, once a layout has been consented, the exclusion zone is to be protected by barriers.

2.3 **The use of the tree information in layout design:** Following my inspection of the trees, the information listed in Appendix 2 was used to provide constraints guidance based on the locations of all the A trees. All the Z trees were discounted because they were not considered worthy of being a material constraint. This guidance identified two zones of constraint based on the following considerations:

- The tree protection zone (TPZ) is an area where ground disturbance must be carefully controlled. The TPZ was established according to the recommendations set out in AS4970-2009 and is the radial offset distance of twelve (x12) times the trunk diameter. In principle, a maximum encroachment of 10% is acceptable within the TPZ and a high level of care is needed during any activities that are authorised within it if important trees are to be successfully retained.

- The structural root zone (SRZ) is a radial distance from the centre of a tree's trunk, where it is likely that structural, woody roots would be encountered. The distance is calculated on trunk flare diameter at ground level. The SRZ may also be influenced by natural or built structures, such as rocks and footings. The SRZ only needs to be calculated when major encroachment (>10%) into a TPZ is proposed.

3. ARBORICULTURAL IMPACT APPRAISAL

3.1 **Summary of the impact on trees:** I have assessed the impact of the proposal on trees by the extent of disturbance in TPZs and the encroachment of structures into the SRZ (as set out briefly in 2.3 above and more extensively in Appendix 2). All the trees that may be affected by the development proposal are listed in Table 1.

It should be noted that any tree removal or likely impact on existing vegetation will need to be subject to a further Development Application which will need to be assessed. At this detailed design phase of any future application, the impact of the sites redevelopment of future trees will need to be considered and there may be opportunities to retain a greater number of trees. This report considers the impacts of the high level master plan as a test case, in order to determine whether the site is suitable for residential redevelopment.

Table 1: Summary of existing trees and trees that may be affected by development

Impact	Reason	Important trees		Unimportant trees	
		AA	A	Z	ZZ
Retained trees that may be affected through disturbance to TPZs	Removal of existing surfacing/structures/ landscaping and/or installation of new surfacing/structures/ landscaping	1, 3, 97, 98, 100, 126	2, 4, 5, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 42, 43, 44, 94, 95, 96, 99, 102, 103, 104, 105, 106, 107, 108, 124, 125, 127, 128, 130, 145 (5x Trees), 146 (11x Trees), 148, 154, 155, 159, 160	6, 7, 11, 21, 22, 23, 41, 46, 47, 61, 62, 93, 109, 110, 111, 112, 113, 114, 115, 129, 131, 147, 149, 150, 151, 152, 153, 157, 158, 161	48, 156
Trees to be removed	Construction and/or level variations within TPZ	101, 135	27, 28, 32, 49, 51, 52, 56, 59, 74, 77, 78, 79, 86, 87, 91, 92, 120, 121, 123, 144, 162, 164, 165, 166, 168	24, 26, 29, 30, 31, 33, 34, 35, 36, 37, 38, 39, 40, 45, 50, 54, 55, 57, 58, 60, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 75, 76, 80, 81, 82, 83, 84, 85, 88, 89, 90, 117, 118, 119, 122, 132, 133, 134, 136, 137, 138, 139, 140, 141, 142, 143, 163, 167, 169, 170, 174	25, 53, 116, 171, 172, 173, 175, 176, 177, 178, 179, 180, 181, 182

3.2 Detailed impact appraisal

3.2.1 **Category AA and A trees to be lost:** The proposed development will necessitate the removal of twenty-seven high category trees (Trees **27, 28, 32, 49, 51, 52, 56, 59, 74, 77, 78, 79, 86, 87, 91, 92, 101, 120, 121, 123, 135, 144, 162, 164, 165, 166** and **168**). These trees are considered moderate to high significance and display good health and condition. In order to compensate for loss of amenity, consideration has been given to replacement planting within the site.

3.2.2 **Category AA and A trees that could potentially be adversely affected through TPZ disturbance:** Sixty-one category A and AA trees could potentially be adversely affected through disturbance to their TPZs as follows:

- Trees **1, 2, 3, 4** and **5**: These are important trees with a high potential to contribute to amenity so any adverse impacts on them should be minimised. The bulk of the proposed works remain largely outside their TPZ and direct impacts are not expected. The proposed pedestrian road must be designed to avoid disturbance to roots. I have reviewed the situation carefully and my experience is that these trees could be successfully retained without any adverse effects if appropriate protective measures are properly specified and controlled through a detailed arboricultural method statement.

- Trees **8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19** and **20**: This avenue of Paperbarks are important trees with a high potential to contribute to amenity so any adverse impacts on them should be minimised. The proposed works remain outside their TPZ and direct impacts are not expected. These trees will form part of an open space or parkland. The existing stormwater canal will be piped and the area above reinstated as open area. I have reviewed the situation carefully and my experience is that these trees could be successfully retained without any adverse effects if appropriate protective measures are properly specified and controlled through a detailed arboricultural method statement.

- Trees **42, 43, 44, 94, 95, 96, 97, 98, 99, 100, 102, 103, 104, 105, 106, 107, 108, 124, 125, 127** and **128**: These are important trees with a high potential to contribute to amenity so any adverse impacts on them should be minimised. The bulk works remain largely outside the TPZ of these trees. Pedestrian paths should be relocated to the outer edge of their TPZ or in areas already occupied with existing hardstand surfaces. I have reviewed the situation and my experience is that these trees could be successfully retained without any adverse effects if appropriate protective measures are properly specified and controlled through a detailed arboricultural method statement.

- Tree **126**: The proposed Building B construction will occupy 8% of the TPZ of this large Sydney Blue Gum. The encroachment is within accordance with AS4970-2009 recommendations however the tree must be protected from site access and build zone. Extreme care and protection of the tree would be necessary if it is to be successfully retained. Specifically, the existing ground levels would be required to remain within the TPZ to avoid

severance of structural roots. Canopy pruning will be required, however given the trees open and high canopy, this should be achievable without causing adverse impact to the trees health or appearance.

- Trees **130, 145** (5x Trees), **146** (11x Trees), **148, 154, 155, 159** and **160**: The proposed works remain outside the TPZ of these trees and direct impacts are not expected. I have reviewed the situation carefully and my experience is that these trees could be successfully retained without any adverse effects if appropriate protective measures are properly specified and controlled through a detailed arboricultural method statement.

3.2.3 **Category Z and ZZ trees to be removed:** The proposed development will necessitate the removal of seventy-six trees of low and very low retention value. None of these trees are considered significant or worthy of special measures to ensure their preservation.

3.2.4 **Category Z trees to be retained:** Thirty-two low category trees can be retained under the current proposal if appropriate protective measures are properly specified and controlled through a detailed arboricultural method statement.

3.3 **Proposals to mitigate any impact**

3.3.1 **Protection of retained trees:** The successful retention of trees within the site will depend on the quality of the protection and the administrative procedures to ensure protective measures remain in place throughout the development. An effective way of doing this is through an arboricultural method statement that can be specifically referred to in the planning condition. An arboricultural method statement for this site is set out in detail in Section 4.

3.3.2 **New planting:** In the context of the loss of trees, a comprehensive new landscaping scheme is proposed including new trees to be planted within available areas in prominent locations. The new trees should have the potential to reach a significant height without excessive inconvenience and be sustainable into the long term, significantly improving the potential of the site to contribute to local amenity and character.

3.3.3 **Summary of the impact on local amenity:** Twenty-seven high category trees and seventy-six low category trees are affected by the proposed master plan. However, a comprehensive landscaping scheme to mitigate these losses can be proposed as part of any subsequent detailed design Development Application following the amendment of the proposed planning controls. The proposed master plan may adversely affect a further sixty-one high category trees and thirty-two low category trees if appropriate protective measures are not taken. However, this report identifies adequate precautions to protect the retained trees as part of any future subsequent Development Application for the site under the proposed planning controls. The assessment of the master plan identifies that the site is appropriate for residential development with regards impact on trees, subject to detailed design and further assessment as part of any future development application.

4. ARBORICULTURAL METHOD STATEMENT

4.1 Introduction

4.1.1 **Terms of reference:** The impact appraisal in Section 3 identified the potential impacts on trees caused by proposed development. Section 4 is an arboricultural method statement setting out management and protection details that must be implemented to secure successful tree retention. It has evolved from Australian Standard AS4970-2009 *Protection of trees on development sites*.

4.1.2 **Plan TMP01:** Plan TMP01 in Appendix 8 is illustrative and based entirely on provided information. This plan should only be used for dealing with the tree issues and all scaled measurements must be checked against the original submission documents. The precise location of all protective measures must be confirmed at the pre-commencement meeting before any demolition or construction activity starts. Its base is the existing land survey, which has the proposed layout superimposed so the two can be easily compared. It shows the existing trees numbered, with high categories (A) highlighted in green triangles and low categories (Z) highlighted in blue rectangles. It also shows the locations of the proposed protective measures.

4.2 Tree protection with fencing and ground protection

4.2.1 **Protection fencing:** Tree protection fencing must comply with AS4970 (section 4.3) recommendations. An illustrative guide is included as Appendix 4. The approximate location of the barriers and the TPZs is illustrated on plan TMP01. The precise location of the fencing must be agreed with the project Arborist before any development activity starts.

4.2.2 **Ground protection:** Any TPZs outside the protective fencing must be covered in ground protection based on AS4970 recommendations until there is no risk of damage from the demolition and construction activity. An illustrative specification for this ground protection is included as Appendix 5. On this site, it must be installed near Tree **126** as illustrated on plan TMP01 before any demolition and construction starts.

4.3 **Precautions when working in TPZs:** Any work in TPZs must be done with care as set out in Appendix 6. On this site, special precautions must be taken near retained trees as illustrated on plan TMP01 and summarised below:

- **Removal of existing surfacing/structures and replacement with new surfacing/structures:** Retained trees may be adversely affected by the demolition and construction works or the installation of new surfacing. Any adverse impact must be minimised by following the guidance set out in Appendix 6.

- **Installation of new soft landscaping:** All landscaping activity within TPZs has the potential to cause severe damage and any adverse impact must be minimised by following the guidance set out in Section 7 of Appendix 6.
- **Installation of new services or upgrading of existing services:** It is often difficult to clearly establish the detail of services until the construction is in progress. Where possible, it is proposed to use the existing services into the site and keep all new services outside TPZs. However, where existing services within TPZs require upgrading or new services have to be installed in TPZs, great care must be taken to minimise any disturbance. Trenchless installation should be the preferred option but if that is not feasible, any excavation must be carried out by hand according to the guidelines set out in Section 6 of Appendix 6. If services do need to be installed within TPZs, consultation must be obtained from the project Arborist and/or council before any works are carried out.

4.4 Other tree related works

4.4.1 **Site storage, cement mixing and washing points:** All site storage areas, cement mixing and washing points for equipment and vehicles must be outside TPZs unless otherwise agreed with the project Arborist and/or council. Where there is a risk of polluted water run off into TPZs, heavy-duty plastic sheeting and sandbags must be used to contain spillages and prevent contamination.

4.4.2 **Pruning:** Any pruning that is required to accommodate hoardings, scaffolding or to accommodate the unloading/loading of vehicles and has been approved by Council shall be carried out by a qualified Arborist (AQF3) and must be in accordance with AS4373 Australian Standards 'Pruning of Amenity Trees'.

4.5 Programme of tree protection and supervision

4.5.1 **Overview:** Tree protection cannot be reliably implemented without arboricultural input. The nature and extent of that input varies according to the complexity of the issues and the resources available on site. For this site, a summary of the level of arboricultural input that is likely to be required is set out in Appendix 7. The project arborist must be instructed to work within this framework to oversee the implementation of the protective measures and management proposals set out in this arboricultural method statement.

The framework in Appendix 7 must form the basis for the discharge of planning conditions through site visits by the project arborist. These supervisory actions must be confirmed by formal letters circulated to all relevant parties. These permanent records of each site visit will accumulate to provide the proof of compliance and allow conditions to be discharged as the development progresses. The developer must instruct the project arborist to comply with the

supervision requirements set out in this document before any work begins on site.

4.5.2 **Phasing of arboricultural input:** Trees can only be properly budgeted for and factored into the developing work programmes if the overall project management takes full account of tree issues once consent is confirmed. The project arborist must be involved in the following phases of the project management:

1. **Administrative preparation before work starts on site:** It is normal for a development proposal to vary considerably from the expectations before consent as the detailed planning of implementation evolves. The early instruction of the project arborist ensures that tree issues are factored into the complexities of site management and can often help ease site pressures through creative approaches to tree protection. Pre-commencement discussions between the project arborist and the developer's team is an effective means of managing the tree issues with difficult constraints.

2. **Pre-commencement site meeting:** A pre-commencement meeting must be held on site before any of the demolition and construction work begins. This must be attended by the site manager and the project arborist. Any clarifications or modifications to the consented details must be recorded and circulated to all parties in writing. This meeting is where the details of the programme of tree protection will be agreed and finalised by all parties, which will then form the basis of any supervision arrangements between the project arborist and the developer.

3. **Site supervision:** Once the site is active, the project arborist must visit at an interval agreed at the pre-commencement site meeting. The supervision arrangement must be sufficiently flexible to allow the supervision of all sensitive works as they occur. The project arborist's initial role is to liaise with developer to ensure that appropriate protective measures are designed and in place before any works start on site. Once the site is working, that role will switch to monitoring compliance with arboricultural conditions and advising on any tree problems that arise or modifications that become necessary.

4.6 **Site management:** It is the developer's responsibility to ensure that the details of this arboricultural method statement and any agreed amendments are known and understood by all site personnel. Copies of the agreed documents must be kept on site at all times and the site manager must brief all personnel who could have an impact on trees on the specific tree protection requirements. This must be a part of the site induction procedures and written into appropriate site management documents.

5. HOW TO USE THIS REPORT

5.1 **Limitations:** It is common that the detail of logistical issues such as site storage and the build programme are not finalised until after consent is issued. As this report has been prepared in advance of consent, some of its content may need to be updated as more detailed information becomes available once the post-consent project management starts. Although this document will remain the primary reference in the event of any disputes, some of its content may be superseded by authorised post-consent amendments.

5.2 **Suggestions for the effective use of this report:** Section 4 of this report, including the relevant appendices, is designed as an enforcement reference. It is constructed so the council can directly reference the detail in a planning condition. Referencing the report by name and relating conditions to specific subsections is an effective means of reducing confusion and facilitating enforcement in the event of problems during implementation. More specifically, the following issues should be directly referenced in the conditions for this site:

1.	Pre-commencement meeting	4.5
2.	Protection fence	4.2.1 and Appendix 4
3.	Ground protection	4.2.2 and Appendix 5
4.	Removal of surfacing/structures	4.3 and Appendix 6 (Section 4)
5.	Installation of surfacing/structures	4.3 and Appendices 6 (Section 5)
6.	Services	4.3 and Appendix 6 (Section 6)
7.	Landscaping	4.3 and Appendix 6 (Section 7)
8.	Programming of tree protection	4.5 and Appendix 7
9.	Arboricultural supervision	4.5 and Appendix 7

Each of the above matters shall be supervised by the project arborist and the relevant conditions can only be discharged once that supervision has been confirmed in writing to the relevant parties. The last column of the table in Appendix 7 is to be used so that the various supervision issues can be recorded as they are confirmed by supervision letters. It is intended to act as a summary quick-reference to help keep track of the progress of the supervision.

6. OTHER CONSIDERATIONS

6.1 **Trees subject to statutory controls:** The subject trees are legally protected under Botany Bay City Council's Tree Preservation Order. It will be necessary to consult the council before any pruning or removal works other than certain exemptions can be carried out. The works specified above are necessary for reasonable management and should be acceptable to the council. However, tree owners should appreciate that the council may take an alternative point of view and have the option to refuse consent.

6.2 **Trees outside the property:** Trees located in the adjacent properties effectively out of the control of the owners of 73-75 Gardeners Road, Eastlakes. It will not be possible to easily carry out the recommended works without the full co-operation of the tree owners. The implications of non-cooperation require legal interpretation and are beyond the scope of this report.

7. BIBLIOGRAPHY

7.1 **List of references:**

Australian Standard AS4373-2007 *Pruning of Amenity Trees.*
Standards Australia.

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International Society ofArboriculture, Savoy, Illinois.

Mattheck, Dr. Claus R., Breloer, Helge (1995) The Body Language of Trees - A Handbook for Failure Analysis;
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Robinson, L (1994) Field Guide to the Native Plants of Sydney
Kangaroo Press, Kenthurst NSW

8. DISCLAIMER

8.1 Limitations on use of this report:

This report is to be utilized in its entirety only. Any written or verbal submission, report or presentation that includes statements taken from the findings, discussions, conclusions or recommendations made in this report, may only be used where the whole of the original report (or a copy) is referenced in, and directly attached to that submission, report or presentation.

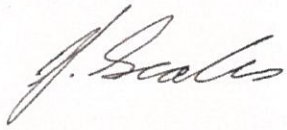
ASSUMPTIONS

Care has been taken to obtain all information from reliable sources. All data has been verified insofar as possible: however, Naturally Trees can neither guarantee nor be responsible for the accuracy of information provided by others.

Unless stated otherwise:

- *Information contained in this report covers only those trees that were examined and reflects the condition of those trees at time of inspection: and*
- *The inspection was limited to visual examination of the subject trees without dissection, excavation, probing or coring. There is no warranty or guarantee, expressed or implied, that problems or deficiencies of the subject trees may not arise in the future.*

Yours sincerely



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APPENDIX 1

Brief qualifications and experience of Andrew Scales

1. **Qualifications:**

Associate Diploma Horticulture	Northern Sydney Institute of TAFE	1995-1998
Certificate in Tree Surgery	Northern Sydney Institute of TAFE	1998
Associate Diploma Arboriculture	Northern Sydney Institute of TAFE	1999-2006

2. **Practical experience:** Being involved in the arboricultural/horticultural industry for in excess of 10 years, I have developed skills and expertise recognized in the industry. Involvement in the construction industry and tertiary studies has provided me with a good knowledge of tree requirements within construction sites.

   As director of Naturally Trees, in this year alone I have undertaken hundreds of arboricultural consultancy projects and have been engaged by a range of clients to undertake tree assessments. I have gained a wide range of practical tree knowledge through tree removal and pruning works.

3. **Continuing professional development:**

Visual Tree Assessment (Prof. Dr. Claus Mattheck)	Northern Sydney Institute of TAFE 2001
Wood Decay in Trees (F.W.M.R.Schwarze)	Northern Sydney Institute of TAFE 2004
Visual Tree Assessment (Prof. Dr. Claus Mattheck)	Carlton Hotel, Parramatta NSW 2004
Tree A-Z / Report Writing (Jeremy Barrell)	Northern Sydney Institute of TAFE 2006
Up by Roots – Healthy Soils and Trees in the Built Environment (James Urban)	The Sebel Parramatta NSW 2008
Tree Injection for Insect Control (Statement of Attainment)	Northern Sydney Institute of TAFE 2008
Quantified Tree Risk Assessment (QTRA) Registered Licensee #1655	South Western Sydney Institute TAFE 2011
Practitioners Guide to Visual Tree Assessment	South Western Sydney Institute TAFE 2011
Quantified Tree Risk Assessment (QTRA) Registered Licensee #1655	Richmond College NSW TAFE 2014
VALID Approach to Likelihood of Failure (David Evans)	Centennial Park NSW 2017

APPENDIX 2
Tree schedule

NOTE: Colour annotation is AA & A trees with green background; Z & ZZ trees with blue background; trees to be removed in red text.

No.	Genus species	Height	Spread	DBH	TPZ	Foliage %	Age class	Defects/Comments	Location	Services	Significance	Tree AZ
1	*Eucalyptus saligna*	30	20	700	**8.4**	80%	M	Nil	Grass	Adjacent building	H	**AA1**
2	*Eucalyptus robusta*	9	10	350	**4.2**	80%	M	Nil	Grass	Nil	M	**A1**
3	*Eucalyptus saligna*	30	20	1000	**12**	80%	M	Nil	Grass	Adjacent building	H	**AA1**
4	*Melaleuca quinquenervia*	12	6	300	**3.6**	70%	M	Nil	Grass	Adjacent structure	M	**A1**
5	*Melaleuca quinquenervia*	12	6	300	**3.6**	70%	M	Nil	Grass	Adjacent structure	M	**A1**
6	*Melaleuca quinquenervia*	20	14	500	**6**	80%	M	Co-dominant (x4 trunk), Growing against building	Garden bed	Adjacent building	H	**Z2**
7	*Melaleuca quinquenervia*	16	12	500	**6**	80%	M	Growing against building	Garden bed	Adjacent building	H	**Z2**
8	*Melaleuca quinquenervia*	18	12	400	**4.8**	80%	M	Nil	Grass	Adjacent driveway	H	**A1**
9	*Melaleuca quinquenervia*	18	14	500	**6**	80%	M	Nil	Grass	Adjacent driveway	H	**A1**
10	*Melaleuca quinquenervia*	14	8	450	**5.4**	80%	M	Nil	Grass	Adjacent structure	M	**A1**
11	*Acacia sp.*	5	7	250	**3**	70%	M	Nil	Grass	Nil	L	**Z1**
12	*Melaleuca quinquenervia*	14	8	450	**5.4**	80%	M	Nil	Grass	Adjacent structure	M	**A1**
13	*Melaleuca quinquenervia*	18	12	500	**6**	80%	M	Nil	Grass	Nil	H	**A1**
14	*Melaleuca quinquenervia*	20	14	500	**6**	80%	M	Nil	Grass	Nil	H	**A1**
15	*Melaleuca quinquenervia*	18	12	500	**6**	80%	M	Nil	Grass	Nil	H	**A1**
16	*Melaleuca quinquenervia*	18	16	1000	**12**	80%	M	Nil	Grass	Nil	H	**A1**
17	*Melaleuca quinquenervia*	20	16	600	**7.2**	80%	M	Nil	Grass	Nil	H	**A1**
18	*Melaleuca quinquenervia*	18	14	600	**7.2**	80%	M	Nil	Grass	Nil	H	**A1**
19	*Melaleuca quinquenervia*	18	14	600	**7.2**	80%	M	Nil	Grass	Nil	H	**A1**
20	*Melaleuca quinquenervia*	18	14	600	**7.2**	80%	M	Nil	Grass	Nil	H	**A1**
21	*Callistemon sp.*	5	5	200	**2.4**	70%	M	Nil	Grass	LV wires	L	**Z1**
22	*Melaleuca quinquenervia*	6	5	300	**3.6**	60%	M	Lopped under wires, Epicormic growth	Grass	LV wires	M	**Z9**
23	*Callistemon sp.*	5	5	200	**2.4**	70%	M	Nil	Grass	LV wires	L	**Z1**
24	*Populus nigra 'Italica'*	14	6	450	**5.4**	60%	O	Borer	Garden bed	Adjacent building	M	**Z4**
25	*Eucalyptus nicholii*	9	6	350	**4.2**	0%	O	Nil	Garden bed	Adjacent building	M	**ZZ4**
26	*Syagrus romanzoffiana*	14	5	350	**4.2**	80%	M	Nil	Garden bed	Nil	M	**Z3**
27	*Eucalyptus botryoides*	9	6	300	**3.6**	80%	S	Nil	Garden bed	Nil	M	**A1**

No.	Genus species	Height	Spread	DBH	TPZ	Foliage %	Age class	Defects/Comments	Location	Services	Significance	Tree AZ
28	*Corymbia citriodora*	14	10	350	4.2	90%	M	Nil	Garden bed	Adjacent building	H	A1
29	*Syagrus romanzoffiana*	14	5	350	4.2	80%	M	Nil	Garden bed	Nil	M	Z3
30	*Syagrus romanzoffiana*	14	5	350	4.2	80%	M	Nil	Garden bed	Nil	M	Z3
31	*Syagrus romanzoffiana*	14	5	350	4.2	80%	M	Nil	Garden bed	Nil	M	Z3
32	*Corymbia citriodora*	16	14	500	6	90%	M	Nil	Garden bed	Adjacent structure	H	A1
33	*Robinia pseudoacacia*	12	14	450	5.4	80%	M	Nil	Garden bed	Adjacent building	M	Z12
34	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Garden bed	Adjacent structure	M	Z3
35	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Garden bed	Adjacent structure	M	Z3
36	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Garden bed	Adjacent structure	M	Z3
37	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Garden bed	Adjacent structure	M	Z3
38	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Garden bed	Adjacent structure	M	Z3
39	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Garden bed	Adjacent structure	M	Z3
40	*Acacia sp.*	5	6	350	4.2	40%	O	Borer, Growing out of retaining wall	Dripline disturbance	Adjacent structure	M	Z4
41	*Melaleuca quinquenervia*	6	6	300	3.6	70%	M	Lopped under wires, Epicormic growth	Grass	LV wires	M	Z9
42	*Corymbia citriodora*	22	16	500	6	80%	M	Nil	Garden bed	Adjacent building	H	A1
43	*Corymbia citriodora*	22	16	500	6	80%	M	Nil	Garden bed	Adjacent building	H	A1
44	*Eucalyptus scoparia*	22	18	700	8.4	80%	M	Nil	Garden bed	Adjacent building	H	A1
45	*Mangifera indica*	6	5	250	3	80%	M	Nil	Garden bed	Adjacent building	L	Z1
46	*Syzygium sp.*	9	8	250	3	90%	S	Pushing over block wall	Garden bed	Adjacent structure	M	Z2
47	*Cupressus sp.*	8	5	200	2.4	90%	M	Nil	Garden bed	Adjacent structure	L	Z12
48	*Pinus radiata*	9	8	400	4.8	50%	O	Failures	Grass	Adjacent structure	M	ZZ4
49	*Casuarina cunninghamiana*	22	14	500	6	80%	M	Nil	Garden bed	Adjacent structure	H	A1
50	*Acacia sp.*	5	6	350	4.2	40%	O	Borer	Dripline disturbance	Adjacent structure	M	Z4
51	*Casuarina cunninghamiana*	18	9	350	4.2	80%	M	Nil	Garden bed	Adjacent structure	M	A1
52	*Casuarina cunninghamiana*	18	9	350	4.2	80%	M	Nil	Garden bed	Adjacent structure	M	A1
53	*Acacia elata*	9	6	300	3.6	50%	O	Borer	Garden bed	Nil	L	ZZ4
54	*Eucalyptus saligna*	14	9	350	4.2	70%	M	Leaning, Hazard beam	Garden bed	Nil	M	Z5
55	*Melaleuca quinquenervia*	10	4	250	3	70%	S	Nil	Garden bed	Nil	L	Z1
56	*Eucalyptus punctata*	14	10	350	4.2	70%	M	Nil	Garden bed	Nil	M	A1
57	*Celtis sinensis*	7	7	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
58	*Eucalyptus scoparia*	10	8	300	3.6	70%	M	Nil	Garden bed	Nil	M	Z9

No.	Genus species	Height	Spread	DBH	TPZ	Foliage %	Age class	Defects/Comments	Location	Services	Significance	Tree AZ
59	*Melaleuca quinquenervia*	14	7	400	4.8	80%	M	Nil	Garden bed	Nil	M	A1
60	*Radermachera sinica*	10	8	350	4.2	80%	M	Nil	Garden bed	Adjacent structure	M	Z10
61	*Callistemon sp.*	5	4	150	2	80%	S	Nil	Grass	Kerb	L	Z1
62	*Callistemon sp.*	5	4	150	2	80%	S	Nil	Grass	Kerb	L	Z1
63	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
64	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
65	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
66	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
67	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
68	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
69	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
70	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
71	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
72	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
73	*Syagrus romanzoffiana*	9	4	250	3	80%	M	Nil	Garden bed	Nil	M	Z3
74	*Syzygium sp.*	10	8	300	3.6	90%	M	Nil	Garden bed	Nil	M	A1
75	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Garden bed	Adjacent structure	M	Z3
76	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Garden bed	Adjacent structure	M	Z3
77	*Lophostemon confertus*	16	10	400	4.8	90%	M	Nil	Garden bed	Nil	H	A1
78	*Lophostemon confertus*	12	8	300	3.6	80%	M	Nil	Garden bed	Nil	M	A1
79	*Syzygium sp.*	16	12	500	6	80%	M	Nil	Garden bed	Nil	H	A1
80	*Stenocarpus sinuatus*	10	7	300	3.6	80%	M	Nil	Garden bed	Nil	M	Z10
81	*Radermachera sinica*	10	8	350	4.2	80%	M	Nil	Garden bed	Adjacent structure	M	Z10
82	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Garden bed	Adjacent structure	M	Z3
83	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Gravel	Adjacent structure	M	Z3
84	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Gravel	Adjacent structure	M	Z3
85	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Gravel	Adjacent structure	M	Z3
86	*Casuarina cunninghamiana*	14	14	500	6	80%	M	Nil	Garden bed	Nil	H	A1
87	*Corymbia citriodora*	18	18	600	7.2	80%	M	Nil	Gravel	Adjacent structure	H	A1
88	*Archontophoenix alexandrae*	5	3	150	2	90%	S	Nil	Garden bed	Nil	L	Z1
89	*Archontophoenix alexandrae*	5	3	150	2	90%	S	Nil	Garden bed	Nil	L	Z1
90	*Archontophoenix alexandrae*	5	3	150	2	90%	S	Nil	Garden bed	Nil	L	Z1
91	*Eucalyptus saligna*	18	16	700	8.4	80%	M	Nil	Garden bed	Nil	H	A1

No.	Genus species	Height	Spread	DBH	TPZ	Foliage %	Age class	Defects/Comments	Location	Services	Significance	Tree AZ
92	*Angophora costata*	10	12	450	5.4	90%	M	Nil	Garden bed	Nil	H	A1
93	*Callistemon sp.*	5	4	150	2	80%	M	Nil	Grass	Nil	L	Z1
94	*Casuarina cunninghamiana*	14	6	350	4.2	80%	M	Nil	Garden bed	Nil	M	A1
95	*Casuarina cunninghamiana*	16	7	300	3.6	80%	M	Nil	Garden bed	Nil	M	A1
96	*Casuarina cunninghamiana*	16	7	300	3.6	80%	M	Nil	Garden bed	Nil	M	A1
97	*Eucalyptus saligna*	24	16	500	6	80%	M	Nil	Garden bed	Nil	H	AA1
98	*Eucalyptus saligna*	24	16	500	6	80%	M	Nil	Garden bed	Nil	H	AA1
99	*Eucalyptus saligna*	10	12	300	3.6	80%	M	Nil	Garden bed	Nil	M	A1
100	*Eucalyptus saligna*	26	20	800	9.6	80%	M	Nil	Garden bed	Nil	H	AA1
101	*Eucalyptus saligna*	24	16	500	6	80%	M	Nil	Garden bed	Nil	H	AA1
102	*Harpephyllum caffrum*	12	10	400	4.8	90%	M	Nil	Garden bed	Nil	M	A1
103	*Harpephyllum caffrum*	12	10	250	3	90%	M	Nil	Garden bed	Nil	M	A1
104	*Harpephyllum caffrum*	12	10	400	4.8	90%	M	Nil	Garden bed	Nil	M	A1
105	*Harpephyllum caffrum*	12	10	400	4.8	90%	M	Nil	Garden bed	Nil	M	A1
106	*Harpephyllum caffrum*	12	10	400	4.8	90%	M	Nil	Garden bed	Nil	M	A1
107	*Harpephyllum caffrum*	12	10	400	4.8	90%	M	Nil	Garden bed	Nil	M	A1
108	*Harpephyllum caffrum*	12	10	400	4.8	90%	M	Nil	Garden bed	Nil	M	A1
109	*Casuarina cunninghamiana*	8	4	300	3.6	60%	M	Lopped under wires, Epicormic growth	Grass	LV wires	L	Z9
110	*Melaleuca quinquenervia*	7	4	300	3.6	70%	M	Lopped under wires, Epicormic growth	Grass	LV wires	L	Z9
111	*Casuarina cunninghamiana*	8	4	300	3.6	60%	M	Lopped under wires, Epicormic growth	Grass	LV wires	L	Z9
112	*Casuarina cunninghamiana*	8	4	300	3.6	60%	M	Lopped under wires, Epicormic growth	Grass	LV wires	L	Z9
113	*Casuarina cunninghamiana*	8	4	300	3.6	60%	M	Lopped under wires, Epicormic growth	Grass	LV wires	L	Z9
114	*Melaleuca quinquenervia*	7	4	300	3.6	70%	M	Lopped under wires, Epicormic growth	Grass	LV wires	L	Z9
115	*Harpephyllum caffrum*	16	14	500	6	70%	O	Failures, Tight growing space	Garden bed	LV wires	M	Z10
116	*Populus nigra 'Italica'*	18	10	900	10.8	30%	O	Failures	Garden bed	Adjacent building	M	ZZ4
117	*Syagrus romanzoffiana*	12	4	300	3.6	80%	M	Nil	Garden bed	Adjacent structure	M	Z3

No.	Genus species	Height	Spread	DBH	TPZ	Foliage %	Age class	Defects/Comments	Location	Services	Significance	Tree AZ
118	*Syagrus romanzoffiana*	12	4	300	**3.6**	80%	M	Nil	Garden bed	Adjacent structure	M	**Z3**
119	*Syagrus romanzoffiana*	12	4	300	**3.6**	80%	M	Nil	Garden bed	Adjacent structure	M	**Z3**
120	*Harpephyllum caffrum*	16	16	600	**7.2**	80%	M	Co-dominant	Garden bed	Nil	H	**A1**
121	*Podocarpus elatus*	18	12	500	**6**	80%	M	Included bark	Garden bed	Nil	M	**A1**
122	*Phoenix canariensis*	8	5	500	**6**	80%	M	Nil	Garden bed	Nil	M	**Z1**
123	*Harpephyllum caffrum*	16	16	600	**7.2**	80%	M	Co-dominant	Garden bed	Nil	H	**A1**
124	*Harpephyllum caffrum*	16	16	600	**7.2**	80%	M	Co-dominant	Garden bed	Nil	H	**A1**
125	*Harpephyllum caffrum*	16	16	600	**7.2**	80%	M	Co-dominant	Garden bed	Nil	H	**A1**
126	*Eucalyptus saligna*	28	20	1000	**12**	80%	M	Nil	Garden bed	Nil	H	**AA1**
127	*Eucalyptus saligna*	26	22	800	**9.6**	80%	M	Co-dominant	Garden bed	Nil	H	**A2**
128	*Eucalyptus saligna*	9	8	300	**3.6**	70%	S	Nil	Garden bed	Adjacent driveway	M	**A1**
129	*Melaleuca quinquenervia*	8	5	250	**3**	80%	M	Nil	Garden bed	Nil	L	**Z1**
130	*Banksia integrifolia*	9	7	300	**3.6**	90%	M	Nil	Grass	Nil	M	**A1**
131	*Casuarina cunninghamiana*	14	12	450	**5.4**	80%	M	Borer, Basal decay, Growing against building	Garden bed	Adjacent building	M	**Z5**
132	*Syagrus romanzoffiana*	12	4	300	**3.6**	80%	M	Nil	Garden bed	Adjacent structure	M	**Z3**
133	*Syagrus romanzoffiana*	12	4	300	**3.6**	80%	M	Nil	Garden bed	Adjacent structure	M	**Z3**
134	*Syagrus romanzoffiana*	12	4	300	**3.6**	80%	M	Nil	Garden bed	Adjacent structure	M	**Z3**
135	*Eucalyptus saligna*	28	18	700	**8.4**	80%	M	Failures	Garden bed	Nil	H	**AA1**
136	*Syagrus romanzoffiana*	12	4	300	**3.6**	80%	M	Nil	Garden bed	Adjacent structure	M	**Z3**
137	*Syagrus romanzoffiana*	12	4	300	**3.6**	80%	M	Nil	Garden bed	Adjacent structure	M	**Z3**
138	*Pinus radiata*	20	18	700	**8.4**	50%	O	Failures	Garden bed	Nil	H	**Z4**
139	*Pinus radiata*	20	18	700	**8.4**	50%	O	Failures	Garden bed	Nil	H	**Z4**
140	*Callistemon sp.*	6	5	200	**2.4**	80%	M	Nil	Garden bed	Nil	L	**Z1**
141	*Persea americana*	9	9	300	**3.6**	80%	M	Nil	Garden bed	Adjacent structure	M	**Z3**
142	*Persea americana*	9	9	300	**3.6**	80%	M	Nil	Garden bed	Adjacent structure	M	**Z3**
143	*Phoenix canariensis*	8	4	400	**4.8**	80%	M	Nil	Garden bed	Nil	M	**Z12**
144	*Phoenix canariensis*	14	6	600	**7.2**	90%	M	Nil	Garden bed	Nil	M	**A1**
145	*Banksia integrifolia*	12	12	450	**5.4**	80%	M	5 x Trees	Grass	Nil	M	**A1**
146	*Melaleuca quinquenervia*	12	8	250	**3**	80%	M	11 x Trees	Grass	Nil	M	**A1**
147	*Banksia integrifolia*	6	5	250	**3**	80%	S	Nil	Grass	Nil	M	**Z1**
148	*Banksia integrifolia*	8	5	300	**3.6**	80%	M	Nil	Grass	Nil	M	**A1**
149	*Eucalyptus saligna*	7	5	200	**2.4**	80%	S	Nil	Grass	Nil	L	**Z1**
150	*Eucalyptus saligna*	7	5	200	**2.4**	80%	S	Nil	Grass	Nil	L	**Z1**
151	*Eucalyptus saligna*	7	5	200	**2.4**	80%	S	Nil	Grass	Nil	L	**Z1**

No.	Genus species	Height	Spread	DBH	TPZ	Foliage %	Age class	Defects/Comments	Location	Services	Significance	Tree AZ
152	*Pinus radiata*	18	16	700	**8.4**	70%	O	Nil	Grass	Nil	H	**Z3**
153	*Pinus radiata*	14	8	500	**6**	70%	O	Borer	Grass	Adjacent structure	M	**Z4**
154	*Eucalyptus botryoides*	14	10	400	**4.8**	90%	M	Nil	Grass	Nil	M	**A1**
155	*Eucalyptus botryoides*	14	10	400	**4.8**	90%	M	Nil	Grass	Nil	M	**A1**
156	*Pinus radiata*	15	8	500	**6**	0%	O	Dead tree	Grass	Nil	M	**ZZ4**
157	*Pinus radiata*	15	8	400	**4.8**	30%	O	Borer	Grass	Nil	M	**Z4**
158	*Acacia saligna*	7	5	200	**2.4**	80%	M	Nil	Garden bed	Nil	L	**Z1**
159	*Angophora costata*	10	5	250	**3**	80%	S	Nil	Garden bed	Nil	L	**A1**
160	*Angophora costata*	10	5	250	**3**	80%	S	Nil	Garden bed	Nil	L	**A1**
161	*Angophora costata*	8	3	150	**2**	80%	S	Nil	Garden bed	Nil	L	**Z1**
162	*Phoenix canariensis*	14	6	600	**7.2**	90%	M	Nil	Garden bed	Nil	M	**A1**
163	*Callistemon sp.*	5	3	150	**2**	80%	M	Nil	Garden bed	Nil	L	**Z1**
164	*Casuarina cunninghamiana*	12	8	300	**3.6**	80%	M	Nil	Grass	Adjacent structure	M	**A1**
165	*Eucalyptus botryoides*	18	14	500	**6**	80%	M	Nil	Garden bed	Kerb	H	**A1**
166	*Eucalyptus botryoides*	18	14	500	**6**	80%	M	Nil	Garden bed	Kerb	H	**A1**
167	*Agonis flexuosa*	6	7	300	**3.6**	50%	O	Co-dominant	Garden bed	LV wires	L	**Z4**
168	*Eucalyptus botryoides*	18	14	500	**6**	80%	M	Cambium damage, Scar on trunk	Garden bed	Kerb	H	**A2**
169	*Acacia sp.*	5	5	200	**2.4**	50%	M	Dieback	Garden bed	Nil	L	**Z1**
170	*Eucalyptus botryoides*	12	12	350	**4.2**	70%	M	Acute lean	Garden bed	Nil	M	**Z9**
171	*Agonis flexuosa*	8	8	400	**4.8**	60%	O	Cavity, Decay	Garden bed	Nil	M	**ZZ5**
172	*Agonis flexuosa*	4	3	150	**2**	60%	O	Cavity	Garden bed	Nil	M	**ZZ9**
173	*Eucalyptus botryoides*	4	5	150	**2**	50%	S	Leaning, Suppressed canopy	Garden bed	Nil	L	**ZZ5**
174	*Eucalyptus ficifolia*	4	4	100	**2**	80%	S	Nil	Garden bed	Nil	L	**Z1**
175	*Casuarina cunninghamiana*	5	3	150	**2**	20%	M	Lopped under power-lines	Grass	LV wires	L	**ZZ5**
176	*Casuarina cunninghamiana*	5	3	150	**2**	20%	M	Lopped under power-lines	Grass	LV wires	L	**ZZ5**
177	*Casuarina cunninghamiana*	5	3	150	**2**	20%	M	Lopped under power-lines	Grass	LV wires	L	**ZZ5**
178	*Casuarina cunninghamiana*	5	3	150	**2**	20%	M	Lopped under power-lines	Grass	LV wires	L	**ZZ5**
179	*Casuarina cunninghamiana*	5	3	150	**2**	20%	M	Lopped under power-lines	Grass	LV wires	L	**ZZ5**
180	*Casuarina cunninghamiana*	5	3	300	**3.6**	20%	M	Lopped under power-lines	Grass	LV wires	L	**ZZ5**

No.	Genus species	Height	Spread	DBH	TPZ	Foliage %	Age class	Defects/Comments	Location	Services	Significance	Tree AZ
181	*Casuarina cunninghamiana*	5	3	300	3.6	20%	M	Lopped under power-lines	Grass	LV wires	L	ZZ5
182	*Casuarina cunninghamiana*	5	3	300	3.6	20%	M	Lopped under power-lines	Grass	LV wires	L	ZZ5

Explanatory Notes

- **Measurements/estimates:** All dimensions are estimates unless otherwise indicated. Measurements taken with a tape or clinometer are indicated with a '*'. Less reliable estimated dimensions are indicated with a '?'.
- **Species:** The species identification is based on visual observations and the botanical name. In some instances, it may be difficult to quickly and accurately identify a particular tree without further detailed investigations. Where there is some doubt of the precise species of tree, it is indicated with a '?' after the name in order to avoid delay in the production of the report. The botanical name is followed by the abbreviation sp if only the genus is known. The species listed for groups and hedges represent the main component and there may be other minor species not listed.
- **Tree number:** relates to the reference number used on site diagram/report.
- **Height:** Height is estimated to the nearest metre.
- **Spread:** The average crown spread is visually estimated to the nearest metre from the outermost tips of the live lateral branches.
- **DBH:** These figures relate to 1.4m above ground level and are recorded in millimetres. If appropriate, diameter is measured with a diameter tape. 'M' indicates trees or shrubs with multiple stems.
- **Foliage Cover:** Percent of estimated live foliage cover for particular species range.
- **Age class:**
  - **Y** Young = recently planted
  - S Semi-mature (<20% of life expectancy)
  - M Mature (20-80% of life expectancy)
  - O Over-mature (>80% of life expectancy)
- **TPZ:** The Tree Protection Zone (TPZ) is the radial offset distance of twelve times the trunk diameter in meters.
- **Tree AZ:** See reference for Tree AZ categories in Appendix 3.
- **Significance:** A tree's significance/value in the landscape takes into account its prominence from a wide range of perspectives. This includes, but is not limited to neighbour hood perspective, local perspective and site perspective. The significance of the subject trees has been categorized into three groups, such as: High, Moderate or Low significance.

APPENDIX 3

TreeAZ Categories (Version 9.02 A+NZ)

Z Category Z: Unimportant trees not worthy of being a material constraint

Local policy exemptions: Trees that are unsuitable for legal protection for local policy reasons including size, proximity and species

Z1	Young or insignificant small trees, i.e. below the local size threshold for legal protection, etc
Z2	Too close to a building, i.e. exempt from legal protection because of proximity, etc
Z3	Species that cannot be protected for other reasons, i.e. scheduled noxious weeds, out of character in a setting of acknowledged importance, etc

High risk of death or failure: Trees that are likely to be removed within 10 years because of acute health issues or severe structural failure

Z4	Dead, dying, diseased or declining
Z5	Severe damage and/or structural defects where a high risk of failure cannot be satisfactorily reduced by reasonable remedial care, i.e. cavities, decay, included bark, wounds, excessive imbalance, overgrown and vulnerable to adverse weather conditions, etc
Z6	Instability, i.e. poor anchorage, increased exposure, etc

Excessive nuisance: Trees that are likely to be removed within 10 years because of unacceptable impact on people

Z7	Excessive, severe and intolerable inconvenience to the extent that a locally recognised court or tribunal would be likely to authorise removal, i.e. dominance, debris, interference, etc
Z8	Excessive, severe and intolerable damage to property to the extent that a locally recognised court or tribunal would be likely to authorise removal, i.e. severe structural damage to surfacing and buildings, etc

Good management: Trees that are likely to be removed within 10 years through responsible management of the tree population

Z9	Severe damage and/or structural defects where a high risk of failure can be temporarily reduced by reasonable remedial care, i.e. cavities, decay, included bark, wounds, excessive imbalance, vulnerable to adverse weather conditions, etc
Z10	Poor condition or location with a low potential for recovery or improvement, i.e. dominated by adjacent trees or buildings, poor architectural framework, etc
Z11	Removal would benefit better adjacent trees, i.e. relieve physical interference, suppression, etc
Z12	Unacceptably expensive to retain, i.e. severe defects requiring excessive levels of maintenance, etc

NOTE: Z trees with a high risk of death/failure (Z4, Z5 & Z6) or causing severe inconvenience (Z7 & Z8) at the time of assessment and need an urgent risk assessment can be designated as ZZ. ZZ trees are likely to be unsuitable for retention and at the bottom of the categorisation hierarchy. In contrast, although Z trees are not worthy of influencing new designs, urgent removal is not essential and they could be retained in the short term, if appropriate.

A Category A: Important trees suitable for retention for more than 10 years and worthy of being a material constraint

A1	No significant defects and could be retained with minimal remedial care
A2	Minor defects that could be addressed by remedial care and/or work to adjacent trees
A3	Special significance for historical, cultural, commemorative or rarity reasons that would warrant extraordinary efforts to retain for more than 10 years
A4	Trees that may be worthy of legal protection for ecological reasons (Advisory requiring specialist assessment)

NOTE: Category A1 trees that are already large and exceptional, or have the potential to become so with minimal maintenance, can be designated as AA at the discretion of the assessor. Although all A and AA trees are sufficiently important to be material constraints, AA trees are at the top of the categorisation hierarchy and should be given the most weight in any selection process.

TreeAZ is designed by Barrell Tree Consultancy (www.treeaz.com/tree_az/)

APPENDIX 4

Tree protection fencing and signs - Illustrative specification

Protective fencing: Protective 1.8m high fencing should be installed at the location illustrated on the Tree Management Plan before any site works start. All uprights should be fixed in position for the duration of the development activity. The fixings must be able to withstand the pressures of everyday site work.

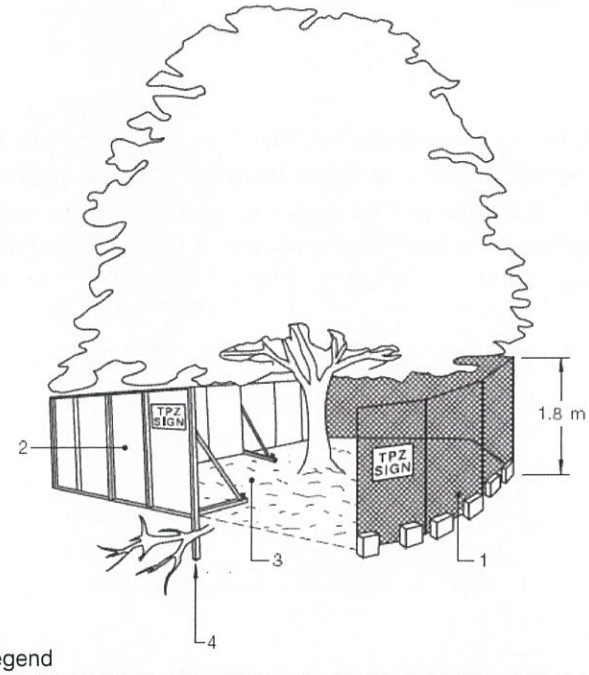
Inside the protective fencing, the following rules must be strictly observed:

- **No vehicular access**
- **No storage of excavated debris, building materials or fuels**
- **No excessive cultivation for landscape planting**
- **No fires**
- **No mixing of cement**
- **No service installation or excavation**

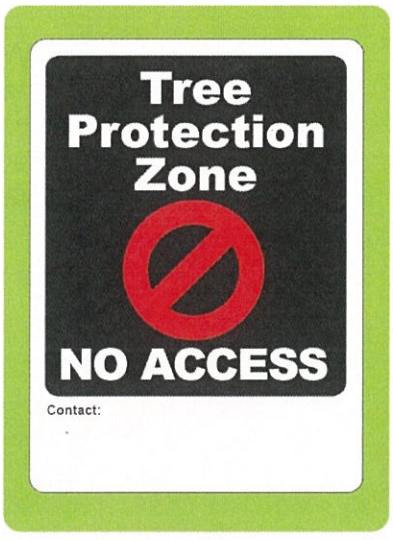
Once erected, protective fencing must not be removed or altered without consulting first with the project Arborist.

Shade cloth or similar should be attached to reduce the transport of dust, other particulate matter and liquids into the protected area and signage must be attached to outside of fencing.

Signage: All signs are to provide clear and readily accessible information to indicate that a TPZ has been established. Signage identifying the TPZ must be attached to outside of fencing and be visible from within the development site.



Signage example:



Legend

1. Chain wire mesh panels with shade cloth (if required) attached, held in place with concrete feet.
2. Alternative plywood or wooden paling fence panels. This fencing material also prevents building materials or soil entering the TPZ.
3. Mulch installation across surface of TPZ (at the discretion of the project arborist). No excavation, construction activity, grade changes, surface treatment or storage of materials of any kind is permitted within the TPZ.
4. Bracing is permissible within the TPZ. Installation of supports should avoid damaging roots.

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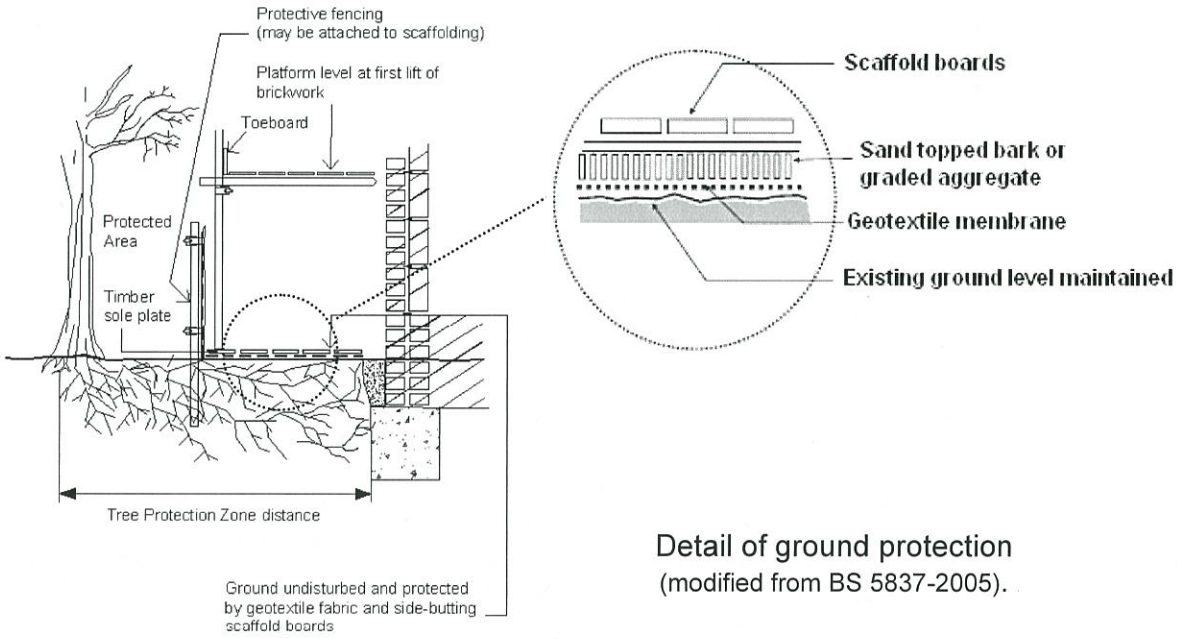
APPENDIX 5

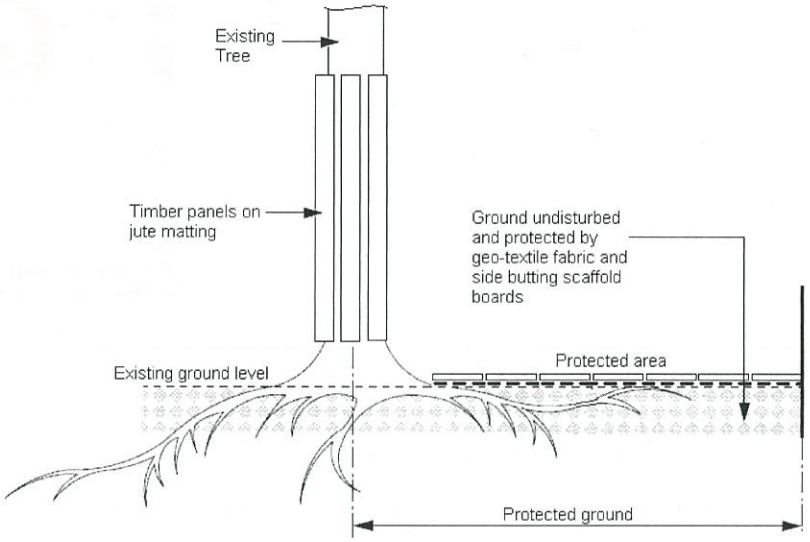
Root zone and trunk protection - Illustrative specification

Root zone protection: Where necessary, access through the TPZ can be achieved by laying aggregate and timber boards (or similar) over the root zone to protect roots. The ground beneath the boarding should be left undisturbed and should be protected with a porous geo-textile fabric covered with sand or mulch.



Detail of ground protection
(modified from BS 5837-2005).

Trunk protection: Where fencing cannot be installed, the vertical trunk of exposed trees shall be protected by the placement of 3.6m lengths of 50 x 100mm hardwood timbers, spaced vertically, at 150mm centres and secured by 2mm wire at 300mm wide spacing over suitable protective padding material e.g. Jute Matting. The trunk protection shall be maintained intact until the completion of all work on site.



Detail of trunk protection.

APPENDIX 6
General guidance for working in TPZ

1 PURPOSE OF THIS GUIDANCE

This guidance sets out the general principles that must be followed when working within a TPZ. Where more detail is required, it will be supplemented by illustrative specifications in other appendices in this document (refer Appendix 4 and 5).

This guidance is based on the Australian Standards (2009) AS4970: *Protection of Trees on Construction Sites*.

Once the site works start, this guidance is specifically for the site personnel to help them understand what has been agreed and explain what is required to fully meet their obligations to protect trees. All personnel working in TPZs must be properly briefed about their responsibilities towards important trees based on this guidance.

This guidance should always be read in conjunction with the Tree Management Plan (TMP01) illustrating the areas where specific precautions are necessary. Each area where precautions are required is explained on the plan as identified on the legend. All protective measures should be installed according to the prevailing site conditions and agreed as satisfactory by the Project Arborist before any demolition or construction work starts.

2 TREE PROTECTION

2.1 Tree Protection Zone (TPZ)

The TPZ is a radial setback, extending outwards from the centre of the trunk, where disturbance must be minimised if important trees are to be successfully retained. The TPZ area is illustrated on the Tree Management Plan (TMP01) accompanying this guidance.

- The TPZ is a radial setback extending outwards from the centre of the trunk equal to the DBH x 12.
- This area shall be protected by tree protective fencing (refer Appendix 4).
- Any part of the TPZ outside of the tree protective fencing area must be isolated from the work operations by protective barriers and/or root zone protection for the duration of the work (refer Appendix 5).
- The Project Arborist shall approve the extent of the TPZ prior to commencement of works.
- The TPZ shall be mulched to a depth of 90mm with approved organic mulch e.g. leaf and wood chip where possible.
- Supplementary watering shall be provided in dry periods to reduce water or construction stress, particularly to those trees which may incur minor root disturbance.

The following activities shall be excluded within the TPZ:

- Excavation, compaction or disturbance of the existing soil.
- The movement or storage of materials, waste or fill.
- Soil level changes
- Disposal/runoff of waste materials and chemicals including paint, solvents, cement slurry, fuel, oil and other toxic liquids
- Movement or storage of plant, machinery, equipment or vehicles.
- Any activity likely to damage the trunk, crown or root system.

2.2 Arboricultural supervision

Any work within TPZs requires a high level of care. Qualified arboricultural supervision is essential to minimise the risk of misunderstanding and misinterpretation. Site personnel must be properly briefed before any work starts. Ongoing work must be inspected regularly and, on completion, the work must be signed off by the Project Arborist to confirm compliance by the contractor.

2.3 Tree protection fencing, root zone and trunk protection

Prior to site establishment, tree protection fencing and root zone and trunk protection shall be installed to establish the TPZ for trees to be retained in accordance with site conditions. These protective barriers shall be maintained entire for the duration of the construction program (refer Appendix 4 and 5).

Tree protection fencing and trunk and root zone protection shall be removed following completion of construction. The mulch layer in the TPZ shall be retained and replenished where required to maintain a 75mm thickness

2.4 Pruning

All pruning work required (including root pruning) should be in accordance with Australian Standard No 4373-1996 - Pruning of Amenity Trees.

2.5 Tree Damage

In the event of damage to a tree or the TPZ, the Project Arborist shall be engaged to inspect and provide advice on remedial action. This should be implemented as soon as practicable and certified by the Project Arborist.

2.6 Post construction maintenance

In the event of any tree deteriorating in health after the construction period, the Project Arborist shall be engaged to provide advice on any remedial action. Remedial action shall be implemented as soon as practicable and certified by the Project Arborist.

3 EXCAVATION AND FILL IN TPZ

3.1 Excavation within TPZ

If excavation within the TPZ is required the following shall be applied to preserve tree root systems:

- Excavation within TPZ must be carried out under the instruction and supervision of the Project Arborist.
- A root mapping exercise is to be undertaken and certified by the Project Arborist. Root mapping shall be undertaken by either ground penetrating radar, air spade, water laser or by hand excavation using hand tools, taking care not to damage the bark and wood of any roots.
- The purpose of the root mapping shall be to locate woody structural roots greater than 40mm in diameter. Where possible, flexible clumps of smaller roots, including fibrous roots, should be retained if they can be displaced temporarily or permanently beyond the excavation without damage.
- If digging by hand, a fork shall be used to loosen the soil and help locate any substantial roots.
- Once roots have been located, the trowel shall be used to clear the soil away from them without damaging the bark.
- Exposed roots to be removed shall be cut cleanly with a sharp saw or secateurs.
- Roots temporarily exposed shall be protected from direct sunlight, drying out and extremes of temperature by appropriate covering.

3.2 Fill within TPZ

Placement of fill material within the Tree Protection Zone of trees to be retained should be avoided where possible. However, where fill cannot be avoided:

- All fill material to be placed within the TPZ should be approved by Project Arborist and consist of a course, gap-graded material to provide aeration and percolation to the root zone. Materials containing a high percentage of 'fines' is unacceptable for this purpose.
- The fill material should be consolidated with a non-vibrating roller to minimise compaction of the underlying soil.
- No fill material should be placed in direct contact with the trunk.

4 DEMOLITION OF SURFACING/STRUCTURES IN TPZ

4.1 Definitions of surfacing and structures

For the purposes of this guidance, the following broad definitions apply:

• **Surfacing:** Any hard surfacing used as a vehicular road, parking or pedestrian path including tarmac, solid stone, crushed stone, compacted aggregate, concrete and timber decking.

• **Structures:** Any man-made structure above or below ground including service pipes, walls, gate piers, buildings and foundations. Typically, this would include drainage structures, services, car-ports, bin stores and concrete slabs that support buildings.

4.2 Demolition and access

Roots frequently grow adjacent to and beneath existing surfacing/structures so great care is needed during access and demolition. Damage can occur through physical disturbance of roots and/or the compaction of soil around them from the weight of machinery or repeated pedestrian passage. This is not generally a problem whilst surfacing/structures are in place because they spread the load on the soil beneath and further protective measures are not normally necessary. However, once they are removed and the soil below is newly exposed, damage to roots becomes an issue and the following guidance must be implemented:

- No vehicular or repeated pedestrian access into TPZ permitted unless on existing hard surfacing or root zone protection.
- Regular vehicular and pedestrian access routes must be protected from compaction with temporary root zone protection as set out in Appendix 5.
- Where a TPZ is exposed by the work, it must be protected as set out in AS4970 until there is no risk of damage from the development activity.

4.3 Removal of surfacing/structures

Removing existing surfacing/structures is a high-risk activity for any adjacent roots and the following guidance must be observed:

- Appropriate tools for manually removing debris may include a pneumatic breaker, crow bar, sledgehammer, pick, mattock, shovel, spade, trowel, fork and wheelbarrow.
- Machines with a long reach may be used if they can work from outside the TPZ or from protected areas within the TPZ.
- Debris to be removed from the TPZ manually must be moved across existing hard surfacing or temporary root zone protection in a way that prevents compaction of soil. Alternatively, it can be lifted out by machines provided this does not disturb the TPZ.
- Great care must be taken throughout these operations not to damage roots.

5 INSTALLATION OF SURFACING/STRUCTURES IN TPZ

5.1 **Basic principles:** New surfacing/structures in a TPZ are potentially damaging to trees because they may disturb the soil and disrupt the existing exchange of water and gases in and out of it. Adverse impact on trees can be reduced by minimising the extent of these changes within the TPZ.

- **Surfacing:** Suitable surfacing should be relatively permeable to allow water and gas movement, load spreading to avoid localised compaction and require little or no excavation to limit direct damage. The actual specification of the surfacing is an engineering issue that needs to be considered in the context of the bearing capacity of the soil, the intended loading and the frequency of loading. The detail of product and specification are beyond the scope of this guidance and must be provided separately by the appropriate specialist.

- **Structures:** Where possible structures are to be constructed above ground level on piled supports and redirecting water to where it is needed. The detailed design and specification of such structures is an engineering issue that should be informed and guided by the Project Arborist. Conventional strip foundations in the TPZ for any significant structure may cause excessive root loss and are unlikely to be acceptable. However, disturbance can be significantly reduced by supporting the above ground part of the structures on small diameter piles/piers or

cast floor slabs set above ground level. The design should be sufficiently flexible to allow the piles to be moved if significant roots are encountered in the preferred locations.

5.2 Establishing the depth of roots

The precise location and depth of roots within the soil is unpredictable and will only be known when careful digging starts on site. Ideally, all new surfacing within a TPZ should be no-dig, i.e. requiring no excavation whatsoever, but this is rarely possible on undulating surfaces.

New surfacing normally requires an evenly graded sub-base layer, which can be made up to any high points with granular, permeable fills such as crushed stone or sharp sand. This sub-base must not be compacted as would happen in conventional surface installation. Some limited excavation is usually necessary to achieve this and need not be damaging to trees if carried out carefully and large roots are not cut.

Tree roots and grass roots rarely occupy the same soil volume at the top of the soil profile, so the removal of a turf layer up to 50mm is unlikely to be damaging to trees. It may be possible to dig to a greater depth depending on local conditions but this would need to be assessed by the Project Arborist.

6 SERVICES IN TPZ

For the purposes of this guidance, services are considered as structures. Excavation to upgrade existing services or to install new services within a TPZ may damage retained trees and should only be chosen as a last resort. In the event that excavation emerges as the preferred option, the decision should be reviewed by the Project Arborist before any work is carried out. If excavation is agreed, all digging should be done carefully and follow the guidance set out in 3.1 above.

7 SOFT LANDSCAPING IN TPZ

For the purposes of this guidance, soft landscaping includes the re-profiling of existing soil levels and covering the soil surface with new plants or an organic covering (mulch). It does not include the installation of solid structures or compacted surfacing.

Soft landscaping activity after construction can be extremely damaging to trees.

No significant excavation or cultivation shall occur within the TPZ (e.g. planting holes). Where new designs require levels to be increased to tie in with new structures or surrounding ground level, good quality and relatively permeable top soil should be used for the fill. It should be firmed into place but not over compacted in preparation for turfing or careful shrub planting.

All areas close to tree trunks should be kept at the original ground level and have a mulched finish rather than grass to reduce the risk of mowing damage.

APPENDIX 7

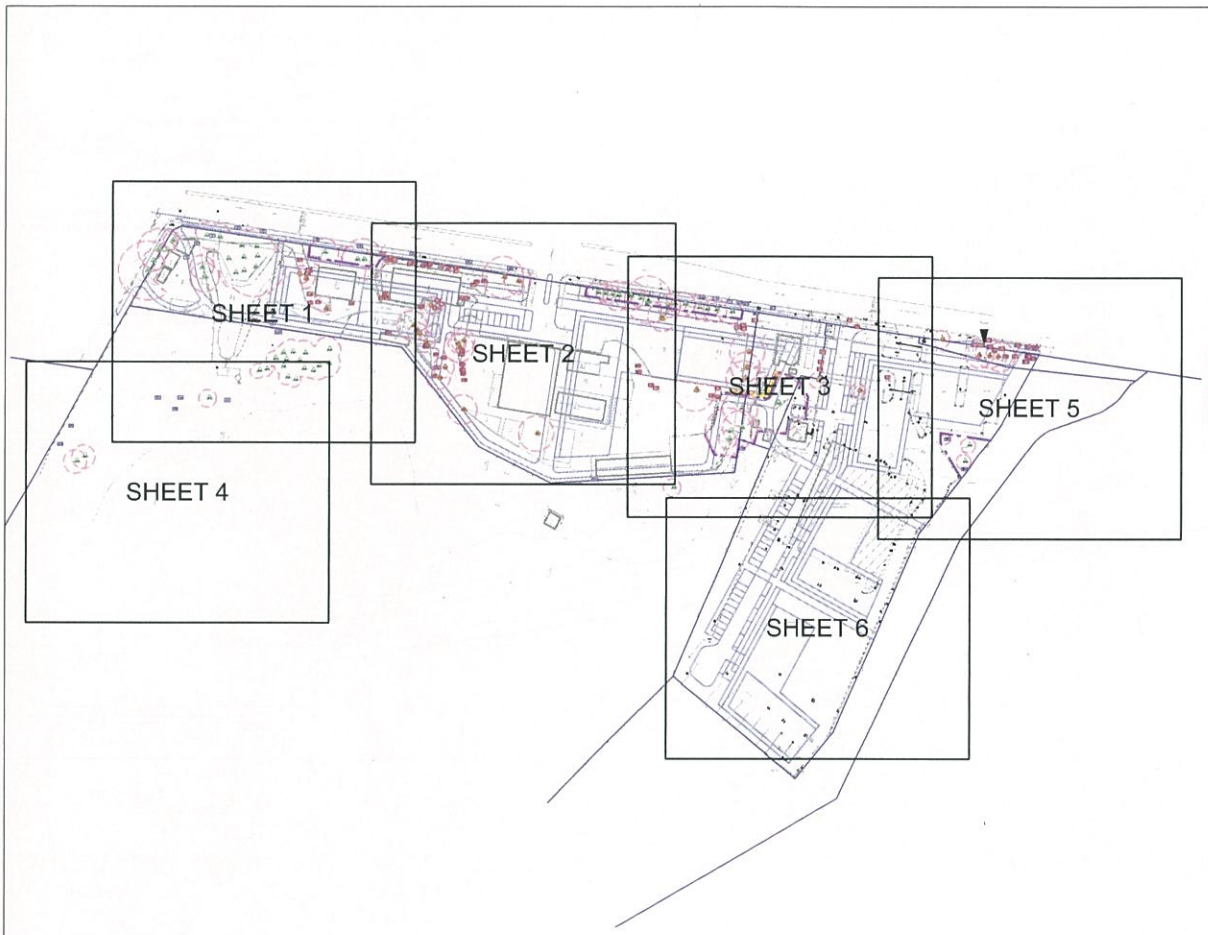
Schedule of works and responsibilities

Hold Point	Task	Responsibility	Certification	Timing of Inspection
1	Indicate clearly (with spray paint) trees approved for removal only	Principal Contractor	Project Arborist	Prior to demolition and site establishment
2	Establishment of tree protection fencing and additional root, trunk and/or branch protection	Principal Contractor	Project Arborist	Prior to demolition and site establishment
3	Supervise all excavations works proposed within the TPZ	Principal Contractor	Project Arborist	As required prior to the works proceeding adjacent to the tree
4	Inspection of trees by Project Arborist	Principal Contractor	Project Arborist	Monthly during construction period
5	Final inspection of trees by Project Arborist	Principal Contractor	Project Arborist	Prior to the issue of Occupation Certificate

APPENDIX 8

Tree management plan

-refer attached Tree Management Plan, Dwg No. TMP01,
by Naturally Trees dated 15 September 2017



LEGEND:

- Category AA — Trees worthy of being a constraint
- Category A — Trees worthy of being a constraint
- Category Z — Trees not worthy of being a constraint
- Category ZZ — Trees not worthy of being a constraint
- Existing layout
- Proposed layout
- Tree protection zone (TPZ) boundaries
- Protective fencing and TPZ area within
- TPZ where ground protection must be installed
- Tree to be removed

N

NOTE: DO NOT SCALE FROM DRAWING. USE FIGURED DIMENSIONS ONLY. CHECK ALL DIMENSIONS ON SITE BEFORE ANY MANUFACTURE OR CONSTRUCTION.

PROJECT: 73-75 Gardeners Road, Eastlakes NSW

CLIENT: Sydney Water

DRAWING: Tree Management Plan

Naturally Trees

DATE: 15/09/17

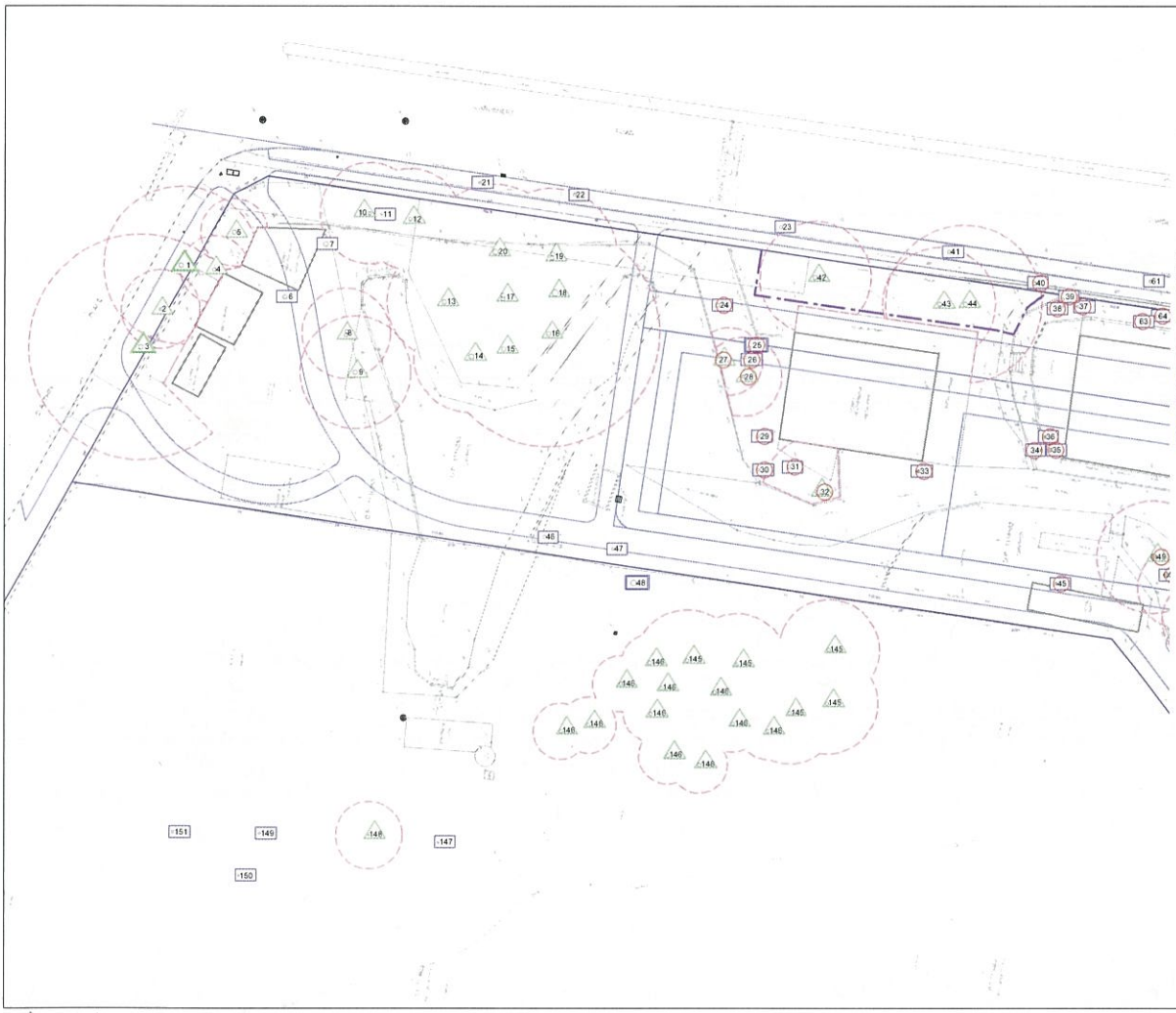
SCALE @ A1: NTS

DRAWN: AS

TMP01

Cover Sheet

Naturally Trees Arboricultural Consulting
PO Box 5886, Elanora Heights NSW 2101 Australia
T: 0417 240 420 W: www.naturallytrees.com.au E: info@naturallytrees.com.au



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PROJECT: 73-75 Gardeners Road, Eastlakes NSW

CLIENT: Sydney Water

DRAWING: Tree Management Plan

Naturally Trees

DATE: 15/09/17

SCALE @ A1: 1:200

DRAWN: AS

TMP01

Sheet 1 of 6

Naturally Trees Arboricultural Consulting
PO Box 5089, Elanora Heights NSW 2101 Australia
T 0417 250 420 W www.naturallytrees.com.au E arb@naturallytrees.com.au

LEGEND:

- Category AA — Trees worthy of being a constraint
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PROJECT: 73-75 Gardeners Road, Eastlakes NSW

CLIENT: Sydney Water

DRAWING: Tree Management Plan

Naturally Trees

DATE: 15/09/17

SCALE @ A1: 1:200

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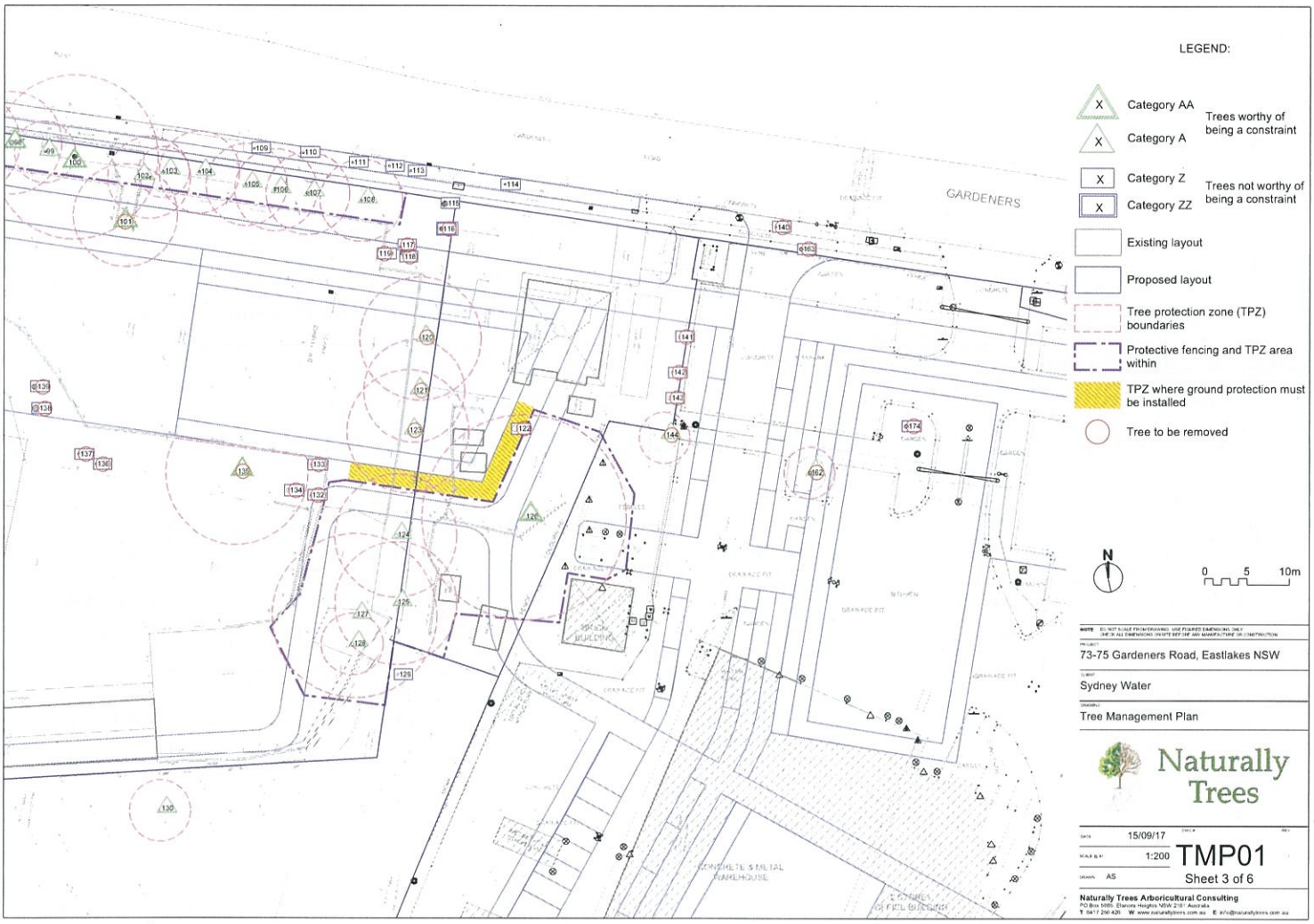
TMP01

Sheet 2 of 6

Naturally Trees Arboricultural Consulting
PO Box 5060, Elanora Heights NSW 2101 Australia
T 0417 250 428 W www.naturallytrees.com.au E info@naturallytrees.com.au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LEGEND:
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Category A
Trees worthy of being a constraint
Category Z
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TPZ where ground protection must be installed
Tree to be removed
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73-75 Gardeners Road, Eastlakes NSW
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Tree Management Plan
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Sheet 3 of 6
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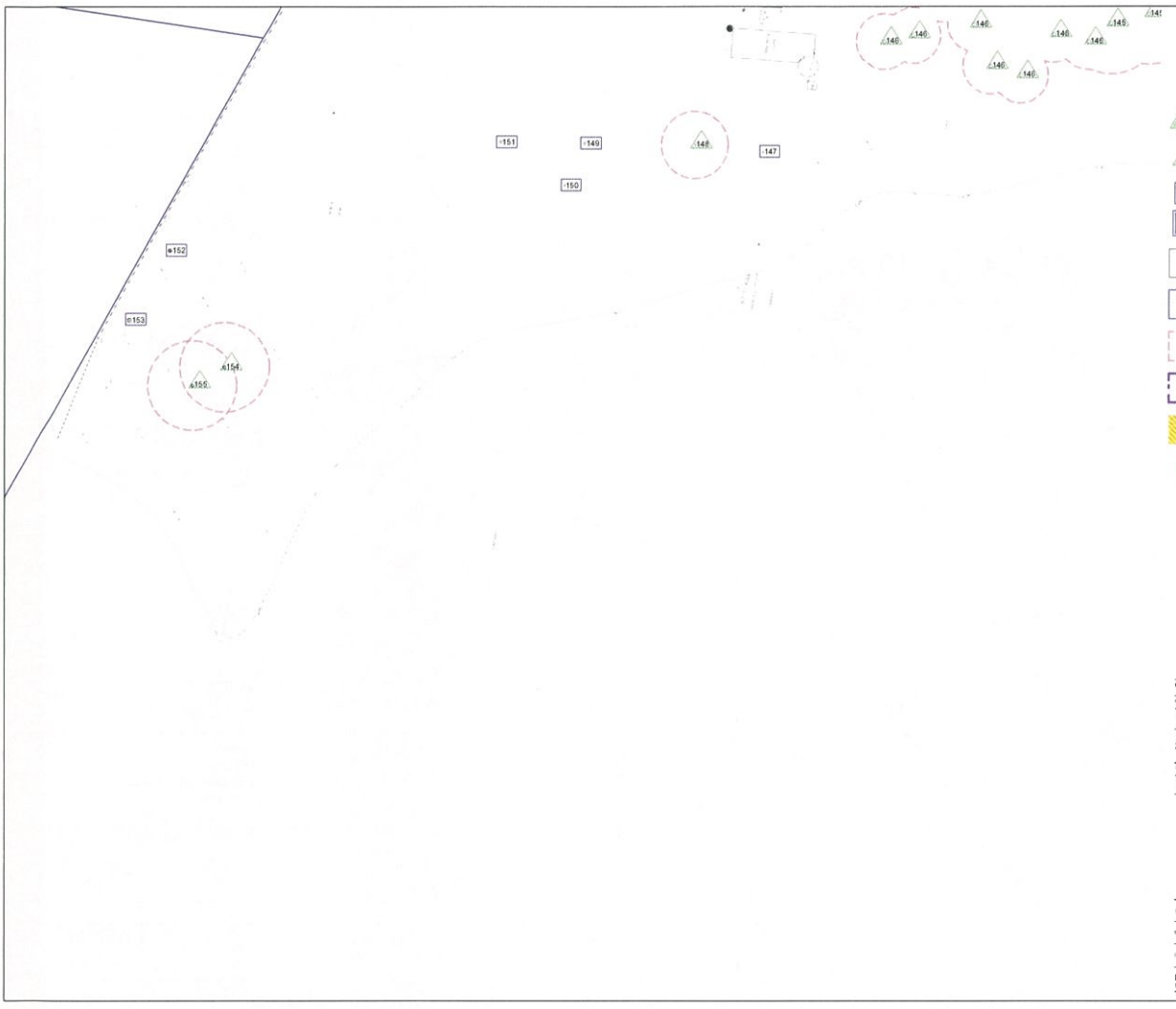
Naturally Trees Arboricultural Consulting



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N

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PROJECT: 73-75 Gardeners Road, Eastlakes NSW

CLIENT: Sydney Water

DRAWING: Tree Management Plan

Naturally Trees

DATE: 15/09/17 DWG #: REV:

SCALE @ A1: 1:200 TMP01

DRAWN: AS Sheet 4 of 6

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GARDENERS
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LEGEND:
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73-75 Gardeners Road, Eastlakes NSW
Sydney Water
Tree Management Plan
Naturally Trees
15/09/17
1:200
TMP01
AS
Sheet 5 of 6
Naturally Trees Arboricultural Consulting

LEGEND:

- Category AA
- Category A

Trees worthy of being a constraint

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PROJECT
73-75 Gardeners Road, Eastlakes NSW

CLIENT
Sydney Water

DRAWING
Tree Management Plan

Naturally Trees

DATE 15/09/17 CHK'D REV

SCALE @ A1 1:200 TMP01

DRAWN AS Sheet 6 of 6

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T 0417 256 420 W www.naturallytrees.com.au E info@naturallytrees.com.au

Attachment L – Geotechnical Assessment 73 Gardeners Road, Prepared by JK Geotechnics, dated July 2017

REPORT

TO
ARCHITECTUS GROUP PTY LTD

ON
GEOTECHNICAL ASSESSMENT

FOR
PLANNING PROPOSAL

AT
73 GARDENERS ROAD, EASTLAKES, NSW

25 September 2017
Ref: 30686ZHrpt Rev1

JK Geotechnics
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Jeffery & Katauskas Pty Ltd, trading as JK Geotechnics ABN 17 003 550 801

Date: 25 September 2017
Report No: 30686ZHrpt
Revision No: 1

Report prepared by:

Adrian Hulskamp
Senior Associate | Geotechnical Engineer

Report reviewed by:

Agi Zenon
Principal | Geotechnical Engineer

For and on behalf of
JK GEOTECHNICS
PO Box 976
NORTH RYDE BC NSW 1670

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1 INTRODUCTION

This report presents the results of a limited scope geotechnical assessment for the proposed development at 73 Gardeners Road, Eastlakes, NSW. A site location plan is presented on the attached Figure 1. The assessment was commissioned by Jane Freeman of Architectus Group Pty Ltd (AG) by signed 'Acceptance of Proposal' form dated 22 June 2017. The commission was on the basis of our proposal (Ref P28577ZH Eastlakes dated 4 May 2017).

To assist with our assessment, we have been supplied with the following information:

1. A survey plan (Drawing No. 118382500 Rev 00, dated 25 May 2017) prepared by Cardno;
2. An unreferenced 'Draft Master Concept' plan prepared by AG dated 6 July 2017. The plan shows two sites, of which 'Site 2' comprises the subject site. 'Site 1' (No. 75 Gardeners Road) bounds the subject site to the west; and
3. Borehole logs (EL01 to EL45 and SS01 and SS02, dated 1 May 2015) and a Sample Location Plan prepared by CH2M Hill. The boreholes were drilled on the neighbouring site ('Site 1') to the west.

The purpose of the geotechnical assessment was to complete a walkover inspection of the site and to map relevant surface features and to review the provided CH2M Hill borehole logs and subsurface information from previous nearby geotechnical investigations carried out by JK Geotechnics. Based on the above, we present our preliminary comments and recommendations to address the likely range of geotechnical issues and constraints for the proposed development.

JK Geotechnics carried out a geotechnical assessment for the neighbouring site ('Site 1') to the west of the subject site and the results were presented in our report (Ref 28577ZTHrpt dated 10 August 2015). We understand that 'Site 1' may also be developed in the future with residential buildings underlain by basements.

2 PROPOSED DEVELOPMENT

We understand that the proposed development is at a 'Draft' Master Plan stage and exact details are currently not available.

The outline of the proposed development site is shown on the attached Figure 2.

We understand that the proposal seeks to rezone the site to allow redevelopment for residential uses at a later stage, following the sites divestment by Sydney Water. This will be subject to a future Development application by others at a later stage. A master plan development has been prepared to inform the proposed planning controls for the site and this is the subject of this report.

Based on our discussions with staff from AG and Sydney Water during the walkover inspection and with reference to the provided unreferenced 'Draft Master Concept' plan, we understand that the development is likely to comprise construction of several residential apartment buildings each up to fourteen storeys high underlain by one, two or possibly even three basement levels. The proposed basement finished floor levels and extents have not been indicated and this is subject to further detailed design and assessment at a later stage.

For the purpose of this report, we have assumed that excavation to a maximum depth of 9m below existing grade will be required for construction of the proposed basements and that the proposed excavations may extend to, or relatively close to, the site boundaries.

We have not been provided with any structural loads, however, we assume that the loads could be in the moderate to high range.

3 ASSESSMENT PROCEDURE

3.1 Walkover Inspection

On 6 July 2017 our Senior Associate level Geotechnical Engineer (Adrian Hulskamp) carried out a walkover inspection of the topographic, surface drainage and geological conditions of the site and its immediate environs. Mapping of the primary geotechnical features identified on, or in close proximity to, the site was carried out and is presented on Figure 2, which is based on the provided survey plan.

Our observations of the western creek bank, as described in Section 4 below, were mostly carried out from within the Lakes Golf Course public car park to the east of the subject site.

Figure 3 presents details of the geotechnical mapping terms and symbols used on Figure 2. Slope angles were measured using a hand held clinometer and the dimensions of features which were accessible were tape measured, otherwise they were estimated. The feature locations shown on Figure 2 are approximate only and, should any of these features be critical to the proposed development, we recommend they be located more accurately using instrument survey techniques.

Specific subsurface investigations, laboratory testing and assessment of potential contamination of the subsurface soils and groundwater were beyond the scope of this assessment.

3.2 Desktop Review of Available Subsurface Information

The walkover inspection was supplemented by a review and search of relevant geotechnical and geological information in our database, as well as a review of the provided CH2M Hill borehole logs.

4 SITE OBSERVATIONS

The following should be read in conjunction with the attached Figure 2.

The site is located within relatively flat to slightly undulating topography. The site is trapezoidal in shape and is approximately 160m to 190m long (north-south) and approximately 65m to 88m wide (east-west). Gardeners Road bounds the site to the north. The site itself is relatively flat.

At the time of the walkover inspection, the site was used by Sydney Water as a maintenance depot. A large concrete and metal warehouse was located towards the middle of the site. The ground floor of the warehouse comprised an on-grade concrete floor slab. A two storey office building adjoined the eastern side of the warehouse building. Both the warehouse and office building appeared to be in good external condition, based on a cursory inspection from within the site. The ground surface surrounding the warehouse and office building was generally covered with concrete and asphaltic concrete pavements, which were in good condition. There were also areas around the perimeter of the site which were covered with grass and garden beds, which contained small to medium sized trees. A small brick 'Pump House' building was located towards the north-western corner of the site and appeared to be in good external condition. A small electrical 'kiosk' was located at the far north-western corner of the site, just off Gardeners Road. The eastern and southern sides of the 'kiosk' platform was supported by an approximate 1m high concrete block retaining wall, which was in good condition.

The Sydney Water 'Dial Before You Dig' plan of the site indicates a 250mm diameter Cast Iron (CI) sewer main passes below the western and central portions of the site. The two maintenance holes within the site had invert depths of either 6m or 6.2m below existing grade. There was also a 250mm diameter sewer rising main which passed below the north-western corner of the site and terminated below the aforementioned brick 'Pump House' building. The plan does not indicate the invert depth of the sewer rising main.

The neighbouring site located off the northern end of the western site boundary (No. 75 Gardeners Road) was mostly vacant, with the exception of a small brick house, which was set back approximately 5m from the common boundary. A detailed description of this neighbouring site was presented in our geotechnical report (Ref 28577ZTHrpt dated 10 August 2015). However, we note though that the former buildings previously described on the neighbouring site to the west had been demolished.

The Lakes Golf Course, which generally comprised vacant areas covered by grass and patchy vegetation, bound the site to the south-west, south and east. In some areas, however, the vegetation was dense, which limited our observations across the common boundaries. A creek ran adjacent to the entire length of the eastern site boundary. There was water estimated to be less than approximately 1m deep in the base of the creek. The western bank of the creek which ranged between approximately 3m and 5m high abutted the eastern boundary of the subject site and generally graded between approximately 15° and 40°. The western creek bank was often obscured by dense vegetation, though where the vegetation was sparse, sandy soils were exposed. Scour and erosion along the toe of the creek banks was evident. The crest of the western creek bank was generally supported by a timber retaining wall to a maximum height of approximately 1m, which in some areas was in poor condition. The timber retaining wall was located just outside the eastern site boundary. Several concrete stormwater pipes daylighted within the western creek bank. Erosion was evident around and below the headwalls of some of the pipe outlets. The toe of the creek bank adjacent to the northern end of the site was supported by a brick retaining wall to a maximum height of approximately 2m and appeared to be in good condition. The creek extended below Gardeners Road to the north through a culvert.

5 ANTICIPATED SUBSURFACE CONDITIONS

The 1:100,000 Geological Map of the Sydney indicates the site is underlain by freshwater swamp, which comprises ‘peat, sandy peat and mud’ but close to the surrounding transgressive dunes, which comprise 'marine' sands of Quaternary age.

Based on the subsurface conditions encountered in the closest CH2M Hill boreholes drilled on the neighbouring site to the west, several previous investigations carried out on nearby sites located within approximately 600m to the east and west of the site and our site observations, we anticipate that the subsurface conditions at the site may comprise the following:

- Sandy fill of variable, but generally limited (less than 1m) thickness.

- The upper subsurface profile may comprise 'soft' soils such as peats and clays as well as sand, though we expect the soils at depth to comprise fine to medium grained sand/silty sand. The density of the sands is expected to increase with depth to at least medium dense and possibly dense and very dense.
- Groundwater could range between less than 2m deep on the eastern side of the site adjacent to the creek to greater than 6m depth on the western side of the site.
- Bedrock is unlikely to be encountered within at least 20m depth, possibly deeper.

6 PRELIMINARY COMMENTS AND RECOMMENDATIONS

6.1 Geotechnical Investigation

Once the architectural drawings are available, we recommend that a site specific geotechnical investigation be completed to assess the subsurface conditions for each proposed building. As a guide, the geotechnical investigations should include, but not be limited to, the following:

- Completion of Cone Penetration Testing (CPT);
- Drilling of boreholes for subsequent laboratory soil testing;
- Completion of groundwater seepage analysis to assess groundwater pumping volumes, suitable embedment depth(s) of the basement shoring systems and the potential groundwater drawdown outside the basement excavations;
- Sampling of the groundwater to assess its quality for disposal purposes; and
- Provide site specific comments and recommendations on geotechnical issues relevant to the proposed development.

We also recommend that a detailed geotechnical assessment be carried out on the western creek bank to the east of the site to assess its stability and provide advice on stabilisation measures, if appropriate.

From experience, we expect the groundwater seepage analysis will be required by Water NSW who will most likely be a consent authority for development on the subject site.

We would be pleased to prepare a proposal for the geotechnical investigations, detailed creek assessment and groundwater seepage analysis at the appropriate time.

6.2 Geotechnical Issues and Constraints

Based on the anticipated subsurface conditions and our experience in this area of Sydney, the likely range of geotechnical issues that will need to be addressed in the design and construction of the proposed development are assessed to be as follows:

Excavation Conditions and Techniques

- Prior to the commencement of excavation, reference should be made to the Safe Work Australia 'Code of Practice – Excavation Work' dated July 2015.

- Council may require a dilapidation survey on the Gardeners Road pavement. Should there be structures present on the neighbouring site to the west at the time of demolition and excavation, then dilapidation surveys should also be carried out on any structures located within 30m of any proposed excavation.

- Prior to the commencement of excavation, we recommend that a detailed services search be carried out across the site. The details should then be plotted onto a survey plan for future reference.

- Where excavation extends below an existing buried service, temporary propping of the buried services may be required, so as to prevent damage to the services as a result of the excavation. Alternatively, the buried service may require diversion, prior to the commencement of, or in association with, excavation.

- A waste classification will need to be assigned to any soil excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), General Solid, Restricted Solid or Hazardous Waste. Analysis takes seven to 10 working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing and associated delays should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

- Following dewatering, where required, bulk excavation to a maximum depth of 9m is expected to encounter soil and may readily be completed using buckets fitted to hydraulic excavators. If there are buildings presented to the west, then we note that sudden stop/start movements of tracked equipment should be avoided, so as to reduce the transmission of ground borne

vibrations which may cause damage to the buildings, boundary walls and paved surfaces. The potential damage may arise from adverse vibrations and/or settlement of the ground due to the vibrations.

Excavation Support

- Where the site geometry permits, and provided the depth of excavation does not exceed 3m, we consider temporary batter slopes through the soil profile feasible above the groundwater level. The temporary batter slopes should be provisionally cut no steeper than 1 Vertical (V) in 1.5 Horizontal (H) subject to geotechnical inspection and provided all surcharge loads are kept well away from the crest of the temporary batters.

- Where the excavation extends to, or close to, the site boundaries or where the excavation depth exceeds 3m, the sides of the excavation will need to be supported by an engineer designed shoring system, which must be installed prior to the commencement of excavation. Suitable shoring systems may comprise secant pile walls, contiguous pile walls, sheet pile walls or cutter soil mixing (CSM) slurry walls. We note that contiguous pile walls will only suitable for excavations above the groundwater table.

- The shoring system must be founded with sufficient embedment below bulk excavation level to satisfy stability, piping and founding considerations. To reduce deflections, the shoring system may need to be anchored and/or braced internally, as excavation proceeds. Careful control of the construction sequence will be required to reduce potential movements.

- For progressively propped or anchored shoring systems, where minor wall movements can be tolerated (for example, adjacent to the Gardeners Road street frontage and provided there are no movement sensitive buried services present), a uniform rectangular earth pressure distribution of 6H (kPa) should be adopted for the soil profile, where H is the retained height. For progressively propped or anchored shoring systems located in areas that are sensitive to lateral movement (for example, walls which are adjacent to movement sensitive buried services or adjacent to existing buildings, such as the brick 'Pump House'), a uniform rectangular earth pressure distribution of 8H (kPa) should be adopted for the soil profile, where H is the retained height. Any surcharge (including construction loads, traffic, inclined backfill surfaces etc.) affecting the walls should be allowed for in the design using an 'at rest' (K_o) earth pressure coefficient of 0.6. A bulk unit weight of 20kN/m^3 should be assumed for the soil profile above the groundwater and 10kN/m^3 for below the groundwater.

- Hydrostatic pressures also need to be considered in the wall design and these are additional to the earth pressure recommendations above. Particular attention needs to be given to the hydrostatic pressures during dewatering as differential water pressures will occur and will have a significant impact on the wall stability and loads.

- If anchors are to extend below a neighbouring property, then permission from the neighbouring property owner must obtained prior to installation.

- The piling contractor may require a working platform, prior to the commencement of piling. The design of such a platform depends on the loading from the piling rig and the platform material used, as well as the subgrade material properties. Therefore, the working platform design cannot be completed until the platform material is selected and a specific piling rig nominated. We can complete a piling rig working platform design at the appropriate time, if requested.

Dewatering

- If groundwater is present within the depth of excavation then in order to maintain a 'dry' excavation during construction, internal dewatering will be required. We expect that dewatering will be carried out using a spear point system or well system.

- If there are buildings present on the neighbouring site to the west, then we forewarn that any uncontrolled lowering of groundwater levels may cause settlement of the nearby structures, unless those structure are fully suspended off piled footings. It will be essential that groundwater levels are adequately monitored during dewatering to reduce the potential for damage to nearby buildings.

- If there are buildings present on the neighbouring site to the west, survey monitoring of the buildings may be warranted to confirm that no untoward settlement of the buildings has occurred as a result of the dewatering.

- Approvals will be required from Water NSW for temporary dewatering.

- We recommend that the dewatering contractor's proposed dewatering methodology be reviewed by the geotechnical engineer, prior to implementation to confirm its suitability.

Footings

- Based on the expected moderate to high column loads, we recommend that the proposed buildings be uniformly supported on either piled footings or a piled raft slab.

- Suitable pile types may include continuous flight auger (cfa) piles or steel (helix) screw piles.

- Steel and concrete durability testing should be carried out.

- Allowable end bearing pressures for pile design will be a function of the pile diameter, founding depths, strength/density of the founding material and presence of groundwater.

Basement Floor Slabs

- Where the proposed basement is located above the groundwater table, then we expect that an on-grade floor slab will be appropriate. The subgrade should be proof rolled with a large static smooth drum roller of at least 10 tonnes deadweight with the final pass carried out under the direction of an experienced geotechnical engineer for the detection of unstable or soft areas. Heaving areas should be locally removed down to a stable base and replaced with engineered fill. Possible alternatives to stripping the full depth of the heaving areas must be provided by the geotechnical engineer during the proof rolling inspection, if appropriate.

- Alternatively, if the proposed basement will be located below the groundwater table, then the basement floor slab will need to be designed as a 'tanked' structure to resist the uplift pressures. Care must be taken with the detailing and construction of the waterproofing at the interface between the floor slab and basement walls, as well as any penetrations through the floor slab.

External Pavements

- For external pavements the subgrade at design subgrade level must be proof rolled as per our comments above. For preliminary design purposes, a subgrade CBR value of 3% is applicable for a clay subgrade and 7% for sand subgrade. The actual design CBR value must be confirmed by laboratory CBR tests on subgrade samples, prior to final design of the pavement.

7 GENERAL COMMENTS

Occasionally, the subsurface conditions may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. As an example, special treatment of soft spots may be required as a result of their discovery during proof-rolling, etc. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

This report provides preliminary advice only on geotechnical aspects for the proposed civil and structural design and is subject to completion of a site specific geotechnical investigation. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of JK Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

AERIAL IMAGE SOURCE: GOOGLE EARTH PRO 7.1.5.1557
AERIAL IMAGE ©: 2015 GOOGLE INC.

This plan should be read in conjunction with the JK Geotechnics report.

Title: **SITE LOCATION PLAN**

Location: 71-73 GARDENERS ROAD
EASTLAKES, NSW

Report No: 30686ZH

Figure No: 1

JK Geotechnics

PLOT DATE: 2 /07/2017 12:29:2: PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\30000'S\30686ZH EASTLAKES\CAD\30686ZH.DWG

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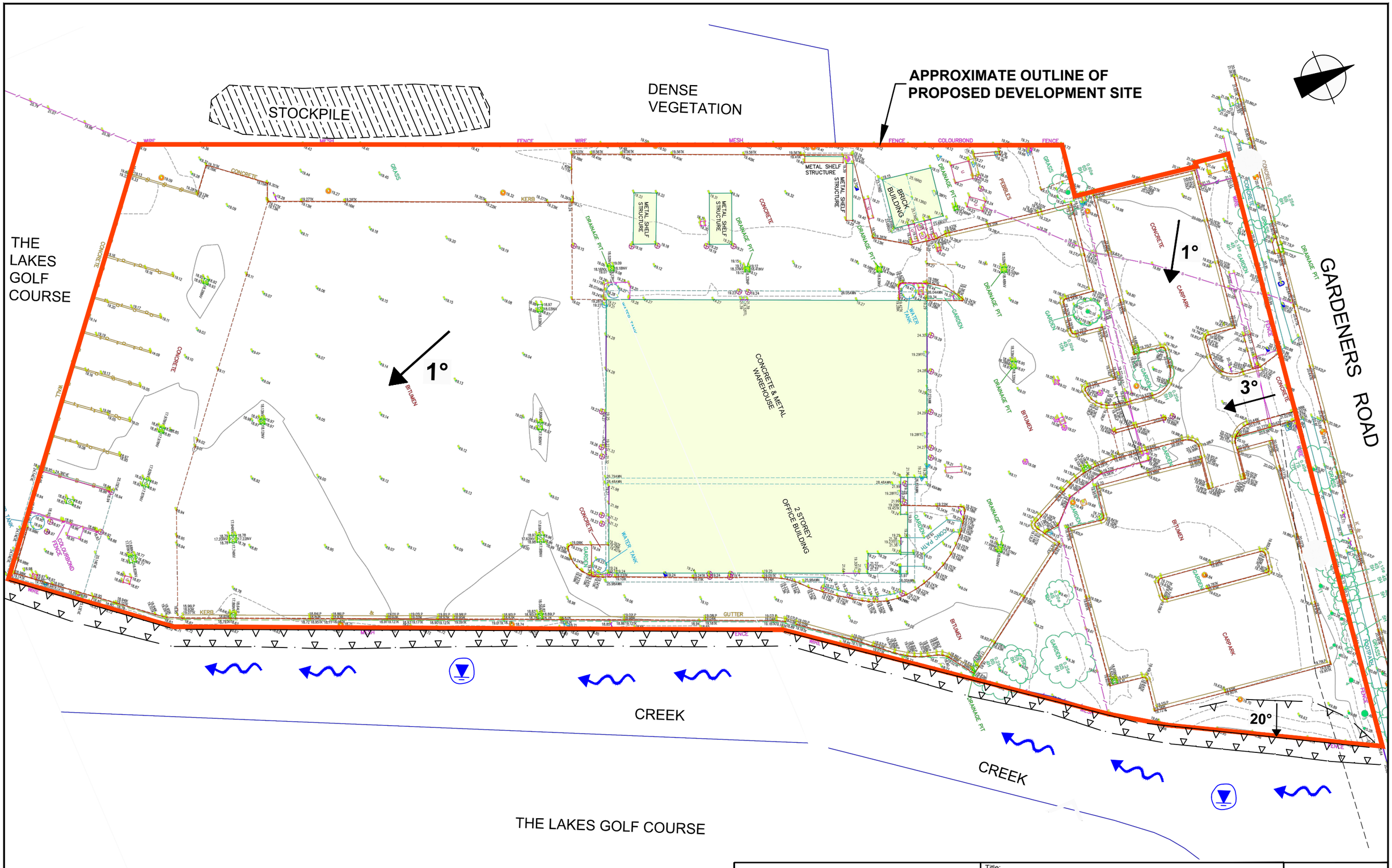

NOTE:
REFER TO FIGURE 3 FOR AN E□PLANATION OF THE GEOTECHNICAL MAPPING S□MBOLS.

0 5 10 15 20 25
SCALE 1:500 □ A3 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title: **GEOTECHNICAL SITE PLAN**

Location: 71-73 GARDENERS ROAD EASTLAKES, NSW

Report No: 30686ZH

Figure No: 2

JK Geotechnics

PLOT DATE: 21/07/2017 3:35:31 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\30000'S\30686ZH EASTLAKES\CAD\30686ZH.DWG

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TOPOGRAPHY

Symbol *Ground Profile*

convex
concave
} well defined or angular break of slope

convex
concave
} poorly defined or smooth change of slope

breaks of slope
changes of slope
} convex and concave too close together to allow the use of separate symbols

sharp
rounded
} ridge crest

3 Cliff or escarpment or sharp break 40° or more (estimated height in metres)

15 Uniform Slope
10 Concave Slope
8 Convex Slope
} Slope direction and angle (Degrees)

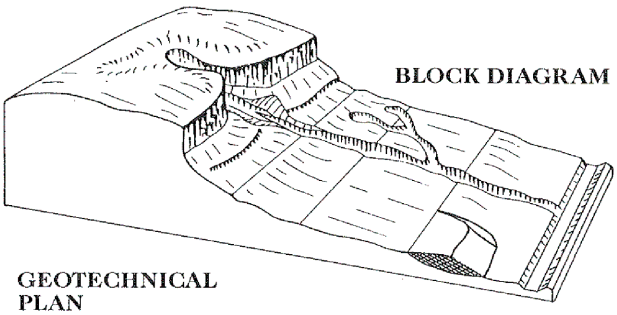
Top
Bottom
} Cut or fill slope, arrows pointing down slope

Hummocky or irregular ground

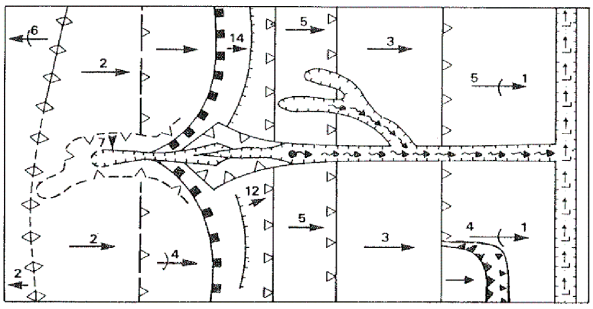
OTHER FEATURES

Boulder
Seepage/spring
Swallow hole for runoff
Natural water course
Open drain, unlined
Open drain, lined
Fenceline
Property boundary
Dry Stone Wall
J —— J 200 Major joint in rock face (opening in millimetres)
– T – T – 10 Tension crack (opening in millimetres)
Masonry or concrete wall
Ponding water
Boggy or swampy area

EXAMPLE OF USE OF TOPOGRAPHIC SYMBOLS:



GEOTECHNICAL PLAN



(After Gardiner, V & Dackombe, R. V. (1983), Geomorphological Field Manual; George Allen & Unwin).

This plan should be read in conjunction with the JK Geotechnics report.

Title:	GEOTECHNICAL MAPPING SYMBOLS
Location:	71-73 GARDENERS ROAD EASTLAKES, NSW
Report No:	30686ZH
Figure No:	3

JK Geotechnics

PLOT DATE: 21/07/2017 2:23:25 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\30000'S\30686ZH EASTLAKES\CAD\30686ZH.DWG

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Attachment M – Geotechnical Assessment 75 Gardeners Road, Prepared by JK Geotechnics, dated May 2015

REPORT

TO
ARCHITECTUS GROUP PTY LTD

ON
GEOTECHNICAL ASSESSMENT

FOR
PROPOSED DEVELOPMENT

AT
75 GARDENERS ROAD, EASTLAKES, NSW

10 August 2015
Ref: 28577ZTHrpt

JK Geotechnics
GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

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dlcs AS/NZS ISO 9001 certified

Date: 10 August 2015
Report No: 28577ZTHrpt
Revision No: 0

Report prepared by:

Adrian Hulskamp
Senior Associate Geotechnical Engineer

Report reviewed by:

Tony Walker
Associate Geotechnical Engineer

For and on behalf of
JK GEOTECHNICS
PO Box 976
NORTH RYDE BC NSW 1670

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b) the limitations defined in the Client's brief to JK;

c) the terms of contract between JK and the Client, including terms limiting the liability of JK.

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1 INTRODUCTION

This report presents the results of a geotechnical assessment for the proposed development at 75 Gardeners Road, Eastlakes, NSW. The assessment was commissioned by Ms Jane Freeman of Architectus Group Pty Ltd by signed 'Acceptance of Proposal' form. The assessment was completed in accordance with our proposal, Ref: 'P40788ZH', dated 2 July 2015.

To assist with our assessment, we have been supplied with the following information:

1. A survey plan (Reference No. 150721, dated 4 August 2015) prepared by Linker Surveying.
2. An unreferenced and undated proposed subdivision plan prepared by Sydney Water.
3. Borehole logs (EL01 to El45 and SS01 and SS02, dated 1 May 2015) and a Sample Location Plan prepared by CH2M.

The purpose of the geotechnical assessment was to complete a walkover inspection to map relevant surface features and to review the supplied CH2M borehole logs and subsurface information from previous geotechnical investigations we have completed on a nearby site. Based on our observations and review of the above subsurface information, we provide our preliminary comments and recommendations on excavation conditions and support, retaining walls, dewatering, footings, basement level on-grade floor slabs and further geotechnical input.

2 PROPOSED DEVELOPMENT

The proposed development is currently at a Master Plan stage, so exact details have not been provided to us. However, the approximate outline of the proposed development site is shown on the attached Figure 1.

Based on our discussions with staff from Architectus Group, we understand that the development is likely to comprise construction of several multi-storey residential apartment buildings underlain by up to two basement car parking levels. The extent and finished floor levels of the proposed basement basements have not been indicated.

For the purpose of this report, we have assumed that excavation to a maximum depth of about 6m below existing grade will be required for construction of the proposed basements and that the excavations may extend to the site boundaries.

We have not been provided with any structural loads, however, we assume that the loads could be in the moderate to high range.

3 ASSESSMENT PROCEDURE

3.1 Walkover Inspection

The geotechnical assessment included a walkover inspection of the topographic, surface drainage and geological conditions of the site and its immediate environs by a Senior Associate Geotechnical Engineer (Adrian Hulskamp) on 20 July 2015. Mapping of the primary geotechnical features identified on site was carried out and is presented on Figure 1, which is based on the supplied survey plan.

Figure 2 presents details of the geotechnical mapping terms and symbols used in Figure 1. Slope angles were measured using a hand held clinometer and the dimensions of features which were accessible were tape measured, otherwise they were estimated. The feature locations shown on Figure 1 are approximate only and, should any of these features be critical to the proposed development, we recommend they be located more accurately using instrument survey techniques.

Specific subsurface investigations, laboratory testing and assessment of potential contamination of the subsurface soils and groundwater were beyond the scope of this assessment.

3.2 Desktop Review of Available Subsurface Information

We have supplemented our walkover inspection by a review and search of relevant geotechnical and geological information in our data-base. We have also been supplied with CH2M borehole logs.

Jeffery and Katauskas (now trading as JK Geotechnics) has completed a previous geotechnical investigation at the nearby Eastlakes Shopping Centre, which is located approximately 400m to the west of the site.

4 SITE DESCRIPTION

The following site description should be read in conjunction with the attached Figure 1.

The site is located within the relatively flat to slightly undulating topography. Gardeners Road and Slattery Place bound the site to the north and west, respectively. The site is approximately 250m long (east-west) and between about 35m and 80m wide (north-south). The Lakes Golf Course which was located to the south was generally covered by grass and patchy vegetation.

At the time of the walkover inspection, the site was occupied by a nursery ('Gardens R Us') business. There were several single storey structures scattered around the site which were generally of timber and weatherboard construction. The ground surface within the site was generally flat to gently sloping. However, just inside the central portion of the southern site boundary, the ground sloped down towards the golf course between about 15° and 20°. This slope appeared to be a sand 'dune' and was generally covered with dense vegetation. The ground surface within the site was often covered with asphaltic concrete (AC) and concrete pavements, but in many areas the ground surface was unsealed. The pavement surfaces were generally in poor condition with numerous cracks and potholes present. Several medium to large trees were scattered across the site, particularly towards the western end of the site.

Several retaining walls were observed, including timber 'Koppers' log walls within the south-eastern and north-western corners of the site. Retained heights were typically up to about 2m. The 'Koppers' log retaining wall at the north-western corner of the site adjacent to the easement was in poor condition, with several timber soldiers and panels leaning over by up to about 20° from the vertical.

The site along the central and eastern ends of the northern site boundary was supported by a concrete crib retaining wall to a maximum height of about 1.6m. The wall appeared to be in good condition, based on a cursory inspection from Gardeners Road. The retained ground surface within the site appeared to have been raised by filling over a width of about 10m back from the crib wall.

Towards the western end of the site there was a gully feature. Along the base of the gully was a drainage easement which contained ponding water. Where the soils were exposed in the base of the easement, the soils had a 'boggy' and 'clayey' appearance. There was no safe access on foot to the base of the gully. At the north-western and north-eastern sides of the easement were concrete headwalls which surrounded reinforced concrete pipes (RCP), which ranged between 450mm and 1200mm diameter. The RCP appeared to drain from below Gardeners Road. The

easement itself appeared to drain towards the golf course to the south. The sides of the easement were supported by low height dilapidated timber 'koppers' log and sandstone block retaining walls.

The neighbouring site to the east was occupied by a single storey brick house. Ground surface levels across the common boundary were similar.

5 ANTICIPATED SUBSURFACE CONDITIONS

The 1:100,000 Geological Map of the Sydney indicates the majority of the site is underlain by transgressive dunes, which comprise 'marine' sands of Quaternary age. However, the map indicates that the western end of the site where the gully feature is present is underlain by freshwater swamp, which comprises 'peat, sandy peat and mud'.

Based on the subsurface conditions encountered in the CH2M boreholes, our previous investigations completed at the nearby Eastlakes Shopping Centre, and our site observations, we anticipate that the subsurface conditions at the site may comprise the following:

- Sandy fill of variable thickness across the site. The CH2M boreholes suggest the fill may be up to about 2m deep. Inclusions such as sandstone gravel and cobbles are present within the fill.
- The natural soils are expected to comprise predominantly fine to medium grained sand and silty sand. The density of the subsurface profile is expected to increase with depth to at least medium dense and possibly dense and very dense.
- At the western end of the site within the gully feature, peat and sandy clay is expected at relatively shallow depth.
- Groundwater is expected between depths of about 1.2m and 8.4m below existing surface levels. Hence groundwater may be at, or very close to, ground surface level within the gully and deepest just behind the crest of the sand 'dune' feature within the central portion of the site.
- Bedrock is unlikely to be encountered at this site within at least 20m depth, possibly deeper.

6 PRELIMINARY COMMENTS AND RECOMMENDATIONS

6.1 Geotechnical Investigation

Once the architectural drawings are available, we recommend that a site specific geotechnical investigation be completed to assess the subsurface conditions. The investigation should include completion of Electrical Friction Cone Penetration (EFCP) tests, as well as boreholes for recovery of samples for subsequent laboratory tests.

EFCP testing involves continuously pushing a testing probe with a conical tip into the soil profile using the hydraulic rams of the EFCP rig. Measurements of the end resistance of the cone tip and the frictional resistance of a separate sleeve located directly behind the cone are made during the testing. We note that EFCP testing does not provide sample recovery. The subsurface material identification, including material strength/density, is by interpretation of the test results using empirical correlations.

We would be happy to prepare a proposal, if requested.

6.2 Geotechnical Issues and Constraints

Based on the anticipated subsurface conditions and our past experience in this, and similar areas, of Sydney, the likely range of geotechnical issues that will need to be addressed in the design and construction of the proposed development are assessed to be as follows:

- The existing buildings, structures and retaining walls will need to be carefully demolished, as there is the potential to damage, de-stabilise and/or remove support from neighbouring buildings, paved surfaces and buried services.

- Council may require a dilapidation survey on the adjoining road pavements. Dilapidation surveys are also recommended for all neighbouring properties if they lie within the zone of influence of the proposed excavations. The zone of influence of the excavations may be defined as a horizontal distance of '2H' from the excavations, where 'H' is the depth of the excavations in metres.

- Prior to the commencement of excavation, we strongly recommend that a detailed services search be carried out across the site. The details should then be plotted onto a survey plan for future reference.

- Reference should be made to Section 7 of this report for guidance on the offsite disposal of soil and groundwater.

- Prior to the commencement of excavation, reference should be made to the Safe Work Australia 'Code of Practice – Excavation Work' dated July 2014.

- Bulk excavations to a maximum assumed depth of 6m will encounter the soil profile and may be readily completed using buckets fitted to hydraulic excavators. We note that sudden stop/start movements of tracked equipment on this site should be avoided, so as to reduce the transmission of ground borne vibrations which may cause damage to neighbouring buildings, boundary walls and nearby paved surfaces. The potential damage may arise from adverse vibrations and/or settlement of the ground, due to the vibrations.

- Following dewatering, if required, and where the site geometry permits, we consider temporary batter slopes through the soil profile feasible. The temporary batter slopes should be cut no steeper than 1 Vertical (V) in 1.5 Horizontal (H), provided all surcharge loads are kept well away from the crest of the temporary batters.

- If the excavations extend to, or close to, the site boundaries, the sides of the excavation will need to be supported by an engineer designed shoring system, which must be installed prior to the commencement of excavation. Suitable systems may comprise secant pile retaining walls, contiguous pile retaining walls, steel sheet pile retaining walls or cutter soil mixing (CSM) slurry walls. We note that contiguous pile walls will only suitable for excavations above the groundwater table.

- The shoring system piles must be founded with sufficient embedment below bulk excavation level to satisfy stability and founding considerations and will need be installed prior to the commencement of excavation. To reduce deflections, the shoring system will need to be anchored and/or braced internally, as excavation proceeds. Careful control of the construction sequence will be required to reduce potential movements.

- If ground anchors are to extend below neighbouring properties, then permission from neighbouring property owners must obtained prior to installation.

- Dewatering will be required where the excavations extend below the groundwater table. Due to the expected relatively high permeability of the natural sand profile, it is likely that dewatering could be carried out using a spear point system or well system.

- The proposed basements are expected be relatively large in plan area. Discharge from the drainage system could be significant and therefore a dewatering license may need to be obtained from the relevant authorities, such as the DPI Water, to allow temporary dewatering and discharge. Limits are imposed on the amount of discharge allowed and analysis of the likely discharge volume is expected as part of the approval process. This will require the installation of standpipes to monitor groundwater levels and infiltration testing to assess the permeability of the subsoil profile. Based on those results, the groundwater inflow into the basements may be estimated. If the permissible limit for permanent discharge cannot be met, tanked basements would be required, such that the basement walls and slab are designed to resist hydrostatic uplift forces. A groundwater investigation and seepage analysis would be required to assess the permeability of the subsoil profile and to estimate likely discharge volumes. Such investigation can only be completed once the plan extent and depth of the basements are known.

- Based on the expected moderate to high column loads, we recommend that the proposed buildings be uniformly supported on piled footings. Due to the presence of groundwater and sandy subsoils, suitable pile types would include continuous flight auger (CFA) piles or steel (helix) screw piles. If steel screw piles are used, consideration must be given to potential long-term corrosion. Allowable end bearing pressures for pile design will be a function of the pile diameter, founding depths, density of the founding material and presence of groundwater.

- We expect that in most areas of the site, the basement floor slabs may be constructed as a slab-on-grade. However, if a basement is proposed close to the gully, the basement floor slabs may need to be designed as suspended due to the expected presence of weak and compressible soils, such as peat and 'soft' clay. Where a slab-on-grade is proposed, we recommend that the subgrade be proof rolled with a large static roller. The final pass of proof rolling should be carried out under the direction of an experienced geotechnical engineer for the detection of unstable or soft areas. Heaving areas should be locally removed down to a stable base and replaced with engineered fill. Possible alternatives to stripping the full depth of the heaving areas must be provided by the geotechnical engineer during the proof rolling inspection, if appropriate. For tanked basements, proof rolling of the subgrade may not be necessary as the uplift forces will control the slab design.

- For external pavements, the subgrade must be proof rolled, as per our comments in the paragraph above. For preliminary design purposes, a subgrade CBR value of 3% is applicable for clayey subgrade and 7% for sandy subgrade. The actual design CBR value must be confirmed by laboratory CBR tests on the subgrade.

- Suitable materials for use as engineered fill comprise well graded granular materials such as crushed sandstone. Alternatively, excavated sandy soils may be suitable for reuse as engineered fill provided they are free of organic matter and do not contain particle sizes greater than 75mm. Compaction should be carried out in maximum 200mm thick loose layers to a density ratio of at least 98% of Standard Maximum Dry Density (SMDD) or an I_D of 75%, whichever is appropriate.

- The piling contractor is likely to require a working platform, prior to the commencement of piling works. The design of such a platform depends on the loading from the piling rig, the track width, the material used for the platform, as well as the subgrade material properties. As such design of the working platform cannot be completed until the platform material is selected and a specific piling rig nominated. The effects of excavations for construction of the working platform on the shoring system and dewatering must be given due consideration.

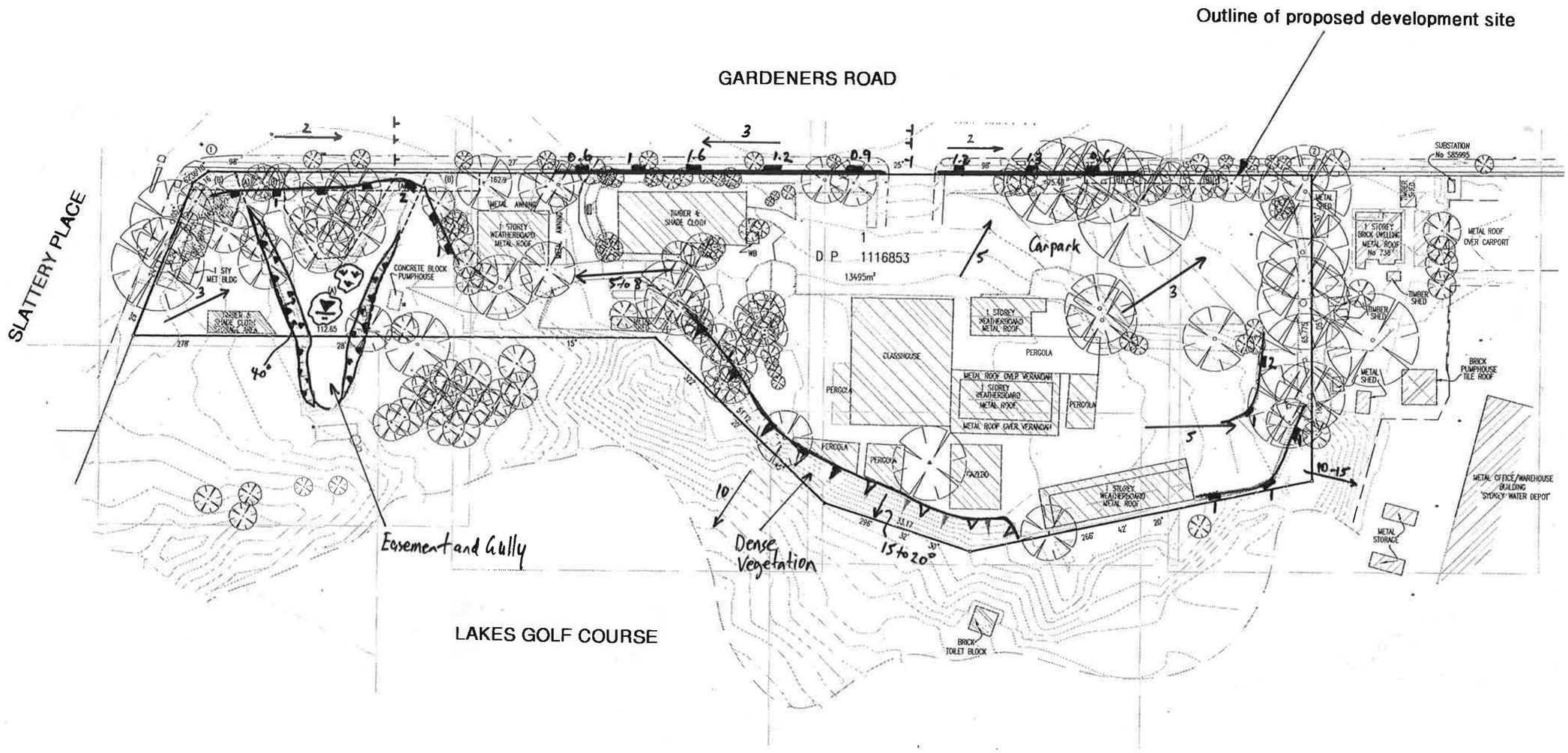
- We note the presence of the easement at the western end of the site. Further advice must be obtained from either a civil or hydraulic engineer with respect to construction either within, or immediately adjacent to, the easement.

7 GENERAL COMMENTS

Occasionally, the subsurface conditions may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

A waste classification will need to be assigned to any soil excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), General Solid, Restricted Solid or Hazardous Waste. If the natural soil has been stockpiled, classification of this soil as Excavated Natural Material (ENM) can also be undertaken, if requested. However, the criteria for ENM are more stringent and the cost associated with attempting to meet these criteria may be significant. Analysis takes seven to 10 working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of JK Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.



SCALE (m)

0 50

Notes:

1. **To be read in conjunction with the text of the report.**
2. **Refer to Figure 2 for explanation of the geotechnical mapping symbols used.**

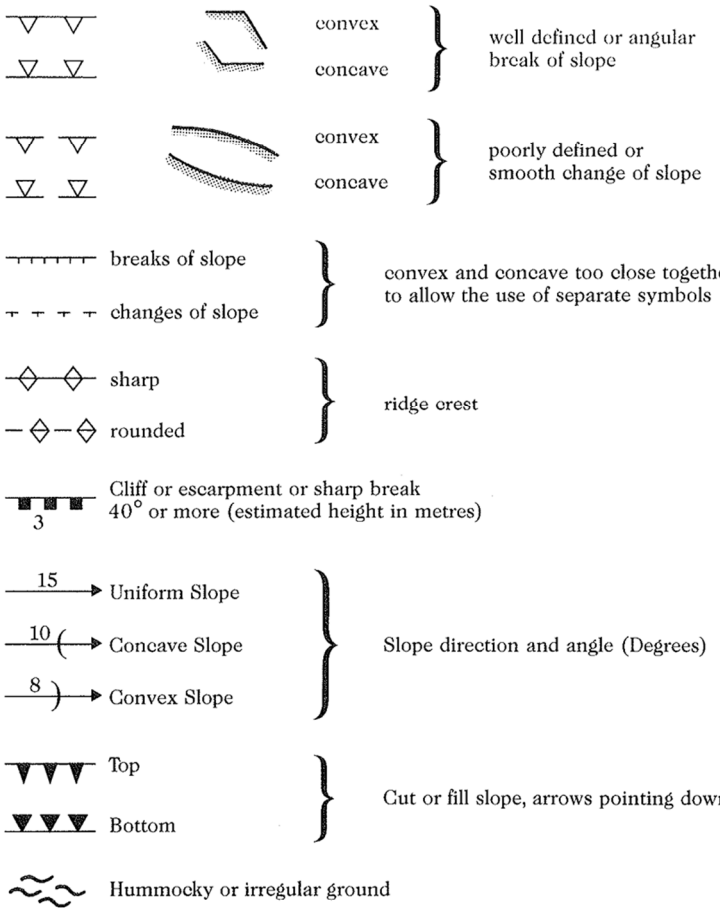
GEOTECHNICAL SITE PLAN

JK Geotechnics
GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

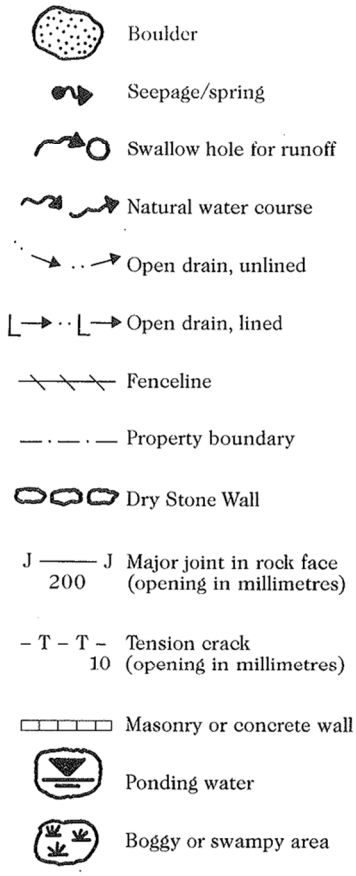
Report No 28577ZH Figure No. 1

TOPOGRAPHY

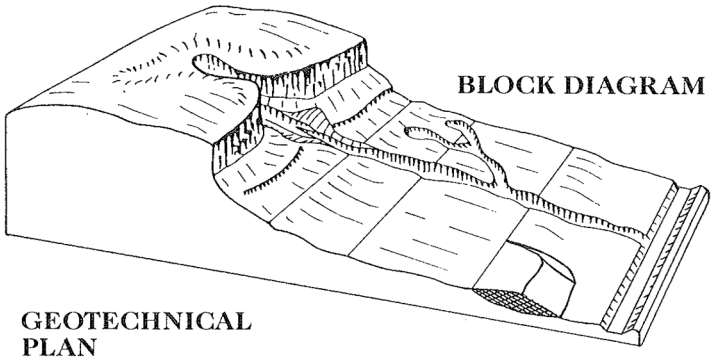
Symbol *Ground Profile*



OTHER FEATURES

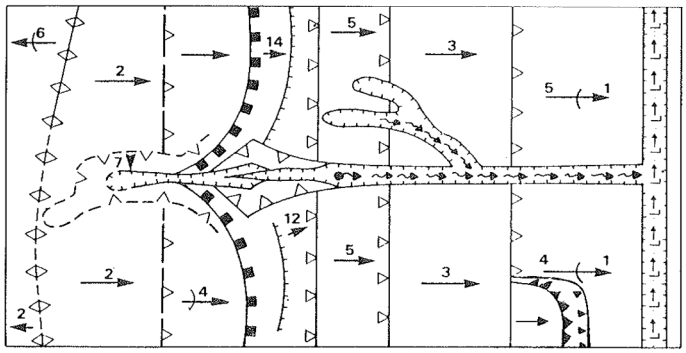


EXAMPLE OF USE OF TOPOGRAPHIC SYMBOLS:



BLOCK DIAGRAM

GEOTECHNICAL PLAN



(After Gardiner, V & Dackombe, R.V. (1983), Geomorphological Field Manual; George Allen & Unwin).

GEOTECHNICAL MAPPING SYMBOLS

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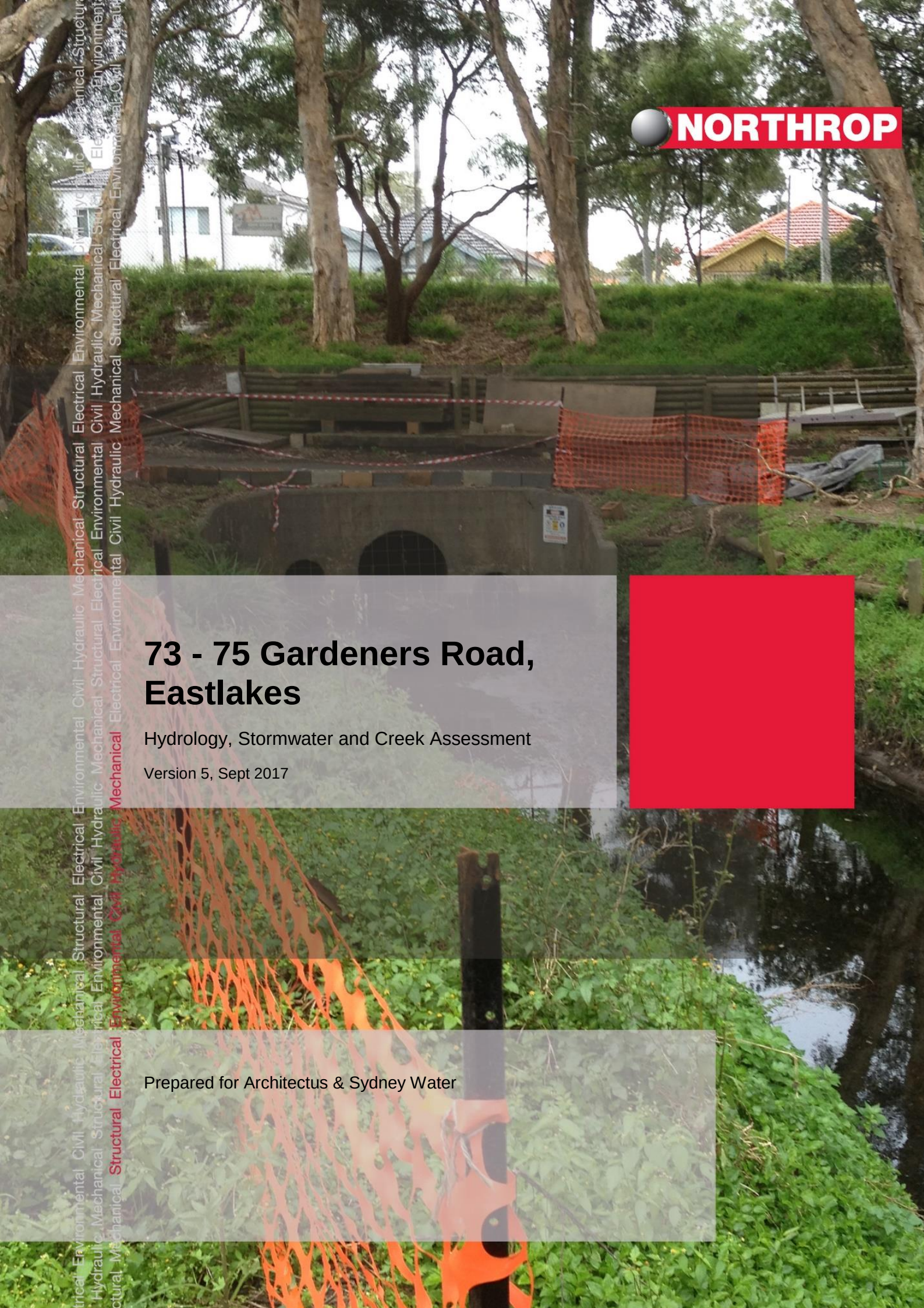
GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

Report No. 28577ZH Figure No. 2

COPYRIGHT

Attachment N – Hydrology, Stromwater and Creek Assessment 73-75 Gardeners Road, Prepared by Northrop Consulting, dated September 2017



NORTHROP

73 - 75 Gardeners Road, Eastlakes

Hydrology, Stormwater and Creek Assessment

Version 5, Sept 2017

Prepared for Architectus & Sydney Water

1. INTRODUCTION

Sydney Water engaged Architectus to prepare a Master Plan for land at 73 and 75 Gardeners Road, Eastlakes for the purposes of informing a Planning Proposal which seeks to amend the current planning controls for the site to allow residential development and supporting land uses.

Sydney Water are in the process of divesting surplus land to allow re-development and improved utilisation of this land within the Sydney Metropolitan area.

In order to test and demonstrate the suitability of the site for the proposed land uses, a Master Plan has been prepared by Architectus and considered by Northrop Consulting Engineers. This master plan identifies that the site should be developed for residential with supporting land uses such as small scale shops, retail or similar uses. The proposal will enable the future re-development of both sites resulting in approximately 744 units, 1,417 parking spaces and a range of building heights between 6-14 storeys. No approval is sought for the Master Plan at this stage as it simply seeks to evidence that the proposed changes to the planning controls are appropriate.

The proposed Master Plan is shown in *Figure 1* below.

Figure 1: Proposed Site Layout

Any future development of the site will be subject to future development applications lodged with Council. Our review of the Master Plan has identified that the site is suitable for the proposed land uses as residential and supporting commercial / retail land uses.

The investigations for this Stormwater Report primarily focused on the following objectives:

- Outline existing site hydrology
- Outline existing flooding constraints
- Identify existing stormwater infrastructure within the vicinity of the proposed site.
- Identify upgrade works and options to existing stormwater infrastructure as part of the proposed development
- Identify risk and engineering challenges associated with the proposed development and outline recommendations.

2. EXISTING SITE CONDITIONS

2.1. Site Description

The project extents incorporates Site 1 located at 75 Gardeners Road and Site 2 located at 73 Gardeners Road, Eastlakes, NSW. The sites are situated within The Botany Council Local Government Area (LGA). The total site area is approximately 2.7 Ha or 27,000m^2.

The site is bounded by Gardeners Road and residential areas to the north and Eastlakes Golf Club to the immediate south, which drains to Botany Wetlands. The site is bounded by Sydney Water Drainage assets along the eastern and western extents.

Figure 2: Existing Site Conditions

Along the western extent of site 1 at 75 Gardeners Road, two Sydney Water stormwater pipes drain into open channels that intersect the site in a north-south alignment. Immediately downstream of the site the open channels converge and enter back into closed culvert and a Gross Pollutant Trap (GPT) - Rocla CDS unit. Ultimately this flow discharges *via* a pipe into the chain of ponds within the golf course.

The existing depot site at 73 Gardeners Roads is mostly impervious and drains *via* multiple stormwater outlets directly into an existing Sydney Water channel which drains along the eastern boundary of the site. The stormwater channel also drains into the larger pond system within the golf course.

3. CATCHMENT CONTEXT

3.1. Upstream Catchment

The upstream stormwater catchments draining to the existing stormwater channels bounding the site are shown in Figure 3, and have the following characteristics:

- Urban Residential catchment
- Relatively flat topography grading gradually to the south.
- Gardeners Road represents a mounded barrier to flow by rising above the surrounding streets.
- Stormwater pipes drain beneath Gardeners Road and into the site at 75 Gardeners Road.
- Drainage infrastructure generally in poor condition

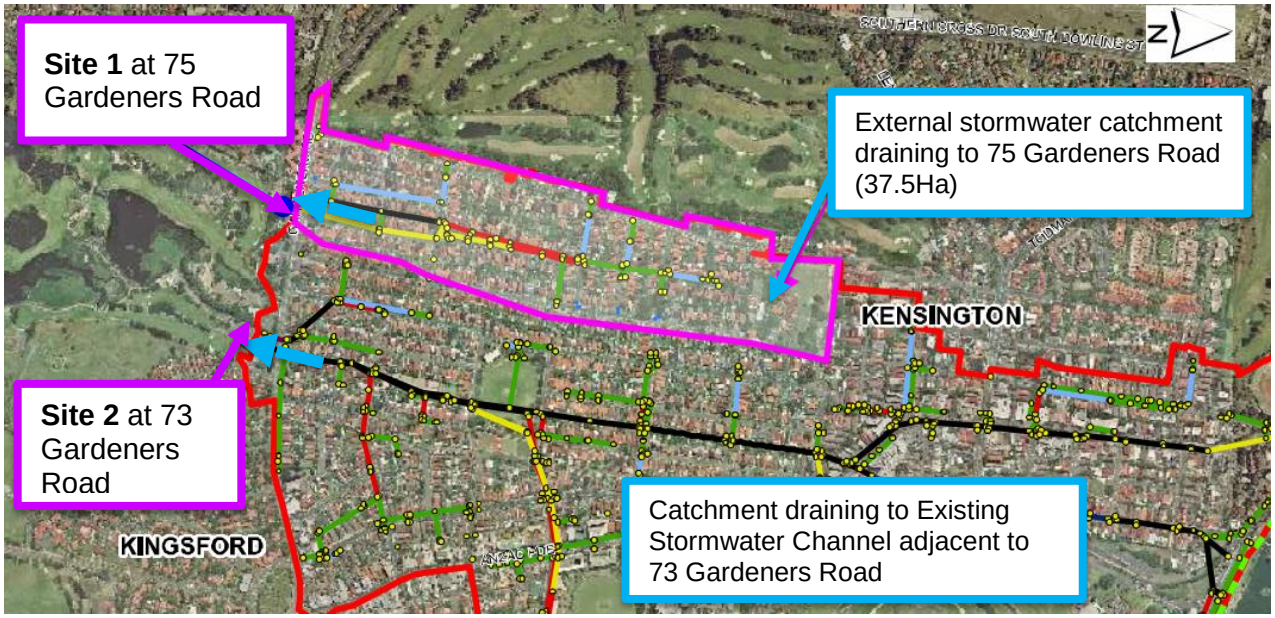


Figure 3: Upstream catchment

Civil Hydraulic Mechanical Structural Electrical Environmental

3.2. Site Catchments

The existing site at 75 Gardeners Road has four distinct drainage sub catchments as shown in Figure 4. Drainage to the southeast is not clearly defined and Sydney Water have advised of the presence of a 600mm Stormwater pipe in this area, however, it was not picked up in the site survey.

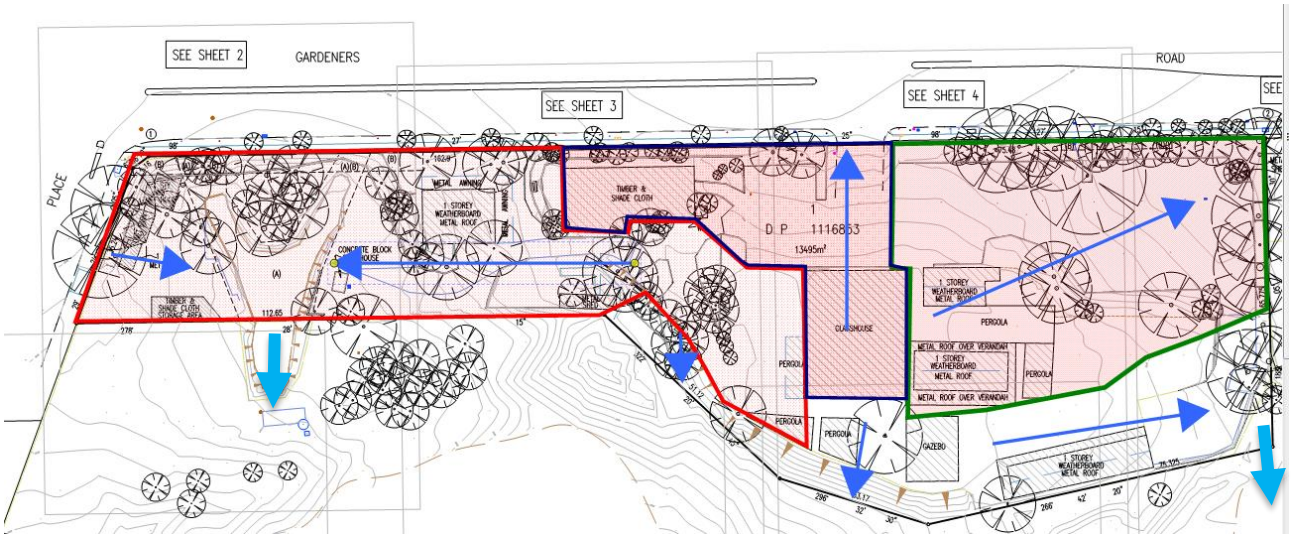


Figure 4: Approximate site sub catchments plan (75 Gardeners Road)

The existing site at 73 Gardeners Road has four distinct drainage sub catchments as shown in Figure 5. The site is drained *via* piped stormwater outlets to the existing Sydney water channel that drains along the eastern boundary of the site.

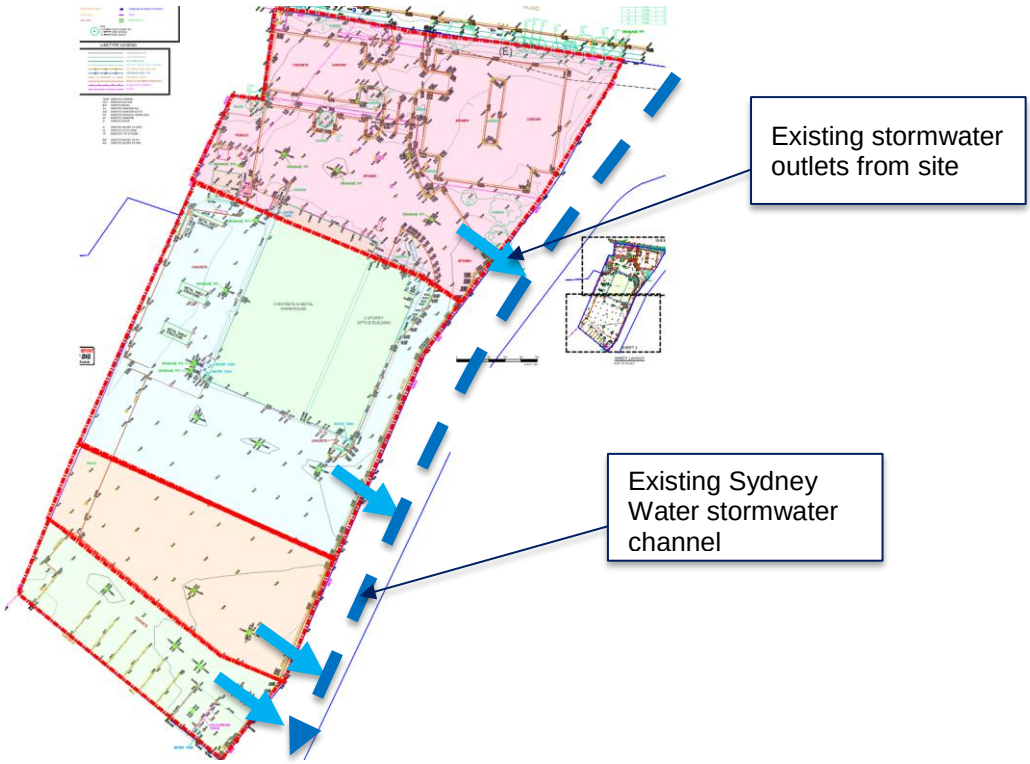


Figure 5: Approximate site sub catchments plan (73 Gardeners Road)

3.3. Downstream Catchment

Downstream of the site has the following characteristics:

- Open channels drain into Eastlakes Golf Course
- Site sits at northern extent of Botany Wetlands (with an adopted Plan of Management, PoM)
- Site sits on land called Botany Water Reserve
- Significance of Botany Wetlands
  - Largest coastal freshwater wetland system in the Sydney region
  - Important wildlife habitats for EECs and migratory water birds
  - Listed on State Heritage Register and Directory of Important wetlands in Australia
  - Subject to State and Commonwealth legislation
  - Important function is stormwater conveyance and flood storage
  - Relevant PoM Targets:
    - Maintain and enhance water quality – GPT performance, SIGNAL macroinvertebrate scores
    - Manage infrastructure in good working order
  - Relevant PoM Action:
    - Repair/Replace defective GPT

4. SYDNEY WATER ASSETS

Sydney Water's asset database details for the site are shown in Figures 6 and 7 below. Note the following characteristics, with numbers representing the items shown and described below:

- Two 1,200mm diameter concrete pipes enter the site from Gardeners Road (1)
- These two pipes discharge into two open channels, which then merge into one channel, before entering a 1,300x1,300mm culvert (2)
- A third 1,200mm concrete Stormwater pipe joins the culvert at the CDS-style GPT. Sydney Water state that the GPT is problematic and not particularly effective at trapping pollutants because it is on a shallow grade and there is no hydraulic head driving the flow through to make it effective. Therefore it is in bypass for much of the time. (3)
- A fourth pipe enters the site from Slattery Place but its size and exact location and connection point are unknown. Two potential locations are shown. (4)
- Downstream of the GPT, a 1,500mm concrete pipe discharges water into the golf course pond (5)
- No Council assets picked up, some minor pipes share the culvert headwall at the upstream inflow (6)
- Sewer is also present with a 225mm clay pipe beneath the open channel (7)

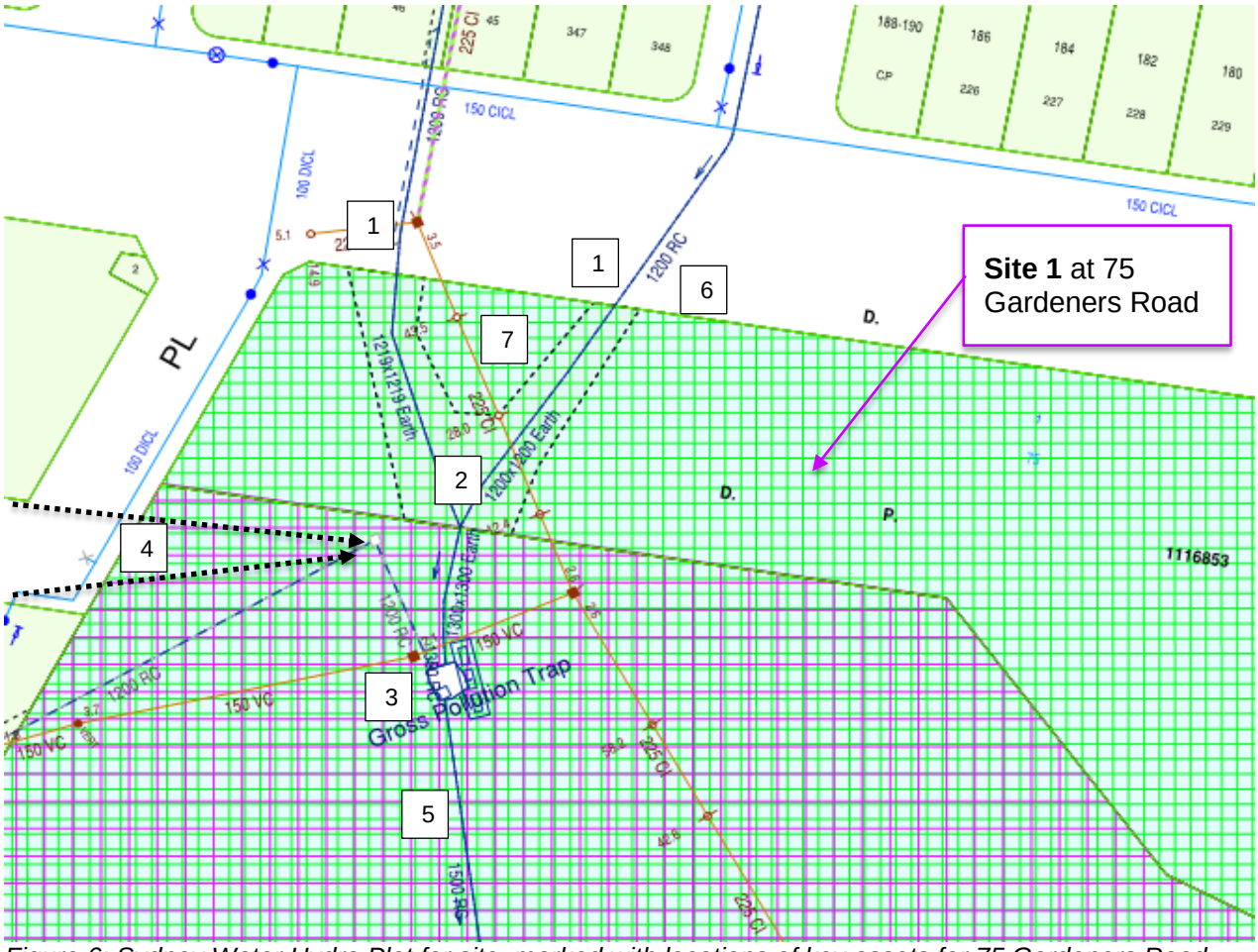


Figure 6: Sydney Water Hydra Plot for site, marked with locations of key assets for 75 Gardeners Road

- Existing 225mm dia. sewer main (8)
- Sydney Water Depot (9)
- 10,000mm wide x 1,520 deep open stormwater channel (C) drains along eastern boundary of site at 73 Gardeners Road (11)

Figure 7: Sydney Water Hydra Plot for site, marked with locations of key assets for 73 Gardeners Road

5. FLOODING

Northrop has reviewed the available Catchment and Flood Planning information provided by Botany Council and Sydney Water for 73-75 Gardeners Road, Eastlakes and provide the following comments relevant to flooding:

<u>Site 1 (75 Gardeners Road)</u>

- The stormwater channels within 75 Gardeners Road are inundated by greater than 2m flood depth. Surrounding areas are also affected with lesser depths. Any access *via* Slattery Place is inundated to 150mm depth.
- Upstream of Gardeners Road flooding occurs over a relatively large area, with 11 residential properties showing inundation in the 1-2m depth range.

Sydney Water advise, and Google Earth time sequenced imagery shows that landscaping of the golf course occurred between 2007-2009. This may have resulted in the placement of fill below the open channel on the site, and thereby preventing the escape of flood flows overland to the pond downstream.

Site 2 (73 Gardeners Road)

- Site 2 (73 Gardeners Road) is located in the floodplain of an existing stormwater channel is also subject to minor overland flooding in the 1% AEP event.
- Flood mapping shows the existing site is flood affected. Flood depths vary between 150-300mm across low points in the existing carpark. Survey identifies these existing low points in the site at 19m AHD.
    - 1% AEP flood levels approx. 18m AHD in adjacent waterway causes site drainage system to back up and pond within the site.
    - 1% AEP flood levels within the site as drainage backs up is approx. *19m AHD*

- Filling within the floodplain for proposed buildings, podium, basement carpark, etc. will need to offset by cutting / lowering of finished levels elsewhere in the site to offset loss to flood storage.
- Flood affected areas = approx. 3,500m^2 (150mm deep), flood storage to be offset = approx. 525m^3

Figure 8 shows flood extents as determined by WMA Water for the catchment that includes the lots at 73 - 75 Gardeners Road.

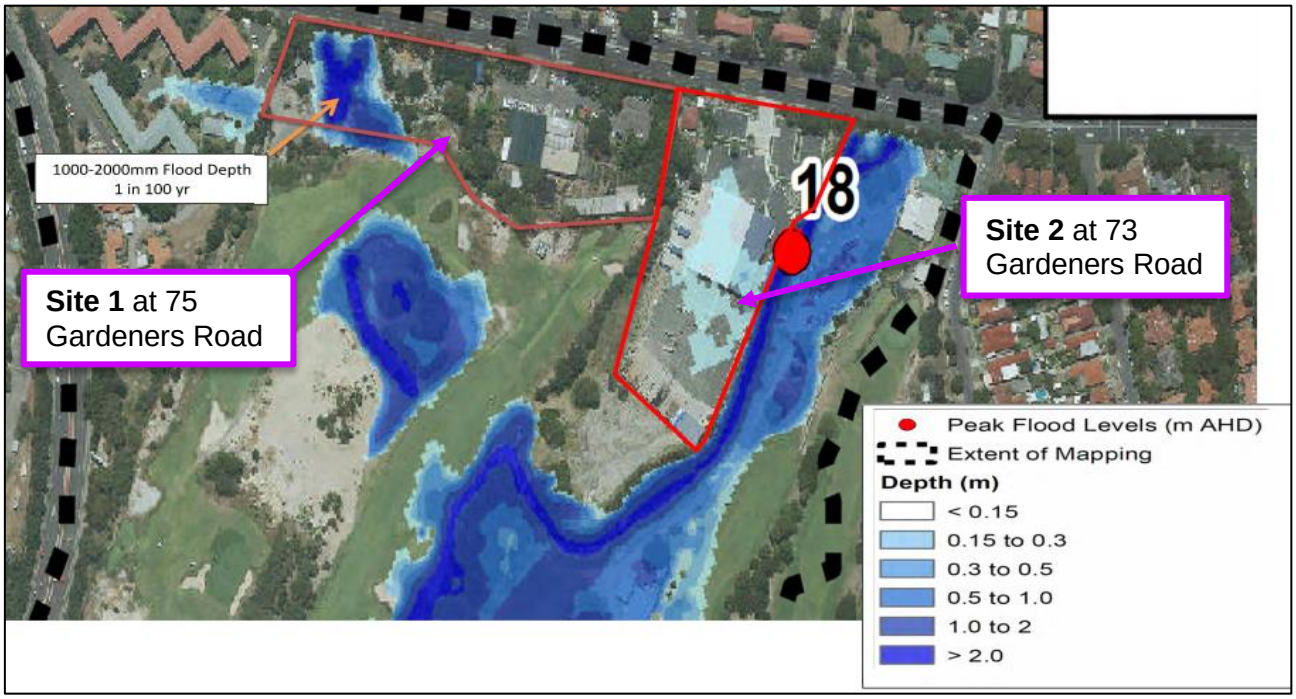


Figure 8: Modelled flood levels/extents 73 - 75 Gardeners Road (1% AEP Event) Source: WMA Water, 2015

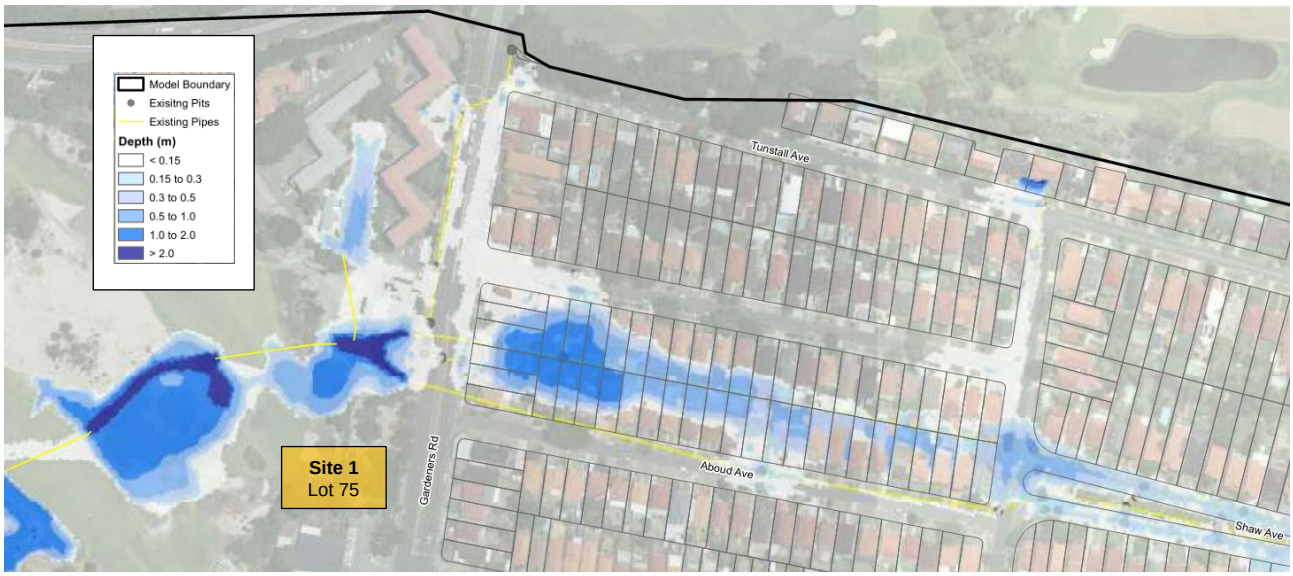


Figure 9: Modelled flood depths/extents 75 Gardeners Road and its upstream catchment (1% AEP Event) Source: WMA Water, 2015

Figure 10: Modelled flood depths/extents 73-75 Gardeners Road and its upstream catchment (1% AEP Event) Source: WMA Water, 2015

5.1. Flood Management Measures

Site 1 (75 Gardeners Road)

Ideally any solution developed for 75 Gardeners Road should accommodate or allow for flood mitigation both on the site, and upstream of Gardeners Road. WMA Water have modelled various flood solutions and the results in relation to flood depths and extents are shown in the Report. They concluded that amplification or duplication of the western conduit under Gardeners Road would have a beneficial effect.

Site 2 (73 Gardeners Road)

The proposed communal open space areas proposed along the Sydney Water channel (eastern boundary) covers an area approximately 2,500m^2. Reducing existing levels across these extents (by approx. 220mm) would sufficiently offset loss to flood storage.

5.2. Flood planning levels at 73 Gardeners Road

Flood planning levels will be dictated by Council's Development Control Plan and in accordance with the NSW Floodplain Development Manual (2005)

- Habitable floor levels to be 1% AEP flood level (RL 19m) + 500mm freeboard = **19.5m AHD**
- Basement driveway entry to be set at a min 1% AEP flood level + 500mm freeboard = **19.5m AHD**

5.3. Flooding Response

The subject sites are affected on the eastern and western peripheries by Overland Flow in the 1% AEP flood event. The master plan has attempted to respond to existing flood conditions by locating buildings outside of the flood prone areas where possible and minor encroachments / earthworks in flood affected areas would be subject to a detailed Flood Impact Assessment following any detailed design as part of any future Development Application for the site.

Flood Planning Levels are achievable for both 73 and 75 Gardeners Road and these levels offer:

- A clear delineation between the 1% AEP flood prone land and the 'built' development portion
- A reduction in risk of flooding for the car park. Basement access is provided above the car park itself. In this regard the entrance to the basement parking is given an allowance of freeboard higher than the 1% AEP flood level

6. WESTERN DRAINAGE EASEMENT

The assets in the western drainage channel are shown in Plates 1-4.

Plate 1: Eastern arm of channel

Plate 2: Western arm inflow

Plate 3: Arm confluence and outflow

Plate 4: Eastern arm inflow

The following defines the channel characteristics:

- Note from previous section that the channel is flood affected
- The channels have stable banks comprising grouted sandstone, and vegetated earth with occasional timber retaining structures
- The channel has no vegetation in the base and is dominated by stormwater sediment deposition, containing organic matter, which anecdotally decomposes to yield odours. Gross pollutants litter the channel base.
- The channel base is very unsightly with the combination of muddy sediments and gross pollutants.
- Vegetation is on the channel banks is typically introduced, likely to be environmental weeds.
- A grove of mature *Melaleuca* trees is situated on a spur of land which separates the two inflow channels

Architectus advise that the best urban design outcome for the site will result from the western drainage channel being filled to provide open space, as indicated in Figure 1. This outcome can be supported in an engineering sense, taking into account Sydney Water's preferences for its assets, as follows:

1. Within the site, extend conduits from Gardeners Road through the site. This may occur in pipes or culverts that would converge at a point just downstream of the southern site boundary.
2. In addition to Item 1, allow for future additional or enlarged conduits to be placed under Gardeners Road. This would have the effect of mitigating flooding upstream of Gardeners Road;
3. The existing GPT is ineffective and needs to be decommissioned. Sydney Water consider the lack of hydraulic head at the site makes a replacement GPT unfeasible. However, stormwater pipes which drains toward the west of the site from Slattery Place could be fitted with GPTs if adequate hydraulic head is available;
4. Where the stormwater conduits converge, there are two options available, i.e.:
    a. remove the existing stormwater conduit and daylight the creek in an open vegetated channel (creek). This channel would connect to the existing pond on the golf course. Golf course re-shaping would be required on the 13th fairway to accommodate this. A bridge would be required to allow access over the channel for golfers. This would provide a solution for an overland flow path, in addition to providing a better ecosystem outcome. A stilling pond could be created at this outflow point with fringe planting of macrophytes to prevent litter moving through the 13^{th} fairway. This flow path would convey water after all rain and runoff events in the upstream catchment. It would be vegetated with native creek vegetation.
    b. Combine the conduits from Gardeners Road into a chamber and then into one or two conduits to convey flow beneath the 13^{th} fairway and into the existing pond. A surcharge pit will be required at the point of convergence of the conduits and a vegetated swale across the 13^{th} fairway would be required as an overland flow path. A bridge would be required for golfers. This overland flow path would only convey water after the capacity of the conduits is exceeded, and therefore would be a dry grassed swale for most of the time that could be mown.
5. The pipes from Slattery Place would be incorporated into the new trunk drainage arrangement by creating an outflow point into the stilling basin (as in Figure 11)

The two drainage arrangements for the western channel are shown in Figure 11 and 12, noting Figure 11 represents Sydney Water's preferred concept.

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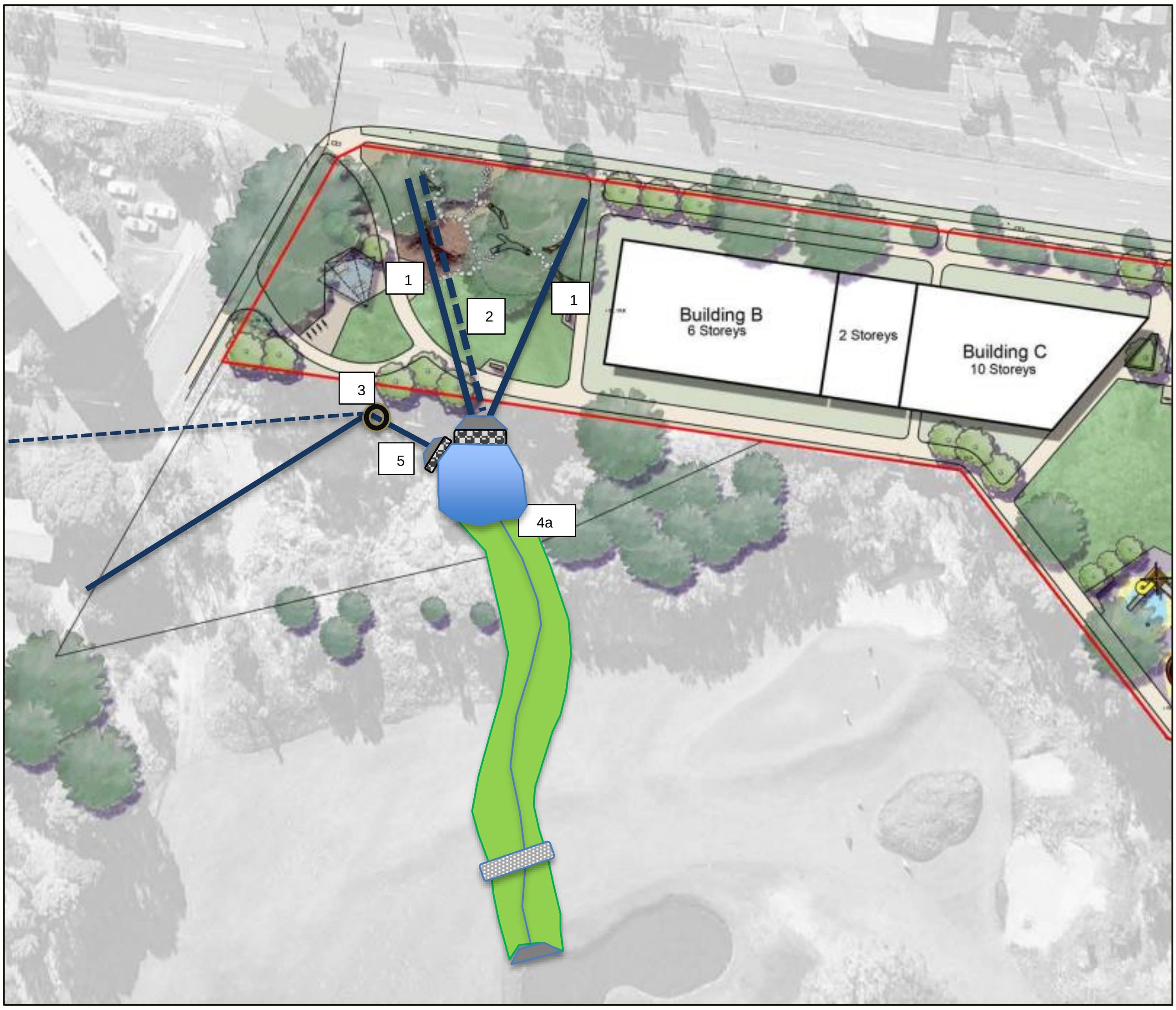

Figure 11: Preferred stormwater concept for the western side of the development. (Note that the outlet to the golf course pond could be shifted further to the east)

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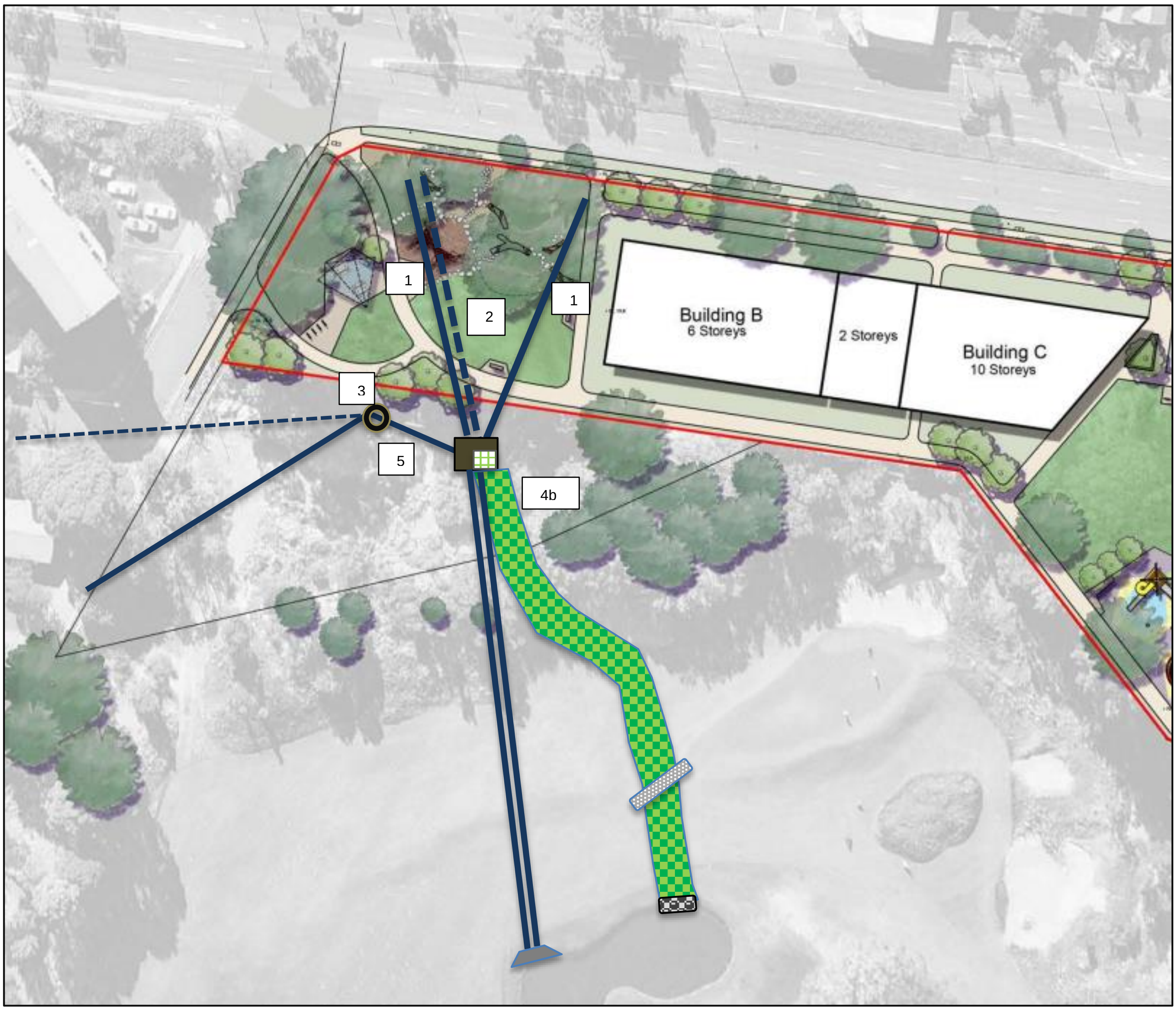

Figure 12: Alternate stormwater concept for the western side of the development. (Note that the grassed channel and two pipes as shown could be swapped)

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7. PLANNING CONTEXT

7.1. Catchment Planning

From the *Botany Bay and Catchment Water Quality Improvement Plan* (Sydney Metro CMA, 2011), all new development, or re-development needs to meet the following targets:

Stormwater reduction targets recommended for urban development in the Botany Bay Catchment.

Stormwater Pollutant	Greenfield Developments Large re-developments	Multi-unit dwellings. Commercial developments. Industrial developments. Small re-developments.
Gross pollutants	90%	90%
Total suspended solids (TSS)	85%	80%
Total phosphorus (TP)	60%	55%
Total nitrogen (TN)	45%	40%

7.2. Council's planning

Based on *Botany Bay Development Control Plan 2013, Part 3G (Draft Amendment No. 1) Stormwater Management,* MUSIC modelling is required to demonstrate target pollutant reductions, in accordance with *Draft NSW MUSIC Modelling Guideline.*

C4 The treatment measure(s) shall include one or more of the following methods or any other as appropriate:

(i) Gross Pollutant Traps;
(ii) Sediment Traps/ Basins;
(iii) Oil Separators;
(iv) Bio-retention Systems;
(v) Constructed wetlands; and
(vi) Rain Gardens.

(ii) For new commercial, industrial and residential flat building (including subdivisions):

- Compliance with State Environmental Planning Policy - Building Sustainability Index (BASIX);
- Site analysis;
- Detailed Water Sensitive Urban Design Strategy (WSUD Strategy);
- Erosion and Sediment Controls Plan (for sites with area ≤ 2,500m²);
- Soil and Water Management Plan (for sites with area > 2,500m²);
- Water Management Statement (for development containing ≤ 15 dwellings); and
- Integrated Water Cycle Plan (for development containing > 15 dwellings).

Note: Integrated Water Cycle Plan is a summary of water conservation measures to be applied on site, including an estimate of total water demands and expected savings associated with water conservation measures, as well as details on how water demands will be managed and monitored.

C6 The following components shall be incorporated in the WSUD design:

(i) WSUD elements should be integrated into landscaped areas to fit seamlessly into a development;
(ii) WSUD elements should be located and configured to maximise the impervious area that is treated; and
(iii) Above-ground rain gardens may be adopted, in the form of planter boxes, to treat runoff from roof areas not draining to a rainwater tank. These typically require less space than an 'in-ground bio-retention system, but may be more costly to construct.

Note: Consideration should be given to incorporation of multiple uses of WSUD infrastructure (e.g. stormwater detention and treatment) where possible.

7.3. Sydney Water

Works to stabilise or enclose the stormwater channels within Site 1 (75 Gardeners Road) will require building approvals from Sydney Water and should be designed in accordance with their Draft Policy for Building over or adjacent to Stormwater Assets (2015).

7.4. NSW Office of Water

Based on *Water Management Act* 2000 and the associated *Guidelines for Riparian Corridors on Waterfront Land*, Sydney Water will need to submit a Controlled Activity Permit for works within 40m of the top of banks of the western channels.

If the creek is constructed across the 13th fairway, the same Guideline would be used in the design, i.e. soft engineering comprising a combination of rock (minimal), vegetation and geotextiles.

7.4.1. Riparian Requirements

The Sydney Water stormwater channel adjacent to 73 Gardeners Road is likely regulated as a 'watercourse' by DPI Water and a minimum 10m riparian setback would need to be established as part of any redevelopment of the site.

The riparian setback is defined from the highest bank of the watercourse. Based on an inspection of the site - the highest bank generally follows the property boundary line. The Riparian setback should be considered as 10m setback from property boundary.

The Riparian Corridor (RC) is to be maintained, restored or rehabilitated using appropriate local species with a range of canopy, understory and groundcover species to enable a healthy and diverse ecosystem.

In accordance with DPI Water Guidelines (2012), development works may be undertaken within the outer 50% of the Vegetated Riparian Zone (VRZ) - outer 5m, as long as the works within these outer extents are offset by connecting an equivalent area to the riparian corridor within the development site. The inner 50% of the VRZ must be fully protected and vegetated with native riparian plant species.

DPI Water guidelines (2012) state that the following non RC uses and development works may be undertaken within the outer 50% of the VRZ in accordance with the offsetting rules:

- Recreational areas.
- Lot and infrastructure development.
- Road construction.

The following non-RC uses and developments works may be undertaken within the outer 50% of the VRZ (outer 5m) and do not require offsetting:

- Stormwater outlet structures and essential services.
- Bridges.
- Cycleways and paths.

Riparian Strategy

Maintain consistent 5m wide inner VRZ along the length of the site and offset encroachment in the outer 5m via provision of offset VRZ in areas nominated as communal open space.

Dedicated riparian areas can also be used to provide offset floodplain storage – as required above.

7.5. Summary of planning requirements

The current proposal seeks consent to rezone the sites to allow for their on sale and redevelopment by others at a later stage. Both sites may be sold jointly or separate depending on decommissioning of the Sydney Water Depot site and market forces.

At this early stage, it is considered that the site is appropriate for the proposed rezoning of the site, subject to further investigations as part of any future development applications including but not limited to:

- Site Stormwater Concept to include WSUD principles (Strategy) and modelled in MUSIC to achieve water quality performance targets
- Integrated Water Management Plan
- Controlled Activity Permit required for submission to NSW Office of Water
- Sydney Water Approval for building over or adjacent to Stormwater Assets (Western Drainage Easement)

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8. PROPOSED STORMWATER STRATEGY

Northrop has reviewed the '*Botany Bay Development Control Plan 2013*' (DCP) to inform the stormwater drainage provisions required for the proposed development. Further consultation is required with Council Engineers to confirm any site-specific stormwater management requirements.

8.1. Piped Drainage Network

A new stormwater drainage network will need to be provided in accordance with best practice for managing urban stormwater, and to satisfy Council's stormwater management requirements.

As a minimum, the proposed stormwater drainage infrastructure is to be designed to capture and convey stormwater flows generated from the 10 year ARI storm event to Sydney Water's drainage infrastructure on the western and eastern extents of the site.

All flows above and beyond the 10 year ARI storm event (up to the 100 year storm event) can be conveyed via overland flow paths. Overland flow paths shall be designed to not present a hazard to people or damage to property.

8.2. On-site Stormwater Detention

The provision of On-site Stormwater Detention (OSD) will be required by Council/Sydney Water. Further consultation is required with Council and Sydney Water Engineers to confirm the OSD requirements for this development. As the site is located upstream of Sydney Water drainage assets, OSD storage will be required, and should be sized in accordance with Sydney Water requirements. Where discharge to Gardeners Road is proposed, OSD should be sized in accordance with Council requirements.

8.3. Controlling Stormwater Pollution

In order to achieve the site stormwater pollutant control targets, the stormwater system for the proposed development would need to include stormwater gross pollutant traps, swales, rainwater tanks, infiltration systems where feasible, and bioretention systems. The use of infiltration techniques (e.g. bioretention, swales) may be constrained by shallow groundwater table.

8.3.1. Rainwater Harvesting

Council's DCP encourages the use of rainwater tanks and the use of stored rainwater for non-potable uses (e.g. irrigation, washing and flushing of toilets). Rainwater tank sizing is to consider BASIX certificate requirements for the development.

A preliminary stormwater concept for Site 1 is depicted in Figure 13. It demonstrates the following characteristics and inclusions:

- Western site drainage arrangement as per Figures 11 or 12.
- WSUD elements, including:
  - rain tanks for reuse on the site;
  - unlined bioretention swales at the site perimeter which would be integrated with landscaping;
  - diffuse surface flow paths to filter flows
  - Infiltration systems within communal space areas
  - Gross Pollutant Traps at outlet points

Figure 13: Preliminary Stormwater Concept

9. CONCLUSIONS

The current proposal seeks consent to rezone the sites to allow for their on sale and re-development by others at a later stage. Both sites may be sold jointly or separate depending on decommissioning of the Sydney Water Depot site and market forces.

At this early stage, it is considered that the site is appropriate for the proposed rezoning of the site, subject to further investigations as part of any future development applications including but not limited to:

- Site Stormwater Concept to include WSUD principles (Strategy) and modelled in MUSIC to achieve water quality performance targets
- Integrated Water Management Plan
- Controlled Activity Permit required for submission to NSW Office of Water
- Sydney Water Approval for building over or adjacent to Stormwater Assets (Western Drainage Easement)

The following investigations are also recommended to provide further information on the potential servicing needs of the development:

- Consult Botany Council and Sydney Water Engineers to confirm site-specific stormwater management requirements (including OSD requirements and water quality treatment targets).
- Consult with Sydney Water to obtain further advice regarding the stormwater channel works (western boundary)
- Consult with Sydney Water to obtain further detailed flood information

- All other details (including the suitability of proposed connections to stormwater infrastructure) will be subject to specific / detailed applications with the respective Authorities, at relevant / subsequent phases of the project.

9.1. Project Risks

The following project risks are identified for the development:

- The site is deemed to be situated within a flood affected area and further site specific flood investigations will be required at later design stages to determine adequate flood planning responses.
- Further discussions are required for works to be undertaken to the stormwater channel intersecting the western extent of Site 1. An application to Sydney Water will inform the requirements for building over or adjacent to the stormwater assets and may place restrictions on the development.

Attachment O – Proposed Mapping Amendments, Prepared by Architectus, dated September 2017

Botany Bay Local Environmental Plan 2013

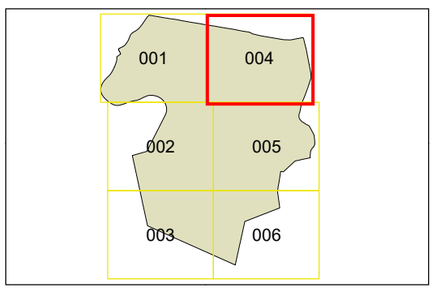
Land Zoning Map - Sheet LZN_004

Zone

B1	Neighbourhood Centre
B2	Local Centre
B3	Commercial Core
B4	Mixed Use
B5	Business Development
B7	Business Park
IN1	General Industrial
IN2	Light Industrial
R2	Low Density Residential
R3	Medium Density Residential
R4	High Density Residential
RE1	Public Recreation
RE2	Private Recreation
SP1	Special Activities
SP2	Infrastructure
W3	Working Waterways
MD	SEPP (Major Development) 2005
DM	Deferred Matter

Cadastre

Base data 12/09/2014 © Land and Property Information (LPI)



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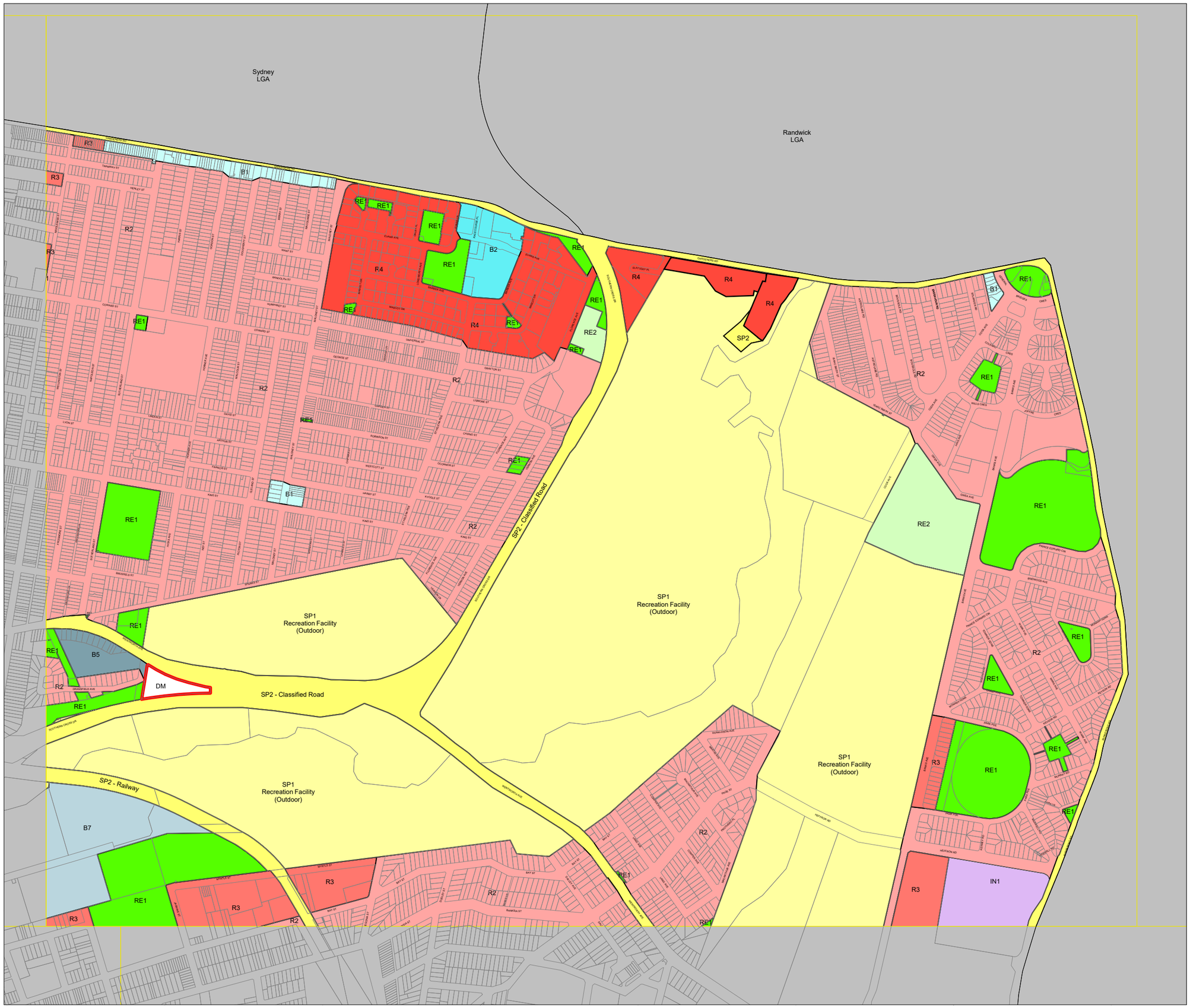


Botany Bay Local Environmental Plan 2013

Height of Buildings Map - Sheet HOB_004

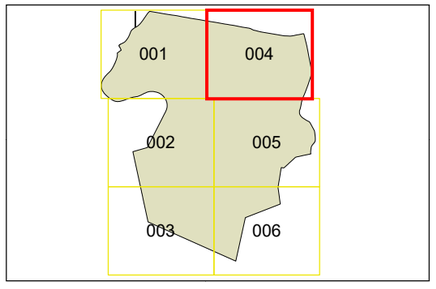
Maximum Building Height (m)

H	7.5
I	8.5
J	9
K	10
L	11
M	12
N	14
P	17
Q	19
R	22
T	25
T1	26
T2	28
T3	29
U	32
U1	33
V	39
W1	40
Y	50

Refer to clause 4.3

Cadastre

Base data 12/09/2014 © Land and Property Information (LPI)



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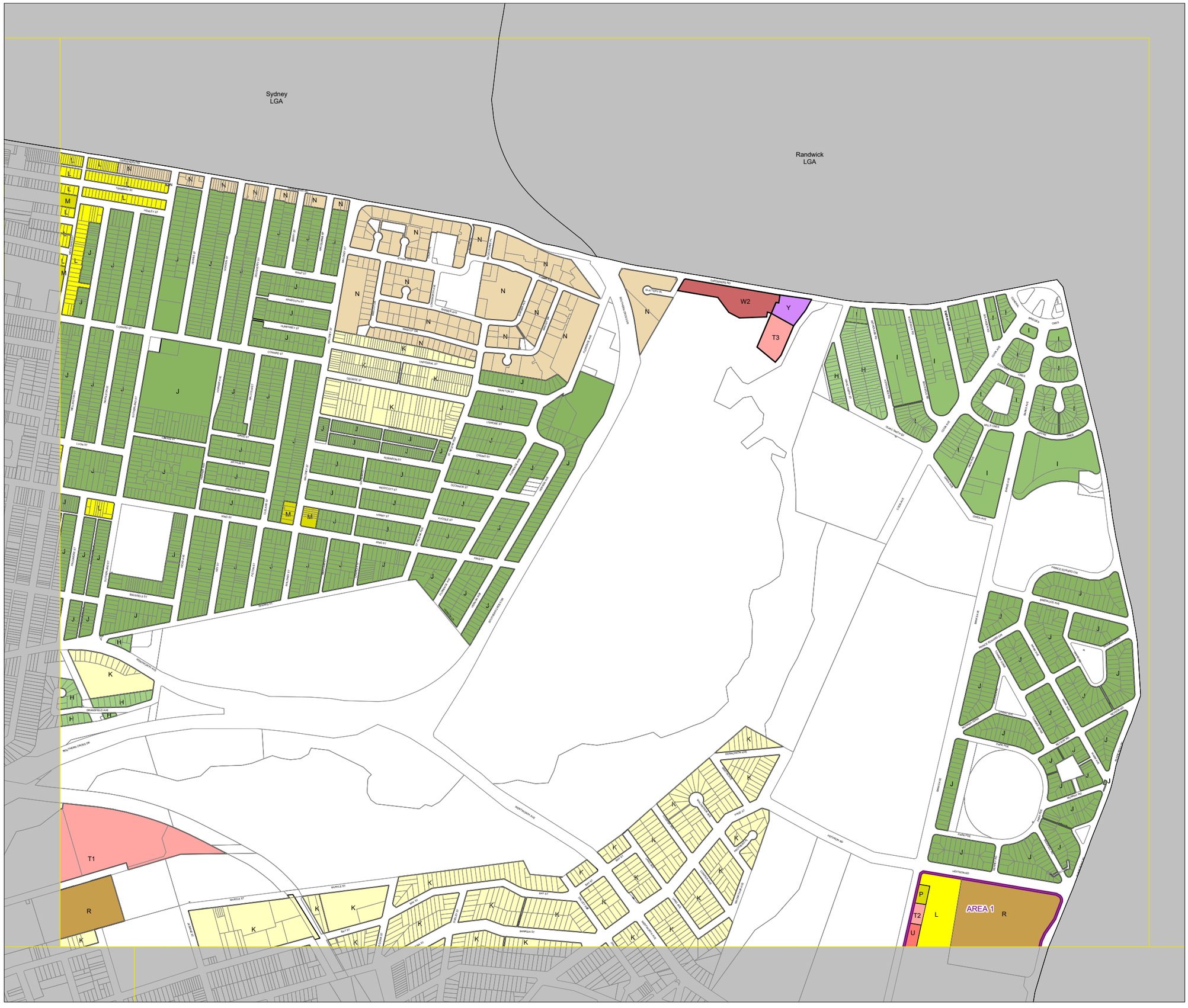

Botany Bay Local Environmental Plan 2013

Floor Space Ratio Map - Sheet FSR_004

Maximum Floor Space Ratio (n:1)

D	0.5
E	0.55
F	0.6
G	0.65
H	0.7
K	0.85
L	0.9
N	1
P	1.2
S	1.5
S1	1.65
S2	1.95
T	2
U	2.5
V1	3
V2	3.2
V3	3.3
W	3.55
	Refer to Clause 4.4A
	Refer to Clause 4.4

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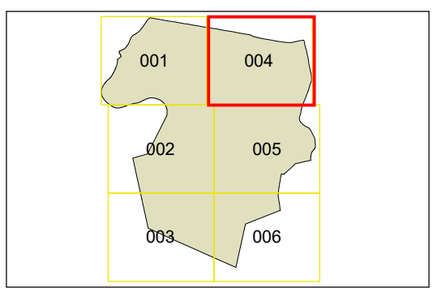
Base data 5/11/2012 © Land and Property Information (LPI)



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