Kellyville Station Precinct

Stormwater Management Plan

Stantec Australia Pty Ltd
Level 6, Building B, 207 Pacific Highway, St Leonards NSW 2065
Tel: +61 2 8484 7000 Email: enquiries.ap@stantec.com www.stantec.com

P:\40416\PROJECT DOCUMENTATION\CIVIL\DOCUMENTS & REPORTS\STORMWATER\40416-CI-RE-KELLYVILLE STORMWATER MANAGEMENT PLAN_07.DOCX

Stantec

Revision

Revision	Date	Comment	Prepared By	Approved By
1	12 August 2019	Initial SSDA Issue	OKW	OKW
2	15 August 2019	Initial SSDA Issue	OKW	OKW
3	9 September 2019	Initial SSDA Issue (Revised to suit Landcom comments)	OKW	OKW
4	22 April 2020	Revised SSDA Issue (Yield & Subdivision Plan Updated)	OKW	OKW
5	2 June 2020	Revised SSDA Issue (Revised to suit Landcom comments)	OKW	OKW
6	3 June 2020	Revised SSDA Issue (Revised to suit APP comments)	OKW	OKW
7	9 June 2020	Revised SSDA Issue (Revised to suit APP comments)	OKW	OKW

Note: Revisions 1 - 3 by Wood & Grieve Engineers now part of Stantec

Contents

1. Introduction 1

2. Site Characteristics 2

2.1 Site Definition 2
2.2 Existing Topography & Surface Features 4
2.3 Existing Geotechnical Conditions & Groundwater Investigation 5
2.4 Existing Flood Affectation 5
2.5 Existing Stormwater Drainage Infrastructure 5

3. Proposed Development 6

3.1 Sydney Metro Northwest Places Overview 6
3.2 Kellyville Station Precinct Overview 6
3.3 Concept SSD Application Scope 6

4. Flood Impact Assessment 8

4.1 Literature Review 8
4.2 Impact of Proposed Development on Flooding 24
4.3 Flood Impact on Proposed & Future Development 26
4.4 Compliance 26
4.5 Recommendations for Future Development 26

5. Stormwater Conveyance 27

5.1 Authority Requirements 27
5.2 Drainage associated with future development of proposed lots 27
5.3 Drainage associated with public roads 28
5.4 Public Reserve/Open Space Drainage 29
5.5 Legal Point of Discharge 30

6. Stormwater Quantity 31

7. Stormwater Quality / Water Sensitive Urban Design 32

7.1 Authority Requirements 32
7.2 Potential Pollutants 35
7.3 Pollutant Reduction System 36
7.4 Proposed Treatment Devices 41
7.5 Sydney Water Regional Stormwater Harvesting Pipeline and Related Drainage Works 47

Contents

8. Erosion & Sedimentation Control 48

8.1 Future Development of Proposed Lots 48
8.2 Public Road Reserves and Public Reserves / Open Space 48

9. Development Staging 49

Appendix A - Site Survey

Appendix B - Geotechnical Report

Appendix C - Elizabeth Macarthur Creek – Trunk Drainage Concept Design Report

Appendix D - Elizabeth Macarthur Creek – Trunk Drainage Concept Drawings

Appendix E - Sydney Water Response to Feasibility Application

Appendix F – Concept Stormwater Management Plans

Appendix G - MUSIC Modelling Results

Certified System
Quality
ISO 9001
SAI GLOBAL

Figures

Figure 2.1 - Kellyville Project Site (the Site) 2
Figure 2.2 - Portion of the Site that is subject of the SSD application 3
Figure 2.3 - Aerial Photograph of the Site (7 April 2019) 4
Figure 3.1 - Urban Design Plan 7
Figure 4.1 – Rouse Hill Flood Study (2014) – Study Area 9
Figure 4.2 - Rouse Hill Flood Study (2014) - 10% AEP Event Flood Levels and Depths (Entire Study Area) 10
Figure 4.3 - Rouse Hill Flood Study (2014) - 10% AEP Event Flood Levels and Depths (In vicinity of Site) 11
Figure 4.4 - Rouse Hill Flood Study (2014) - 5% AEP Event Flood Levels and Depths (Entire Study Area) 12
Figure 4.5 - Rouse Hill Flood Study (2014) - 5% AEP Event Flood Levels and Depths (In vicinity of Site) 13
Figure 4.6 - Rouse Hill Flood Study (2014) - 2% AEP Event Flood Levels and Depths (Entire Study Area) 14
Figure 4.7 - Rouse Hill Flood Study (2014) - 2% AEP Event Flood Levels and Depths (In vicinity of Site) 15
Figure 4.8 - Rouse Hill Flood Study (2014) - 1% AEP Event Flood Levels and Depths (Entire Study Area) 16
Figure 4.9 - Rouse Hill Flood Study (2014) - 1% AEP Event Flood Levels and Depths (In vicinity of Site) 17
Figure 4.10 - Baseline Flood Condition (EMC Trunk Drainage Concept Design Report) 19
Figure 4.11 - Baseline Flood Condition - Site Area Only (EMC Trunk Drainage Concept Report) 20
Figure 4.12 - Design Flood Condition (EMC Trunk Drainage Concept Report) 22
Figure 4.13 - Design Flood Condition - Site Area Only (EMC Trunk Drainage Concept Report) 23
Figure 4.14 - Extent of proposed development encroachment into 'baseline' 100 year ARI flood zone (marked excerpt from EMC Trunk Drainage Report) 25
Figure 5.1 - Development Drainage Stormwater Conveyance Flow Chart 27
Figure 5.2 - Public Road Drainage Stormwater Conveyance Flow Chart 28
Figure 5.3– Public Reserve / Open Space (Impervious) Drainage Stormwater Conveyance Flow Chart 29
Figure 5.4– Local Public Reserve / Open Space (Pervious) Stormwater Conveyance Flow Chart 30
Figure 5.5 - Regional Public Reserve /Open Space (Pervious) Stormwater Conveyance Flow Chart 30
Figure 7.1 – Treatment Train for Existing Private Allotments Constructed by NRT 38
Figure 7.2 – Treatment Train for Existing Public Roads Constructed by NRT 38
Figure 7.3 - Proposed Treatment Train for the Site 39
Figure 7.4 - Typical Street Tree Pit 41
Figure 7.5 - Public Reserve (Open Space) Infiltration 43
Figure 7.6 - Rainwater Reuse Cycle in Regional Public Reserves 44
Figure 7.7 - Typical Gross Pollutant Trap (GPT) 46

Tables

Table 5.1 - Design Average Recurrence Intervals (ARIs) 27
Table 7.1 - Post-development pollution reduction targets prior to discharge to EMC 32
Table 7.2 - MUSIC Model Parameters 36
Table 7.3 - Recommended MUSIC Runoff Generation Parameters 37
Table 7.4 - MUSIC Source Node Concentration Parameters for Sydney Catchments 37
Table 7.5 - Assumed Post-Development Pollutant Reduction Results – Existing Private Lots Constructed by NRT 38
Table 7.6 - Post-Development Pollutant Reduction Results – Existing Public Roads Constructed by NRT 38
Table 7.7 - Post-Development Pollution Reduction Targets - Future Development of Proposed Lots 39
Table 7.8 - Estimated Pollution Reduction Results - Proposed Precinct Including Existing Roads 40
Table 7.9 - Estimated Pollutant Reduction Results - Proposed Precinct Excluding Existing Roads 40
Table 7.10 - Street Tree Pit MUSIC Modelling Parameters 42
Table 7.11 - Pervious Public Reserve MUSIC Modelling Parameters 43
Table 7.12 - Public Reserve Rainwater Reuse MUSIC Modelling Parameters 45
Table 7.13 - Gross Pollutant Trap MUSIC Modelling Parameters 46

Glossary

Abbreviation	Definition	Details
AEP	Annual Exceedance Probability	
AHD	Australian Height Datum	
ARI	Average Recurrence Interval	
Creek	Elizabeth Macarthur Creek	
EMC	Elizabeth Macarthur Creek	
EMC Trunk Drainage Report	Elizabeth Macarthur Creek – Trunk Drainage Concept Design Report	Revision C, dated 17 July 2017, prepared by AAJV on behalf of Sydney Water
FERV	Flood Event Runoff Volume	
GPT	Gross Pollutant Trap	
Ha	Hectare	
MARV	Mean Annual Runoff Volume	
MUSIC	Model for Urban Stormwater Improvement Conceptualisation	WSUD software by eWater
NRT	Northwest Rapid Transit	
Rouse Hill Flood Study	Rouse Hill Flood Study	Revision 2, dated 10 April 2014, prepared by WMA Water on behalf of Sydney Water
Site	The Kellyville Station Precinct	
SMNW	Sydney Metro Northwest	
SSD	State Significant Development	
Stantec	Stantec Australia Pty Ltd	
TN	Total Nitrogen	
TP	Total Phosphorous	
TSS	Total Suspended Solids	
WSUD	Water Sensitive Urban Design	

1. Introduction

Stantec Australia Pty Ltd have been engaged by Landcom ('the Proponent') to prepare a Stormwater Management Plan for the Kellyville Station Precinct ('the Site'). The plan/report is intended to address the management of stormwater and water sensitive urban design (WSUD) to support the concept State Significant Development (SSD) application for portion of the Site that is owned by or under the control of Sydney Metro.

The Site includes both government and non-government owned lands. While the SSD application covers only land owned or controlled by Sydney Metro, consideration has been given to the broader precinct to ensure that a coordinated stormwater management strategy is developed.

The purpose of this report is to provide preliminary advice regarding stormwater management to facilitate development of the Site, including the following:

- Flooding;
- Stormwater quantity;
- Stormwater quality (WSUD);
- Erosion & sediment control.

Liaison has occurred with both Council (as owner of proposed public infrastructure) and Sydney Water (as owner of Elizabeth Macarthur Creek, which abuts the Site) to determine appropriate stormwater management measures.

No physical works are proposed in this SSD application, hence information provided hereunder is conceptual only. Detailed analysis and calculations and designs are required for future development applications for physical works.

2. Site Characteristics

2.1 Site Definition

The Kellyville Station Precinct ('the Site') is shown in **Figure 2.1** below and is bounded by:

- Old Windsor Road to the west;
- Samantha Riley Drive to the north;
- Memorial Avenue to the south; and
- Elizabeth Macarthur Creek (EMC or 'the creek') to the east.

The Site is in The Hills Shire Council local government area.

The portion of the Site that forms part of the SSD application, including the legal description, is shown in **Figure 2.2** overleaf.

While the SSD application includes only a portion of the Site, consideration has been given to stormwater management of the entire Site to ensure that a coordinated strategy is developed. The portion of the Site that is subject of the SSD application is 18.8 Ha and the area considered in the stormwater strategy is 22 Ha.

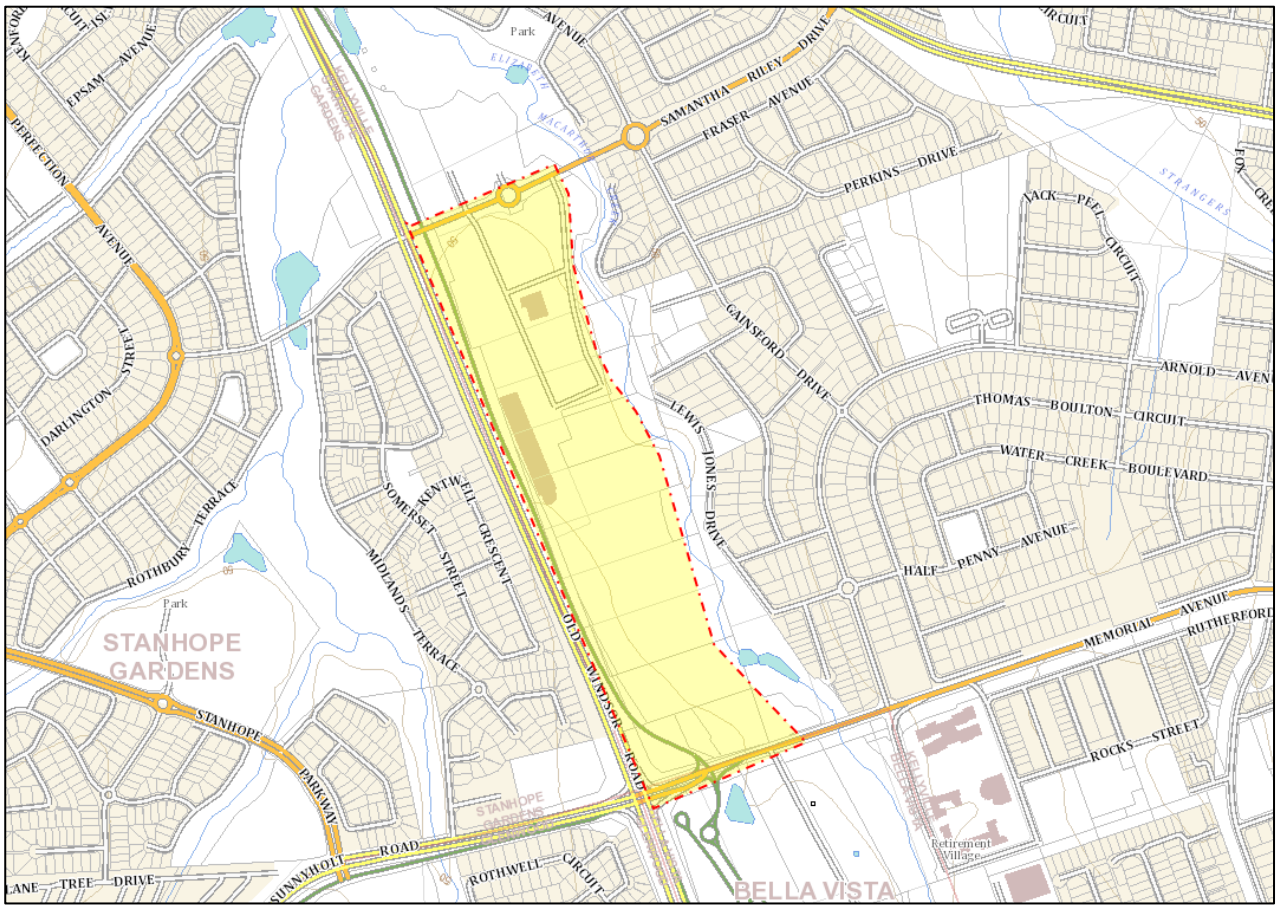


Figure 2.1 - Kellyville Project Site (the Site)

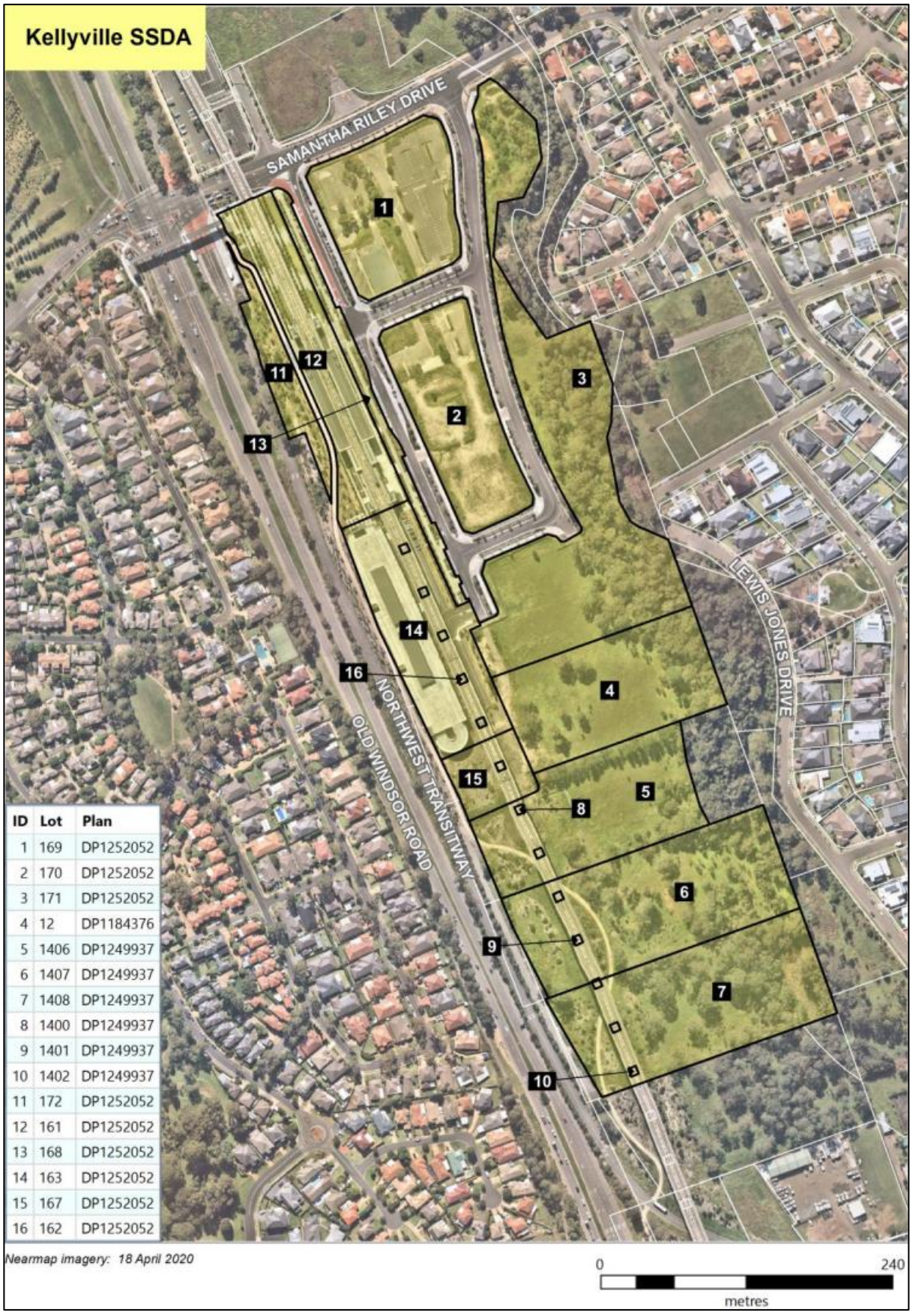


Figure 2.2 - Portion of the Site that is subject of the SSD application

2.2 Existing Topography & Surface Features

The topography of the Site undulates; however, surface levels generally fall to the east towards the creek. There is also a gentle gradient to the north. Topography for the majority of the Site is shown on the site survey included in Appendix A.

At the time of preparation of this report, roads and associated infrastructure have recently been constructed by Northwest Rapid Transit (NRT) to facilitate the opening of Kellyville Station. These roads are within the Site and are shown in **Figure 2.3.**

Undeveloped areas of the Site that are outside of the riparian area are generally either cleared and grassed or sparsely vegetated.

Figure 2.3 - Aerial Photograph of the Site (7 April 2019)

2.3 Existing Geotechnical Conditions & Groundwater Investigation

The geotechnical character of the Site has been investigated by PSM Consult, care of JBS&G. A copy of the PSM consult geotechnical report (dated 29 May 2019, reference PS3675-003L Rev 2) is included in Appendix B.

A desktop groundwater assessment has also been included in the PSM Consult report.

2.4 Existing Flood Affectation

Flood affectation of the Site has previously been assessed by AAJV. The results of this assessment are included in the report entitled 'Elizabeth Macarthur Creek – Trunk Drainage Concept Design Report' (Revision C, dated 17 February 2017). The report shall be here forth referenced as 'EMC Trunk Drainage Report'. A copy of the EMC Trunk Drainage Report is included in Appendix C.

Flood affectation is further investigated in Section 4 of this report.

2.5 Existing Stormwater Drainage Infrastructure

Stormwater drainage infrastructure has been installed to suit recent NRT works. Infrastructure includes the following:

- Typical private pit and pipe network and stormwater quality treatment measures to collect, convey and treat runoff from private allotments prior to discharge to the public stormwater network in accordance with typical Council controls;
- Typical public pit and pipe network to collect and convey runoff from public roads to the creek; and
- Gross Pollutant Traps (GPTs) prior to discharge of the public road stormwater network to the creek.

3. Proposed Development

3.1 Sydney Metro Northwest Places Overview

The NSW Government and Sydney Metro have finalised the first stages of Australia's biggest public transport project that have seen the commencement of new metro services in Sydney's northwest in May 2019.

Under the Sydney Metro Northwest (SMNW) Places program, Landcom and Sydney Metro are working collaboratively with the Department of Planning and Environment, local councils, other government organisations and key stakeholders to develop the long-term vision and delivery program to guide the redevelopment and urban renewal of surplus government owned or controlled land around new SMNW station precincts.

SMNW Places will deliver vibrant and integrated precincts surrounding the new Bella Vista and Kellyville metro stations that will facilitate the renewal and delivery of a greater supply and diversity of housing, new employment opportunities and new public and community facilities.

3.2 Kellyville Station Precinct Overview

The Kellyville Station Precinct forms part of a network of eight station precincts along the corridor of the NSW Government's $8.4 billion SMNW. The Precinct was identified by the NSW Government as a Priority Precinct to support and drive the urban renewal of rural residential land into a new urban environment.

The Kellyville Station Precinct is envisaged to provide 1,000 new jobs and, in conjunction with the adjacent Bella Vista Station Precinct, up to 8,400 new homes shared between the precincts.

3.3 Concept SSD Application Scope

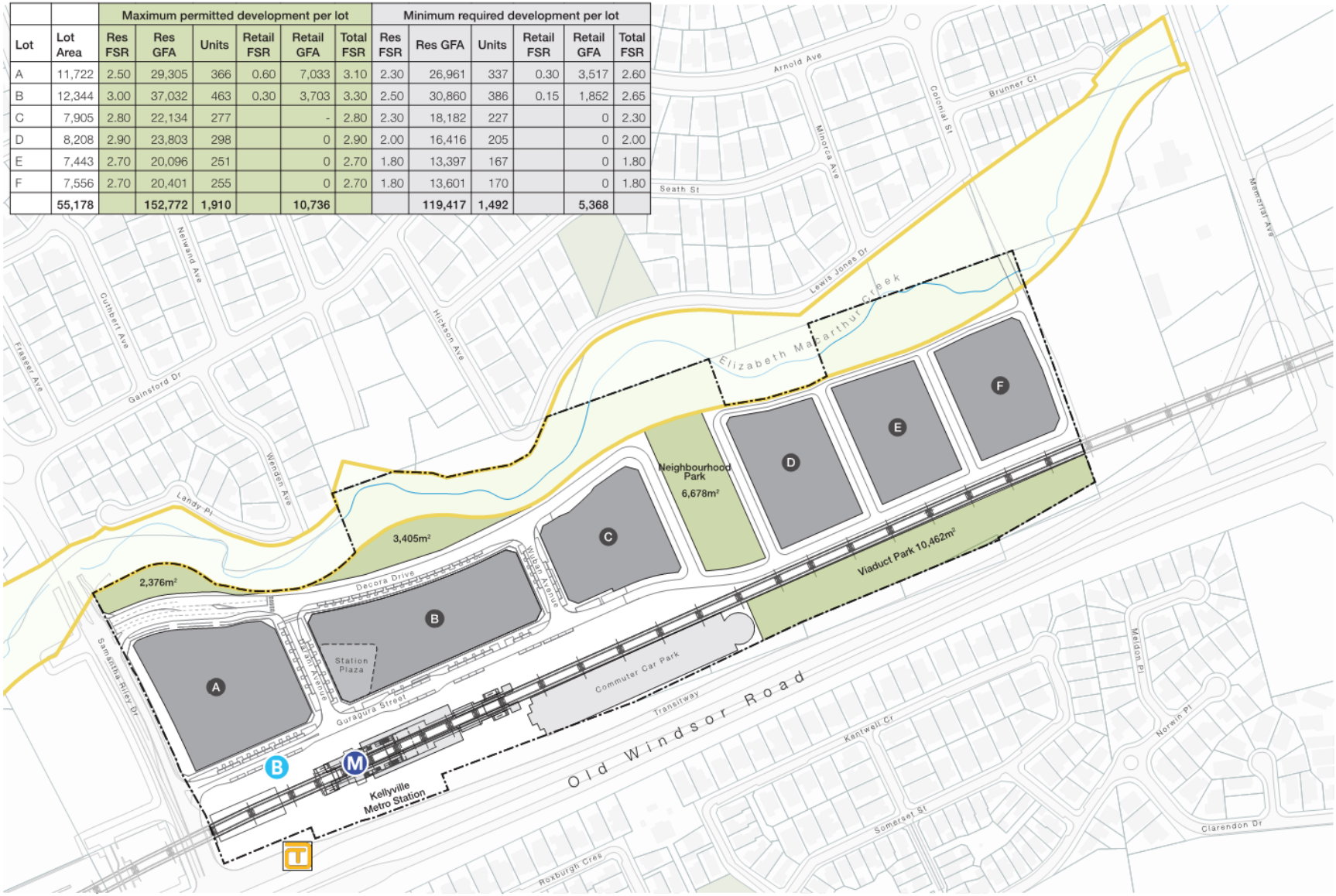
Development consent is sought for a concept development application pursuant to section 4.22(1) of the Environmental Planning and Assessment Act 1979 (EP&A Act) that sets out the concept proposal for a portion of the Site that comprises the following components:

- A land use strategy that identifies the overall allocation, quantum and location of land uses across a portion of the Site, including:
  - Residential dwellings comprising residential flat buildings and terraces;
  - Non-residential land uses including retail and commercial;
  - Public open space including public domain and parks; and
  - Community facilities.
- Urban Design Guidelines that includes built form design principles, guidelines and controls, including maximum building heights and street wall setbacks and heights;
- Allocation of maximum gross floor area (GFA) across a portion of the Site for each development block and for specific land uses, including allowable GFA transferred from roads and open space to identified development lots pursuant to clause 8.3 of The Hills Local Environmental Plan 2012 (Council's LEP);
- Street hierarchy and layout, including the identification of pedestrian and vehicular movement and access arrangements, and the indicative location and configuration of new streets and intersection connections to the existing road network; and
- Identification of criteria or thresholds for subsequent development stages to be assessed as State Significant Development pursuant to section 4.37 of the EP&A Act.

The concept SSD application does not seek development consent for any physical works. All development set out in the concept proposal will be subject to a separate approval pathway.

The urban design plan submitted for approval under the concept SSD application is included in **Figure 3.1**. This plan forms the basis of further investigation.

		Maximum permitted development per lot						Minimum required development per lot					
Lot	Lot Area	Res FSR	Res GFA	Units	Retail FSR	Retail GFA	Total FSR	Res FSR	Res GFA	Units	Retail FSR	Retail GFA	Total FSR
A	11,722	2.50	29,305	366	0.60	7,033	3.10	2.30	26,961	337	0.30	3,517	2.60
B	12,344	3.00	37,032	463	0.30	3,703	3.30	2.50	30,860	386	0.15	1,852	2.65
C	7,905	2.80	22,134	277		-	2.80	2.30	18,182	227		0	2.30
D	8,208	2.90	23,803	298		0	2.90	2.00	16,416	205		0	2.00
E	7,443	2.70	20,096	251		0	2.70	1.80	13,397	167		0	1.80
F	7,556	2.70	20,401	255		0	2.70	1.80	13,601	170		0	1.80
	55,178		**152,772**	**1,910**		**10,736**			**119,417**	**1,492**		**5,368**	



Kellyville subdivision and yield framework plan

Scale
1:3000@A3

Drawing number [00]
Revision number [00]
Project number 5947
Project name Kellyville Station Precinct
Project address Kellyville
Client Landcom

Key
development lots
open space (RE1)
riparian corridor (SP2)

SJB Urban
Level 2, 490 Crown Street, Surry Hills NSW 2010
T. 61 2 9380 9911 sjb.com.au
SJB Architecture (NSW) Pty Ltd
ABN 20 310 373 425 ACN 081 094 724
Adam Haddow 7188 John Pradel 7004

Figure 3.1 - Urban Design Plan

4. Flood Impact Assessment

4.1 Literature Review

4.1.1 The Hills Shire Council Local Environment Plan 2012

Section 7.3 of Council's LEP sets out Flood Planning controls. Section 7.3 is quoted below:

"7.3 Flood planning

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

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

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

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

(2) This clause applies to land at or below the flood planning level.

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

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

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

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

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

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

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

(5) In this clause:

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

Council's LEP sets out that the flood planning level is the 100-year ARI flood event plus 0.5m freeboard.

4.1.2 Sydney Water Rouse Hill Flood Study (2014)

The Site abuts Elizabeth Macarthur Creek (EMC). The creek is a Sydney Water asset. In 2014 Sydney Water commissioned WMA Water to prepare the 'Rouse Hill Flood Study' for the Rouse Hill Development Area. The study includes the Site and a large surrounding area, as shown in Figure 4.1 of this report.

The Rouse Hill Flood Study includes a detailed investigation of 'baseline' flooding. It is noted that the baseline conditions do not equate to the existing conditions. The Rouse Hill Flood Study adopts the ultimate catchment development conditions to define hydrologic inputs to the TUFLOW model. As the contributing catchment areas upstream of the development area are not yet fully developed, flood modelling is anticipated to slightly overestimate the resulting catchment runoff potential and therefore the flow rates along EMC when compared to existing conditions.

Figure 4.2 to Figure 4.9 of this report contain excerpts from the Rouse Hill Flood Study, showing the baseline flood affectation of the Site and surrounding areas in various flood events up to the 1% AEP event. The figures show that the lower lying areas of the Site are inundated during flood events up to and including the 1% AEP event.

Figure 4.1 – Rouse Hill Flood Study (2014) – Study Area - Site boundary indicatively marked green by Stantec

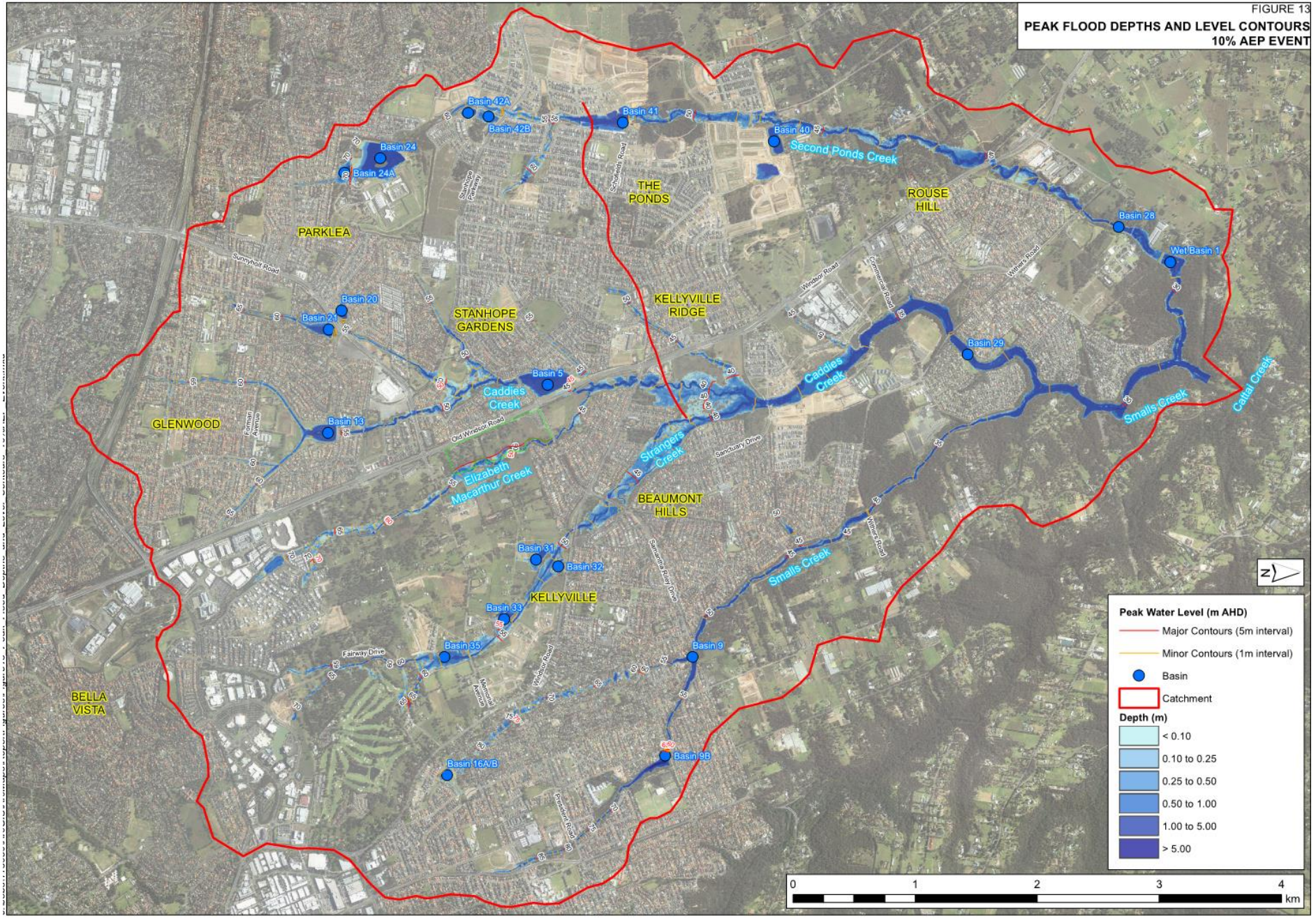


Figure 4.2 - Rouse Hill Flood Study (2014) - 10% AEP Event Flood Levels and Depths (Entire Study Area)
Site boundary and SP2 zone boundary indicatively marked green and red respectively by Stantec

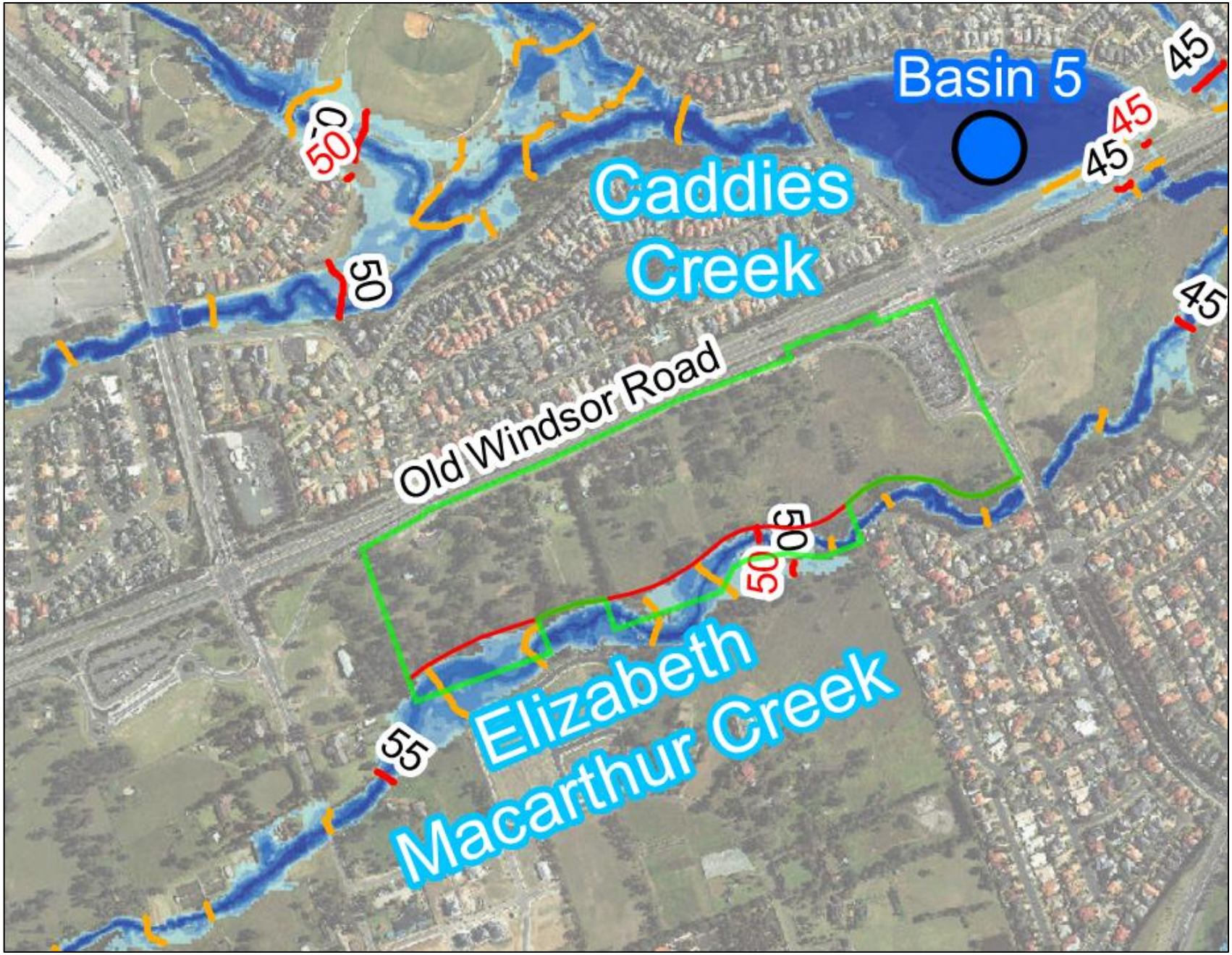


Figure 4.3 - Rouse Hill Flood Study (2014) - 10% AEP Event Flood Levels and Depths (In vicinity of Site)
Site boundary and SP2 zone boundary indicatively marked green and red respectively by Stantec

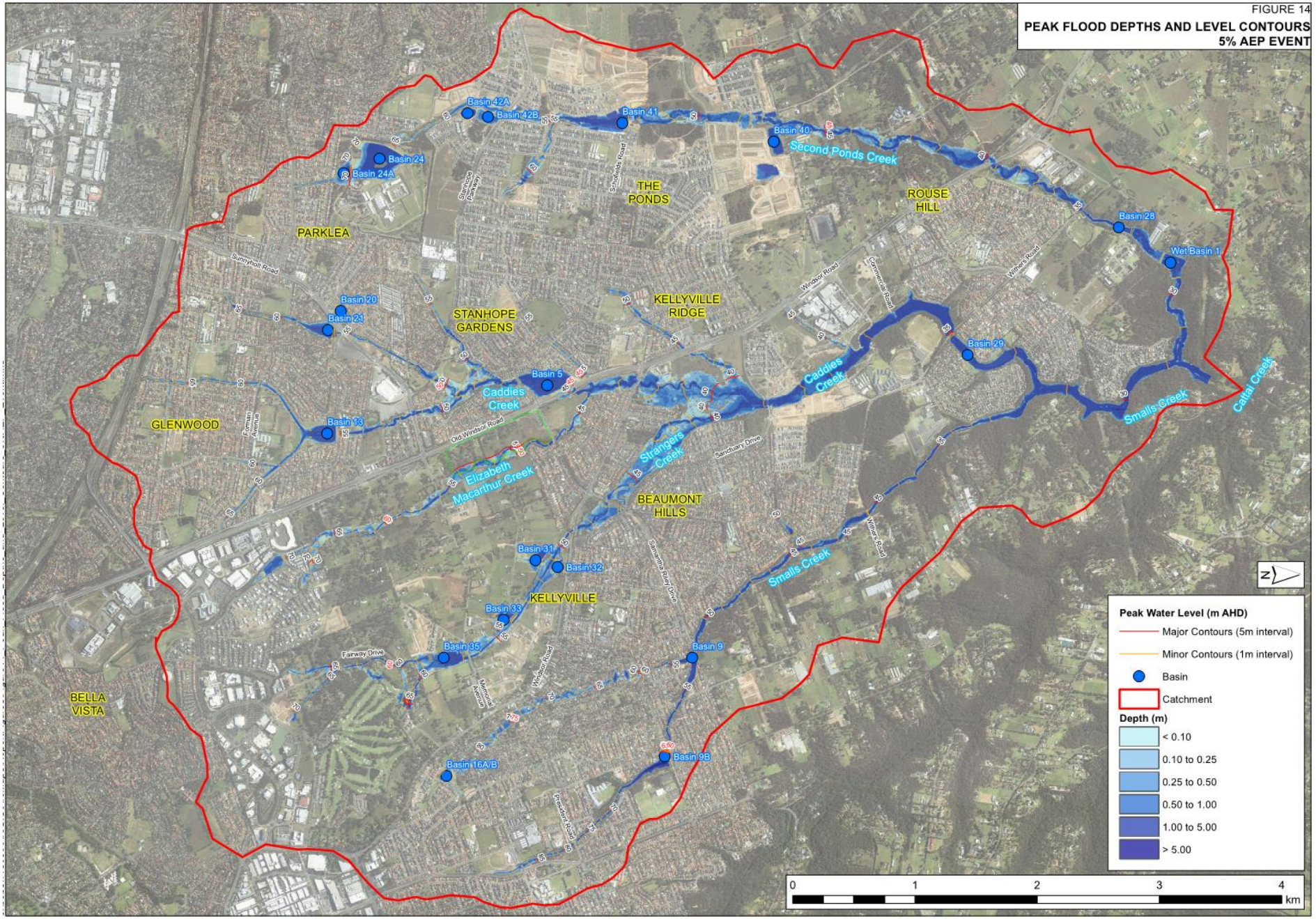


Figure 4.4 - Rouse Hill Flood Study (2014) - 5% AEP Event Flood Levels and Depths (Entire Study Area)
Site boundary and SP2 zone boundary indicatively marked green and red respectively by Stantec

Figure 4.5 - Rouse Hill Flood Study (2014) - 5% AEP Event Flood Levels and Depths (In vicinity of Site)
Site boundary and SP2 zone boundary indicatively marked green and red respectively by Stantec

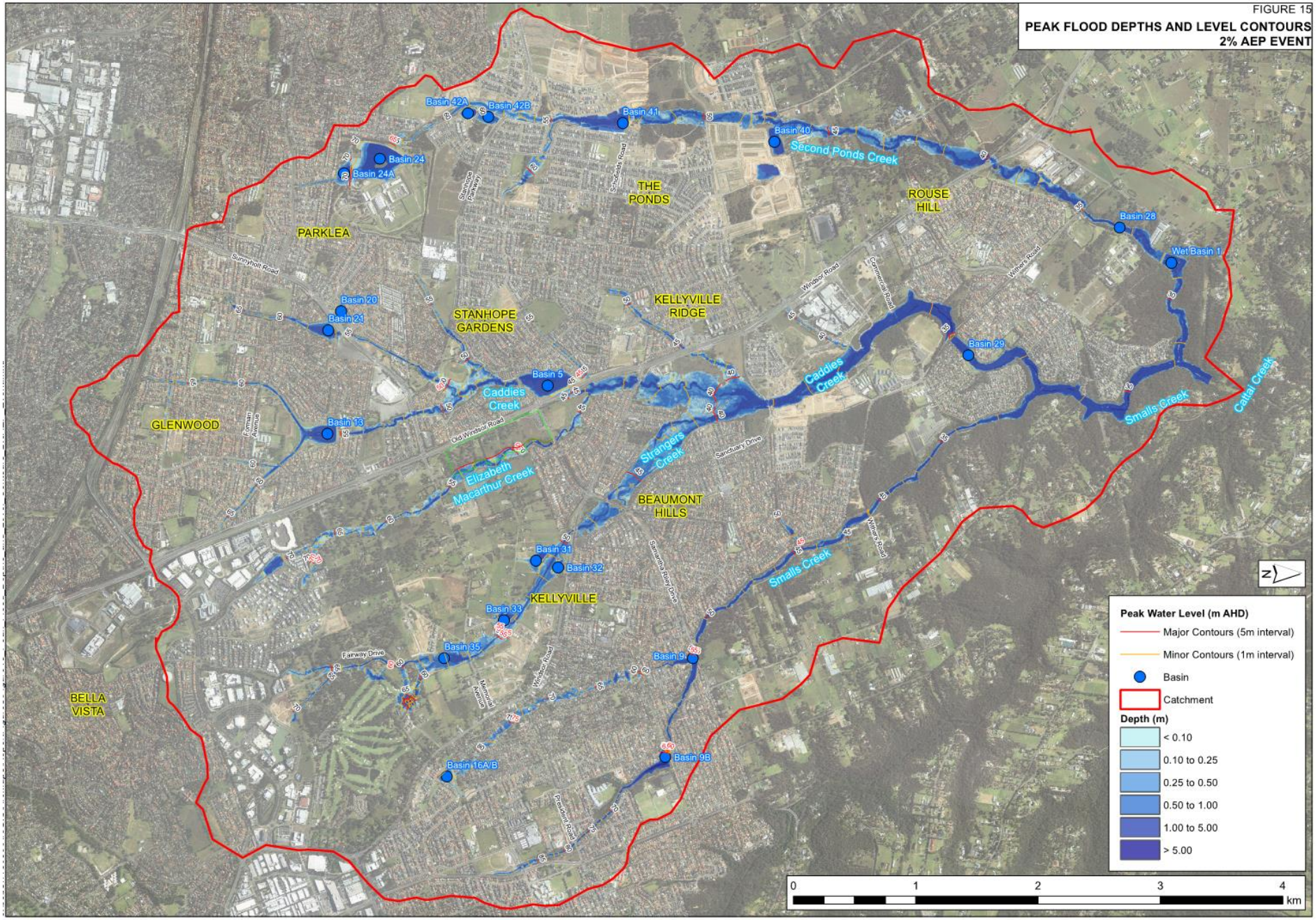


Figure 4.6 - Rouse Hill Flood Study (2014) - 2% AEP Event Flood Levels and Depths (Entire Study Area)
Site boundary and SP2 zone boundary indicatively marked green and red respectively by Stantec

Figure 4.7 - Rouse Hill Flood Study (2014) - 2% AEP Event Flood Levels and Depths (In vicinity of Site)
Site boundary and SP2 zone boundary indicatively marked green and red respectively by Stantec

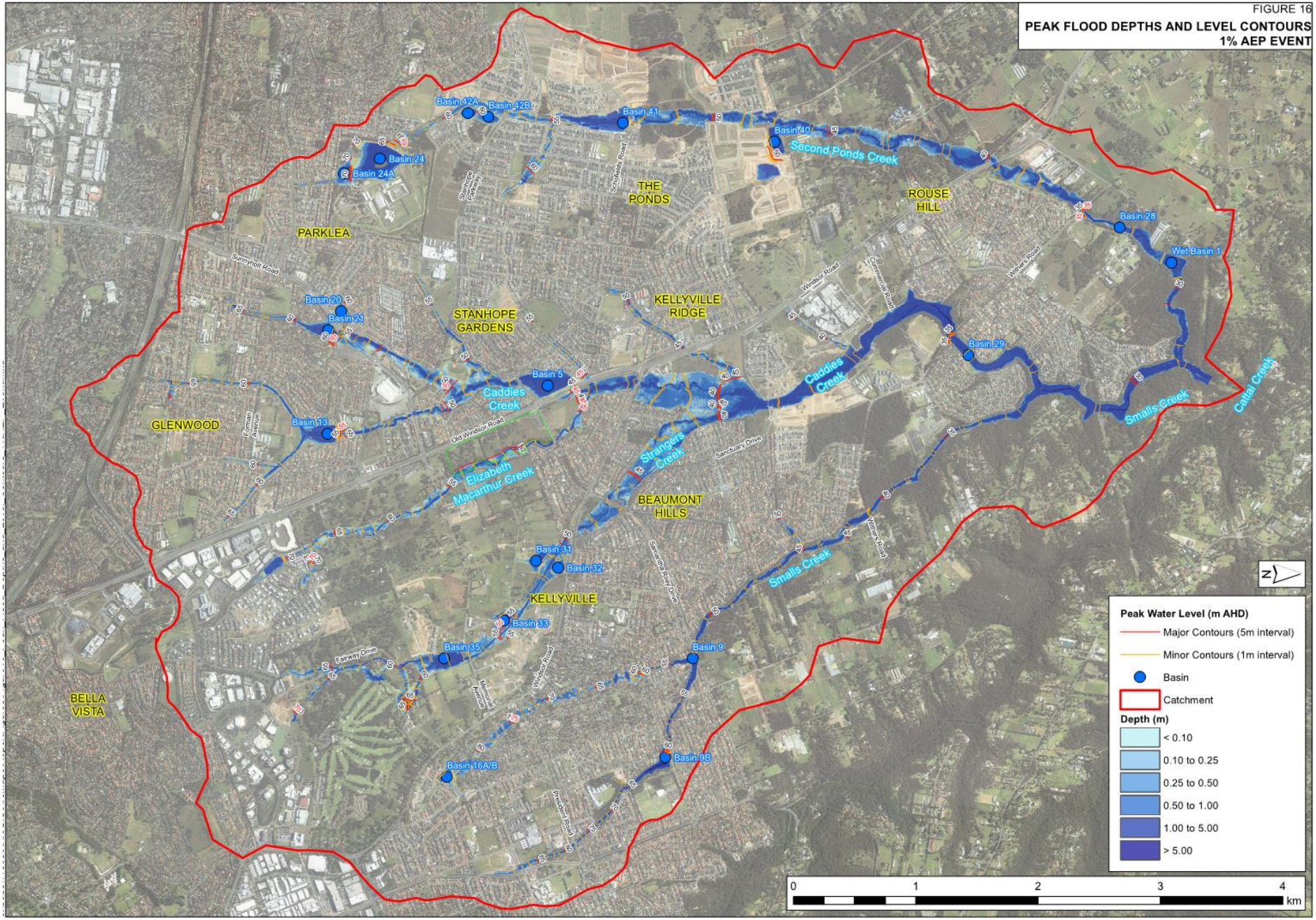


Figure 4.8 - Rouse Hill Flood Study (2014) - 1% AEP Event Flood Levels and Depths (Entire Study Area)
Site boundary and SP2 zone boundary indicatively marked green and red respectively by Stantec

Figure 4.9 - Rouse Hill Flood Study (2014) - 1% AEP Event Flood Levels and Depths (In vicinity of Site)
Site boundary and SP2 zone boundary indicatively marked green and red respectively by Stantec

4.1.3 Sydney Water Elizabeth Macarthur Creek Trunk Drainage Concept Design Report

In 2017 Sydney Water commissioned AAJV to prepare the 'Elizabeth Macarthur Creek Trunk Drainage Concept Design Report'. A copy of the report and associate drawings is included in Appendices C & D respectively. Note that several Appendices to the EMC Trunk Drainage Report have been deleted from the copy appended to this report as they are not pertinent to the proposed development.

The purpose of the EMC Trunk Drainage Report is to "…design and document the preferred trunk drainage concept design for EMC, including related guidelines for stormwater and floodplain management that could be used to inform planning and development in other similar urban release areas."

The EMC Trunk Drainage Report utilised the flood modelling for the Rouse Hill Flood Study and refined it to focus on EMC. The number of refinements is too numerous to exhaustively list, however they include the following items listed below and investigated further hereunder:

- Increasing modelling resolution to improve accuracy;
- Incorporating filling of the Site;
- Flood mitigation/stream improvement measures in EMC; and
- New vehicular and pedestrian bridges adjacent to the Site.

The Rouse Hill Flood Study made allowance for the ultimate development of the study area, which included development of the Site. The Rouse Hill Flood Study references an average impervious percentage of 66% over the study area, as outlined in Table 8 of the report. This hydrologic model was adopted and refined for the EMC Trunk Drainage Report (refer to Section 2.6.1 of the report). The flood modelling for the EMC Trunk Drainage Report therefore considers the post-development scenario for the Site (referenced in the report as the 'Design' scenario). The report also considers the 'Baseline' flooding scenario, in which the Site is not yet developed and proposed works in EMC have not yet occurred. It is reiterated that this 'Baseline' scenario is not equivalent to the existing flood scenario, as outlined in Section 4.1.2 of this report.

The EMC Trunk Drainage Report includes a detailed investigation of flooding in the vicinity of the Site (refer to Section 2.6 of the report). **Figure 4.10** of this report contains an excerpt of the EMC Trunk Drainage Report, showing the baseline flood affectation of the Site and surrounding areas in the 100-year ARI event. **Figure 4.11** shows a higher resolution copy of the same except, focusing on the Site. A portion of the Site in the vicinity of the creek is shown to be flood affected in the baseline 100-year ARI event.

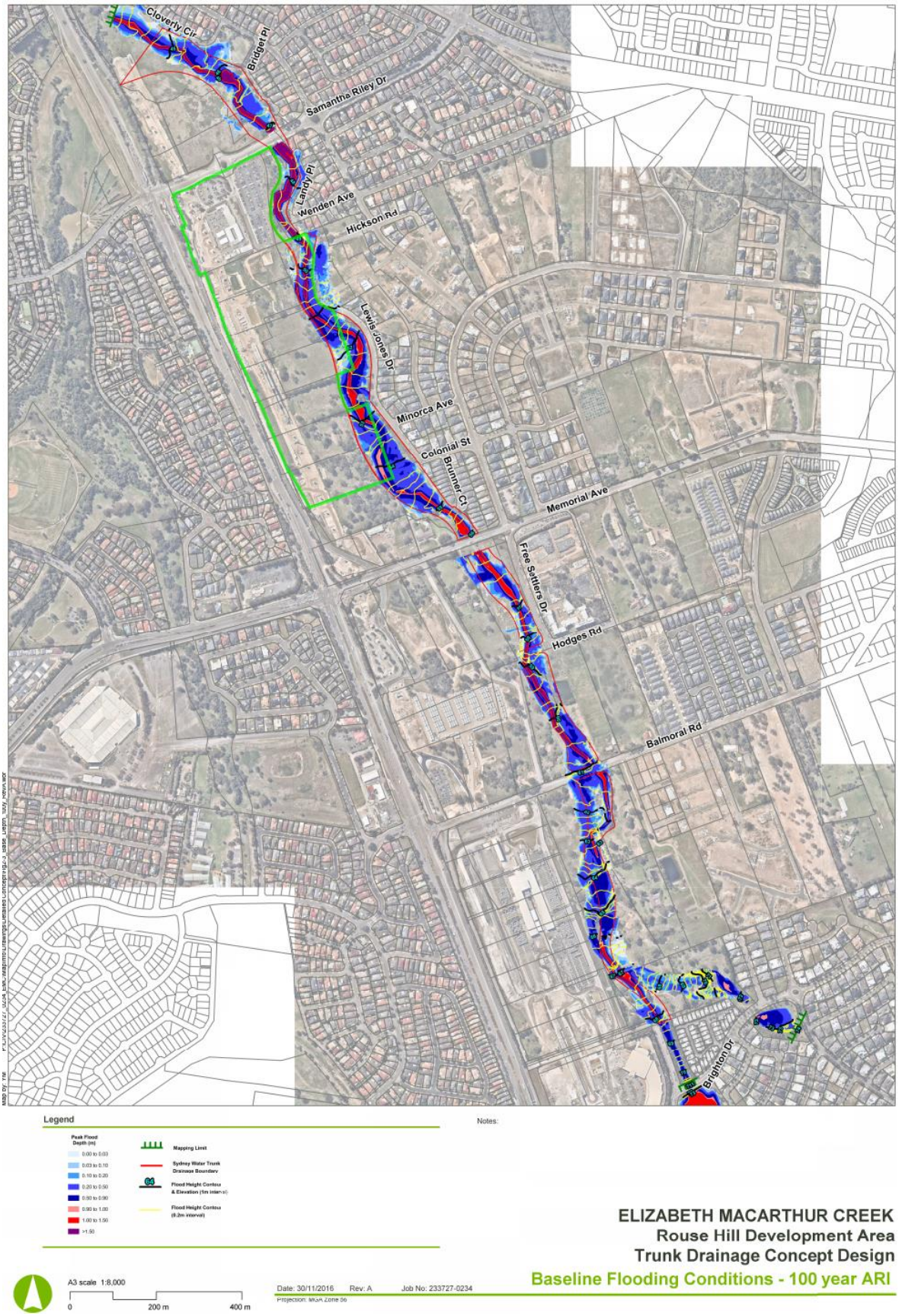


Figure 4.10 - Baseline Flood Condition (EMC Trunk Drainage Concept Design Report) - Site boundary indicatively marked green by Stantec

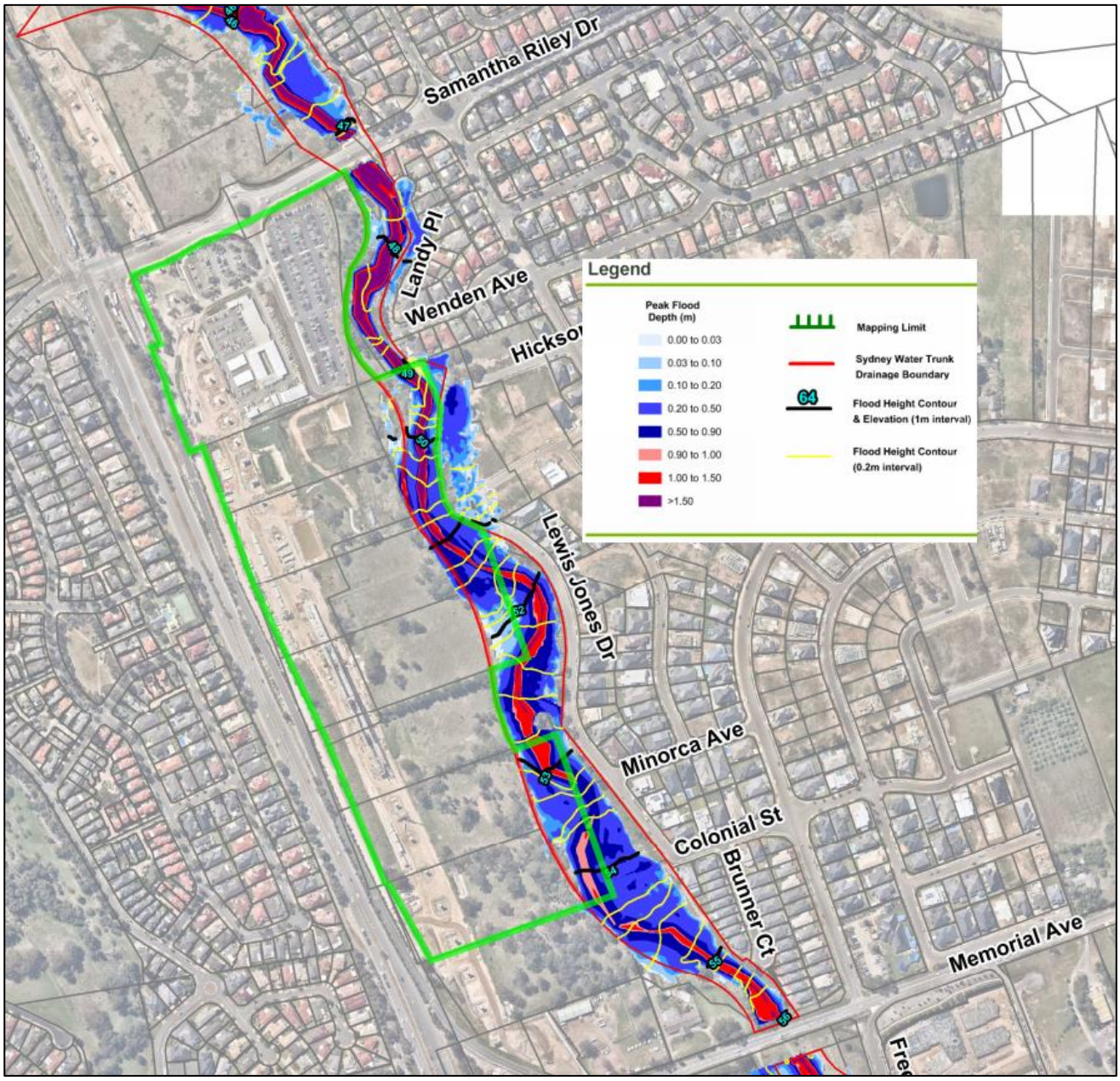


Figure 4.11 - Baseline Flood Condition - Site Area Only (EMC Trunk Drainage Concept Report) - Site boundary indicatively marked green by Stantec

The EMC Trunk Drainage Report proposes numerous stream rehabilitation measures to (among other outcomes) mitigate flood affectation of surrounding properties, including the Site. The report references allowance being made for future development of the Site and landfill of flood affected areas such that they are above adjacent flood levels. Section 3.3.9 of the EMC Trunk Drainage Report outlines the approach to flood management. An excerpt of the Section 3.3.9 is included below, noting that only relevant items have been included:

> *"The general design approach adopted to develop an overall flood management strategy was to:*
>
> *(1) …*
>
> *(2) Incorporate future landfill to facilitate urban development up to the proposed TDL (Trunk Drainage Land) boundary.*
>
> *Note this landfill would extend to an elevation of at least peak 100-year ARI flood levels, and allow for some minor encroachment of fill into the TDL to afford an element of conservatism should developers overreach in the future.*

(3) *…*

(4) *Incorporate future bridge crossings to facilitate road/pedestrian access through adjacent future urban development areas.*

The hydraulic performance of the bridge crossings were then optimised to either increase or reduce the resulting afflux as appropriate.

Seven future bridge crossings were identified by both THSC (The Hills Shire Council) and UrbanGrowth/TfNSW to support their future development plans. Generally downstream of Memorial Avenue it is desirable to reduce afflux as far as possible to avoid adverse flood impacts on existing development. Upstream of Memorial Avenue there is more scope to increase peak flood levels as there is little development adjacent to EMC, and future development can be set (through specification of fill levels) at the appropriate elevation.

(5) *…"*

At the time of preparation of the EMC Trunk Drainage Report the future extent of development of the Site was unknown. Sydney Water/AAJV therefore assumed that all areas outside of the SP2 (Infrastructure) zoned land (which will ultimately be owned by Sydney Water) would be filled to be at or above the 100-year ARI flood level. This assumption was made to facilitate future development of adjacent areas. Post-development flood modelling incorporated this filling, as depicted in **Figure 4.12**, which shows the post-development flood affectation of the Site and surrounding areas. **Figure 4.13** shows a higher resolution copy of the same excerpt, focussing on the Site. These figures show that the extent of 100-year ARI flooding in the post-development scenario is limited to Sydney Water's land (SP2 zoned land) fronting the Site.

In summary, the EMC Trunk Drainage Report and associated drawings sets out the following key design criteria affecting development of the Site:

- Allowance has been made for all areas outside of the SP2 zoned area to be filled to be at or above the 100-year ARI flood level. Guidance is provided regarding flood levels at the interface of the SP2 zoned area;
- Encroachment of works into the SP2 zoned area must be limited to prevent flood impacts, though some minor encroachment is permitted. Guidance is provided regarding the extent and nature of encroachment into the SP2 zoned area, however it is ultimately subject to Sydney Water's approval; and
- Allowance has been made for future creek crossings at various locations. Guidance is provided regarding geometric constraints associated with each creek crossing.

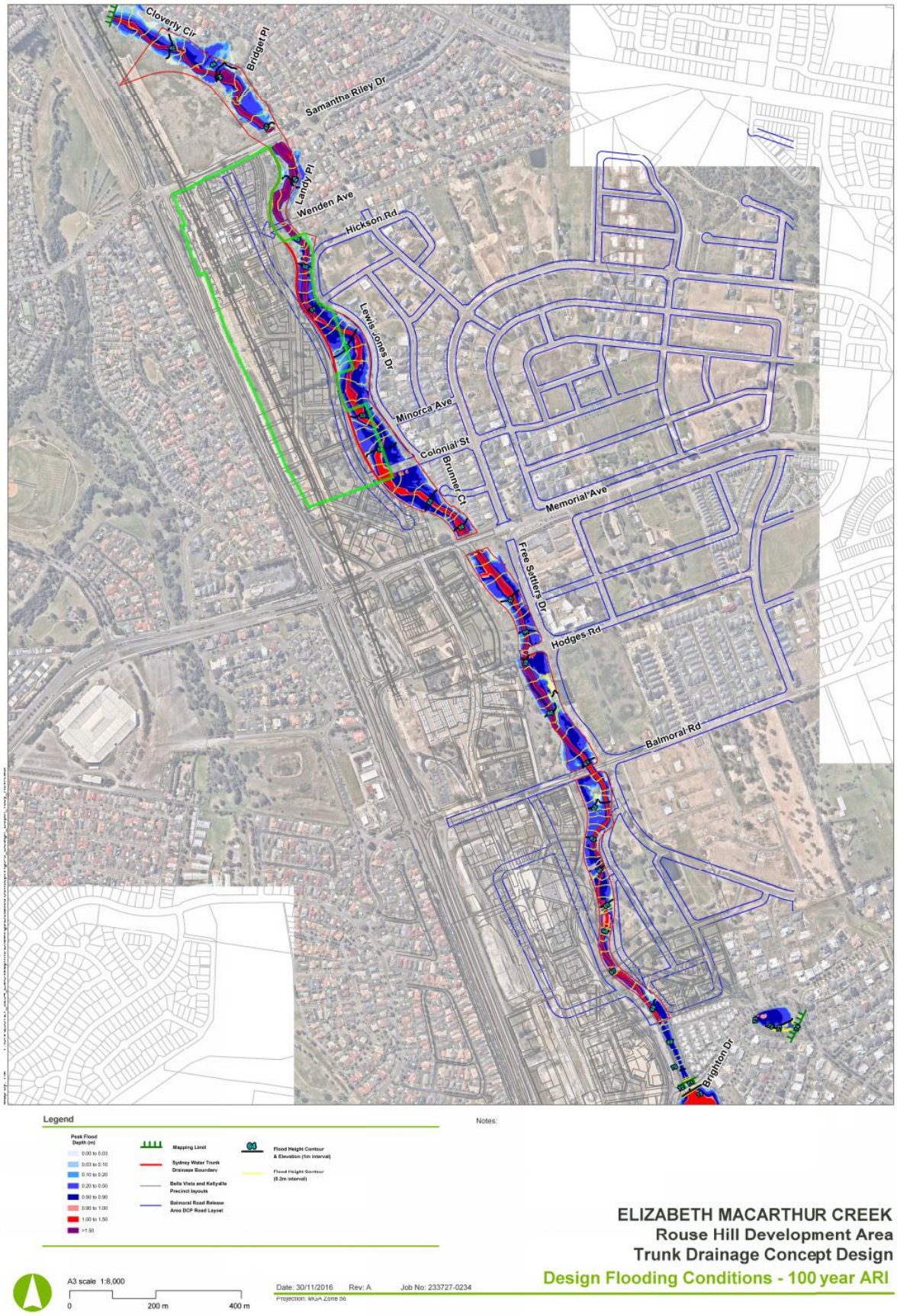


Figure 4.12 - Design Flood Condition (EMC Trunk Drainage Concept Report) - Site boundary indicatively marked green by Stantec

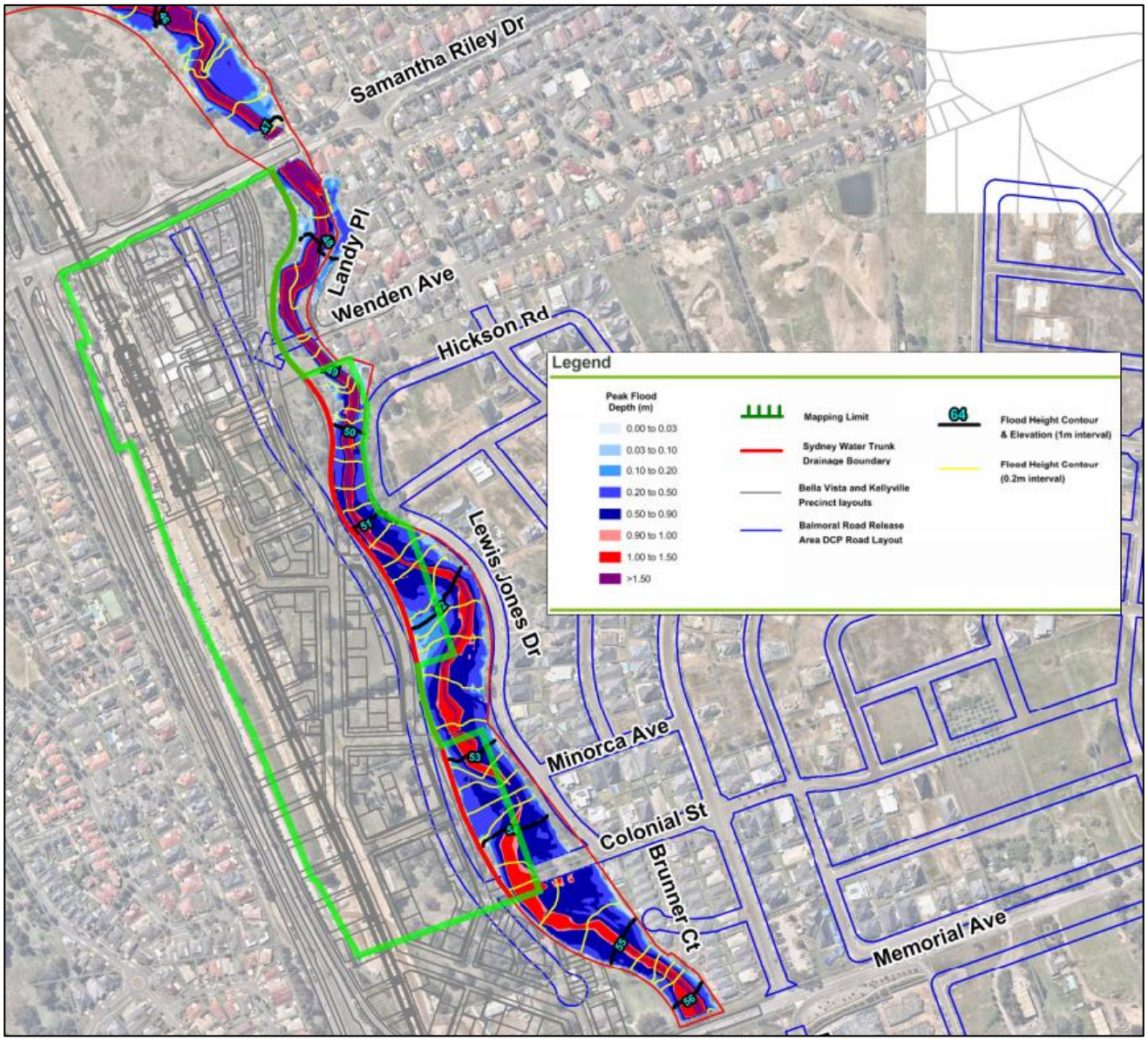


Figure 4.13 - Design Flood Condition - Site Area Only (EMC Trunk Drainage Concept Report) - Site boundary indicatively marked green by Stantec

4.1.4 Sydney Water response to Feasibility Application

A Feasibility Application for the proposed development was lodged with Sydney Water on 11 January 2019 and a response was received on 14 May 2019. A copy of Sydney Water's response letter is included in Appendix E. An excerpt from Sydney Water's response is included below:

> *"Any filling carried out as part of the development will need to be contained wholly within the boundaries of proposed lots and roads, and not encroach onto the 100-year flood boundary or Sydney Water land. Also, any fill will need to be stabilised in such a way so as to prevent any collapse or intrusion onto the trunk drainage lands over time. Details of the work adjacent to the Creek are to be submitted to ensure that these requirements are met.*
>
> - *Minor batter spill into the trunk drainage corridor is acceptable*
> - *Desirable maximum spill 1.5 metres at 3H:1V*
> - *Absolute maximum spill 2.0 metres at 3H:1V for short occasional isolated sections"*

Sydney Water were subsequently contacted and clarified the above requirements. The following additional advice was provided:

- Further encroachment and/or more gentle grading into the trunk drainage / SP2 zoned / Sydney Water land may be acceptable where it does not encroach upon the 100-year ARI flood zone. Such encroachment would be subject to Sydney Water's approval;
- Block retaining walls may be utilised in lieu of batters, as detailed in the EMC Trunk Drainage report and associated drawings.

4.2 Impact of Proposed Development on Flooding

The impact of the proposed development on flooding within EMC has been considered in the EMC Trunk Drainage Report. Please refer to Appendices C and D for details.

At the time of preparation of the EMC Trunk Drainage Report the nature of the proposed development of the Site was not fully understood. Based on current urban design plans, the impact of the proposed development on EMC flooding will be less than anticipated in the EMC Trunk Drainage Report as only a portion of the area west of SP2 zoned land is proposed to be earth filled, rather than the entire area.

Two scenarios must be considered in assessing the impact of the development on flooding:

1. **The proposed development occurs subsequent to or concurrent with the works proposed in the EMC Trunk Drainage Report** - In this event the impact on flooding in EMC will be less than the forecast 'design' flood conditions in the EMC Trunk Drainage Report as the extent of fill within the flood zone is less than the amount anticipated; and
2. **The proposed development prior to the works proposed in the EMC Trunk Drainage Report** – In this event there would be an impact on existing flooding, however the impact is anticipated to be insignificant. The 'existing' flood conditions are not considered in either the Rouse Hill Flood Study or the EMC Trunk Drainage Report. The Rouse Hill Flood Study refers to the 'baseline' flood conditions, in which developable areas within the Study Area have reached ultimate yield. Given that the Study Area is yet to be developed to its ultimate yield, the extent of 'existing' flooding is less than the extent of 'baseline' flooding that has been considered in each study. Further to this, the encroachment into the flood zone is minor as depicted in Figure 4.14. Figure 4.14 is a marked excerpt from the EMC Trunk Drainage Report and shows that the encroachment of the proposed development upon the 'baseline' flood extents in the 100 year ARI event is minor and does not encroach beyond the flood fringe.

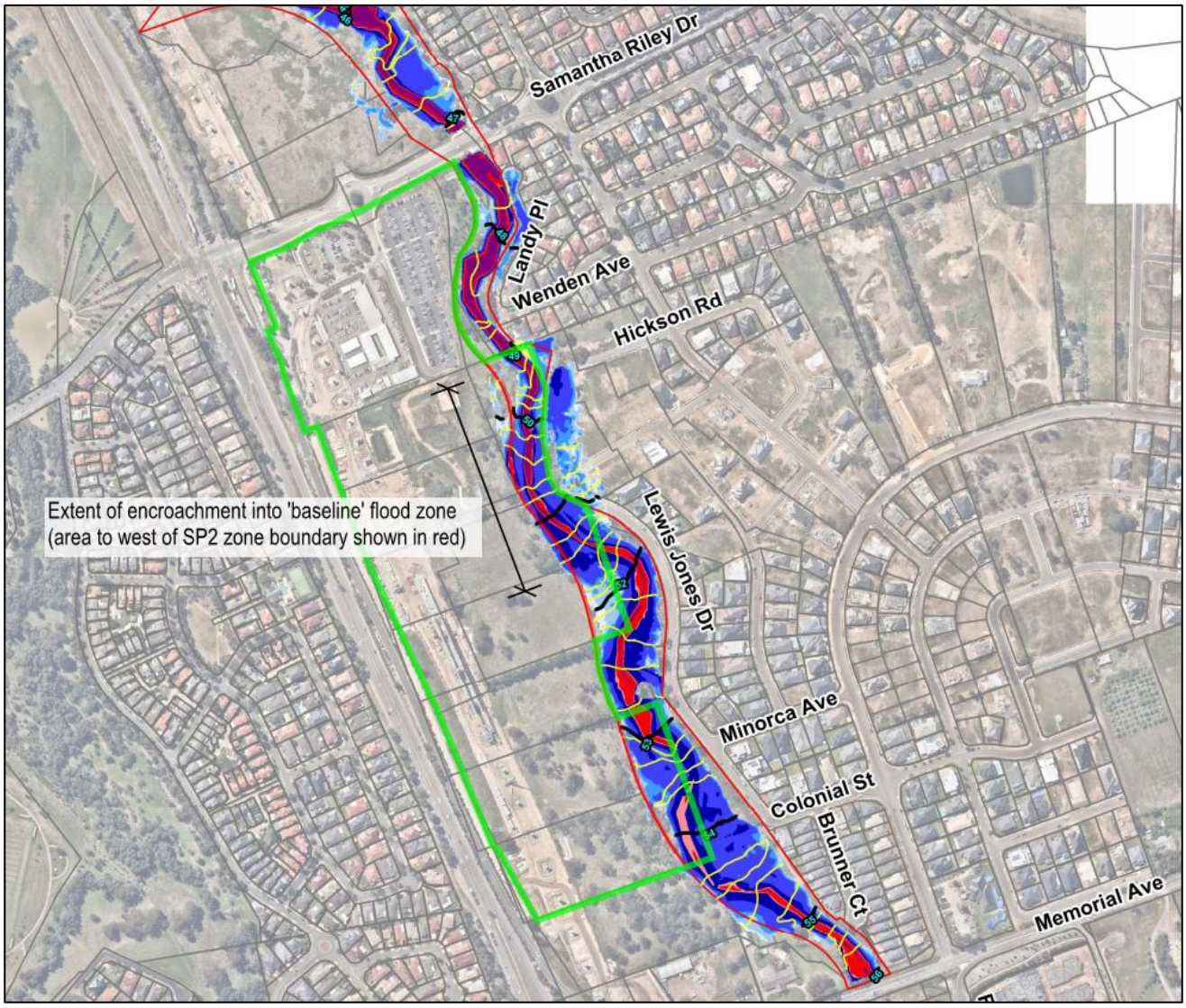


Figure 4.14 - Extent of proposed development encroachment into 'baseline' 100 year ARI flood zone (marked excerpt from EMC Trunk Drainage Report)

Based on the above, the proposed development has a nil effect on the flood emergency response of the community.

4.3 Flood Impact on Proposed & Future Development

The design of proposed Council infrastructure within flood affected areas of the Site must be performed in consultation with Sydney Water, with reference to the EMC Trunk Drainage Report and associated drawings, and in accordance with Council requirements. Generally, this will result in flood affected areas within the proposed development being earth filled such that surface levels are above the adjacent 100-year ARI flood level in EMC. The exception to this is non-habitable public reserve areas abutting EMC, which may potentially be filled to achieve a reduced clearance to flood levels if desired.

As the Site is generally proposed to be filled such that surface levels are above EMC flood levels, Flood Planning Levels for the future development of proposed lots within the Site will generally not be governed by EMC flood levels, but by the overland flows through the precinct within the public road corridors. Council's LEP states that:

> *"A minimum freeboard of 500 mm shall be provided between the 100-year flood level and habitable floor levels."*

Based on the above, Flood Planning Levels applicable to future development of proposed lots will be the higher of either (1) the 100 year ARI flood level in EMC plus 500mm freeboard or (2) the 100 year ARI overland flow level plus 500mm freeboard. Where overland flow levels vary around or within a proposed lot, the Flood Planning Level for future development will be based on the overland flow level at the applicable 'point of interest'. A 'point of interest' is typically a doorway/opening, basement entry ramp, or something similar in nature.

An overland flow assessment will be undertaken during design development of the proposed public road reserves to ascertain overland flow depths in the 100-year ARI event. These overland flow depths will subsequently be used to inform the Flood Planning Levels for the future development of each proposed lot.

4.4 Compliance

Based on the above review, the proposed development is compliant with the requirements of Clause 7.3 of Council's LEP (as referenced in Section 4.1.1 of this report).

4.5 Recommendations for Future Development

As the proposed development has been anticipated for some time by Sydney Water as owner of EMC, the EMC Trunk Drainage Report included in Appendix C makes numerous recommendations regarding more detailed development requirements, particularly regarding (1) the minimum elevation of any proposed infrastructure abutting the SP2 zoned area and (2) the interface treatment between the proposed infrastructure and EMC. These requirements shall be considered during future concept and detailed design of the proposed development.

5. Stormwater Conveyance

This section of the report investigates stormwater conveyance from/through the Site to the legal point of discharge.

5.1 Authority Requirements

Design requirements for stormwater management associated with proposed public infrastructure have been set in the Council's 'Design Guidelines for Subdivisions/Developments'.

Council's guidelines state the minimum requirements for the design of stormwater conveyance infrastructure.

Location	Minor System (ARI)	Major System (ARI)
General	10	100
Sag	20	100

Table 5.1 - Design Average Recurrence Intervals (ARIs)

An overland flow path will be provided for all public drainage systems (such as the proposed road network), regardless of whether 100-year ARI runoff can be conveyed solely within the associated pit and pipe network.

5.2 Drainage associated with future development of proposed lots

Drainage associated with future development of proposed allotments will be designed in accordance with both Council standards and AS3500.3 to convey minor event runoff from the (private) development to the public drainage system within road reserves via an in-ground pit and pipe network. Runoff in excess of the minor event will surcharge the in-ground pit and pipe network and discharge overland to public road reserves.

Figure 5.1 below depicts the stormwater conveyance mechanism for future development of proposed lots in minor storm events. Note that the water quality treatment component of the below is further investigated in the 'Stormwater Quality' section of this report.

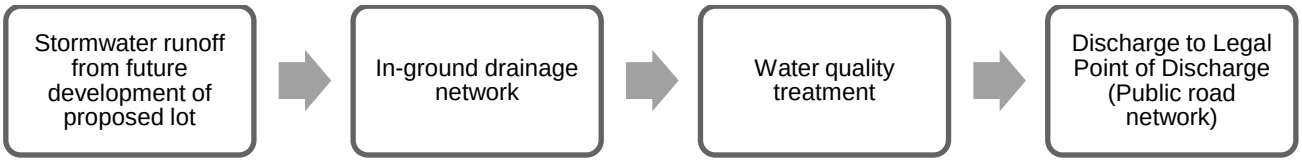


Figure 5.1 - Development Drainage Stormwater Conveyance Flow Chart

5.3 Drainage associated with public roads

5.3.1 Existing Public Roads

There are numerous existing public roads within the Site that were recently constructed by NRT.

Stormwater runoff from minor events is collected and conveyed via a conventional pit and pipe network. Stormwater ultimately discharges to EMC via a GPT, headwall and erosion protection measures. There are multiple discharge locations to EMC to suit road grading.

Stormwater runoff from major events is conveyed via a combination of the pit and pipe network and overland flow to low points in the road network adjacent to EMC. Stormwater ponds at these low points prior to overtopping kerb/verge and discharging to EMC.

5.3.2 Proposed Public Roads

Stormwater runoff from minor events is proposed to be drained via a conventional pit and pipe network in accordance with AS3500.3 and Council's stormwater drainage guidelines. The in-ground network is proposed to discharge to EMC via a GPT, headwall and erosion protection measures. It is envisaged that multiple discharge locations to EMC will be required to suit road grading. Discharge locations and details will be subject to future Sydney Water approvals.

Stormwater runoff from major events is proposed to be conveyed via a combination of the pit and pipe network and overland flow to low points in the road network adjacent to EMC. Stormwater will pond at these low points prior to overtopping kerb/verge and discharging to EMC in an uncontrolled manner.

Figure 5.2 below depicts the stormwater conveyance mechanism for proposed public roads in minor storm events.

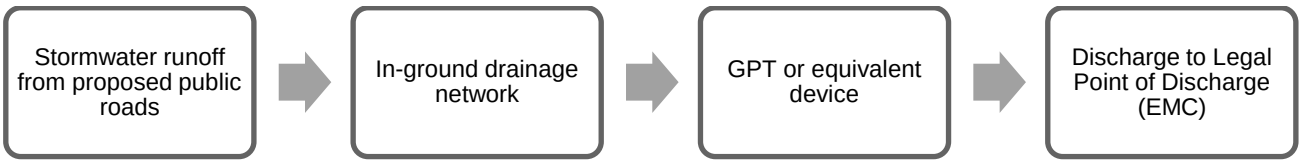


Figure 5.2 - Public Road Drainage Stormwater Conveyance Flow Chart

It is noted that stormwater runoff from smaller-scale minor events (e.g. the 3-month ARI event) is intended to discharge to street tree pits in lieu of the in-ground stormwater drainage network. This is further investigated in the 'Stormwater Quality' section of this report.

5.4 Public Reserve/Open Space Drainage

5.4.1 Impervious Areas

Stormwater runoff from minor events is proposed to be drained via either:

- A conventional pit and pipe network in accordance with AS3500.3 and Council's stormwater drainage guidelines. The in-ground network is proposed to discharge to either:
  - EMC via a GPT, headwall and erosion protection measures; or
  - The public road network; or
- Via overland flow to pervious areas within the public reserve.

The appropriateness of each of the above options must be assessed on a case-by-case basis. For example, it is not appropriate to formally collect and convey runoff from all footpath areas, however it may be appropriate to formally collect and convey runoff from more expansive impervious areas (such as plazas and community buildings).

Stormwater runoff from major events is proposed to be conveyed via overland flow to either the public road network or to EMC pending detailed grading of public reserve areas

Figure 5.3 below depicts the stormwater conveyance mechanism for impervious areas in proposed public reserves in minor storm events.

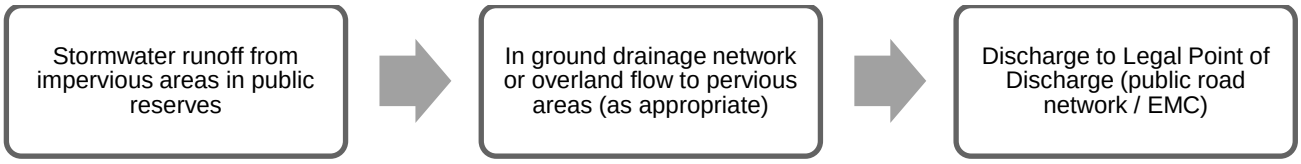


Figure 5.3– Public Reserve / Open Space (Impervious) Drainage Stormwater Conveyance Flow Chart

5.4.2 Pervious Areas

Minor event stormwater runoff from pervious areas in proposed local parks is not proposed to be formally collected. It is envisaged that stormwater runoff from minor events will discharge via infiltration to the groundwater table. Runoff in excess of the infiltration capacity of the pervious surface will be conveyed via overland flow to either the public road network or to EMC.

Minor event stormwater runoff from pervious areas in the proposed 0.67Ha neighbourhood park (between Blocks C & D in **Figure 3.1**) is proposed to be collected via in-ground infiltration and a subsoil drainage network and discharge to a rainwater reuse system. The rainwater reuse system will be owned and operated by Council and used to supply irrigation for the neighbourhood park. Generally, infiltrated stormwater will be collected by a series of subsoil drains discharging to a subsurface rainwater storage tank. Water stored in this tank will be used to irrigate the park via a pumped irrigation system. Runoff in excess of the infiltration capacity of the pervious surface will be conveyed via overland flow to either the public road network or to EMC.

Stormwater runoff from major events is proposed to be conveyed via overland flow to either the public road network or to EMC pending detailed grading of public reserve areas

Figure 5.4 below depicts the stormwater conveyance mechanism for pervious areas in proposed local public reserves in minor storm events.

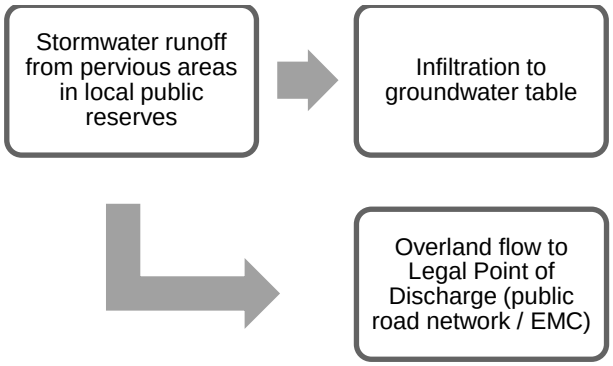


Figure 5.4– Local Public Reserve / Open Space (Pervious) Stormwater Conveyance Flow Chart

Figure 5.5 below depicts the stormwater conveyance mechanism for pervious areas in the proposed neighbourhood park in minor storm events.

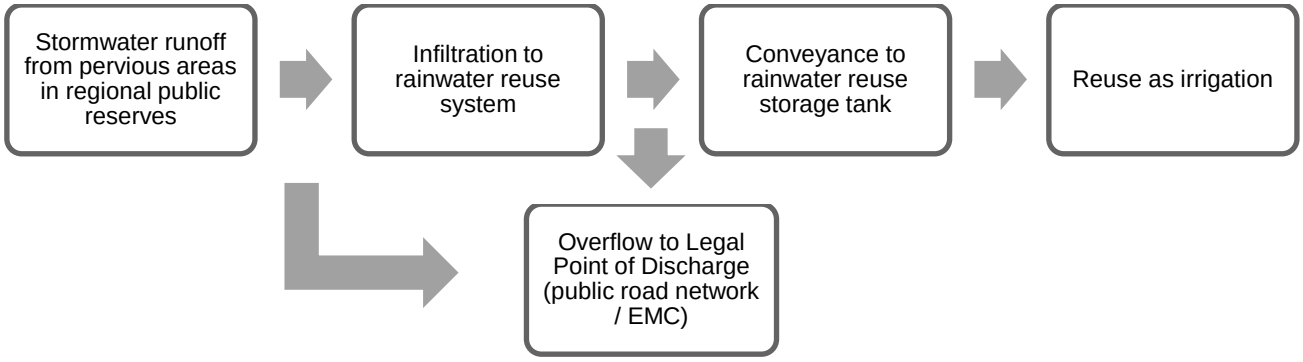


Figure 5.5 - Regional Public Reserve /Open Space (Pervious) Stormwater Conveyance Flow Chart

5.5 Legal Point of Discharge

For public infrastructure (road reserves and public reserves/open space) the Legal Points of Discharge from the Site will be to EMC. There will be a number of discharge points, as determined by the grading of proposed public roads. The nature and location of each discharge will be determined during detailed design and will be subject to Sydney Water approval.

For future development of proposed lots, the Legal Point of Discharge will be to public road reserves. The number, nature and location of each discharge will be determined during detailed design for development of each lot and will be subject to Council approval.

6. Stormwater Quantity

This section of the report investigates stormwater quantity in peak storm events.

As outlined in the 'Stormwater Conveyance' section of this report, stormwater from the Site will ultimately discharge to the Sydney Water owned Elizabeth Macarthur Creek. Sydney Water therefore set requirements for the control of stormwater discharge from the Site.

The EMC Trunk Drainage Report assessed the feasibility of upgrading the EMC trunk drainage corridor and sought to minimise the amount of land required for trunk drainage purposes and increase the quantum of land available for development.

The EMC Trunk Drainage Report adopted the flood modelling undertaken for the Rouse Hill Flood Study, refined it to focus only on EMC, and updated it to incorporate earth filling of the Site and flood mitigation measures in EMC. The Rouse Hill Flood Study made allowance for the ultimate development of the study area, which included development of the Site. The Rouse Hill Flood Study references an average impervious percentage of 66% over the study area, as outlined in Table 8 of the report. This hydrologic model was adopted and refined for the EMC Trunk Drainage Report (refer to Section 2.6.1 of the report). The flood modelling for the EMC Trunk Drainage Report therefore considers the post-development scenario for the Site.

Further to the above, both the Rouse Hill Flood Study and the EMC Trunk Drainage Report accounted for a variety of 'structures', 'basins' and the like within the study area (and outside of the Site) that serve a stormwater retention/detention purpose. Neither report references additional detention being required for proposed development of the Site. This has been confirmed by Sydney Water on various occasions during the consultation process in preparation of the SSD application. It is also noted that Sydney Water's 'Stormwater connections to natural waterways – Rouse Hill Development Area' does not reference a requirement for detention.

As flood modelling for the area accounts for un-detained runoff from the proposed development, no on-site detention is proposed.

As no detention is required to facilitate future development of proposed lots, the proposed public stormwater network will be sized to convey the unattenuated minor design storm runoff flows from proposed lots on the assumption that the proposed lots will be fully developed in the future (90% - 100% imperviousness). It is noted that the existing stormwater installed by NRT is sized for this percentage of impervious area for future development lots within the Site.

7. Stormwater Quality / Water Sensitive Urban Design

This section of the report investigates stormwater quality / WSUD proposed to be adopted to facilitate development of the Site.

7.1 Authority Requirements

7.1.1 Sydney Water

As the precinct will discharge to the Sydney Water owned Elizabeth Macarthur Creek, Sydney Water set the requirements for the control of stormwater quality discharging to the Creek.

In the aforementioned response to the Feasibility Application, Sydney Water reference "Stormwater Connections to Natural Waterways – Rouse Hill Development Area", which stipulates the following ideal water quality outcomes:

Pollutant	Post-Development Pollutant Load Reduction Objective (%)
Gross Pollutants (>5mm)	90
Total Suspended Solids	85
Total Phosphorus	65
Total Nitrogen	45

Table 7.1 - Post-development pollution reduction targets prior to discharge to EMC

7.1.2 Council

Council set stormwater quality requirements for private development prior to discharge to public infrastructure. As part of a previous planning application for the Kellyville Station Precinct in May 2018, Council proposed the following draft Development Control Plan (DCP) controls, which are proposed to be adopted moving forward with minor amendment as shown in red below.

"Water Sensitive Urban Design

1. *Water Sensitive Urban Design (WSUD) principles and techniques are to be adopted for all development to provide sustainable and integrated management of land and water resources, incorporating best practice stormwater management, water conservation and environmental protection measures.*
2. *Stormwater runoff must be treated on the development site before it discharges to a public drainage system or into land zone SP2 Infrastructure (Stormwater Management System).*
3. *A WSUD Management Plan is to be prepared for all development. This plan can be incorporated into the Stormwater Management Plan.*
4. *A WSUD Management Plan is to take into account water quality and stream erosivity objectives, together with attenuating flow rates and runoff volumes to acceptable levels following urban development. Water management performance objectives are set out in Table 5.*

Table 5 – Water Quality & Stream Erosivity Performance Objectives

	Water Quality % Reduction in Pollution Loads				*Environmental Flows Stream Erosivity Control Ratio*
	Gross Pollutants (>5mm)	*Total Suspended Solids*	*Total Phosphorous*	*Total Nitrogen*	*Post Development Duration of above 'Stream Forming Flow' Natural Duration of Above 'Stream Forming Flow'*[1]
Stormwater Management Objective	*90*	*85*	*65*	*45*	*3.5 – 5.0 : 1*
Ideal Stormwater Outcome	*100*	*95*	*95*	*85*	*1 : 1*

1. *For the purposes of these objectives, the 'stream forming flow' is defined as 50% of the 50% AEP flow rate estimated for the catchment under natural conditions. This ratio should be minimised to limit stream erosion to the minimum practicable. Development proposals should be designed to achieve a value as close to one as practicable, and values within the nominated range should not be exceeded. A specific target cannot be defined at this time.*

5. *Industrial/commercial/residential flat building developments within the Precincts are required to manage the pollutant loads from each separate allotment to ensure compliance with the performance objective listed in Table 5 prior to discharge to any adjoining drainage system.*
6. *Water quality modelling undertaken to support development proposals within the Precincts shall utilise MUSIC Version 5 (or later) and be in line with the ~~Draft~~ NSW MUSIC Modelling Guidelines, Sydney Metropolitan Catchment Management Authority, 2010, utilising the modelling parameters in Tables 6 & 7.*

Table 6 – Soil/groundwater parameters recommended for adoption in MUSIC modelling

	Units	*Urban*	*Non-Urban*
Impervious area parameters			
Rainfall threshold	*mm/day*	*1.4*	*1.4*
Pervious area parameters			
Soil storage capacity	*mm*	*170*	*210*
Initial storage	*% of capacity*	*30*	*30*
Field capacity	*mm*	*70*	*80*
Infiltration capacity coefficient – a		*210*	*175*
Infiltration capacity coefficient – b		*4.7*	*3.1*
Groundwater properties			
Initial depth	*mm*	*10*	*10*
Daily recharge rate	*%*	*50*	*35*
Daily baseflow rate	*%*	*4*	*20*
Daily seepage rate	*%*	*0*	*0*

Table 7 – Recommended Stormwater Quality Parameters for MUSIC modelling

Land use	Storm Flow						Base Flow					
	TSS		TP		TN		TSS		TP		TN	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	(all values expressed as log_{10} mg/l)											
General urban	2.15	0.32	-0.60	0.25	0.30	0.19	1.20	0.17	-0.85	0.19	0.11	0.12
Residential												
Industrial												
Commercial												
Roads	2.43	0.32	-0.30	0.25	0.34	0.19	-	-	-	-	-	-
Roofs	1.30	0.32	-0.89	0.25	0.30	0.19	-	-	-	-	-	-
Forest/Natural	1.60	0.32	-1.10	0.25	-0.05	0.19	0.78	0.17	-1.52	0.19	-0.52	0.12

Note: SD = standard deviation, TSS = total suspended solids, TP = total phosphorous, and TN = total nitrogen.

7. *For developments generating oil and grease, ~~the additional objective of no visible oils for flows up to 50% of the one-year ARI peak flow shall be achieved~~ an oil/grease/floatables baffle shall be installed in a discharge control pit within the lot prior to discharge to Council's drainage network.*
8. *WSUD infrastructure elements are to be designed and constructed in accordance with the following publications:*
   - *Australian Runoff Quality (Engineers Australia 2005);*
   - *Water Sensitive Urban Design Technical Guidelines for Western Sydney (NSW Government Stormwater Trust and UPRCT, May 2004);*
   - *Adoption Guidelines for Stormwater Biofiltration Systems – Cities as Water Supply Catchments – Sustainable Technologies (CRC for Water Sensitive Cities, 2015);*
9. *As part of a WSUD management plan, residential, employment and commercial developments are to install rainwater tanks to meet a portion of water supply demand such outdoor use, laundries and toilets. With the exception of detached residential dwellings, a water balance assessment is to be undertaken for the development and rainwater tanks appropriately sized to cater for the water use demand. The following provisions apply for each development type:*

   Detached residential dwellings

   a. *All residential dwellings are required to provide a (minimum) 3,000 litre rainwater tank and such tank is to be connected for use in toilet flushing and external uses. Larger tanks than the minimum requirement are permitted.*
   b. *The rainwater tank must be connected to laundries as well as being available for outdoor use including filling of swimming pools.*

   Multi Dwelling Housing

   a. *The minimum storage capacity of this system must be 3,000 litres per proposed dwelling or as defined by a detailed water balance assessment of the development.*
   b. *Rainwater tanks may be connected to laundries as well as being available for outdoor use including filling of swimming pools.*

Residential Flat, Mixed Use and Commercial Buildings

a. *The capacity of rainwater tanks to be provided on the development is to be determined through a detailed water balance assessment.*

b. *The tanks are to be used for external uses only and may only be used for other purposes such as any washdown bays and laundry facilities.*

10. *Each rainwater tank is to be provided with ~~potable~~ recycled water trickle top-up with a back flow prevention device, complying with Sydney Water requirements.*

11. *In accordance with the recommendations made in the publication "Guidance on the Use of Rainwater Tanks" (enHealth, Commonwealth Government 2004), diversion of the "first flush" of up to 180 litres is to be incorporated into the design of the rainwater tank and associated plumbing based on a ~~minimum~~ first flush of ~~1L/m²~~ 0.5L/m² - 2L/m² of roof area.*

Generally, all future development of proposed allotments will be subject to Council's stormwater quality requirements.

7.2 Potential Pollutants

There are a wide range of potential stormwater pollutant sources which occur from urbanised catchments, many which can be managed through appropriate stormwater quality treatment. Typical urban pollutants include:

- Atmospheric deposition;
- Erosion (including that from subdivision and building activities);
- Litter and debris;
- Traffic emissions and vehicle wear;
- Animal droppings;
- Pesticides and fertilisers;
- Application, storage and wash-off of car oil, detergents and other household and commercial solvents and chemicals;
- Solids accumulation and growth in stormwater systems; and
- Weathering of buildings

These pollutants in urban stormwater can be placed into various categories as follows. The pollutants underlined below can be readily modelled:

- Suspended Solids;
- Litter (or gross pollutants);
- Nutrients such as Nitrogen and Phosphorous;
- Biological oxygen demand and chemical oxygen demand materials;
- Micro-organisms;
- Toxic organics;
- Trace metals; and
- Oils and surfactants

While only the key pollutants underlined above can be readily modelled, the stormwater quality treatment measures implemented are expected to assist in reducing a wide range of pollutants. For example, heavy metals are commonly associated with and bound to fine sediments, thus reducing the discharge of fine sediment during the construction and operational phases will also reduce the discharge of heavy metals to existing stormwater systems.

7.3 Pollutant Reduction System

7.3.1 Pollutant Reduction Modelling

To demonstrate that the proposed treatment train meets the required reduction targets, pollutant reduction modelling is proposed using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software by eWater CRC. Pollutant export rates are currently only available for Total Suspended Solids (TSS), Total Nitrogen (TN), Total Phosphorous (TP) and Gross Pollutants (GP), therefore only quantitative modelling for TSS, TN, TP & GP has been undertaken using MUSIC.

Modelling has been undertaken on the post-development scenario (including proposed treatment) to demonstrate the percentage reduction for each pollutant type.

7.3.2 MUSIC Model Establishment

This section explains the setup of the MUSIC model with the detailed pollutant reduction calculations being included in the MUSIC results in Appendix G.

For MUSIC modelling the following parameters have been used:

Model Parameters	
Meteorological Data	Parramatta Road (Masons Drive) 1984 - 2010
Evaporation Data	Parramatta Road (Masons Drive) 1984 - 2010
Time Step	6 minutes

Table 7.2 - MUSIC Model Parameters

The following properties have been used in the MUSIC Modelling based on the Land Use Rainfall and Pollutant Parameters. It is noted that these parameters are generally more conservative than those proposed by Council in the draft DCP controls. This is to allow some factor of safety to account for the conceptual modelling performed at this preliminary stage.

Parameter	Urban Residential
Rainfall Threshold (mm)	1 (General)
	0.3 (Roof)
	1.5 (Sealed Roads)
Soil Capacity (mm)	54
Initial Storage (%)	10
Field Capacity	51
Infiltration Capacity Coefficient a	135
Infiltration Capacity Coefficient b	4
Initial Depth (mm)	50
Daily Recharge Rate (%)	10
Daily Drainage Rate (%)	10
Daily Deep Seepage Rate (%)	0

Table 7.3 - Recommended MUSIC Runoff Generation Parameters

Land-use Type	Parameter	Total Suspended Solids (TSS) Log_{10} mg/L		Total Phosphorous (TP) Log_{10} mg/L		Total Nitrogen (TN) Log_{10} mg/L	
		Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow
Urban Residential	Mean	1.20	2.15	-0.85	-0.60	0.11	0.30
	Standard Deviation	0.17	0.32	0.19	0.25	0.12	0.19
Urban Roof	Mean	N/A	1.30	N/A	-0.89	N/A	0.30
	Standard Deviation	N/A	0.32	N/A	0.25	N/A	0.19
Sealed Roads	Mean	1.2	2.43	-0.85	-0.30	0.11	0.34
	Standard Deviation	0.17	0.32	0.19	0.25	0.12	0.19

Table 7.4 - MUSIC Source Node Concentration Parameters for Sydney Catchments

7.3.3 Existing Private Allotments

Existing private allotments have previously been created by NRT to facilitate opening of the Kellyville Station. Specifically, the station site and the on-grade and multi-level carparking immediately south of the station. While details of WSUD infrastructure installed in each private allotment are unknown, based on review of engineering drawings it appears that WSUD infrastructure has been installed to meet typical Council standards.

Existing private allotments constructed by NRT incorporate the following stormwater quality treatment:

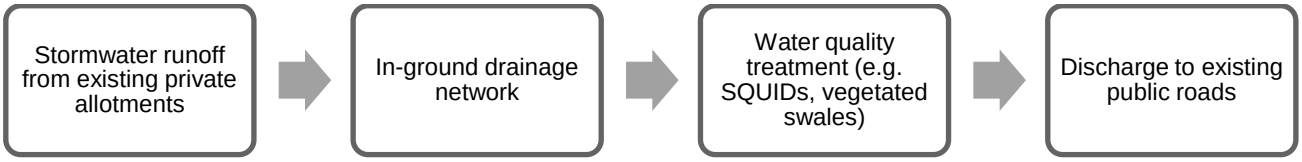


Figure 7.1 – Treatment Train for Existing Private Allotments Constructed by NRT

It is assumed that existing private allotments created by NRT have achieved typical Council WSUD targets in accordance with the table below.

Pollutant	Post-Development Pollutant Load Reduction Objective (%)
Gross Pollutants (>5mm)	90
Total Suspended Solids	85
Total Phosphorus	65
Total Nitrogen	45

Table 7.5 - Assumed Post-Development Pollutant Reduction Results – Existing Private Lots Constructed by NRT

7.3.4 Existing Public Roads

The existing public roads constructed by NRT incorporate the following stormwater quality treatment:

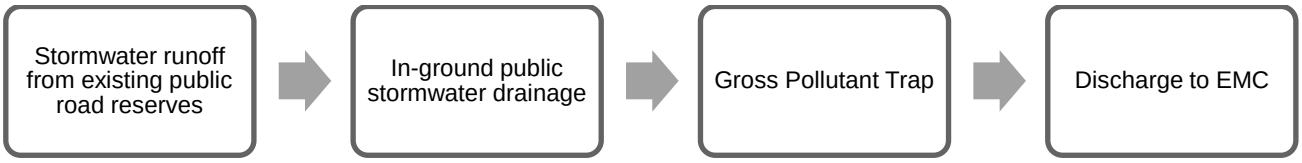


Figure 7.2 – Treatment Train for Existing Public Roads Constructed by NRT

Modelling the existing road corridors in MUSIC the pollutant reduction values summarised below were calculated.

Pollutant	Post-Development Pollutant Load Reduction (%)	Post-Development Pollutant Load Reduction Objective (%)
Gross Pollutants (>5mm)	98.0	90
Total Suspended Solids	59.9	85
Total Phosphorus	9.4	65
Total Nitrogen	0	45

Table 7.6 - Post-Development Pollutant Reduction Results – Existing Public Roads Constructed by NRT

It is noted that existing public roads constructed by NRT do not appear to incorporate current best-practice WSUD. This is evidenced by failure to comply with the above WSUD objectives.

7.3.5 Future Development of Proposed Lots

To facilitate modelling of water quality treatment for the entire precinct, it has been assumed that all future development of proposed lots will be required to achieve Council-specified pollutant reduction targets prior to discharging to the public drainage network, as specified in the table below.

Pollutant	Post-Development Pollutant Load Reduction Objective (%)
Gross Pollutants (>5mm)	90
Total Suspended Solids	85
Total Phosphorus	65
Total Nitrogen	45

Table 7.7 - Post-Development Pollution Reduction Targets - Future Development of Proposed Lots

It will be the future developer's responsibility to achieve these objectives via means appropriate for the development. These will be subject to future Council approval.

7.3.6 Proposed Precinct Treatment

The following stormwater quality treatment train is proposed for the Site:

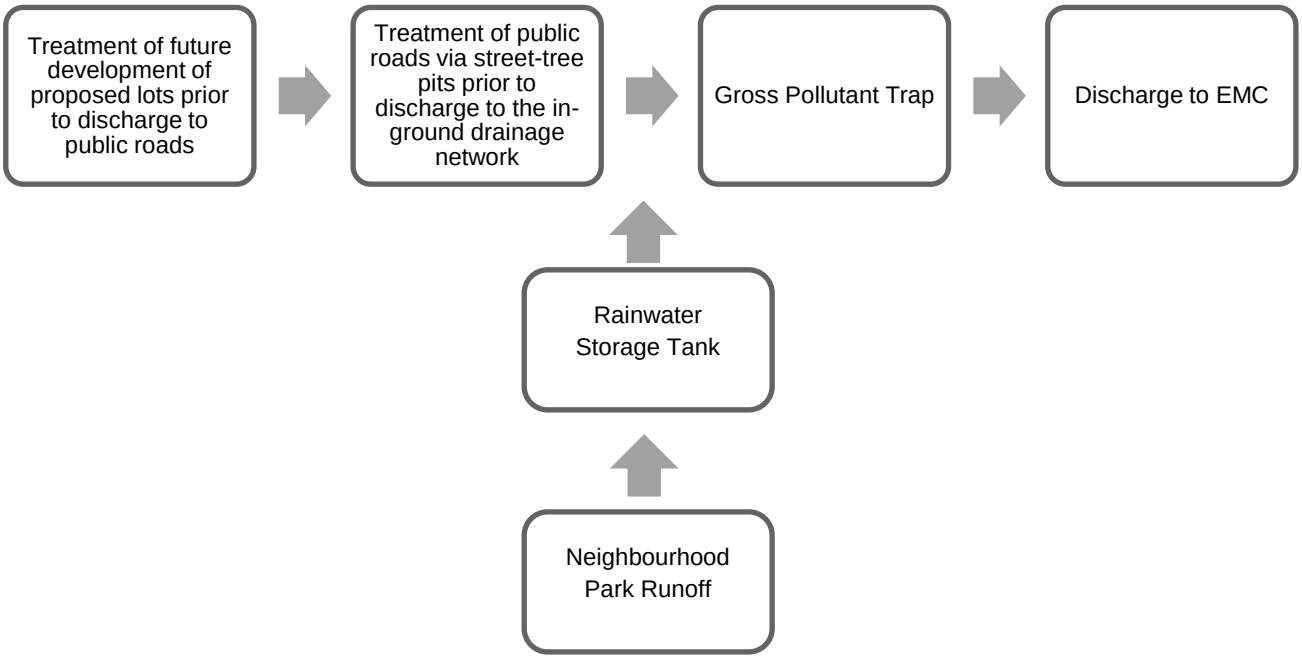


Figure 7.3 - Proposed Treatment Train for the Site

Further background regarding WSUD modelling and the associated treatment train is included in the Concept Water Cycle Management Plans included in Appendix F**.**

Noting that existing roads previously constructed by NRT do not appear to comply with current best practice WSUD objectives, MUSIC modelling of the Site in its entirety (including existing roads) yielded the following pollutant reduction values.

Pollutant	Post-Development Pollutant Load Reduction (%)	Target (%)
Gross Pollutants (>5mm)	99.5	90
Total Suspended Solids	77.3	85
Total Phosphorus	52.0	65
Total Nitrogen	37.4	45

Table 7.8 - Estimated Pollution Reduction Results - Proposed Precinct Including Existing Roads

As can be noted above, Sydney Water's ideal WSUD objectives for the Site in its entirety have not been met.

Alternative modelling has been undertaken to exclude existing roads constructed by NRT (including only proposed and future works). The alternative modelling yielded the following reduction values.

Pollutant	Post-Development Pollutant Load Reduction (%)	Target (%)
Gross Pollutants (>5mm)	99.9	90
Total Suspended Solids	85.3	85
Total Phosphorus	66.4	65
Total Nitrogen	46.3	45

Table 7.9 - Estimated Pollutant Reduction Results - Proposed Precinct Excluding Existing Roads

By removing the existing roads constructed by NRT from MUSIC modelling it can be seen above that the stormwater pollutant reduction targets can potentially be met by the proposed treatment train.

Stantec performed an assessment of the works that would be required to retrofit additional water quality treatment measures to the existing roads. This assessment determined that works to increase the stormwater quality treatment for existing roads would necessitate significant reworks of recently constructed roads.

It is noted that all calculations within this report are preliminary only. The concept-level modelling performed to support the subject SSD application is subject to further review pending detailed design. It is noted that multiple assumptions have been made as specified in this report.

7.4 Proposed Treatment Devices

7.4.1 Tree Pits

Tree pits are proposed within proposed public road reserves and are intended to be owned and maintained by Council. Tree pits provide stormwater quality treatment through infiltration.

Rainfall runoff from road reserves is proposed be conveyed as overland flow along kerb & gutter towards the tree pits. The kerb at the tree pit locations will be designed to allow overland flow to discharge to the tree pits, providing passive irrigation to the tree and vegetation in the pit. Stormwater will infiltrate into soil within the tree pit, removing suspended solids and binding pollutants to the soil. A portion of the infiltrated water will be consumed by trees via osmosis. The remaining water will be collected at the bottom of the tree pit via a subsoil drainage network discharging to the in-ground public stormwater drainage network.

Figure 7.4 - Typical Street Tree Pit

Tree pits have been modelled in MUSIC as an infiltration node with the following properties:

Item	Unit	Value
Inlet Properties		
Low Flow By-pass	m^3/s	0
High Flow By-pass	m^3/s	100
Storage Properties		
Extended Detention Depth	m	0.05
Surface Area	m^2	430
Exfiltration Rate	mm/hr	0
Filtration Properties		
Filter Area	m^2	430
Filter Depth	m	0.8
Filter Media Particle Diameter	mm	0.45
Saturated Hydraulic Conductivity	mm/hr	125
Depth below underdrain pipe	% of Filter Depth	0
Outlet Properties		
Overflow Weir Width	m	2 (per pit)

Table 7.10 - Street Tree Pit MUSIC Modelling Parameters

It is noted that the number and location of tree pits is subject to detailed geometric design of roads and associated car parking. For the purposes of MUSIC modelling it has been assumed that tree pits will be located at regular intervals on both sides of the road. Preliminary landscape concepts indicate that two $5m^2$ street tree pits will be located for every two proposed on-street car bays. For the purposes of MUSIC modelling a more conservative approach has been undertaken as outlined below.

- Allowance has been made for 1 tree pit every 30 linear metres of proposed road, on both sides of the road. This is less than is referenced in landscape design as the number of parking bays and tree pits will be limited by detailed geometric road design (e.g. intersections, lot accesses, pram ramps); and
- 25% of all proposed road areas will bypass tree pits. It is likely that some portion of road runoff will bypass tree pits as a result of detailed road and stormwater design. A 25% allowance is a conservative estimate.

The above allowances have been made to ensure that the number of tree pits allowed in preliminary MUSIC modelling is achievable. The number of tree pits ultimately installed should be increased wherever possible in conjunction with engineering and landscape design, and the quantity of road runoff that bypasses tree pits should be minimised wherever possible. This can be achieved via regular and strategic location of street trees and via the use of low-flow bypass stormwater inlet pits.

7.4.2 Public Reserve / Open Space Infiltration

Infiltration will naturally occur in pervious areas within public reserves. This serves as an effective stormwater quality treatment measure for low flows.

Rainfall on public reserves will be conveyed in accordance with the ‘Stormwater Conveyance’ section of this report.

A detail of this arrangement is provided overleaf.

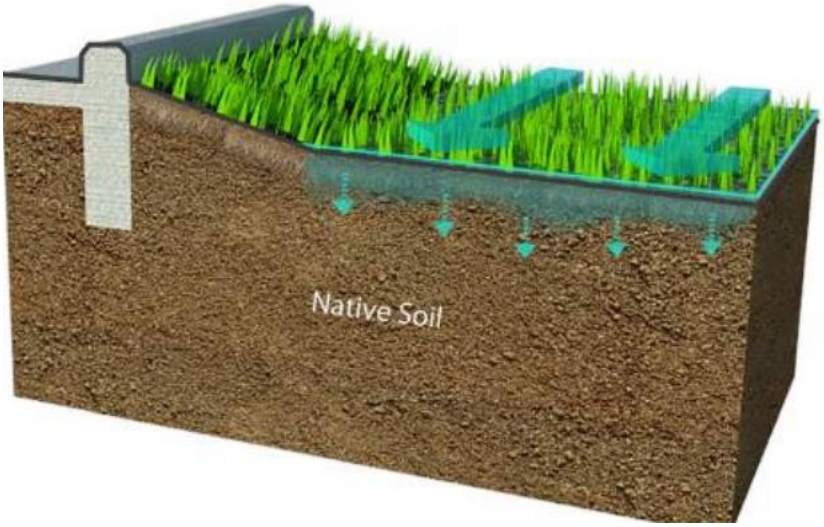


Figure 7.5 - Public Reserve (Open Space) Infiltration

Public reserves have been modelled in MUSIC as an infiltration node with the following properties:

Item	Unit	Value
Inlet Properties		
Low Flow By-pass	m^3/s	0
High Flow By-pass	m^3/s	100
Storage Properties		
Extended Detention Depth	m	0.03
Surface Area	m^2	12,459
Exfiltration Rate	mm/hr	0
Filtration Properties		
Filter Area	m^2	12,459
Filter Depth	m	0.3
Filter Media Particle Diameter	mm	0.45
Saturated Hydraulic Conductivity	mm/hr	100
Depth below underdrain pipe	% of Filter Depth	0
Outlet Properties		
Overflow Weir Width	m	100

Table 7.11 - Pervious Public Reserve MUSIC Modelling Parameters

7.4.3 Rainwater Re-use

The neighbourhood park is proposed to incorporate a rainwater re-use system as proposed in the 'Stormwater Conveyance' section of this report. The rainwater reuse system is intended to be owned and maintained by Council.

The storage volume for the subsurface storage tank has been modelled to provide enough stored water to reduce the non-potable water usage for irrigating the regional parks by up to 45% - 50%.

It is noted that adoption of a rainwater reuse scheme for the neighbourhood park reserve has the following advantages:

- Provides a sustainable method for irrigating the parks throughout the year by reducing the amount of mains water required. It is noted that a recycled water network is proposed for the development and this will be utilised to top-up the rainwater tank when necessary;
- Reduces the cost to Council for irrigating the parks;
- Reduces the volume of water discharging into the EMC reducing erosion issues along the creek;
- Assists in achieving a better water quality for stormwater discharging from the precinct to the EMC.

Storage is proposed to be provided in underground storage tanks. By placing these tanks underground there will be no impact on available public space or aesthetics within the regional park.

The flow chart below shows the process for the reuse.

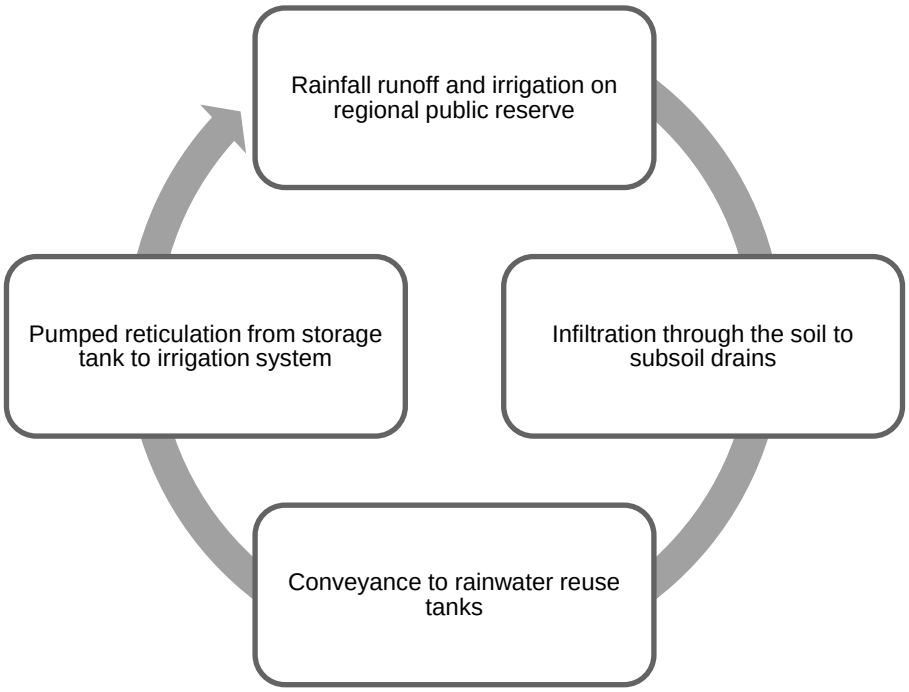


Figure 7.6 - Rainwater Reuse Cycle in Regional Public Reserves

For modelling purposes in MUSIC the reuse system has been modelled as an infiltration node and rainwater tank with the following properties.

Item	Unit	Value
Inlet Properties		
Low Flow By-pass	m^3/s	0
High Flow By-pass	m^3/s	100
Storage Properties		
Number of Tanks	No	1
Filtration Properties		
Volume below overflow pipe	kL	650
Depth above overflow pipe	m	0.2
Surface Area	m^2	550
Outlet Properties		
Overflow Pipe Diameter	mm	50
Rainwater Re-Use Properties		
Annual Demand	kL/year	2,671.2 (= 0.4 kL/year/m^2 x 6,678 m^2)
Distribution	N/A	PET

Table 7.12 - Public Reserve Rainwater Reuse MUSIC Modelling Parameters

7.4.4 Gross Pollutant Traps

For each discharge point into the EMC a Gross Pollutant Trap is proposed to be installed directly upstream of the discharge headwall. The GPTs are intended to be located within the public road reserve and are intended to be owned and maintained by Council. The indicative location and number of GPTs is demonstrated on the plans included in Appendix F. GPTs trap large pollutants such as litter, preventing them discharging into the waterway.

A detail of a typical Gross Pollutant Trap is provided below.

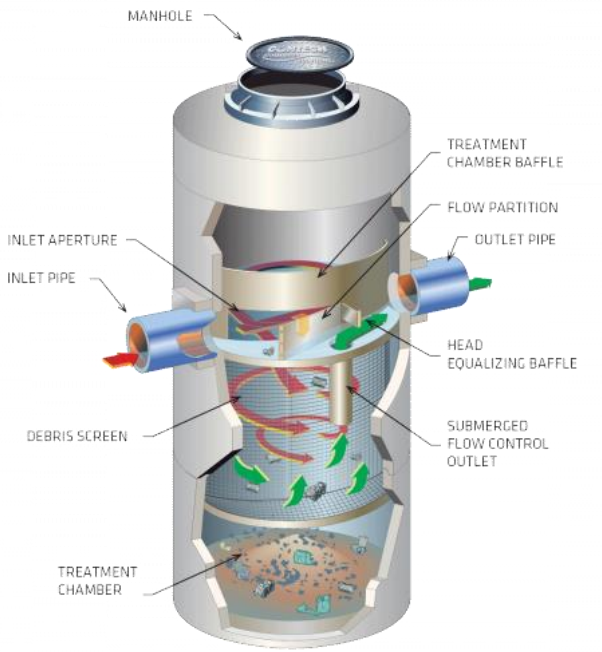


Figure 7.7 - Typical Gross Pollutant Trap (GPT)

Gross Pollutant Traps have been modelled in MUSIC as a Generic node with the following properties:

Item	Unit	Value
Inlet Properties		
Low Flow By-pass	m^3/s	0
High Flow By-pass	m^3/s	10
Target Element – Gross Pollutants		
Transfer Function – Concentration Based Capture Efficiency		
Initial Input	kg/ML	0
Initial Output	kg/ML	0
Final Input	kg/ML	100
Final Output	kg/ML	2

Table 7.13 - Gross Pollutant Trap MUSIC Modelling Parameters

7.5 Sydney Water Regional Stormwater Harvesting Pipeline and Related Drainage Works

Through discussions with Sydney Water during the stakeholder consultation process, Sydney Water advised that they are investigating the feasibility of incorporating a Regional Stormwater Harvesting System (also known as a Stormwater Interception Pipeline) system along the EMC corridor.

In simple terms, the system is understood to involve the following:

- Collecting 'low-flow' stormwater runoff from the Site and other adjacent areas that currently discharge to EMC;
- Storing and conveying this stormwater to a regional treatment plant;
- Treating the stormwater; and
- Using treated stormwater to supplement the recycled water system in the area.

There are numerous benefits to the incorporation of such a system, including but not limited to:

- Reduction of mean-annual runoff volume (MARV) and flood-event runoff volume (FERV) to EMC*;
- Reduction of pollutants to EMC; and
- Reduction of potable water supply required to supplement Sydney Water's recycled water network.

**It is noted that the concept of both MARV and FERV have recently been introduced to the WSUD lexicon by Sydney Water. Through the stakeholder consultation process, Sydney Water have advised that they are in the process of developing a 'Stormwater Retention and Detention for WSUD' guideline that is intended to expand upon what is currently considered best-practice WSUD and address MARV and FERV more directly. Upon its release to the public, it is recommended that consideration be given to incorporation of the guidelines in WSUD design for the Site.*

The Regional Stormwater Harvesting System is generally understood to be (at least in concept) a more holistic means of managing broader water cycle management, incorporating both current best-practice WSUD and expanding upon it, while also considering the potential use of stormwater to supplement water supply. The installation of a Regional Stormwater Harvesting System between the Site and EMC may potentially remove/reduce the requirement to incorporate the WSUD measures aforementioned in this report and may result in a significant reduction in the quantity of potable water used to supplement the recycled water supply.

At the time of submission of this report, Sydney Water are reviewing the feasibility of the Regional Stormwater Harvesting System and as such it is not possible to rely on its future incorporation to facilitate development of the Site. It is recommended that WSUD measures for the Site are reviewed as further updates become available from Sydney Water.

8. Erosion & Sedimentation Control

This section of the report discusses the erosion and sedimentation control measures to be implemented during construction of the precinct in order to prevent the discharge of sediment from the works to EMC and prevent erosion caused by the discharge of stormwater to EMC during the construction of the precinct.

All erosion and sedimentation control measures adopted during the construction of the works are to be in accordance with the Landcom's "Managing Urban Stormwater – Soils and Construction – 4th Edition" manual and are subject to Council approval.

8.1 Future Development of Proposed Lots

The future developer of each proposed lot will be responsible for ensuring erosion and sedimentation controls are established during the construction of the development. These measures are to be constructed to ensure no sediment is discharged into the surrounding public drainage networks or directly into the EMC.

As a minimum the following measures should be considered:

- Sediment fences should be installed along all downstream boundaries of the development lot to prevent sediment discharging overland onto the public areas.
- A sediment basin should be installed within the site at the lowest point to allow for the storage of sediment within the site boundary.
- Flocculation processes should be incorporated into the site management procedures to ensure the removal of suspended soils from all stormwater draining from the site sediment basins into the public stormwater drainage network.
- Shaker grids and vehicle wash down areas should be provided at any site exit areas to ensure construction vehicles do not track soils and site materials into the public areas.
- All downstream stormwater inlet structures likely to be impacted by the construction works on site are sandbagged to prevent sediment entering the public drainage network.

8.2 Public Road Reserves and Public Reserves / Open Space

During the construction of the public roads the constructor of the works will be responsible for ensuring erosion and sedimentation controls are established and maintained for the duration of the works. These measures are to ensure no sediment is discharged into the surrounding public drainage networks or directly into the EMC.

Measures similar to those proposed above are anticipated to be required for construction of proposed public roads.

9. Development Staging

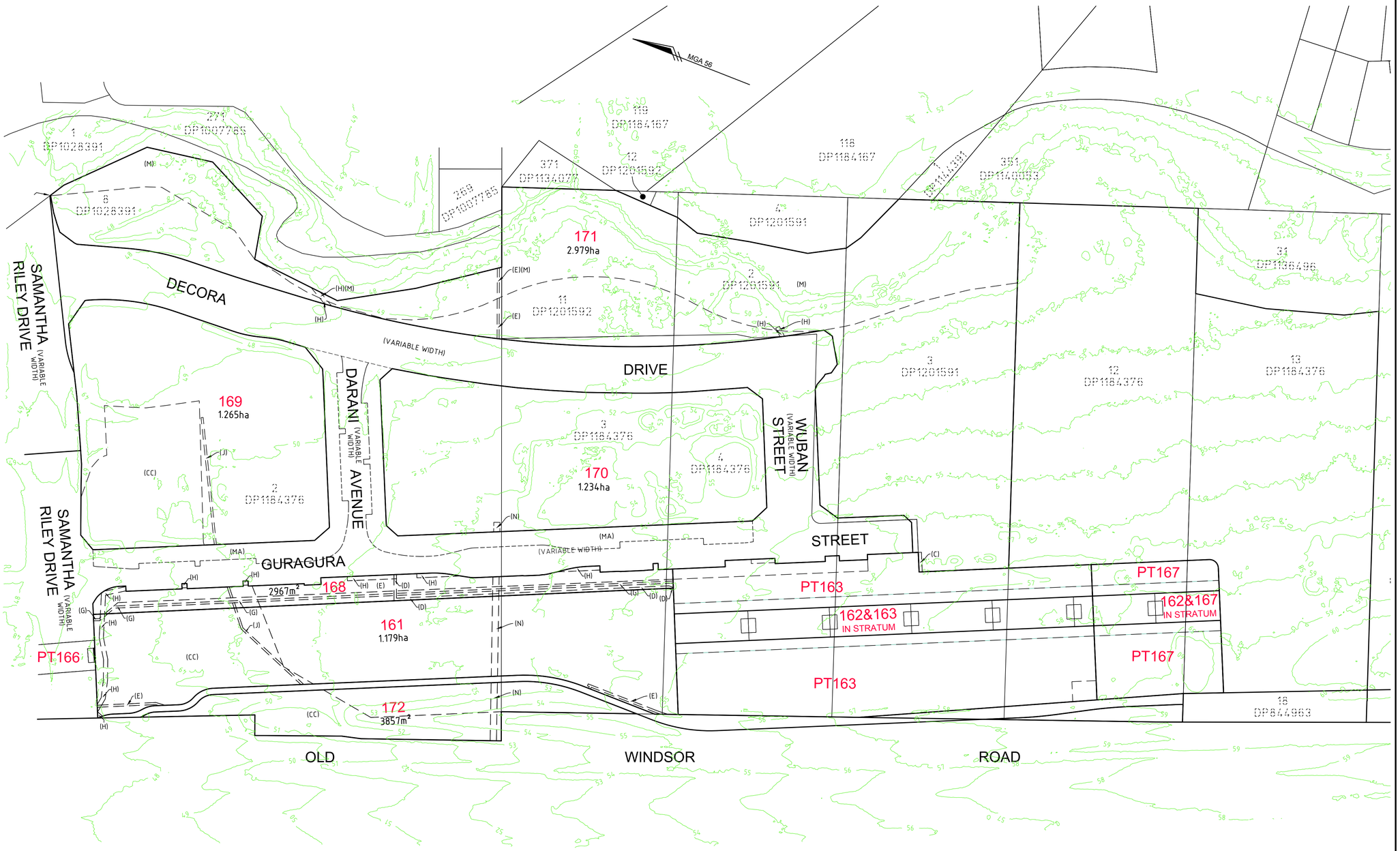
Indicative project staging has been included in the Urban Design Reports submitted as part of the SSD application. While indicative staging has been provided, it is envisaged that the proposed development works may be staged in a different manner. This may incorporate smaller or larger stage areas.

Each development stage must comply with the requirements of this document and the relevant Council and Sydney Water controls.

Flood related controls are unlikely to significantly affect staging as a limited portion of the Site is flood affected, though consideration must be given to maintaining overland flow paths when filling operations are performed.

Stormwater management controls must be addressed for each stage. This may necessitate temporary infrastructure (i.e. gross pollutant traps or temporary discharges to EMC). This is not anticipated to significantly affect development staging.

Appendix A - Site Survey



NOTES

- LIDAR SURVEY WAS CONDUCTED ON 21.12.2018
- ACCURACY OF THE LIDAR SURVEY IS LIMITED TO ± 0.060m
- DENSE POINT CLOUD HAS BEEN RATIONALIZED TO PRODUCE A MORE CLEARER REPRESENTATION OF THE NATURAL SURFACE CONTOURS
- LOT NUMBERS SHOWN IN RED ARE PROPOSED ONLY
- LOTS REPRESENTED BY THICKER LINE WIDTH ARE PROPOSED ONLY
- ADJOINING BOUNDARIES & LOT NUMBERS ARE SHOWN FOR INFORMATION ONLY
- PROPOSED LINEWORKS AND ADJOINING INFORMATION ARE NOT ACCURATE & SHOULD NOT BE RELIED UPON FOR CADASTRAL SURVEY PURPOSES
- DIAL BEFORE YOU DIG (DBYD) PLAN SEARCH & UNDER GROUND UTILITY INVESTIGATION WERE NOT UNDERTAKEN FOR THIS SURVEY

(C) PROPOSED EASEMENT FOR SERVICES 1.5 WIDE
(CC) RIGHT OF WAY (DP1079166)
(D) PROPOSED EASEMENT FOR DRAINAGE OF WATER 1.2 WIDE
(E) PROPOSED EASEMENT FOR ELECTRICAL SERVICES 1 WIDE AND VARIABLE
(F) PROPOSED EASEMENT FOR COMMUNICATION SERVICES 1 WIDE
(G) PROPOSED EASEMENT FOR DRAINAGE OF WATER 2 WIDE
(H) PROPOSED EASEMENT FOR DRAINAGE OF WATER 2 WIDE
(J) PROPOSED EASEMENT FOR SERVICES 1 WIDE
(M) PROPOSED AQUISITION BY SYDNEY WATER
(N) EASEMENT FOR UNDERGROUND CABLES 3 WIDE (DP1243408)
(MA) PROPOSED EASEMENT FOR MAINTAINED ASSET VARIABLE WIDTH

NOTE: LIDAR SURVEY AND THE SUBSEQUENT DELIVERY OF ALL SURVEY DATA INCLUDING THE BOUNDARY INFORMATION ON THIS PLAN ARE ON MGA CO-ORDINATE SYSTEM , SO THAT THE DISTANCES MEASURED ARE GRID DISTANCES ONLY.

REVISIONS

No.	DATE	REVISION DETAILS	DRAWN	CHK	APP
A	30.01.2019	INITIAL VERSION	BN	SP	WB

HORIZ. SCALE: 1:1000 | VERT. SCALE: @ A1
COORDINATES: MGA | DATUM: AHD
ORIGIN: SSM112061 | ORIGIN: SSM112061
20 10 0 20 40 60
SCALE IN METRES AT ORIGINAL REDUCTION RATIO

NOTES

ANY ELECTRONIC FILE IS PROVIDED WITHOUT WARRANTY AND SHOULD BE USED ONLY IN CONJUNCTION WITH THE SUPPLIED PDF/PAPER COPY OF THIS PLAN.

THE BOUNDARY COMPONENT OF THIS SURVEY HAS BEEN UNDERTAKEN IN ACCORDANCE WITH CLAUSE 9 OF THE SURVEYING AND SPATIAL INFORMATION REGULATION 2017 "SURVEYS NOT REQUIRING STRICT ACCURACY", AND IS A COMPILED PLAN WITHIN THE MEANING OF THOSE REGULATIONS.

NO BOUNDARY SURVEY HAS BEEN UNDERTAKEN.

BEARINGS, DIMENSIONS AND AREA ARE FROM TITLE ONLY AND ARE SUBJECT TO CONFIRMATION BY BOUNDARY SURVEY.

DIMENSIONS AND AREA(S) SHOWN ARE APPROXIMATE ONLY AND ARE SUBJECT TO CONFIRMATION BY BOUNDARY SURVEY.

LEVELS ARE BASED ON AUSTRALIAN HEIGHT DATUM (AHD) USING SSM112061 WITH RL OF 53.326m (Class LC & Order L3) LOCATED AT CNR SCHOFILED ROAD AND WINDSOR ROAD.

ORIGIN OF CO-ORDINATES SSM112061 WITH MGA CO-ORDINATE VALUES OF E307415.853 N6270201.693

CONTOURS ARE AN INDICATION OF LANDFORM AND SHOULD NOT BE TAKEN IN PREFERENCE TO SPOT LEVELS SHOWN.

CONTOUR INTERVAL 0.25m.

CLIENT: LANDCOM

SURVEY:	VARIOUS	DATE OF SURVEY:	21.12.2018
DRAWN:	BN	DATE OF PLAN:	10.01.2019
CHECKED:	SP	DATE LAST SAVED:	30.01.2019
APPROVED:	WB	DATE APPROVED:	30.01.2019

TITLE
AERIAL LIDAR SURVEY
KELLY VILLE & BELLA VISTA STATION PRECINCTS

DRAWING No: PR141707_190130.dwg

JOB No: PR141707
ISSUE: A
SHEET 2 OF 2 SHEETS
SIZE: A1

www.dialbeforeyoudig.com.au DIAL 1100 BEFORE YOU DIG

COPYRIGHT: © RPS GROUP PLC.
INFORMATION CONTAINED IN THIS DRAWING / FILE IS THE COPYRIGHT OF RPS GROUP PLC. COPYING OR USING THIS DATA IN WHOLE OR PART, IN ANY FORMAT, WITHOUT PERMISSION INFRINGES COPYRIGHT. © THIS DOCUMENT IN BOTH ELECTRONIC AND HARDCOPY FORMAT IS AND SHALL REMAIN THE PROPERTY OF RPS GROUP PLC. THE INFORMATION MAY ONLY BE USED FOR THE PURPOSE FOR WHICH IT WAS COMMISSIONED AND IN ACCORDANCE WITH THE TERMS OF ENGAGEMENT FOR THE COMMISSION. UNAUTHORISED USE OF THIS INFORMATION IN ANY FORM WHATSOEVER IS PROHIBITED.

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
SUITE 404 29-31 LEXINGTON DR, PO BOX 6843 BAULKHAM HILLS NSW 2153
T: 02 8884 6900 F: 02 8884 6999 www.rpsgroup.com.au

THIS IS A COLOURED PLAN.
REPRODUCTION IN COLOUR ONLY.

RPS MAKING COMPLEX EASY

N:\Projects\141K\PR141707 - Old Windsor Rd, Bella Vista & Kellyville\05 Drafting\Survey\02 Detail\PR141707_190130.dwg

Appendix B - Geotechnical Report

G3 56 Delhi Road
North Ryde NSW 2113
P +61-2 9812 5000
F +61-2 9812 5001
E mailbox@psm.com.au
www.psm.com.au

Our Ref: PSM3675-003L Rev2

29 May 2019

JBS&G
Level 1, 50 Margaret Street
Sydney NSW 2000

Attention: Rohan Hammond

Dear Rohan

RE: LANDCOM URBAN TRANSFORMATION PROJECT
SYDNEY METRO NORTHWEST (SMNW)
KELLYVILLE STATION PRECINCT
SSDA STAGE GEOTECHNICAL ASSESSMENT

1 Introduction

This letter presents the results of a State Significant Development Application (SSDA) stage geotechnical desktop assessment completed by PSM as part of the Sydney Metro Northwest (SMNW) Urban Transformation program for the Kellyville Station Precinct (the Site).

This geotechnical assessment has considered information which is in the public domain including geological maps and factual and interpretive data supplied to tenderers for the SMNW project. It has also benefited from the extensive experience gained from our intimate involvement in the SMNW project from design through to construction.

In addition, the following documents supplied by the Client were reviewed:

1. NSW Department of Planning and Environment - Kellyville Station Precinct Proposal (December 2015)
2. NSW Department of Planning and Environment - Kellyville Station Precinct Planning Report (December 2015)
3. Roberts Day Bella Vista and Kellyville Urban Design Report (December 2015)

2 Proposed Development

Based on the supplied documents, we understand that the Site is located adjacent to (on the east side of) Old Windsor Road, bound by Samantha Riley Drive to the north, Memorial Avenue to the south and Elizabeth Macarthur Creek to the east (Figure 1). The project would involve development around Kellyville Station and the SMNW line comprising of residential, business and commercial buildings, and open and recreational spaces. In addition, the development also includes roads, landscaping and parks.

Figure 1: Kellyville Station Precinct location (source: GLN Planning Pty Ltd Memo dated 15/05/19)

3 Ground Conditions

3.1 Surface Conditions

The northern half of the Site and a corridor to the east of Old Windsor Road is primarily a construction site for the SMNW project with construction largely completed. The southern half of the Site has remained vacant. The natural landform generally slopes gently down from the southwest to the northeast towards Elizabeth Macarther Creek with an elevation change of between 10 m to 15 m.

Historical aerial photographs from September 2013 to November 2018 (sourced from Nearmap) are presented in Attachment A. Based on our knowledge of the Site and review of the historical aerial photographs, bulk earthworks (cut to fill) have been completed within the construction sites to provide a level surface. As part of the earthworks for site establishment, some new sediment basins have been excavated.

3.2 Geological Setting

The 1:100,000 Penrith Geological Map (Ed 1 1991) indicates the Site is underlain by Ashfield Shale (Rwa) (refer Figure 2), the basal unit of the Wianamatta Group (which overlies the Mittagong Formation and Hawkesbury Sandstone units). It comprises dark grey to black claystone and siltstone grading into a distinct laminite of fine sandstone and siltstone.

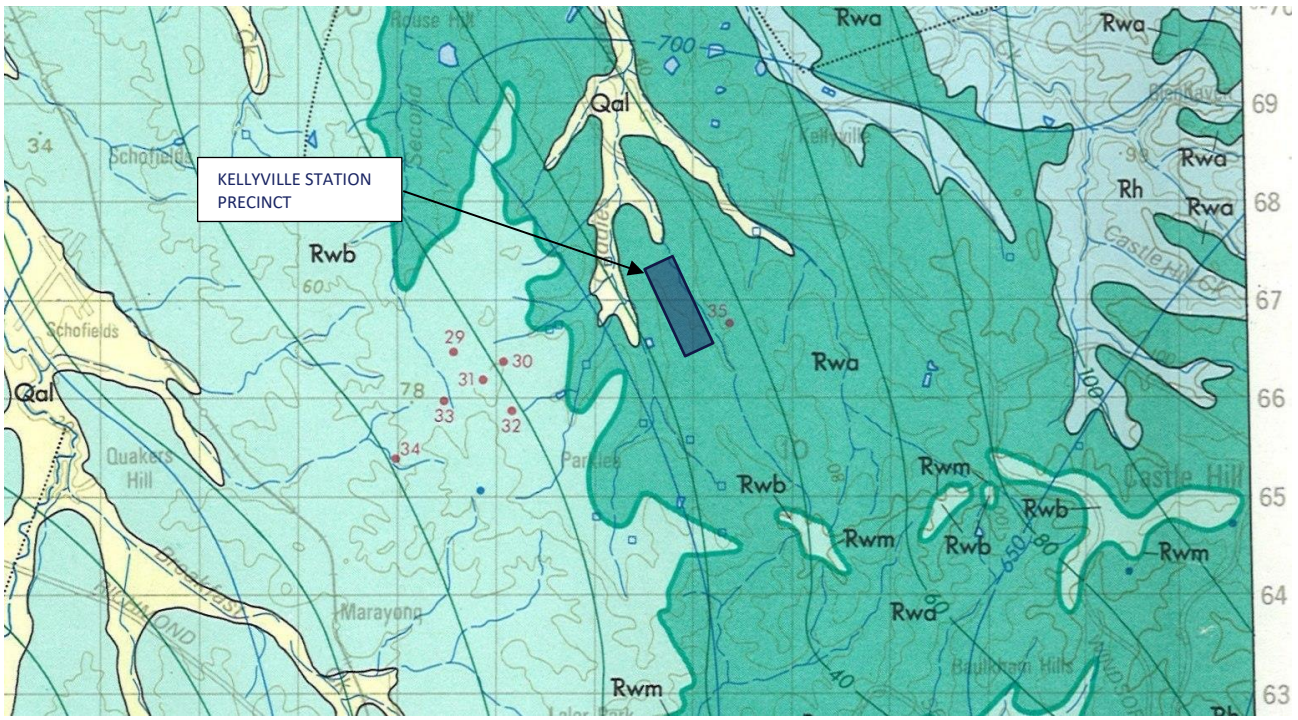


Figure 2: Site location on geological map (source: 1:100,000 Penrith Geological Map 1991)

The maximum thickness of Ashfield Shale is between 60 to 70 m thick comprising four siltstone and laminate sub units (youngest to oldest) – Mulgoa Laminite, Regentville Siltstone, Kellyville Laminite, Rouse Hill Siltstone. These are described as follows:

- The laminated sub units (Mulgoa and Kellyville) tend to remain intact and can form relatively steep quarry faces, while the siltstone sub units (Regentville and Rouse Hill) tend to fret and weather more readily.
- The distinct character of the Kellyville Laminite provides a distinct marker unit. It is typically observed as regular equally spaced laminations of dark grey siltstone and fine grained grey sandstone.
- The Rouse Hill Siltstone typically contains more geological structures than the overlying Ashfield Shale subgroups such as faults, shears, clay seams and slickensided defects and is essentially free of sandstone laminations.

3.3 Subsurface Conditions

The upper two of the four sub units of the Ashfield Shale have been observed in excavations and from site investigations at the Site. The typical subsurface profile is expected to comprise:

- Topsoil and fill over most, or all, of the Site. The topsoil is expected to be of relatively shallow depth within the vacant land in the southern half of the Site and fill depth is expected to be variable due to the bulk earthworks completed as part of SMNW site establishment works
- Residual soil derived from shale bedrock, 3 m to 5 m thick, comprising silty clay, stiff to hard, of medium to high plasticity. In areas where the SMNW bulk earthworks are in cut, some or all of the residual soil could have been removed
- Ashfield Shale — extremely to moderately weathered Mulgoa Laminite (southern portion) and Regentville Siltstone (north portion), 3 m to 5 m depth comprising Class III to Class V Shale (rock mass classification per Pells et al. 1998)[1].

[1] Pells PJN, Mostyn G & Walker BF. (1998), *Foundations on Sandstone and Shale in the Sydney Region,* Australian Geomechanics, Vol 33(2) 17-29.

- Ashfield Shale — slightly weathered to fresh Mulgoa Laminite and Regentville Siltstone to depths greater than 30 m at the southern end (Memorial Avenue boundary) comprising Class I to II Shale, overlying the Kellyville Laminite and Rouse Hill Siltstone
- Ashfield Shale - slightly weathered to fresh Kelly Laminite and Rouse Hill Siltstone to approximately 15 m depth at the northern end (Samantha Riley Drive boundary) comprising Class I to II Shale, overlying slightly weathered to fresh Mittagong Formation and Hawkesbury Sandstone units

3.4 Geological Structures in Ashfield Shale

Based on a review of available information and experience with local conditions of the Site, no major regional geological structures such as significant faults or shears have been identified.

The sedimentary succession in the Sydney Basin is generally sub-horizontal. The regional dip of bedding is near horizontal with warping (gentle folding) producing regional dips of between 5° to 10° in places. Bedding/lamination dips in Ashfield Shale of up to 20° have been recorded near faulted areas where faulting has locally steepened bedding/laminations.

Two steeply dipping (90° ± 20°) orthogonal joint sets striking generally north-south and east-west can be expected and are considered to be ubiquitous. Joint spacing usually ranges between 0.3 to 5 m. However, random and very well defined joints also occur in shale, with dips usually in the range between 15° to 70°.

Faults dipping between 25° and 60° are known and are reportedly more common and closely spaced towards the base of the unit i.e. in the Rouse Hill Siltstone.

Faulting and related jointing in the Ashfield Shale is expected to cover a wide range of orientations. The origin of faulting and jointing in the Ashfield Shale is associated with dewatering during the lithification process as well as tectonic processes that have occurred post lithification.

Sub vertical doleritic dykes trending east west have been mapped within excavations at Bella Vista Station and can be expected to occur elsewhere around the Site. The dolerite is extremely weathered to slightly weathered, of very low to medium strength. Weathering and strength of these dykes tend to mimic the weathering of the country rock.

Summary sheets presented by Bertuzzi (2014)[2] provide useful example core photographs and typical geotechnical characteristics for the various classes of Ashfield Shale that are relevant to the subsurface conditions of the Site. Example photographs of excavated faces and geological features in Ashfield Shale are presented in Attachment B.

3.5 Groundwater

The regional groundwater table is expected to be at depth within the Hawkesbury Sandstone. However some “perched” groundwater is likely to be present in the soils and siltstone in the top 5 m, especially after prolonged rainfall.

4 Excavation

4.1 Excavatability

The expected subsurface conditions are typical for many parts of Sydney and, based on our experience, excavation will be able to be undertaken using conventional approaches (e.g. large excavators with rock hammers and rock saws, and often where space permits with large bulldozers equipped with ripping tynes). It is expected that any excavation would be undertaken by contractors with suitable experience in rock excavation close to existing structures. The contractor will need satisfy itself regarding the suitability of its plant to the site conditions.

[2] Bertuzzi R. (2014), *Sydney Sandstone and Shale Parameters for Tunnel Design,* Australian Geomechanics, Vol 49(1) 4-39, Vol 49(2) 95-104.

4.2 Shoring

The conventional shoring system in these conditions is to construct bored reinforced concrete soldier piles around the excavation perimeter prior to excavation commencing, down to below the bulk excavation level. Ground anchors are then installed to support the piles as excavation progresses. The number of rows of anchors will be dependant on depth of excavations and a matter of design. Shotcrete is typically applied to support the ground between the piles, although usually only the soils and weathered rock require the shotcrete to be applied prior to construction of the permanent structure.

Another approach, which allows savings on pile lengths, is to terminate some of the piles below the weathered rock but above the bulk excavation level. This design approach would need a contingency to stabilise pile toes that are underlain by rock defects, and a contingency to install rock bolts/anchors to stabilise any faulted or jointed rock faces below the pile toes. A higher level of geotechnical construction oversight would also be required for such a design. Therefore this approach involves an increased risk of delays and extra costs during the excavation.

4.3 Ground Movements Due to Excavation

The road and rail authorities would often require assessment of the excavation induced ground movements on the adjacent infrastructure. A predicted effects assessment (geotechnical and structural) is generally undertaken to assess effects of new developments on existing infrastructure. Pre and post construction dilapidation surveys of adjacent infrastructure should also be allowed for, as well as survey of ground movement during the works which will likely include monitoring of the development and where required, monitoring of the existing infrastructure.

5 Site Classification

Based on the available information, we have classified the site as Class “P” in accordance with Australian Standard AS 2870-2011 “Residential slabs and footings – Construction” due to the likely presence of fill on the Site. The Site may be reclassified following further investigation and assessment for specific lots.

For earthquake provisions, we have classified the site sub-soil as Class Ce in accordance with Section 4.2 of AS 1170.4-2007 “Earthquake Actions in Australia”.

6 Foundations

We expect that the building foundations are likely to be shallow pad footings founded on structural fill, residual soils or bedrock. Where building loads are high, piles extending to the better quality shale could be adopted, or the foundation design could involve larger/embedded pads or strip footings to reduce the bearing pressures. All these options are conventional foundation types and the type adopted will depend on the structure and is a matter of design. These foundation types would be suitable for consideration in designing pedestrian and cycle bridges as well.

7 Civil Surface Works

Civil surface works such as pavements and low embankments should not present any unusual geotechnical challenges. Material won from any bulk excavation should be suitable to use as general compacted fill subject to development of a suitable earthworks specification. We expect that site won material will be able to be used on site or disposed of as VENM or ENM provided it is not contaminated but we defer to the environmental consultant for advice on material disposal.

8 Geotechnical Investigation

Geotechnical investigations have been completed for the SMNW comprising boreholes and testpits. These investigations were focused around the SMNW alignment generally to the west of the site (Figure 3). There is

a higher concentration of investigation locations around the southern and northern boundaries of the Site (around the area south of Memorial Avenue and at Kellyville Station). We consider that the level of investigation completed to date is adequate for development concept planning and SSDA purposes. Further targeted geotechnical investigations are expected to be required at detailed design to supplement the existing information and fill any gaps identified by the designers. Investigation requirements will be dependant on the specific development and should be considered at the detailed design stage together with the historical data.

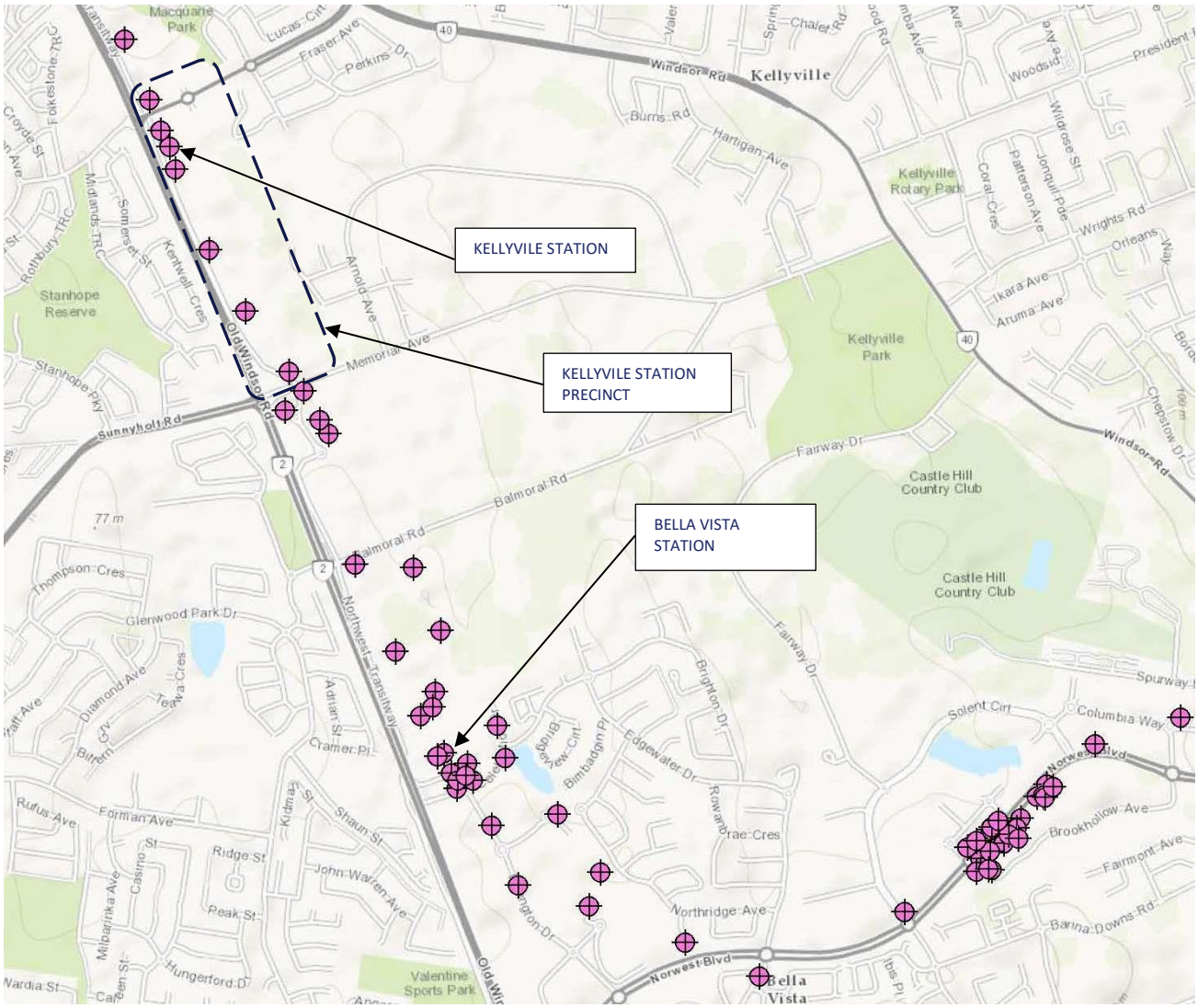


Figure 3: Historical investigation locations

9 Summary and Closure

In summary, we do not expect geotechnical conditions that are unusual for north western Sydney to exist on this Site. In general, normal civil engineering and building approaches will be satisfactory for geotechnical aspects of the proposed development.

We trust that this letter meets your requirements. Should you have any queries please do not hesitate to contact the undersigned.

For and on behalf of
PELLS SULLIVAN MEYNINK

BERNARD SHEN
PRINCIPAL

Attachment A

Notes:

1. Photograph source: Nearmap
2 Site boundary shown is schematic only

JBS&G

SMNW Urban Transformation Project

Kellyville Station Precinct

HISTORICAL AERIAL PHOTOGRAPH

19 SEPTEMBER 2013

PSM3675-003L	**ATTACHMENT A1**

Notes:

1. Photograph source: Nearmap
2 Site boundary shown is schematic only

JBS&G

SMNW Urban Transformation Project

Kellyville Station Precinct

HISTORICAL AERIAL PHOTOGRAPH

27 JULY 2014

PSM3675-003L	**ATTACHMENT A2**

Notes:

1. Photograph source: Nearmap
2 Site boundary shown is schematic only

JBS&G

SMNW Urban Transformation Project

Kellyville Station Precinct

HISTORICAL AERIAL PHOTOGRAPH

30 NOVEMBER 2014

PSM3675-003L	ATTACHMENT A3

Notes:

1. Photograph source: Nearmap
2 Site boundary shown is schematic only

JBS&G

SMNW Urban Transformation Project

Kellyville Station Precinct

HISTORICAL AERIAL PHOTOGRAPH

5 JULY 2015

PSM3675-003L	**ATTACHMENT A4**

Notes:

1. Photograph source: Nearmap
2 Site boundary shown is schematic only

JBS&G

SMNW Urban Transformation Project

Kellyville Station Precinct

HISTORICAL AERIAL PHOTOGRAPH

18 JULY 2016

PSM3675-003L	**ATTACHMENT A5**

Notes:

1. Photograph source: Nearmap
2 Site boundary shown is schematic only

JBS&G

SMNW Urban Transformation Project

Kellyville Station Precinct

HISTORICAL AERIAL PHOTOGRAPH

13 NOVEMBER 2018

PSM3675-003L	ATTACHMENT A6

Attachment B

Photo 1: Excavation face in weathered Ashfield Shale

Photo 2: Excavation face in weathered Ashfield Shale

Notes:

1.

JBS&G	
SMNW Urban Transformation Project	
Kellyville Station Precinct	
EXAMPLE PHOTOGRAPHS OF EXCAVATIONS IN ASHFIELD SHALE	
PSM3675-003L	**ATTACHMENT B1**

Photo 3: Bulk excavation of fresh Ashfield Shale

Photo 4: Excavation face in fresh Ashfield Shale with jointing

Photo 5: Excavation face in fresh Ashfield Shale with dolerite dyke

Notes:

1.

JBS&G

SMNW Urban Transformation Project

Kellyville Station Precinct

EXAMPLE PHOTOGRAPHS OF EXCAVATIONS IN ASHFIELD SHALE

PSM3675-003L	**ATTACHMENT B2**

Photo 6: Excavated floor in fresh Ashfield Shale with typical geological structures

Photo 7: Excavated floor in fresh Ashfield Shale with typical geological structures

Notes:

1.

JBS&G	
SMNW Urban Transformation Project	
Kellyville Station Precinct	
EXAMPLE PHOTOGRAPHS OF EXCAVATIONS IN ASHFIELD SHALE	
PSM3675-003L	**ATTACHMENT B3**

Appendix C - Elizabeth Macarthur Creek – Trunk Drainage Concept Design Report

Reference: AAJV-0234
Prepared for: Sydney Water
Revision: C
17 February 2017

Sydney Water Corporation Engineering and Environmental Services Panel

Elizabeth Macarthur Creek

Trunk Drainage Concept Design Report

Document Control Record

Document prepared by:

AAJV

ABN 14 821 636 099

2 Palmer Street
North Parramatta NSW 2151
Australia

T +61 2 8896 4100
F +61 2 9890 3558

A person using AAJV documents or data accepts the risk of:

a) Using the documents or data in electronic form without requesting and checking them for accuracy against the original hard copy version.
b) Using the documents or data for any purpose not agreed to in writing by AAJV.

Document control

Report Title	**Elizabeth Macarthur Creek Trunk Drainage Concept Design Report**					
Document ID	AAJV-0234-D02		Project Number	0234		
File Path	AAJV ProjectWise/0234/Project Delivery/Deliverables					
Client	**Sydney Water**		Client Contact	**Rezwan Rahimullah / Ray Parsell**		
Rev	Date	Revision Details/Status	Prepared by	Author	Verifier	Approver
A	16 August 2016	Draft for client review	G.Kirby, W.Legg,	N.Bartho	B.Withnall	M.Axton
B	23 January 2017	Revised draft for client review	N. Bartho	N.Bartho	B.Withnall	M.Axton
C	17 February 2017	Final report (no changes)	N. Bartho	N.Bartho	B.Withnall	M.Axton

Current Revision	**C**

Approval

Author Signature		Approver Signature	
Name	**Nick Bartho**	Name	**Mike Axton**
Title	**Assignment Manager**	Title	**Assignment Director**

Contents

1 Introduction 1

1.1 Background 1

1.2 Project Purpose and Objectives 4

1.3 Available Data 4

1.4 Stakeholder Consultation 6

1.5 Report Purpose and Structure 8

2 Existing Conditions 9

2.1 Introduction 9

2.2 Site Overview 9

2.3 Flora and Fauna 12

2.4 Subsurface Conditions 12

2.5 Geomorphology 13

2.6 Flooding 16

3 Creek Design 24

3.1 Guiding Principles for Stream Rehabilitation 24

3.2 Stream Rehabilitation Opportunities and Constraints 25

3.3 Design Approach for In-Stream Works 38

3.4 Concept Design Summary 45

3.5 Key Design Features for the Creek Works 54

3.6 Flood Management 62

4 Safety in Design 81

4.1 Introduction 81

4.2 Statutory and Regulatory Obligations 81

4.3 Safety Objectives 81

4.4 Affected Groups 81

4.5 Safe Design Process 81

4.6 Responsibilities and Reporting Arrangements 82

4.7 Assumptions, Constraints and Dependencies 82

5 Future Implementation 84

5.1 Land Acquisition and Access 84

5.2 Land Rezoning 85

5.3 Vegetation Management 85

5.4 Staging Implications 85

6 References 86

Appendices

Appendix A

Constraint Mapping

Appendix B

Site Photographs

Appendix C

Desktop Geotechnical Assessment

Appendix D

Phase 1 and Targeted Phase 2 Contamination Investigation

Appendix E

Preliminary Planning Advice

Appendix F

Review of Bushfire Protection and Hazard Reduction Zone Creation Assessment

Appendix G

Safe Design Risk Register

Appendix H

Appendix I

Figures

Figure 1: Site Overview 2
Figure 2: AAJV TUFLOW Model Structure – Baseline Conditions 21
Figure 3: Baseline Flooding Conditions – 2 year ARI 22
Figure 4: Baseline Flooding Conditions – 100 year ARI 23
Figure 5: Plan of existing conditions 27
Figure 6: Example of erosion control matting with densely planted tubestock within riparian zone 40
Figure 7: Example of coir logs within channel 41
Figure 8: Conceptual stormwater harvesting strategy 43
Figure 8: Concept Design Reach Summary Overview Maps 46
Figure 9: Vegetated channel through existing online dams 54
Figure 10: Upper bank erosion treatment 55
Figure 11: Rock lining on bed and banks 56
Figure 12: Grade control structures - rock riffles and pools 58
Figure 13: Head cut controls 59
Figure 14: Scour hole treatment 60
Figure 15: Sandstone block wall treatment 61
Figure 16: AAJV TUFLOW Model Structure – Design Conditions 63
Figure 17: Representative channel and overbank/floodplain vegetation for future conditions 65
Figure 18: Existing channel and overbank/floodplain vegetation for Priority Vegetation Management Reach 66
Figure 19: Proposed levee at Lewis Jones Drive 69
Figure 20: Proposed signage array as minor flood control structure 70
Figure 21: Design Flooding Conditions – 2 year ARI 71
Figure 22: Design Flooding Conditions – 100 year ARI 72
Figure 23: Impact of Combined Trunk Drainage Works and Future Works on Baseline Flooding Conditions – 100 year ARI 73

Figure 24: Design flood profiles – 100 year ARI 74
Figure 25 Floodplain storage compartment boundaries 78
Figure 26: Floodplain discharge-storage results – 100 year ARI flood 79

Tables

Table 1: Specific PoM Actions/Directions for EMC 3
Table 2: Summary of external stakeholder consultation 6
Table 3: Site inspection summary 9
Table 4: General Site Features 10
Table 5: Generalised subsurface profile 15
Table 6: Creek Condition, Constraints and Opportunities 30
Table 7: Concept Design Summary 49
Table 8: Vegetated channel through existing online dams 55
Table 9: Upper bank erosion treatment 56
Table 10: Rock lined channel 57
Table 11: Grade control structures - rock riffles and pools 58
Table 12: Head cut controls 59
Table 13: Scour hole treatment 61
Table 14: Sandstone block wall treatment 62
Table 15: Summary of bridge optimisation outcomes 68

1 Introduction

1.1 Background

Elizabeth Macarthur Creek (EMC), a tributary of Caddies Creek, flows through the Hills Shire Council's Balmoral Road Release Area in Kellyville and forms part of the larger Hawkesbury-Nepean River catchment. The Caddies Creek catchment extends across a large part of the Rouse Hill Development Area (RHDA) which, as a result of regional planning, has seen significant urban development since the 1990s. The RHDA is located approximately 33 km north-west of the Sydney central business district.

The Study Area (refer to **Figure 1)** covers approximately 2.5 km of EMC extending from Celebration Drive, Bella Vista in the south to Bridget Place, Kellyville in the north. EMC flows northwards to its confluence with Caddies Creek.

EMC is located within The Hills Shire Council (THSC) Local Government Area and is one of the major creeklines within its Balmoral Road Release Area. The creek is bordered by Old Windsor Road to the west, developed commercial/residential areas of Bella Vista to the south, and a mix of generally low density urban and semi-rural areas to the east, with the remaining rural areas likely to be urbanised within the next few years.

The RHDA was originally identified and described by the *Sydney Regional Environmental Plan No. 19*, (SREP19) which encourages urban development within the area in order to accommodate part of the long term population growth of the Sydney Region. One objective of SREP19 is to protect the Hawkesbury River and its tributaries from the potential impact of urban development.

As part of planning for the RHDA, all lands within the extent of the 100 year average recurrence interval (ARI) flood associated with five main creek lines (Caddies Creek, EMC, Second Ponds Creek, Smalls Creek and Strangers Creek) were mapped using the available data and models at the time and classed as RHDA Trunk Drainage Lands (TDL). Within the RHDA Sydney Water's traditional sewerage and water supply functions extends further to include trunk stormwater management for the TDL.

The purpose and use of the TDL is formalised by appropriate zoning within applicable land use planning instruments. To this end, the TDL along EMC are currently zoned SP2 (Stormwater Management System) under THSC Local Environment Plan 2012 (LEP 2012).

Sydney Water developed a Plan of Management (PoM) for TDL in the RHDA in 2013 (Sydney Water, 2013) that outlined specific management actions and directions for EMC. The management objectives centre on the priority areas of flood management, water quality management/improvement, re-establishing protection and expansion of endangered ecological communities (EEC's) and other native vegetation, weed management and management of Aboriginal heritage sites/materials.

The PoM identified specific high and medium priority actions / directions to achieve the following management objectives outlined in **Table 1**.

Figure 1: Site Overview

SITE OVERVIEW

KEY

- Project area boundary
- Suburb boundary

0 50 100 200 m

Table 1: Specific PoM Actions/Directions for EMC

High priority	• improved flood management design data and TDL identification
Medium priority	• to protect and enhance Cumberland Plain Woodland EEC • the protection of EECs during subdivision and residential development process • to control noxious and environmental weeds • to remediate erosion problems, especially where drainage infrastructure is threatened • to ensure TDL values and functions considered during planning and development of adjacent areas • to improve the on-ground definition of TDL, particularly in subdivision/development areas • to provide for safe local access routes.

The TDL are owned and maintained for the most part by Sydney Water. The acquisition or transfer of additional TDL areas to Sydney Water's ownership and management is occurring progressively and generally in line with the release of new urban development areas. Along EMC, partial acquisition has already occurred and a key outcome of the present study is to confirm the land required for trunk drainage purposes to support Sydney Water's land acquisition process.

However, the need for the present study arises to resolve (and minimise to the extent practicable) Sydney Water's future land requirements for trunk drainage purposes not solely on the basis of flood management, but considering a broad range of unresolved issues such as the following:

- Changes in flood behaviour over time (i.e. since the initial TDL definition) as a result of both changes to catchment and floodplain conditions, as well as advances in flood modelling techniques.
- Managing flood risk to property owners and the local community, as well as owners of infrastructure and utilities along the creek.
- The irregular nature of the current trunk drainage zoning boundary, which leads to poor land use outcomes for developable lands adjoining EMC including inefficient and/or impractical development and subdivision layouts and poor urban planning outcomes more generally.
- Lack of allowance for future bridge crossings in previous flood management planning, which has significant implications for trunk drainage land requirements as well as potentially undermining the current development plans of both the State Government and THSC for lands adjoining EMC.
- Legacy infrastructure located both within the creek channel and the floodplain, online farm dams, culverts, causeways, fences, etc.
- Existing active scouring, erosion and other geomorphic processes that threaten creek bed and bank stability at various locations along EMC.
- Generally poor water quality outcomes that have occurred throughout the RHDA to date, as a result of both historic trunk drainage planning and local catchment management, and which is amplified by more contemporary aspirational targets for removal of urban pollutants from stormwater.
- Consideration of and integration of the TDL with desired vegetation and ecological outcomes. In particular there are some reaches of EMC that contains vegetation and habitat of relatively high-value that should be preserved and enhanced where possible.

Sydney Water prepared an initial trunk drainage concept design for EMC as an internal project over the past few years (documented as part of the Project Brief) with the aim of addressing the above issues, as well as exploring several more contemporary strategies for stormwater and flood management that could assist in optimising outcomes across objectives that are often competing in nature.

The Sydney Water Initial Concept Design essentially forms the starting point for further investigations and formalisation of a preferred trunk drainage concept design that is intended to be the primary outcome of the current project.

1.2 Project Purpose and Objectives

The purpose of the project is to design and document the preferred trunk drainage concept design for EMC, including related guidelines for stormwater and floodplain management that could be used to inform planning and development in other similar urban release areas. It is intended that the preferred trunk drainage concept design will be implemented through a future, separate detailed design and construct (D&C) contract.

The main objective of the concept design process is to minimise the amount of land required for trunk drainage purposes in a way that resolves, to the extent practicable, the issues noted above. For guidance, the following identifies a range of supporting objectives that capture Sydney Water's intent:

- Stabilise the creek channel within the TDL to the extent necessary to minimise the risk of scouring and erosion to existing properties and infrastructure.
- Minimise where possible extensive earthworks within the creek channel, and in particular avoid disturbance of the creek invert.
- Remove legacy infrastructure within the TDL.
- Maximise development potential adjacent to the TDL by allowing for future filling in existing flood fringe areas, and develop design guidance for this future filling.
- Develop design guidance for future bridge crossings that may be required to facilitate surrounding urban development, and consider how these future assets might be used to assist in flood management within the TDL. In particular the existing culvert crossing at Balmoral Road is problematic due to its poor integration with adjacent reaches of creek, resulting in its permanent submergence and associated asset maintenance and public safety issues.
- Reduce existing flood risk exposure to property/asset owners and the local community where feasible.
- Preserve to the extent possible the existing conveyance/storage function of the floodplain.
- Protect and enhance remnant natural riparian vegetation and habitat opportunities, as well as other environmental values (e.g. heritage). Conversely, interventions in the form of excavation or other suitable remediation should be considered to address weed infestations where appropriate.
- Allow for multiple use objectives (e.g. future development, local transport needs, community usage, amenity, recreation, ecology, habitat, etc.) within the TDL.
- Allow for open space integration opportunities with adjacent urban developments (existing and future).
- Investigate the potential for integrating on-site stormwater retention (OSR) strategies and initiatives to improve stream rehabilitation and water quality outcomes.

1.3 Available Data

Information and data made available by Sydney Water included the following:

- Background information relating to previous Sydney Water trunk drainage concept design option for EMC, including:
    - Report (pdf format)
    - Various HEC-RAS models, including options for encroachment only as well as encroachment plus conceptual floodplain obstructions to induce compensatory vertical storage.
    - CAD file containing various georeferenced existing/design features relating to the creek corridor.
- Rouse Hill Flood Study, including:
    - TUFLOW model and associated data files
    - Study report (WMA, April 2014).
- Approved subdivision plans and work-as-executed (WAE) plans for existing or committed adjacent developments within the Balmoral Road Release Area.
- WAE plans for existing culverts under Samantha Riley Drive, Memorial Avenue and Balmoral Road.
- Rouse Hill Vegetation Mapping 2013 by Travers Bushfire and Ecology including:
    - Report entitled *"Vegetation Assessment – Rouse Hill Trunk Drainage Lands"* (Travers, 2013).
    - Associated GIS data files.
- Safety Workshop documentation relating to previous trunk drainage strategy developed for Strangers Creek.
- Property ownership details (selected only, at September 2015).
- Report entitled *"Bushfire Protection and Hazard Reduction Zone Creation Assessment for Sydney Water Trunk Drainage Land"* (Travers, 2013) received in February 2016.
- DS-100 Specific Technical Specification template, version v03 dated December 2015.
- Sydney Water *"Aboriginal Due Diligence Assessment Template – SWEMS0031.06".*
- Report entitled *"Aboriginal Sites in Sydney Water Trunk Drainage Lands – Rouse Hill Development Area"* (Sydney Water, 2015) received in May 2016.
- Preliminary details of proposed Sydney Water Low Flow Bypass Pits, including Concept Drawings and pit arrangements currently proposed for hydraulic inflow capacity testing.

Other key information/data that was received over the course of the project included the following:

- Utilities data, including:
    - DBYD data, based on a search initiated in August 2015.
    - Sydney Water asset data, extracted from Hydra in September 2015.
    - Stormwater asset data received from THSC in October 2015.
- Various spatial datasets including:
    - Aerial photography, sourced from LPI and Nearmap.
    - Constraint mapping (e.g. soil landscapes, regional geology, salinity hazard, existing land zoning), typically sourced from LPMA/LPI.
- Concept design information relating to RMS' proposed upgrade of Memorial Avenue, including:
    - Design drawings and genio files.
    - Design report.

- Review of Environmental Factors.
- Flood models (RAFTS and TUFLOW models).
- Draft geotechnical factual and interpretative reports.

- Sydney Metro North West - Geotechnical Data Report by Coffey Geotechnics (Volumes 4 and 6) dated 15 June 2012 for TfNSW.
- Preliminary concept layouts for the priority precincts of Bella Vista and Kellyville, the latest digital version of which was received from UrbanGrowth in October 2015.
- Preliminary designs for proposed civil infrastructure works to be delivered support the Sydney Metro North West, received from TfNSW in October 2015.
- Proposed locations for future bridge crossings across EMC. Various versions were received, the latest of which came from TfNSW in May 2016.

1.4 Stakeholder Consultation

1.4.1 External Stakeholder Consultation

Comprehensive external stakeholder consultation was undertaken over the course of the concept design process (refer **Table 2** for summary) for the purposes of:

- Informing stakeholders of project commencement and progress.
- Obtaining relevant information/data from stakeholders.
- Identifying key opportunities and potential synergies for proposed trunk drainage works to complement the plans or activities of stakeholders and thereby optimise overall outcomes for the EMC corridor.

Table 2: Summary of external stakeholder consultation

Date	Location	External Stakeholders in Attendance (1)	Purpose
3 July 2015	Sydney Water, Parramatta	THSC, BCC, DPE, TfNSW, UG	Project inception meeting
12 August 2015	Sydney Water, Parramatta	RMS	RMS/SW coordination meeting regarding proposed Memorial Avenue Upgrade.
11 September 2015	The Hills Shire Council, Baulkham Hills	THSC	Project coordination meeting, including discussion of opportunities/issues Council would like to see addressed by the trunk drainage works.
16 September 2015	UNSW Water Research Laboratory, Manly Vale	TfNSW, UG, THSC, BCC, CoS, MU, Uni SA, NWS	Full day forum for presentations and discussion of stormwater management in the context of stream health and management, and in particular the relevance of at-source controls and use of onsite stormwater retention (OSR) as a strategy to provide both water quality and quantity benefits. The EMC project was put up as a case study in this context. The day also involved a tour of the WRL lab and demonstration of hydraulic pit testing being undertaken by WRL on behalf of Sydney Water.
30 September 2015	Sydney Water, Parramatta	TfNSW, UG	Project coordination meeting, including discussion of opportunities/issues to integrate trunk drainage works with adjacent development and road/rail infrastructure planning by UG and TfNSW.

Date	Location	External Stakeholders in Attendance (1)	Purpose
15 December 2015	AECOM, Sydney	TfNSW, UG	Project coordination meeting, including SW/AAJV progress update and discussion of opportunities to integrate trunk drainage works with adjacent open space planning.
19 February 2016	Sydney Water, Parramatta	TfNSW, UG, DPE	Project coordination meeting, including SW/AAJV progress update and various discussion points relating to: • review of preliminary concept plans for trunk drainage works tabled by SW/AAJV • site specific planning/design issues
7 April 2016	Sydney Water, Parramatta	TfNSW, UG, DPE, THSC	Project coordination meeting, including SW/AAJV progress update and various discussion points relating to: • further development of concept plans for trunk drainage works • review of DP&E rezoning plan and outstanding issues • review of SW proposed land ownership and land acquisitions • proposed public domain areas and potential integration with trunk drainage corridor • proposed DCP controls for priority precincts
3 May 2016	Sydney Water, Parramatta	TfNSW, UG, DPE, THSC	Project coordination meeting, including SW/AAJV progress update and various discussion points relating to: • refinement of concept plans for trunk drainage works as well as proposed TDL boundary • review of DP&E rezoning plan and outstanding issues • future bridge crossing locations • proposed DCP controls for priority precincts including fill specification

(1) Abbreviations:

THSC - The Hills Shire Council

DPE - NSW Department of Planning and Environment

TfNSW - Transport for NSW

UG - UrbanGrowth NSW

RMS - Roads and Maritime Services

BCC - Blacktown City Council

CoS - City of Sydney Council

LCC - Liverpool City Council

MU - Melbourne University

Uni SA - University of South Australia

NWS - North Western Survey

The discussion and outcomes of the various activities formed inputs to constraints and opportunities that were assessed as part of the concept design development.

1.4.2 ISEPP Consultation

It is noted that formal consultation with THSC was also undertaken under the provisions of State Environmental Planning Policy (Infrastructure) (ISEPP). Under ISEPP, public authorities such as Sydney Water are required to consult with local councils and other public authorities prior to the commencement of certain types of development. The proposed trunk drainage works were considered to trigger this requirement. Further details in relation to the ISEPP consultation process are documented in the Review of Environmental Factors (REF) (AAJV, 2016a).

1.4.3 Internal consultation

Consultation with several internal departments of Sydney Water occurred during the concept design process, including:

- Land and Waterways
- Delivery Management
- Community Relations
- Environmental Representatives
- Asset Planning

This generally involved progress meetings and informal design planning workshops.

A CHAIR (Construction Hazard Assessment and Implications Review) workshop was also held in May 2016 as part of the safe design process (refer **Chapter 4** for details).

1.4.4 Community consultation

Community consultation did not form part of the concept design process.

1.5 Report Purpose and Structure

The purpose of this document is to provide a consolidated reporting of the concept design process. The following chapters describe:

- existing conditions (**Chapter 2**);
- rationale and description of the trunk drainage concept design (**Chapter 3**);
- safety in design (**Chapter 4**);
- future implementation (**Chapter 5**); and
- references (**Chapter 6**).

Several appendices provide supporting documentation and mapping including:

- Constraint Mapping (**Appendix A**).
- Site Photographs (**Appendix B**).
- Desktop Geotechnical Assessment (**Appendix C**).
- Phase 1 and Targeted Phase 2 Contamination Investigation (**Appendix D**).
- Preliminary Planning Advice (**Appendix E**).
- Review of Bushfire Protection and Hazard Reduction Zone Creation Assessment and implications for trunk drainage planning (**Appendix F**).
- Safe Design Risk Register (**Appendix G**).
- Superseded concept designs for future bridge crossings, representing initial/unoptimised designs (**Appendix H**).
- Selected flood maps at high resolution (**Appendix I**).

This report should be read in conjunction with the following other key project deliverables:

- Trunk Drainage Concept Design Drawings
- Technical Specification
- REF

Other related project deliverables comprise:

- Guidelines for Release Area Floodplain Development Strategy
- Stormwater Retention At-Source Guidelines

2 Existing Conditions

2.1 Introduction

An understanding of existing conditions within the Study Area was developed from review of available information (refer **Section 1.3**), visual inspections undertaken at various times between October 2015 and April 2016, and more detailed site investigations undertaken for selected discipline areas. **Table 3** provides a summary of the inspections undertaken over the course of the project.

Table 3: Site inspection summary

Date	Description
16 October 2015	Full day site walkover to identify, where accessible and visible, the condition of the creek and any opportunities and/or constraints. This rapid visual assessment included: - land use and instream / floodplain structures - vegetation - heritage - channel form and stability - flooding - water quality - geotechnical / contamination
3 November 2015	Follow-up geomorphic and drainage/flooding assessment
2 December 2015	Briefing of SW Environmental Representatives
27 January 2016	Contamination investigation (targeted Phase 2)
4 May 2016	Terrestrial and aquatic habitat assessment (Part 1) plus follow-up geomorphic assessment
25 May 2016	Terrestrial and aquatic habitat assessment (Part 2)

The following sections provide an overview of existing conditions, opportunities and constraints. **Appendix A** contains a range of constraint mapping that was produced as part of the initial phase of investigations.

2.2 Site Overview

Table 4 provides a summary of the general characteristics and features of the project site.

Table 4: General Site Features

Study Area	The Study Area runs generally parallel to Old Windsor Road from Celebration Drive in the south to Clovelly Circuit in the north, over a distance of approximately 2.5 km (refer **Figure 1**). All of the maps in **Appendix A** show the Study Area boundary.
Topography	The topography of the study area is generally flat. The surrounding landscape comprises broad rounded crests and ridges with gently inclined slopes, usually less than 5% as generally represent by the Wianamatta Group shales. Refer to **Map W012** in **Appendix A**.
Geology	The study area generally contains sandstone geology and shale geology. The site lies in an area underlain by Triassic aged Annan Shale of the Wianamatta Group. This comprises shale with thin sandstone lenses. In addition, the upper reaches of EMC in the north-west portion (north of Wenden Place) comprises Quaternary aged alluvial soils – generally comprising fine grained sand, silt and/or clay. Refer **Map W010** in **Appendix A**. Further discussion regarding geotechnical conditions and potential subsurface contamination is provided below.
Soil	The study area generally contains Clay, Silty Clay or Sandy Clay overlaid by topsoil. The majority of the site is comprised of the Blacktown soil landscape, with approximately 400 m of the lower southern reach consisting of the South Creek soil landscape. Refer to **Map W009** in **Appendix A**. Available salinity mapping (refer **Map W033** in **Appendix A**) indicates that the majority of the Study Area is categorised as typically having a high salinity potential. Known salinity is identified in the northern section of EMC around Samantha Riley Drive. The potential for occurrence of acid sulfate soils within the Study Area is low.
Catchment and drainage	EMC is a tributary of Caddies Creek, which forms part of the Cattai Creek catchment eventually joining the Hawkesbury River. The creek is predominantly fed by stormwater runoff from a catchment comprised of natural bushland, maintained parkland and mixed urban land use adjacent to the Creek. Flows are typically low to discontinuous, however the rapid urbanisation is altering the hydrology accordingly. **Map W007** in **Appendix A** provides an overview of existing surface water drainage features and stormwater infrastructure. The creek has been subject to significant modification as part of the previous agricultural, market gardens land use activities and in more recent years due to the commercial and urban development of the surrounding area. This modification has included establishment of several online dams, channel altering / straightening, road crossings and other structures. Apart from the online dams, the upper reaches of the creek are relatively narrow and shallow. As the creek progresses downstream the channel deepens and widens as a result. The creek is exhibiting signs of active erosion including creek bank scouring, undercutting, slumping, rilling/gullying and creek bed incision and headcut (headward erosion) migration upstream.
Vegetation	Prior to the 1950's much of the remnant vegetation was cleared for grazing and as a result the upper reaches of the creek are heavily modified with no remnant bushland and limited stands of mature trees. Cleared grassed paddocks often extend to the creek bank (PoM). Downstream the vegetation can be described as modified remnant woodland or open / scattered woodland (PoM). Generally, the vegetation within the creek corridor is characteristic of a mixture of remnant and/or regrowth vegetation (mainly

	stands of Eucalypts or Casuarinas, over mixed shrubs or weedy understory), pasture and introduced grasses, weeds as well as areas of mass plantings and recent rehabilitation works. Vegetation types include two EEC's of Sydney Coastal River-flat Forest and Cumberland Plain Woodland. Mapping of vegetation types and condition was undertaken by Travers (2013) for the whole of the RHDA. Existing vegetation type is shown on **Map W019** in **Appendix A**, whilst existing vegetation condition is shown on **Map W018**. This mapping is superseded to some extent by later ground-truthed mapping produced by ELA (2016), however was found by ELA to be generally spatially and descriptively accurate – refer **Section 2.3** for further details. Several noxious weed species were identified within the study area. Eight of these were identified as Weeds of National Significance (WoNS). Generally, the majority of the study area had a moderate to high level of weed invasion (refer **Map W019** for indicative extent of high priority 'target' weeds), likely from stormwater disturbance, vegetation clearance and development edge effects.
Heritage	An Aboriginal archaeological due diligence assessment was undertaken as part of the concept design process. While the gently undulating topography adjacent to EMC would have been amenable to past Aboriginal activity, the level of past disturbance in the area is likely to have significantly impacted on cultural deposits across the area. Whilst the Aboriginal Heritage Information Management System (AHIMS) database identifies several sites in close proximity to the creekline (refer **Map W020** in **Appendix A)**, no artefacts were able to be located on site inspection. Furthermore no additional sites were identified. Due to levels of past disturbance, most of the creekline is considered of low archaeological sensitivity, however the reach between Minorca Avenue and Samantha Riley Drive was considered of relatively higher sensitivity.
Land use	Land use has changed significantly over the years (Refer to historical photos contained in the Contamination Report in **Appendix D**). Pre 1960's it was prominently cleared grazing land. In the 1970's to 90's the area consisted of small agricultural holdings and is now characterised by rural residential land that is currently transitioning into low and medium/high density urban development and associated urban land uses.
Land ownership	Existing land ownership is shown on **Map W028** in **Appendix A**. Sydney Water owns substantial parcels of land along EMC. Large areas north of Memorial Avenue and south of Balmoral Road are in State Government ownership, in particular along the alignment of and adjacent to the Sydney Metro North West, whilst several parcels remain in private ownership.
Land zoning	Existing land zoning is shown on **Map W011** in **Appendix A**. A review of existing statutory planning arrangements is documented in the Preliminary Planning Advice Memo in **Appendix E**.
Infrastructure and utilities	**Map W008** in **Appendix A** provides an overview of existing (and under construction) transport infrastructure in the vicinity of the Study Area. There are also numerous existing utilities/services within the Study Area, the location of which are shown on **Map W015** in **Appendix A**. The utilities have been mapped from the following sources: • Hard copy and/or pdf plans received via DBYD and subsequently digitised by AAJV. • GIS data extracted from Hydra (Sydney Water assets only). • GIS data received from THSC (stormwater assets only).

2.3 Flora and Fauna

Subsequent to initial desktop assessment that relied on the previous work of Travers (2013) (refer **Table 4**), Eco Logical Australia (ELA) were engaged to undertake field assessment and ground-truthing of Travers (2013) vegetation mapping to assist in understanding potential impacts on threatened species and ecological communities, and to assist in refining the proposed scope of works. ELA's work also included assessments of significance under State and Commonwealth legislation and development of a comprehensive suite of mitigation measures to ensure that the proposed trunk drainage works can avoid any adverse ecological impacts. It is noted this included several specific measures in regards future vegetation management requirements for the TDL.

ELA confirmed that two EEC's, Cumberland Plain Woodland and River-flat Eucalypt Forest, listed under the *Threatened Species Conservation Act 1995* are present along EMC. These communities occur along the riparian corridor of the creek, predominately in a disturbed state due to the dominance of exotic species and weeds.

No threatened flora species were observed or considered as having a potential occurrence along EMC. Whilst no fauna species were observed, or have previously been observed within the subject site, the following species were considered as having a potential to occur, and thus could potentially be affected by the proposed works; *Meridolum corneovirens* (Cumberland Plain Land Snail), *Mormopterus norfolkensis* (Eastern Free-tail Bat), *Myotis macropus* (Southern Myotis), *Saccolaimus flaviventris* (Yellow Sheathtailed-bat), *Scoteanax rueppellii* (Greater Broad-nosed Bat).

No threatened ecological communities, threatened flora or fauna listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or *Fishers Management Act 1994* were observed within the study area or considered has as having a potential to be adversely impacted by the proposed works.

Further details, in particular related to impacts, assessments of significance and proposed mitigation measures that should form part of the overall scope of trunk drainage works and future vegetation management within the TDL, are provided in the REF.

2.4 Subsurface Conditions

2.4.1 Contamination

A Phase 1 and targeted Phase 2 contamination investigation (AAJV, 2016b) was undertaken as part of the concept design process (refer **Appendix D**).

Desktop soil contamination investigation was undertaken and included a review of the NSW EPA contaminated land record. These investigations did not identify any recorded sites of contamination within the study area.

During the first site investigation for the contamination investigation in October 2015, six areas of environmental concern (AoECs) were identified within the study area. These areas where characteristic of uncontrolled fill material. No visual or olfactory signs of soil contamination or asbestos containing material (ACM) were observed during this site inspection. Subsequently ten soil samples were collected from the AoECs and analysed for contamination. Fill material was encountered from all boreholes to maximum depth of 2.1 m. Groundwater and bedrock was not encountered in any of the boreholes.

Based on the soil analytical results, soils excavated generally along the creekline are likely to be suitable for reuse on site, or for disposed off-site at a NSW EPA licensed landfill as General Solid Waste, with the exception of some isolated areas where visual observations identified potential ACM.

Further investigations will be required during detailed design to confirm the potential or otherwise for contamination once the extent and scope of ground disturbance is further refined and confirmed.

2.4.2 Geotechnical conditions

A desktop geotechnical assessment (AAJV, 2016c) was undertaken as part of the concept design process (refer **Appendix C**). Assessment was based on existing geotechnical investigation information available generally within 200 m of the creekline, and developed preliminary geotechnical design parameters and recommendations for measures to mitigate constraints and risks for the proposed trunk drainage design.

In general terms the typical subsurface profile comprises up to 2 m thick fill underlain by 1.5 to 4 m thick alluvium deposits of medium to high plasticity sandy/silty clay of stiff consistency. Residual soils encountered below the alluvium deposits generally comprise high plasticity silty clays of very stiff consistency and are typically 0.5 to 1.5 m thick over the weathered bedrock profile. The weathered bedrock profile comprise extremely to highly weathered Siltstone, estimated to be very low to low strength.

Particular constraints for the trunk drainage works are likely to include:

- Low slope stability requiring flat battering or otherwise support / retaining structures.
- Residual soils or clay origin are susceptible to erosion requiring protection and management.
- Potential low strength of residual soils may require removal or other suitable ground improvement works.
- Potentially unsuitable and saturated materials lining the invert of the various existing online dams.

It is noted that further investigations will be required during detailed design to confirm design parameters as well as proposed geotechnical design and ground improvement measures, once the extent and scope of proposed works is further refined and confirmed.

2.5 Geomorphology

A site assessment of EMC was undertaken on 16 October 2015. The assessment was in the form of a site walkover, identifying (where accessible and visible) the condition of the creek, including:

- channel form
- channel stability (bed or bank erosion), and
- vegetation.

2.5.1 Review of Historical Aerial Photographs

A review of historical aerial photographs reveals that EMC has changed significantly over the last 70 odd years. A brief summary is outlined below: (Note that several of the referenced aerial photos are included in the Contamination Report in **Appendix D**.)

- 1947 (January 1947, Run 37) – much of the site has been cleared of vegetation for grazing purposes. The reach between the now present-day Balmoral Road to Memorial Avenue contains the only reasonable stand of riparian vegetation. It appears the remaining reaches have been significantly cleared. Erosion appears to be present in numerous locations with bed incision (deepening) evident. The reach between Memorial Avenue downstream to the confluence of Caddies Creek looks to have significant in-channel and riparian erosion.
- 1955 (October 1955, Run 13) – Riparian vegetation similar to 1947. It appears that the erosion between Memorial Avenue and Caddies Creek isn't as severe with grasses now covering some of the erosion area.
- 1970 (July 1970, Run 11) – Presence of the roads: Memorial Ave, Balmoral Rd and Celebration Drive running east – west. It appears that an increased partitioning of land block size and change in land use from broadacre stock grazing to market gardens with the construction of a number of online and offline dams for irrigation purposes. The 1970 image contains a small dam at the confluence of an unnamed tributary approximately 130 m

downstream of the Celebration Drive. Additionally a major dam is present from the start of the present day second dam upstream of Balmoral Rd, continuing approximately 300 m downstream along the side of the driveway for 20 Memorial Ave. The creek has now altered to enter a new significant third dam between Balmoral Rd and Memorial Ave to likely service the market gardens. The creek line had visible channel incision (bed deepening) and channel expansion in some locations.

- 1978 (March 1978, Run 10) – Increased development along Old Windsor Rd. Expansion of market gardens and small acre farming practices. It appears further channelisation between Celebration Drive and Balmoral Rd with a new dam present where the creek takes a sharp 90 degree right-hand bend under the driveway at 40 Balmoral Rd. A constructed dam exists immediately downstream of Memorial Ave and another large dam just offline approximately 350 downstream on the west of the creek. It also appears to be a drought or low-rainfall period.
- 1982 (November 1982, Run 18) (North of Balmoral Rd not present) – Increased development particularly between Balmoral Rd and Samantha Riley Drive. Subdivision of Arnold Ave and Thomas Boulton Circuit area. It appears that there was significant erosion upstream and downstream of Memorial Ave.
- 1986 (August 1986, Run 16) – The block along and straddling the creek immediately downstream from Celebration Drive appears disturbed with bare earth and erosion prior to the small dam at the first confluence of the unnamed tributary. A levee appears to be present in this location. The second major dam has now reduced in size to its current size and the creek is channelized along the western side of the driveway. The creek between Balmoral Rd and Memorial Ave appears to be further straightened to facilitate a series of eight tennis courts on the western side of the creek. There is further clearing of vegetation around an online dam downstream of Memorial Ave.
- 1991 (August 1991, Run 6) – increased development of the area. It appears further erosion has occurred downstream of the present day Samantha Riley Drive.
- 2004 (February 2004, Google Earth) – The area immediately upstream of the site, 4 Celebration Drive and Norwest Business Park, and the residential area (Bella Vista Waters) to the east of this is being developed. Samantha Riley Drive is constructed and the adjacent housing developments are established.
- 2009 (October 2009, Nearmap) – Upstream extent of site contains two concrete causeways, culvert, creek hard lining and other creek structures (adjacent path and pedestrian crossing). Land parcels appear to house horses and stable yards in this reach. An ephemeral drainage line and horse yards connect the two online dams. Erosion appears present downstream of the second dam to where it takes a hard right-hand bend under the driveway of 40 Balmoral Rd. A western lateral overland drainage line intercepts where the creek passes under the driveway. The present day Balmoral Rd culvert system is present. A low depression area in front of the large off-line dam associated with the market dams exists. The creek line in front of 41 Memorial Ave illustrates signs of shaping and hardening, including two concrete causeways. Upper western bank erosion is present opposite 13 Landy Place.

2.5.2 Current Creek Condition

As highlighted above, EMC has changed significantly over the last 70 odd years. The creek has been modified in numerous locations through the clearing of vegetation, construction of online and adjacent dams, straightening and/or construction of new channel associated with development and changing land use practices.

Based on the findings of a geotechnical desktop assessment (refer **Appendix C**), a generalised subsurface level profile along the creekline is shown in **Table 5**.

Table 5: Generalised subsurface profile

Geotechnical Unit	Depth below existing ground level (m)	Thickness (m)	Description
Topsoil	0 to 0.2	0.2	Clayey silt
Residual Soil	0.2 to 1.2 1.2 to 2.6	1.0 1.4	firm clay of high plasticity stiff / very stiff to hard silty clay
Bedrock	2.6 to 4.0 >4.0	1.4	extremely weathered to moderately weathered siltstone, low to medium strength extremely weathered to highly weathered shale, low to medium strength

Even since the 2009 aerial photograph, the present day condition of the creek has also changed significantly. A brief summary of the current condition is outlined below and in **Table 6**.

Reach 1: Celebration Drive to Balmoral Road

The upstream section of this reach is highly modified and constrained, containing a concrete culvert and two concrete causeways at the start of the site. Immediately downstream the channel has been straightened and hardened, upon where it meets a constructed lateral channel and levee system. The channel bed in this locality is showing signs of bed incision (deepening) and lateral expansion (widening) where the channel is laterally unconstrained. Downstream of the levee area the creek has been significantly altered by the construction of two large online dams. Additionally the construction of the Sydney Metro Northwest tunnel dive and adjacent Bella Vista station has significantly changed the floodplain area. Immediately downstream of the second dam there is an approximate 1 m differential erosion headcut that has previously had dumped rock to try and reduce any erosion impact. The channel adjacent to the driveway of 40 Balmoral Rd has been straightened and is illustrating signs of channel incision and lateral expansion, particularly on the steeper eastern bank. The driveway culvert system is undersized causing overbank flows. The subsequent approximate 100 m of creek appears to be in its natural channel location however, it is affected by horses accessing the creek line and significant rabbit infestation and from dumping of anthropogenic material. This creek section also shows signs of erosion on the upper western bank and minor bed incision prior to entering the upstream Balmoral Rd culvert dissipation area.

Reach 2: Balmoral Road to Memorial Avenue

The culverts downstream of Balmoral Road are drowned out, creating a completely submerged culvert system. The adjacent stand of good riparian (EEC) vegetation on 38 Balmoral Ave had been cleared during the project period, leaving little mature vegetation downstream of the culverts. The creek and adjacent area are low-lying and the floodplain appears to have been regularly engaged. A modified straightened creek channel flows downstream into a low bunded depression area adjacent to a large semi off-line dam. Historically the creek entered and drained from this dam, however a constructed straightened channel now appears on the western edge of this depression area. This section illustrates signs of channel incision and expansion. Adjacent to the dam appears to be an old tip with numerous car bodies and other litter/waste items present or partially buried. The majority of the depression area and adjacent banks is dominated by blackberry and other weeds species. Downstream of the depression / blackberry area the creek remerges into a defined channel passing through a small stand of mature casuarinas. Beyond this stand of trees the channel becomes ill defined into a broad flat discontinuous ephemeral channel, prior to entering an elongated pool immediately upstream of Memorial Ave.

Reach 3: Memorial Avenue to Samantha Riley Drive

Immediately downstream of the Memorial Ave concrete apron there is a small series of headcuts present. The channel passes through a shallow, narrow channel between a dense stand of casuarinas. The western floodplain is constrained by historic fill material and a fence line. The creek bed has minor incision occurring, currently being limited by the casuarinas, and where devoid of any root system the creek morphs into a deeper narrow pool. A concrete bed slab has been constructed along some of this reach prior to entering a series of three constructed online dams. A concrete causeway exists between the first two dams with an additional concrete causeway downstream of the second dam in this locality. The third dam is choked with Typha (cumbungi) species and contains a number of willow (Salix) trees on the fringe. An incised narrow channel between a dense stand of casuarinas joins the third constructed dam and the fourth dam. A series of large fill material / spoil mounds are present in this location. Immediately downstream of the dam the creek channel contains a number of headcuts. The channel and floodplain in this vicinity contain a dense closed-forest canopy of casuarinas, no mid-storey, with a weed infested understory of tradescantia. The dense casuarina trunks and root-wads have caused the channel to meander and avulse throughout this area. The channel is ill-formed, almost braided, with flood-runners, scour holes and headcuts throughout. Headcuts and channel incision occur where the root systems have failed or are missing. A compound channel starts to emerge once the creek passes the closed forest of casuarinas with evidence of a series of incision events. The channel generally becomes deeper and wider from this point. Active bed incision and channel expansion is present throughout. Further downstream close to Wenden Av the channel is approximately 2.5 to 3 m deep and 12 m wide. Within this locality a historic gully and newly constructed drain / ditch are present on the eastern bank. Active channel migration appears to be occurring in the vicinity of the gully in the direction of 14 Wenden Av. Sedimentation and accumulation has occurred on a number of the inside meanders as part of a cut and fill process. Historic bank revetment works have occurred downstream of this section, particularly on the right-hand bank, prior to entering a series of box culverts under Samantha Riley Drive.

Reach 4: Downstream (north) of Samantha Riley Drive

The channel section downstream of Samantha Riley Drive and adjoining floodplain have been cleared and modified in this locality. The creek illustrates signs of historic erosion with some minor active erosion still present. A number of stormwater pipes outlet into the creek and contain rock bank and channel bed protection. There is minor bed and bank erosion associated with these outlets as well as dislodgement of rock protection. The creek then enters into a minor constructed pool area near downstream extent of the project. Trenching through a meander to straighten the channel was present.

2.6 Flooding

2.6.1 Background

Various hydrologic and hydraulic models have been used to develop an understanding of flooding conditions along EMC. The present investigation uses the most recent work undertaken as part of the *Rouse Hill Flood Study*, which was prepared by WMAwater for Sydney Water in 2014.

In summary, the Rouse Hill Flood Study developed a new TUFLOW hydraulic model (herein referred to as the 'WMA TUFLOW Model') covering all of the major waterways and associated floodplains located within the RHDA, including EMC. Flood behaviour was defined for a range of design flood events with average recurrence intervals (ARIs) between 2 and 100 years[1]. The TUFLOW model uses

[1] WMAwater, 2014 adopts flood terminology that is consistent with the current Australian Rainfall and Runoff Revision Project (Ball et al, 2016). This involves use of the terms *Annual Exceedance Probability* (AEP) and *Exceedances per Year* (EY) to describe flood probabilities, in preference to use of the term *Average Recurrence Interval* (ARI). In this report, use of ARI has been adopted for consistency with the project background and typical internal Sydney Water usage.

inflow hydrographs derived from an XP-RAFTS model previously developed by SKM (2009). Further details of this work, as well as a summary of earlier flooding investigations undertaken in the Study Area and other relevant background information, are documented in WMAwater (2014).

Brief review of the WMA TUFLOW Model for suitability was undertaken as one of the initial projects tasks. The following sections provide a summary of the outcomes of this review, minor adjustments that were subsequently made to the TUFLOW model, and an overview of baseline flooding conditions within the Study Area.

It is relevant to note that *baseline conditions* do not equate to *existing conditions* in this case, as the Rouse Hill Flood Study adopts ultimate catchment development conditions to define hydrologic inputs to the TUFLOW model. As the contributing catchment areas upstream of the Study Area are not yet fully developed, the WMA TUFLOW Model is expected to slightly overestimate the resulting catchment runoff potential, and therefore flow rates along EMC, when compared to existing conditions. However, the adoption of ultimate catchment development conditions for the purposes of this study is consistent with all previous and ongoing trunk drainage and flood management planning throughout the RHDA.

2.6.2 Review of WMA TUFLOW Model

On review of the WMA TUFLOW Model it was found that several aspects of the model structure and schematisation required adjustment to more accurately simulate flooding conditions within the Study Area. The key issues noted were as follows:

Model inflow boundaries

The location of model inflow boundaries along EMC were considered unrepresentative, and in particular did not correctly distribute inflows across the detention basins located upstream of the Study Area.

This issue was addressed by making adjustments to the inflow boundary locations and extents.

The impact on peak 100 year ARI flood levels was to increase flood levels upstream of Balmoral Road generally, typically in the range 0.05-0.1 m up to a maximum of about 0.2 m. Downstream of Balmoral Road there was no substantial change.

Hydraulic roughness

Hydraulic roughness was considered to be underestimated within the inbank section of the creek for selected reaches (e.g. between Balmoral Road and Hodges Road). The roughness of immediate overbank areas that are densely vegetated was also considered to be underestimated in various areas, owing largely to the 1D schematisation of the creek channel which included adjacent floodplain areas above top of bank level.

The typical increase in Mannings n value that was applied to improve hydraulic roughness definition under existing conditions on account of the above issues was from 0.06 to 0.08. It is noted that Mannings n values were also locally adjusted in other areas where appropriate to represent variations in vegetation extent and/or density, as well as to apply a consistent approach to the way other land uses (e.g. residential properties) were represented in the TUFLOW model.

The impact on peak 100 year ARI flood levels was to generally increase flood levels throughout the Study Area, typically in the order of 0.05-0.1 m up to a maximum of about 0.3 m in some isolated locations.

1D schematisation of creek channel

EMC and its immediate floodplain were represented in the WMA TUFLOW Model using a series of 1D cross sections. On review this was found to be problematic in particular along the 1D-2D interface boundary as spill levels were not well defined and resulted in poor connectivity, with flows entering and leaving the 1D domain at unrepresentative locations. This also contributed to some model instability, which was considered problematic for future impact assessment purposes.

This issue was resolved by removing the 1D schematisation so that the entire floodplain including creek channel is represented fully in 2D. The creek channel topography was defined using a separate digital terrain model that was developed using the previous cross section data, and was 'stamped' on top of the LiDAR-based topography that informs the whole of the 2D domain. Additionally, the model grid resolution was increased from the original 5 m to 2 m. Comparisons of the modelled waterway area, channel conveyance and floodplain storage between the previous 1D and revised 2D definitions showed sufficiently close agreement.

The impact on peak 100 year ARI flood levels varied along the length of EMC. Whilst some isolated reductions were noted, typically flood levels were increased throughout the Study Area, typically in the range 0.1-0.2 m up to a maximum of approximately 0.3 m in selected locations.

2.6.3 TUFLOW Model Refinement

The WMA TUFLOW Model was modified to include the adjustments described above. In addition, a series of further refinements were made as described below. The modified TUFLOW model is herein referred to as the 'AAJV TUFLOW Model', the structure of which is shown on **Figure 2**.

- The model was trimmed to suit the Study Area, which enabled faster model run times and provided the opportunity to increase the 2D model resolution.
- The 2D model grid size was reduced from 5 m to 2 m, which enabled increased topographic resolution to represent finer scale elements that influence local flooding conditions within the Study Area.
- Inclusion of twin 1200 mm diameter pipes that convey EMC under the driveway upstream of Balmoral Road.
- Definition of floodplain features either not defined or poorly defined by LiDAR data, including:
    - Existing solid colorbond fence on the left (west) creek overbank immediately downstream of Memorial Avenue.
    - Existing raised soil stockpiles and other filling in various locations along EMC.
    - Existing embankment crest levels downstream of existing online dams.

  Definition of these features was achieved using topographic modifiers (e.g. zshapes or zlines as appropriate), the location of which are shown on **Figure 2**.
- Patches in various locations to fix issues/errors with the underlying LiDAR data.
- Inclusion of approved / committed works that are soon to be constructed, including:
    - Upgrade of Memorial Avenue by RMS. This will include widening and raising the road where it crosses EMC as well as a major upgrade of the existing transverse drainage structure. Details of the proposed road and drainage upgrade works were adopted from information supplied by Beca on behalf of RMS in August 2015. The existing 3 off 3000 x 900 RCBC's will be upgraded to 4 off 3000 x 1800 RCBC's, and will achieve 100 year ARI flood immunity for the upgraded road.
    - Extension of Lewis Jones Drive to the north to connect to Gainsford Drive. Road crown levels taken from approved subdivision plans (and based on previous flood levels advised by Sydney Water to the developer) were enforced in the TUFLOW model.

The modified TUFLOW model (herein referred to as the 'AAJV TUFLOW Model') was then used to define baseline flooding conditions within the Study Area. The 2 hour storm duration was used for all models runs. Whilst WMAwater (2014) produced a peak envelope of results for storm durations of 2, 6 and 9 hours to define design flood levels for each ARI, there is insufficient difference between results along EMC to warrant this approach.

It is noted that blockage factors as applied to major culvert structures in the WMA TUFLOW Model were adopted, as follows:

- Samantha Riley Drive – 10% blockage
- Memorial Avenue – 20% blockage
- Balmoral Road – 50% blockage

These factors were derived with reference to recent guidance developed as part of the current Australian Rainfall and Runoff Revision Project (Ball et al, 2016).

2.6.4 Baseline Flooding Conditions

Figure 3 and **Figure 4** show baseline flooding conditions in terms of extents and depths of inundation for the 2 and 100 year ARI events, respectively.

The approximate hydrologic standards achieved for the major road crossings in the Study Area are as follows:

- Samantha Riley Drive – exceeds 100 year ARI
- Memorial Avenue – exceeds 100 year ARI (once proposed road upgrade is implemented)
- Balmoral Road – less than 2 year ARI

It is also relevant to note that Landy Place and the future extension of Lewis Jones Drive are both overtopped by shallow flooding in a 100 year ARI event (refer **Figure 4**). This is in contrast to previous flood investigations which showed that both roads were located above peak 100 year ARI flood levels. The change in modelled flood behaviour at Landy Place is attributed to the change from 1D to 2D definition of the adjacent creek channel, along with a change in definition of crest levels along the right (east) top of bank which now more accurately reflects available LiDAR data. Increases in peak 100 year ARI flood levels further upstream at the future extension of Lewis Jones Drive are primarily driven by the relatively higher hydraulic roughness that has been assessed as part of the present investigation.

The greatest flood risk to existing development within the Study Area is in the reach of EMC extending upstream from Samantha Riley Drive to Wenden Avenue. Whilst Landy Place properties are above peak 100 year ARI flood levels, the backyards of two properties located at the western end of Wenden Av (i.e. Nos. 14 and 16) are shown to be affected by shallow flooding less than 0.15 m deep for a flood of this magnitude (refer **Figure 4)**.

To the north of Samantha Riley Drive, and to the south of Wenden Avenue, existing development is indicated to be situated above peak 100 year ARI flood levels.

2.6.5 Flood Management Priorities

Based on an understanding of baseline flooding conditions, the following specific flood management priorities were identified for further investigation during the concept design development, which expand on Sydney Water's general objectives for the project:

- Ensure peak 100 year ARI flood levels in the vicinity of Nos. 14 and 16 Wenden Avenue are not increased. If practical the trunk drainage works should seek to provide some reduction in flood levels at this location.
- Ensure peak 100 year ARI flood levels in the vicinity of Landy Place, and at Brunner Court and No. 10 Colonial Street, are not increased such that floodwaters would encroach into existing residential properties in these areas.
- Ensure peak 100 year ARI flood levels in the vicinity of No. 21 Balmoral Road are consistent with the approved Development Application (DA) for this property. In particular, changes to flood levels should ensure that freeboard to approved habitable floor levels is not reduced below 500 mm, and that any additional property flooding does not create conditions that are hazardous to future residents. It is noted that the property is subject to shallow inundation for the 100 year ARI under baseline conditions.

- Investigate measures that could reduce peak flood levels in the vicinity of Landy Place and the future extension of Lewis Jones Drive, to prevent overtopping of these roads for events up to and including 100 year ARI.

  In particular, overtopping of the future extension of Lewis Jones Drive should be prevented if possible given approved future road levels in this area were previously advised by Sydney Water (albeit on the basis of now superseded flood modelling).

Figure 2: AAJV TUFLOW Model Structure – Baseline Conditions

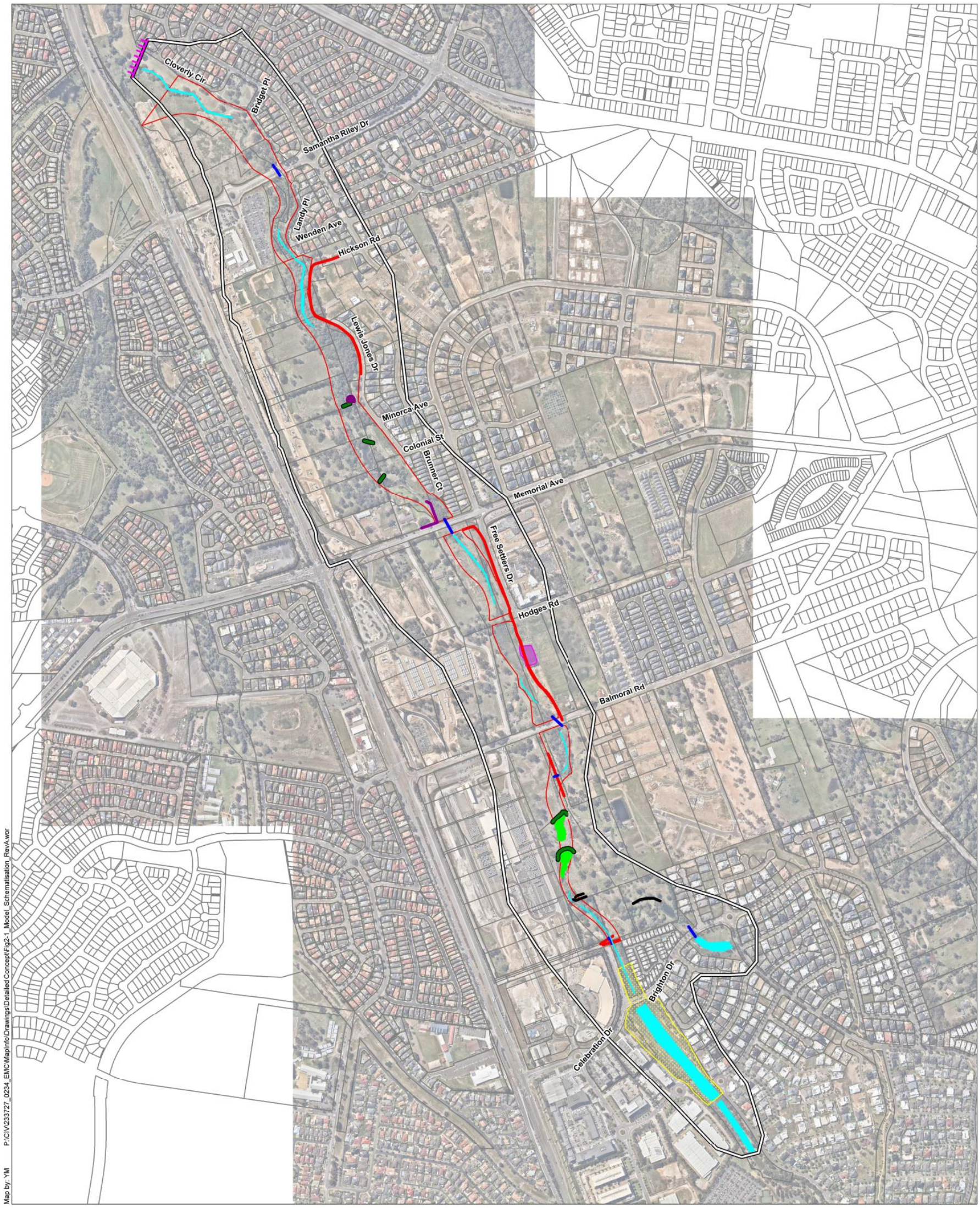


Figure 3: Baseline Flooding Conditions – 2 year ARI

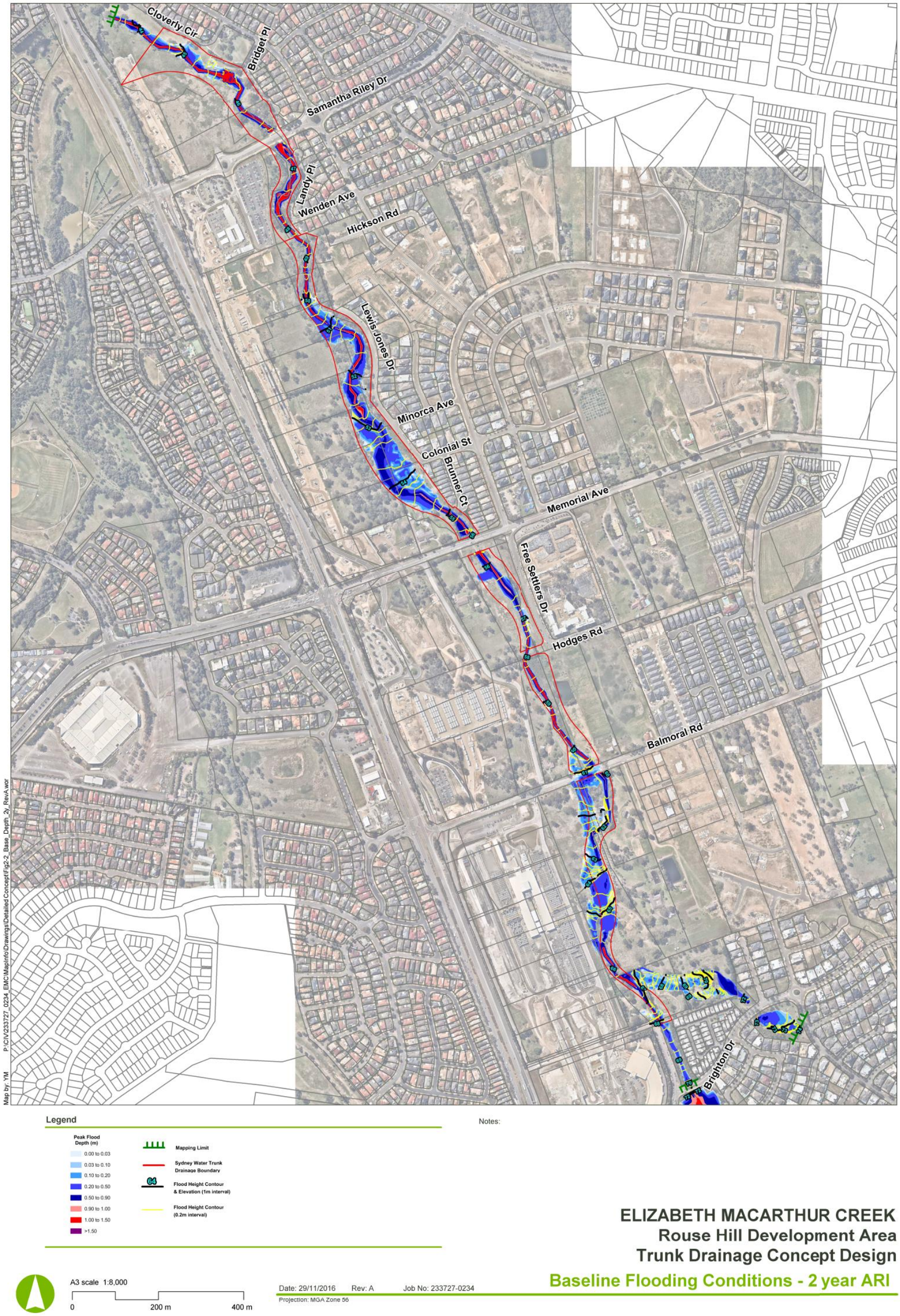
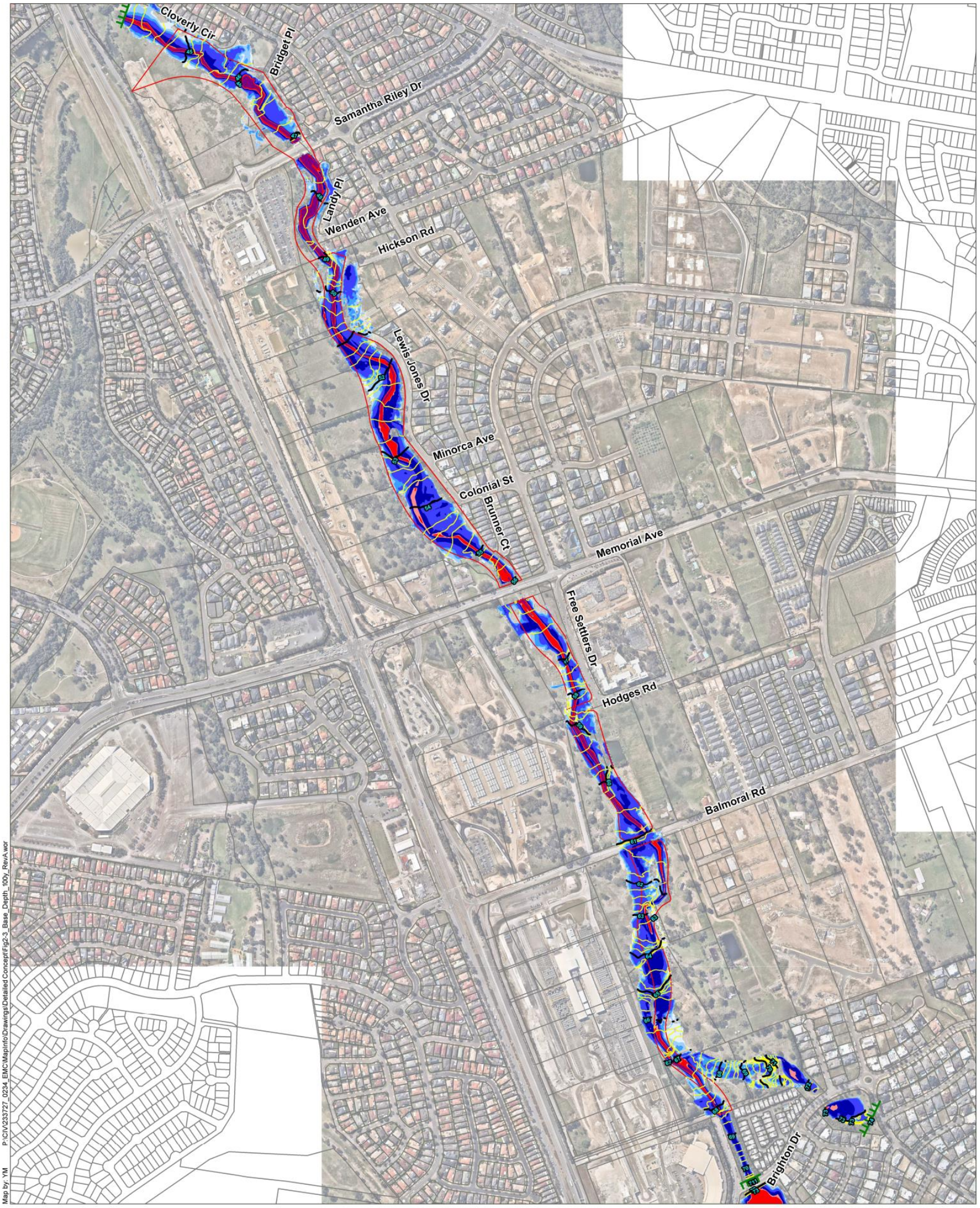


Figure 4: Baseline Flooding Conditions – 100 year ARI



3 Creek Design

3.1 Guiding Principles for Stream Rehabilitation

The rehabilitation of EMC is to incorporate design measures that contribute to the liveability of the local neighbourhood and the provision of ecosystem services. The design template for the stream is based on the Sydney Water project objectives, PoM priorities and the existing environment. It is proposed to allow the stream to naturally adjust to the changing flow regime wherever possible, with enhancements in order to maximise floodplain engagement within the TDL. The rehabilitation objectives for EMC include:

- Conveyance – in line with Sydney Waters' mandate for the TDL to provide flood conveyance, one of the primary focuses for the project is the provision of sufficient capacity to convey stream flows without allowing flood waters to cause damage to property or risk to life in adjacent existing developments.
- Flood storage – to use the TDL to engage the floodplain as much as possible without impacting surrounding properties. Using local road crossings as flow constrictions. Using revegetation to create surface roughness.
- Redundant infrastructure – to remove redundant assets from past residential / rural land uses that impede flows and/or impact the surrounding environment.
- Minimise disturbance / allow natural adjustment – to allow the creek to evolve and adjust naturally with inter-annual variations in runoff and changes to the vegetation community wherever possible, and where sufficient floodplain buffer is present within the TDL.
- Stream alteration / erosion control – intervention to occur where a naturally adjusting creek may significantly impact the environment and/or adjacent anthropogenic assets. Intervention will limit the use of rock where possible. Rock use to be limited to arresting headward erosion (i.e. headcuts), for bed and grade control (e.g. chutes and riffle) and on outer banks and in the low flow channel where warranted due to high shear stresses. Stability created with increases in capacity and/or flatter longitudinal bed grades at specific locations, use of soil bioengineering incorporating vegetation, natural biodegradable erosion control measures (e.g. Jute matting and coir logs) and large wood.
- Riparian cover – along the full length of the project that is consistent with the requirements of the NSW Office of Water. Fully structured native vegetation community including canopy cover, mid-stratum (shrubs), ground cover and aquatic.
- Habitat – rehabilitation of the riparian corridor with species from the Endangered Ecological Communities (EEC's) (*Sydney Coastal River-flat Forest (Alluvial Woodland)* and *Cumberland Plain Woodland*) of plants appropriate to the site. Rehabilitation would extend the cover of these communities from the existing pockets to the full extent possible, given other limited site uses. Rehabilitation of plant communities should be based on bush regeneration principles. Aquatic habitat diversity such as pools and riffles can be created in association with in-stream works that are required for stability or infrastructure.

- Water quality improvement – to use the riparian corridor and floodplain to provide opportunities to improve the quality of water within EMC. Opportunities considered include engaging the floodplain, vegetated channels, and stormwater harvesting to treat runoff from adjacent developments.
- Alternative water supplies – stormwater harvesting and/or stream flows can be harvested to provide an alternative water supply for non-potable water demands. This could be done by harvesting treated local catchment runoff via a parallel pipeline, disconnecting existing and new pipe outlets from the creek and re-directing into the low flow pipeline with controlled discharge at bridge abutments.
- Amenity – Provision of high value public open space through the provision of many features that contribute to the recreational opportunities of the adjacent developments: greenery, shade, comfortable microclimate, diversity of vegetation, access tracks, water features (stream and ponds) and formal active or passive recreation areas.
- Low maintenance – Features within the trunk drainage lands should be designed to minimise the effort required for on-going maintenance in the long-term. Key principles include:
    - Robust communities of native plants that are weed resistant and resilient to or can adapt to changes in climate between seasons, el Niño cycles and longer term changes.
    - Monitoring – timely intervention for erosion and weed infestations is cost effective
    - Leasing – Where trunk drainage lands may be used for compatible uses by other parties, the maintenance of those areas can be transferred from Sydney Water to the other parties for the duration of the lease.

3.2 Stream Rehabilitation Opportunities and Constraints

EMC has been significantly disturbed / altered over recent years by vegetation clearing, channel alterations and online infrastructure. The upper reach (Celebration Drive to Memorial Ave) of the project site has prominently been cleared of native vegetation except for isolated patches and/or scattered native tress. The lower reach, (Memorial Ave to Samantha Riley Drive) of the study site contains reasonable riparian canopy species from the two EEC's: Cumberland Plain Woodland and River-flat Eucalypt Forest, however a dense groundcover of weed species is generally present through the project site. As a result of this disturbance the creeks' current form in some locations doesn't represent the structure of a resilient, naturally functioning creek system. The creek is adjusting to a change in flow regime associated with the urbanisation of the catchment. This adjustment is in the form of channel deepening and widening in many locations. Creek erosion is a natural process and the philosophy of letting the creek self-adjust can be accommodated where sufficient space is present and where threats to the environment, water quality, habitat, public safety and infrastructure are minimal. Generally the whole site requires significant weed control and the installation of a native riparian and floodplain vegetation corridor. In some locations the creek needs stabilisation or alteration to meet the Sydney Water objectives.

General constraints and opportunities are identified in **Figure 5** and listed below.

3.2.1 Constraints to stream rehabilitation works

Stream rehabilitation works would be constrained in the following ways:

- Cost and value for money of undertaking rehabilitation works.
- EEC's must be protected from damage and in some locations these EEC's surround sites of erosion.
- Declared weed infestations occur within the corridor and these must be removed and managed.
- Construction within the stream requires specialised skills and machinery, and many areas requiring stabilisation measures are located within areas of protected vegetation.

- Existing stream crossings such as driveways, culverts and other crossings impair stream connectivity.
- There are many locations where expansion of the local road network to support future development will require new creek crossings.
- Utilities (e.g. sewer, water, power, etc.) occur in proximity to the creek.
- Fences cross the creek.
- The impacts of the existing and proposed stormwater outlets, and stormwater networks required consideration.
- Suspected land-fill and contaminated fill occurs in some places in the project site.
- Dispersive or sodic soils may occur in places. These may need to be capped with engineering clay, with topsoil placed on top and anchored.
- Heritage features.

3.2.2 Opportunities with stream rehabilitation works

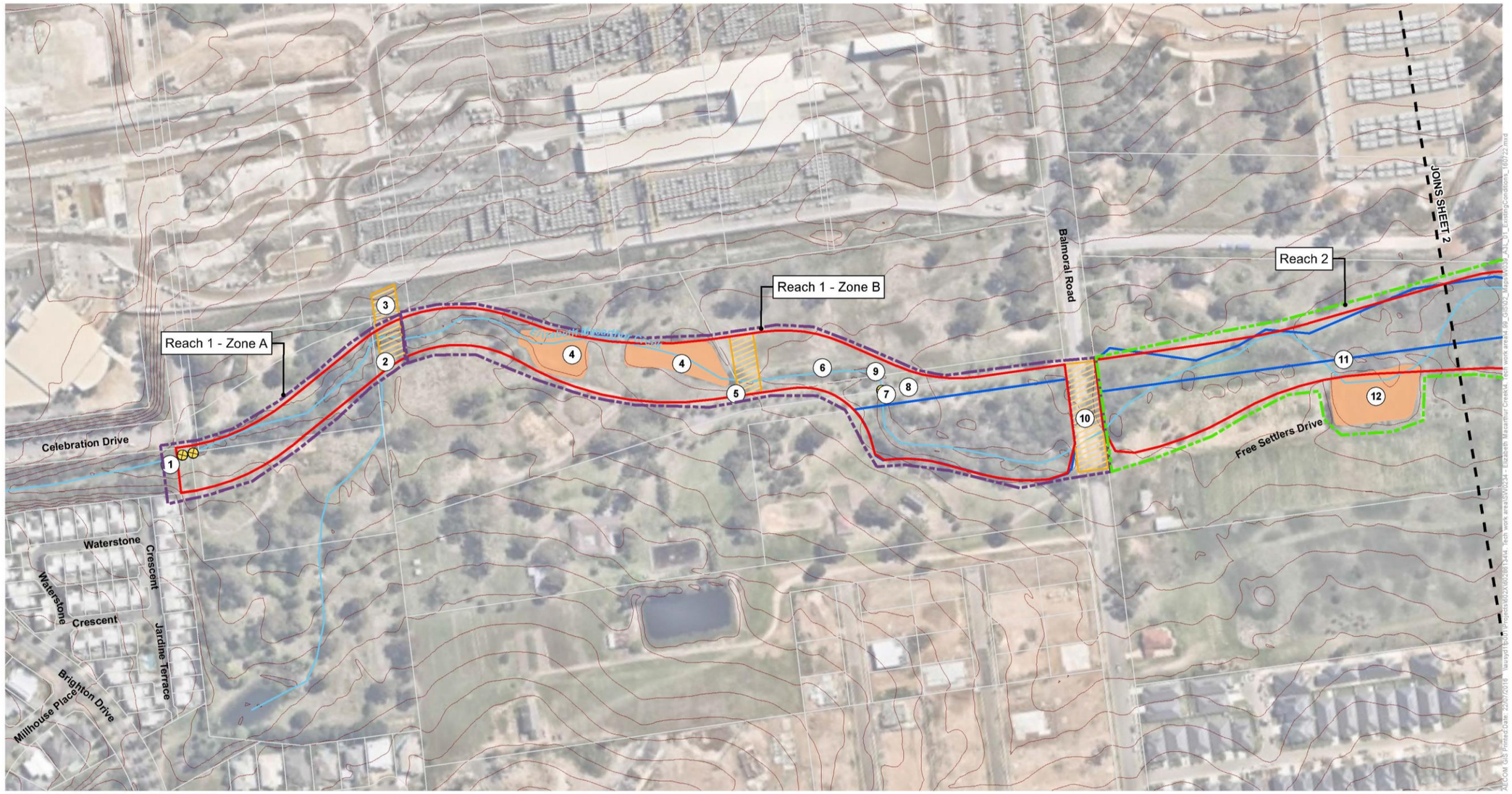
Stream rehabilitation works offer the following opportunities:

- Stream / floodplain connectivity – reinstatement of stream / floodplain connectivity through the removal of existing anthropogenic structures such as fences, culverts, concrete creek crossings, driveways and other infrastructure that impair stream / floodplain connectivity.
- Vegetation communities and connectivity – opportunity to protect and expand the existing fragmented EEC's present. Additional opportunity to install a connected riparian corridor with an appropriate ground, mid and canopy structure that provides a resilient, biodiverse ecosystem to the TDL and surrounding developments.
- Amenity - Where access must be made to undertake in-stream works, the path that would be created could become part of a future public access track. Rock riffles and pools are features of interest.
- Maintenance access - Access will be required for maintenance, and this could be facilitated by the in-stream works.
- Bush restoration – Works areas would create access nodes that could be a focal point for restoration or bushcare work. Typical areas that are models of stable banks and successful stabilisation works can be used as reference sites.

3.2.3 Site specific creek conditions, constraints and opportunities

Refer to **Figure 5** for site-specific opportunities and constraints. The figure contains 'Works Identifier' labels that are cross-referenced to relevant discussion in the following **Table 6**.

Figure 5: Plan of existing conditions



SHEET 1: EXISTING CONDITIONS

Date: 22/07/2016 Rev: A

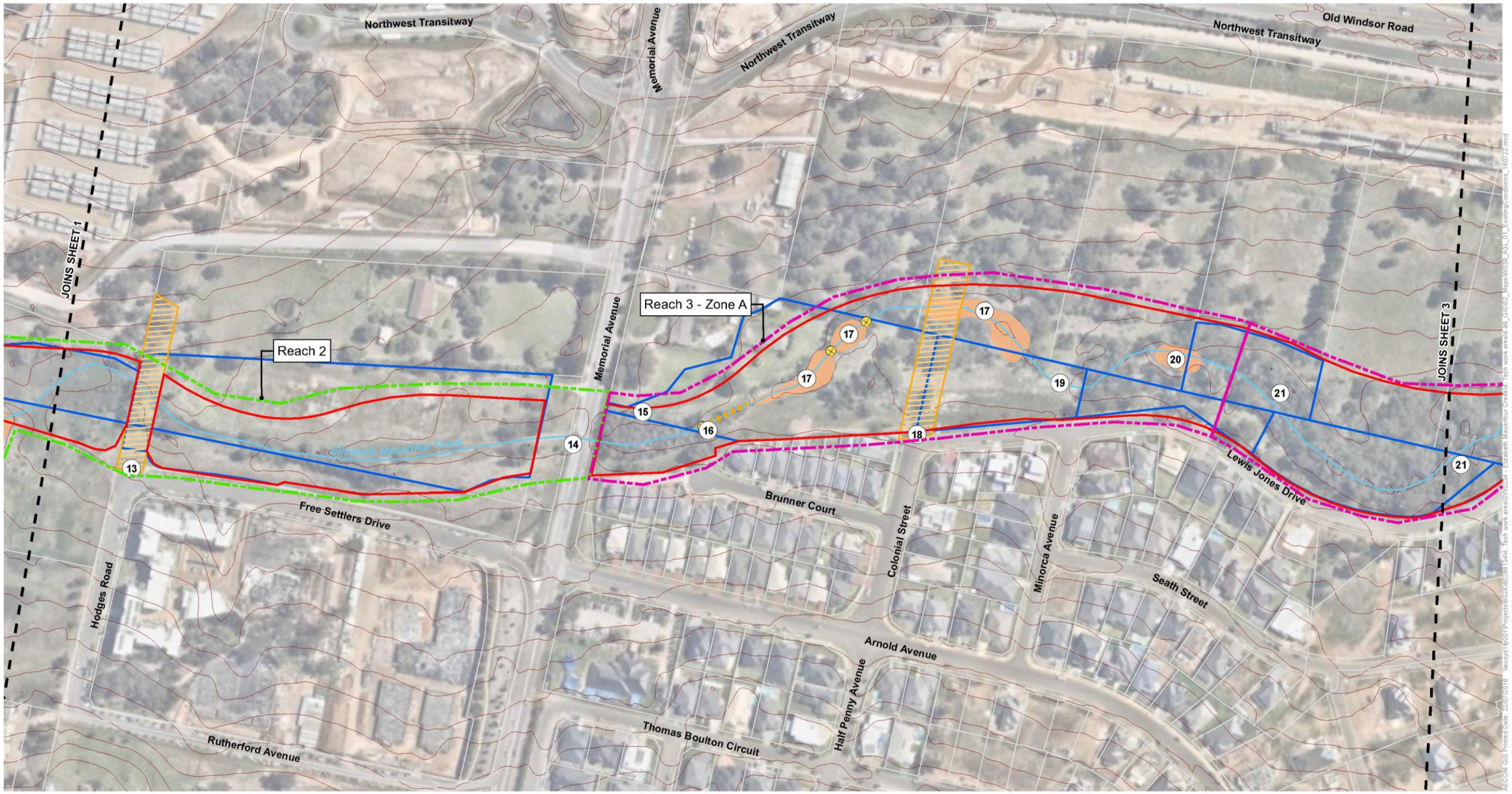
KEY

- Trunk drainage land boundary
- Watercourse
- SWC Land
- Cadastre
- 1m contour
- Existing in-bank structure
- Existing concrete lining
- Existing online dam
- (1) Works identifier (refer seperate table)
- Reach 1
- Reach 2
- Reach 3
- Reach 4

0 50 100 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.



SHEET 2: EXISTING CONDITIONS

Date: 22/07/2016 Rev: A

KEY

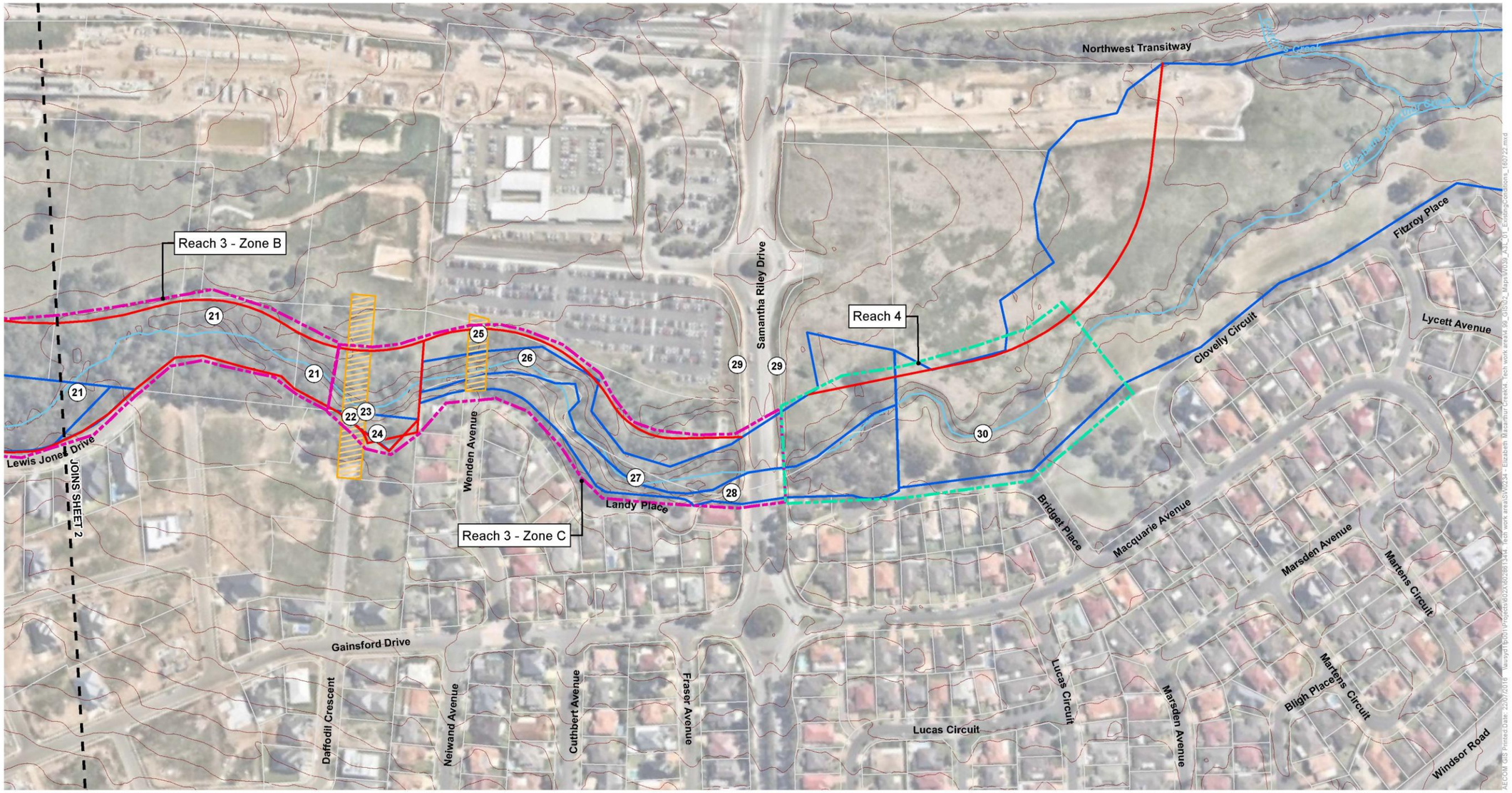
- Trunk drainage land boundary
- Watercourse
- SWC Land
- Cadastre
- 1m contour
- Existing in-bank structure
- Existing concrete lining
- Existing online dam
- (1) Works identifier (refer seperate table)
- Reach 1
- Reach 2
- Reach 3
- Reach 4

0 50 100 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

AECOM GIS Printed Date: 22/07/2016 \\ausyd1fp001\Projects\60234\60281344_Tech work areas\WIA4 - Elizabeth Macarthur Creek\4_Tech work areas\4_99_GIS\02_Maps\W039_A3L_01_ExistingConditions_160722.mxd



SHEET 3: EXISTING CONDITIONS Date: 22/07/2016 Rev: A

KEY

- Trunk drainage land boundary
- Watercourse
- SWC Land
- Cadastre
- 1m contour
- Existing in-bank structure
- Existing concrete lining
- Existing online dam
- (1) Works identifier (refer seperate table)
- Reach 1
- Reach 2
- Reach 3
- Reach 4

0 50 100 m

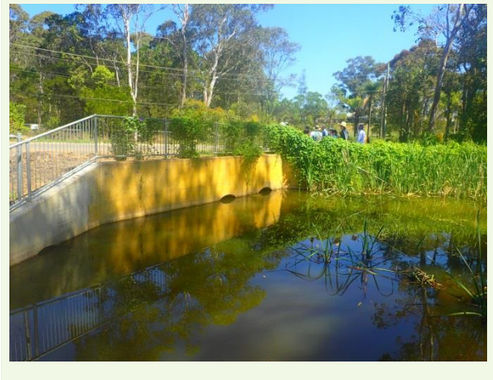
Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

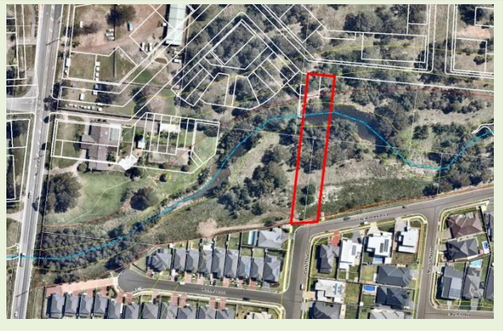
Table 6: Creek Condition, Constraints and Opportunities

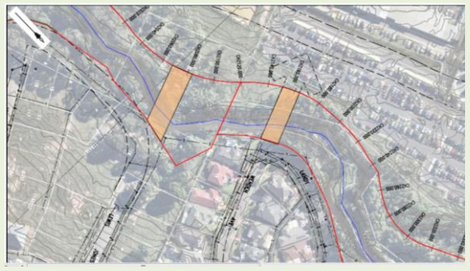
Works Identifier	Description / Location	Existing Condition of Creek / Feature	Constraints	Opportunities	Photographic example
Reach 1 – Zone A					
1	Upstream extent of project site at TDL boundary.	Small altered channel with 1-2 m wide low-flow channel and 3-5 m wide bank-full channel). Channel erosion present with incised bed and eroding banks. Disturbed environment from prior land use and residential / farming facilities previously located at site. Well vegetated with many weeds. Downstream of the road crossing contains thin stand of native Casuarina trees running along the top of bank zone. Construction debris in waterway (i.e. bricks) Culvert and 2 x concrete causeway associated with legacy driveway crossings. Redundant services. Very large Willow tree on northern bank. Refer to Figure 4 to 9 in Appendix B.	Source water coming from a urbanised upper catchment area. Concrete culvert located in close proximity to TDL boundary, therefore works required within adjacent property to south. Sewer and power services in close proximity. Redundant services near road crossing to be removed. Significant concrete assets to be removed / remediated.	Few native vegetation species present at upstream extent that will likely impede construction activity. Space to include a GPT or similar water quality treatment measure. Channel relatively small to facilitate floodplain engagement. Utilise the existing top of bank Casuarina trees to stabilise channel and assist in regeneration. * Reinstate an appropriate local native vegetation structure within the channel, riparian and floodplain zones. Create a riparian / habitat corridor. * Facilitate public access, interaction with waterway and the natural environment. Potential construction compound and stockpile location. ** Applicable opportunity for all areas*	
2	Levee and confluence with unnamed tributary	Lateral levee runs adjacent to the unnamed tributary. Levee and associated landfill / spoil mound are approximately 1 m high. Unnamed tributary approximately 1-2 m wide with sub-vertical banks and shows signs of incision. Weed trees and occasional Casuarina tree present on levee. Refer to Figure 11 in Appendix B.	Levee slope runs directly down to the tributary.	Remove levee and landfill / spoil mound blockages to flood flows	
3	Potential future bridge crossing #1	As for (2).	A bridge crossing is proposed as part of an expansion of the local road network.	The bridge will be designed and constructed by others. The bridge structure will be required to satisfy the desired flooding and riparian corridor outcomes for the creek line. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes	

Works Identifier	Description / Location	Existing Condition of Creek / Feature	Constraints	Opportunities	Photographic example
Reach 1 – Zone B					
4	Two large online dams (Dam 1 and Dam 2)	Two large online constructed dams. Dam #1 approximately 45m long and 28m wide. Dam #2 approximately 68m long and 25m wide. Dam #1 appears shallower or more sediment deposition than Dam #2 which appears deeper. Bank height varies but generally steep bank and approx. 0.5m high above water surface level. Water depth various but estimate it's between 0.5-1m in depth. Small constructed channel connecting the two dams. Vegetation within and around dam is mainly weed species. The scattered large mature native trees are located adjacent on the floodplain, some with fauna habitat boxes. Headcut immediately downstream of Dam 2. Refer to Figure 12 to Figure 16 in Appendix B.	Very large online dams with unknown depth and deposition material. Dam extends outside the TDL. Removal of dams will likely require a significant amount of earthworks and fill material.	Few native vegetation species present around the dams that will likely impede construction activity. Create a public open water body for adjacent land development; or, a meandering creek channel and riparian vegetation system that allows engagement of the floodplain.	
5	Potential future bridge crossing #2 at Balmoral Road	As for (4)	A bridge crossing is proposed as part of an expansion of the local road network.	The bridge will be designed and constructed by others. A bridge structure will be required to satisfy the desired flooding and riparian corridor outcomes for the creek line. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	
6	Existing straightened channel adjacent to historic residential driveway downstream of Dam #2	The existing creek appears to have been straightened and has steep, minimal topsoil, and poorly vegetated banks that are susceptible to erosion and scouring. Increased erosion present on inside meander as channel flows towards the road crossing. Lateral overland flow path adjoins creek at outside meander. Refer to Figure 17 and 18 in Appendix B.	Historic residential driveway with row of large date palms on either side. Adjacent property boundary is close to eastern bank Sewer line and high voltage overhead transmission line in close proximity to meander and driveway	Removal of redundant road infrastructure. Reinstate an improved channel geometry and planform that can support appropriate native vegetation and engage the floodplain. Realign channel meander at a more suitable axis to reduce erosion potential.	

Works Identifier	Description / Location	Existing Condition of Creek / Feature	Constraints	Opportunities	Photographic example
7	Concrete piped culvert crossing under driveway	Duel concrete pipe culvert under driveway hardstand. Pipe diameters appear undersized for the channel size. This undersized culvert and the 90 degree meander are contributing to an overland flow path in high flow events. Erosion present around headwall. Refer to Figure 20 in Appendix B.	Adjacent property boundary is close to eastern bank. Close proximity to downstream EEC.	Removal of redundant road and culvert infrastructure to create a more natural like channel. Reinstate an improved channel geometry and planform that can support appropriate native vegetation and engage the floodplain.	
8	Driveway/hardstand and date palms	The driveway (residential access) has become redundant following Sydney Water's acquisition of land within the proposed trunk drainage corridor. Approximately 3.5m wide and 140m long redundant residential driveway off Balmoral Road present. Large date palm trees exist along either side of the driveway. Total width of driveway corridor is ~20m. Driveway and hardstand extend beyond the TDL (total length is around 350m). Refer to Figure 19 in Appendix B.	TDL boundary cuts across driveway. Works required outside the TDL boundary. Sewer, water and electricity services in close proximity.	Removal of redundant road and associated infrastructure to create a more natural landscape.	
9	Overland flood channel	Low depression zone on western side of driveway containing weedy pasture with some native tree species.	Outside the TDL boundary. Sewer, water and electricity services in close proximity.	Potential flood relief channel or off-line wetland area.	
10	Future bridge crossing #3 at Balmoral Road	Balmoral Road culvert crossing appears poorly designed / constructed. Culvert pipe are permanently submerged. Downstream pool and channel are flat and continuously contain ponded water. Road appears to be regularly overtopped. Refer to Figure 23 to 29 in Appendix B.	Balmoral Road is a local road maintained by THSC.	The bridge will be designed and constructed by others. The bridge structure will be required to satisfy the desired flooding and riparian corridor outcomes for the creek line. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	

Works Identifier	Description / Location	Existing Condition of Creek / Feature	Constraints	Opportunities	Photographic example
Reach 2					
11	Modified, straightened creek.	Creek flows into a low bunded depression area dominated by blackberry and other weed species. Channel shows signs of incision and expansion with intermittent steep banks. Refer to Figure 30, 32 and 33 in Appendix B.	Existing straight channel planform means significant earthworks would be required to realign the channel to a meandering planform.	Channel could be re-aligned into a more natural meandering form. Reconstructed channel to have improved channel geometry, stabilised with vegetation. Rock riffle grade control structures incorporated as required to flatten grade. To reduce the amount of earthworks, the channel alignment could be retained and the upper banks regraded to a more stable gradient.	
12	Dam 3 – Offline Dam	Large semi offline dam. Dam embankments dominated by Blackberry and other weeds species. Assumed old tip with numerous car bodies and other litter/waste items present or partially buried adjacent to the dam. Short reach with defined channel adjacent to a narrow stand of Casuarinas on right hand bank. Refer to Figure 31 in Appendix B.	Majority of the dam is outside the TDL boundary. Dam located within proposed road footprint.	Removal of dam and dam embankments to surrounding surface level and infill of dam to provide flood storage and conveyance. Dam could potentially be used for disposal of spoil from other works areas. Dam removal, filling and rehabilitation would likely be undertaken as part of the adjacent land development.	
13	Future bridge crossing #4 at Hodges Road	As for (11).	The crossing location is identified in THSC DCP for the Balmoral Road Release Area	The bridge will be designed and constructed by others. The bridge structure will be required to satisfy the desired flooding and riparian corridor outcomes for the creek line. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	
14	Memorial Avenue culvert	Online pool immediately upstream of Memorial Avenue. Minor bed erosion and series of small headcuts downstream of Memorial Avenue Refer to Figure 37, 38 and 40 in Appendix B.	The existing culvert crossing will soon be upgraded as part of the Memorial Avenue Upgrade, to be undertaken by RMS.	Scour protection works design (to be undertaken by RMS) for new culvert to give consideration to the control of the bed erosion and headcuts within close proximity to the culvert.	

Works Identifier	Description / Location	Existing Condition of Creek / Feature	Constraints	Opportunities	Photographic example
Reach 3 – Zone A					
15	Spoil / Landfill downstream of Memorial Avenue	Landfill within floodplain on left hand side of channel. Colourbond fence runs along crest of landfill. Refer to Figure 42 in Appendix B.	Lowering landfill zone to surrounding surface level would require works outside the TDL boundary.	Remove spoil/landfill down to surrounding surface. Remove fence. Rehabilitate with native vegetation.	
16	Concrete base to channel	Channel currently has a concrete base which extends into the downstream online Dam 4. A stand of mature casuarinas is situated on right hand bank. A metal gate has been installed across the channel blocking debris. Refer to Figure 41 to 46 in Appendix B.	Existing stormwater tailout drains into channel upstream of concrete channel.	Removal of instream structures. Reconstruction of channel. Channel to be stabilised with rock riprap and/or vegetation.	
17	Three online dams (Dam 4, Dam 5, Dam 6)	Highly modified environment with concrete causeway structure controlling water levels between Dam 4 and Dam 5 and at the downstream end of Dam 5. Typha species in Dam 6 and a number of Willow trees on fringe of Dam 6. Refer to Figure 46 to 54 in Appendix B.	Large online dams with unknown depth and deposition material. Removal of dams will likely require a significant amount of earthworks and fill material. Structural integrity of inline structures (causeways) is unknown.	Remove unsuitable material and causeways and create a meandering creek channel to reduce waterway area, with remaining parts of the dams partially infilled and revegetated for flood engagement. Opportunity to extend meandering channel continuously to downstream of Dam 7; or Maintain existing dams and replace concrete causeways on Dam 4 and 5 with rock riffle system.	
18	Future bridge crossing #5 at Colonial Street.	At Colonial Street the creek is currently in poor condition. It has an on-line dam, areas of incised channel and weedy growth. Refer to Figure 54 in Appendix B.	A future bridge crossing is required as part of an expansion of the local road network. The crossing location is identified in THSC DCP for the Balmoral Road Release Area.	The bridge will be designed and constructed by others. The bridge structure will be required to satisfy the desired flooding and riparian corridor outcomes for the creek line. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	

Works Identifier	Description / Location	Existing Condition of Creek / Feature	Constraints	Opportunities	Photographic example
Reach 3 – Zone B					
19	Creek between Dam 6 and Dam 7	Relatively steep graded creek invert with narrow incised channel. Dense stand of casuarinas and weed growth either side of channel. Refer to Figure 54 and 55 in Appendix B.	High value riparian corridor and threatened ecological communities in this area	Installation of bed control structures to control further channel incision.	
20	Dam 7	Historic spoil/landfill occurs within the floodplain either side of the creek downstream of Dam 7. Dam 7 has a minor headcut at its outflow point. Refer to Figure 57 to 61 in Appendix B.	Stormwater outlet immediately downstream of Online Dam 7 and right hand bank spoil.	Removal of landfill to surrounding surface level and revegetation of area.	
21	Various head cuts and creek incision downstream of Dam 7	The channel is ill-formed, almost braided, with headcuts, flood runners and scour holes throughout. Dense Casuarina (EEC) forest surrounding channel. Once the creek passes the closed-forest of Casuarinas a compound channel starts to emerge, with evidence of a series of incision events. Refer to Figure 62 to 84 in Appendix B.	High value riparian corridor and threatened ecological communities in this area	Installation of bed control structures to control head cuts. Installation of erosion treatments to control further erosion within the floodplain scour holes.	
Reach 3 – Zone C					
22	Future bridge crossing #6	As for (22)	A future bridge crossing is required as part of an expansion of the local road network. The crossing location is identified in THSC DCP for the Balmoral Road Release Area.	The bridge will be designed and constructed by others. The bridge structure will be required to satisfy the desired flooding and riparian corridor outcomes for the creek line. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	

Works Identifier	Description / Location	Existing Condition of Creek / Feature	Constraints	Opportunities	Photographic example
23	Stream erosion near Wenden Avenue	Scour/erosion threatens the vegetation, many utilities and property in this area, including: Active bed scouring, bed incision and bank slumping threatens the western boundary of the residential property (No. 16 Wenden Avenue). Overhead power and sewer utilities are at risk from scour/erosion. A large tree (eucalyptus spp.) located at top of the western bank is at risk of being undermined from scour/erosion. This tree may fall in the direction of No. 16 Wenden Avenue and is sufficiently tall to extend into the property. Floodwaters in this area for the 100 year ARI are shown to extend into No. 16 Wenden Avenue and adjacent properties. Refer to Figures 88 to 100 in Appendix B.	Overhead and underground power utilities and sewer utilities present. Close proximity to residents.	Layback banks at a stable grade construct rock rip rap treatments.	
24	Erosion resulting from lateral overland flows near Wenden Avenue	Localised gully erosion and bank slumping is evident in several locations where lateral overland flows approach the creek line. Refer to Figure 93 in Appendix B.	Gully location near apex of outside meander. Close proximity to services	Stabilise erosion associated with lateral overland flows. Tie inflow points into bank protection works.	
25	Future bridge crossing #7	Relatively straight short reach in front of existing road. Low-flow channel approx. 2m wide and high flow approx. 9m. Erosion present.	A future bridge crossing is required as part of an expansion of the local road network. The crossing location is identified in THSC DCP for the Balmoral Road Release Area.	The bridge will be designed and constructed by others. The bridge structure will be required to satisfy the desired flooding and riparian corridor outcomes for the creek line. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	
26	Upper bank erosion on western, outer bend near Landy Place	2009 aerial photograph illustrates excess fill material placed at top of bank. Compound channel form with two stage bed incision erosion. Active upper sub-vertical bank erosion and low flow channel bed incision. Refer to Figure 100 in Appendix B.	Close proximity to residents.	Regrade upper banks at a stable grade and revegetate.	

Works Identifier	Description / Location	Existing Condition of Creek / Feature	Constraints	Opportunities	Photographic example
27	Priority vegetation management between Wenden Avenue and Samantha Riley Drive.	This section of the reach comprises a reasonably scattered native canopy species (EEC (Sydney Coastal River-flat Forest (Alluvial Woodland) and Cumberland Plain Woodland) with some bush regeneration scattered shrubs and dominate weedy understorey. Compound channel from staged incision. Minor active bed and bank erosion. Historic lateral gullies and bench scour. Historic bank rock revetment present on both banks. Sediment deposition area. Rocklined stormwater outlet channel near Samantha Riley Drive. Refer to Figure 101 to 110 in Appendix B.	Close proximity to road, house and services. Rock revetments present. Established native trees. Difficult access.	Vegetation management to protect and enhance the existing riparian environment through weed removal and bush regeneration	
28	Local scouring under footpath	Loss of bedding material / structural support was noted under the existing footpath along the eastern side of the creek immediately upstream (south) of Samantha Riley Drive. Refer to Figure 111 in Appendix B.	It is understood that the footpath is maintained by THSC.	Stabilisation works to arrest the scour. It is recommended that Sydney Water undertake further consultation with THSC to confirm responsibility and scope of rectification works required. At this stage the works will be undertaken separately to the trunk drainage works.	
29	Earth mounds at Samantha Riley Drive	Earth mounds along either side of Samantha Riley Drive, located within the road reserve, appear to be left from previous road construction works in this area.	Whilst not influencing flooding for events up to 100 year ARI, the mounds represent a barrier to floodwaters which would overtop the road in larger less frequent floods or during high blockage incidents, and would increase the risk of property flooding and evacuation difficulties for residents in Landy Place. It is understood that the road reserve is maintained by THSC.	Removal of the mounds back to surrounding ground levels. It is recommended that Sydney Water undertake further consultation with THSC and TfNSW. At this stage the works will be undertaken separately to the trunk drainage works. It is noted that TfNSW have indicated previously that the works to remove the mounds could potentially be undertaken as part of their future civil works in the vicinity of Kellyville Station.	 *Earth mound immediately behind kerbline along southern side of Samantha Riley Drive*
Reach 4					
30	Downstream (north) of Samantha Riley Drive.	This reach of creek is relatively stable with only minor active scouring. Two stormwater pipe outlets discharge to the creek. Minor scour / erosion within creek at outlet locations. Wire fencing across the creek.		Minor maintenance works (e.g. removal of existing wire fencing across the creek, repair of handrail above existing stormwater outlet) have been identified however this will be undertaken as routine maintenance. Ongoing monitoring (e.g. of active scour locations) and vegetation management activities is required in this reach.	

3.3 Design Approach for In-Stream Works

3.3.1 Minimising Works

Sydney Water's objective was to minimise in-stream works, and in particular disturbance of the existing creek invert, wherever possible and to allow the creek to evolve and adjust naturally with inter-annual variations in runoff and changes to vegetation communities over time.

Areas where the existing creek channel position / future channel migration was in close proximity to the TDL boundary and over time could present a risk to adjacent assets (e.g. near Wenden Ave) were considered high risk and required intervention. However, it is noted that for the majority of the proposed TDL corridor provided sufficient area to contain the 100 year ARI flood extent and for the creek channel to meander and evolve over time.

In-stream works were also considered necessary where legacy assets are to be removed or the erosion and channel feature caused (or had the potential to cause) a significant ecological impact, or was a potential safety and/or maintenance concern.

The design approach was to work with nature, through weed control and extensive planting of local native vegetation to stabilise and improve the TDL.

3.3.2 Removal of Legacy Assets

In-stream structures

Existing redundant in-stream structures (culverts, concrete causeways, concrete channel works, fences, redundant services / infrastructure) are to be removed. These pose the following constraints to the desired outcomes of stream rehabilitation:

- Creek channel disconnection.
- May constrict and alter instream flows.
- In some locations are causing increased erosion.
- May act as a fauna barrier.
- Provide no environmental benefit and restrict an improved environmental outcome.

The design approach is to replace these legacy assets with a more natural-like channel system, replicating or improving the upstream and/or downstream channel geometry. Where bed slope, shear stress or flow control warrants the intervention of a harder engineering approach, this may be required to reduce increased erosion / maintenance requirements.

Online Dams

A number of old farm dams exist along the creek line. The first two (Dam 1 and Dam 2) are of significant size and pose the following constraints to the desired outcomes of stream rehabilitation:

- Ongoing maintenance for the trunk drainage lands may be simplified by reducing the area of open water.
- Potential drowning risk to the public.
- Weeds within the ponds acting as weed seedbank for the creek and riparian areas.

The design approach is to replace the two online dams with a more natural-like channel system, replicating or improving the upstream and/or downstream channel geometry. Where bed slope, shear stress or flow control warrants the intervention of a harder engineering approach, this may be required to reduce increased erosion and maintenance requirements.

It is noted that, due to the significant size of the dams and unknown depth and sediment/subgrade materials, the concept may need to be altered to achieve the most cost effective outcome at these locations.

3.3.3 Removal of Previous Unauthorised Earthworks / Filling

Previous filling or other unauthorised earthworks (e.g. construction of earth levees) that have been placed within the proposed TDL, either as part of historic land management practices or more recent subdivision earthworks, will be removed in several locations along the creekline. Removal of fill is desirable to:

- reduce ground levels that currently act to impede floodwaters, and thereby increase the width of TDL required for flood conveyance; and
- create landforms that are compatible with the desired aesthetic and vegetation management outcomes for the TDL

The design approach is typically to reduce finished levels in these areas to match that of the surrounding floodplain. Re-establishment of vegetation will form a key aspect of these works to ensure that disturbed areas are appropriately stabilised to minimise the potential for erosion in the short-term whilst also consistent with the longer-term TDL vegetation management objectives.

3.3.4 Increase Channel and Floodplain Hydraulic Roughness

Flow velocity and thus shear stress was reduced as much as possible by increasing channel hydraulic roughness. Roughness was also introduced into the design through dense in-stream planting in vegetated channels, and dense riparian planting where appropriate. Dense riparian planting would include groundcover and mid-storey species.

Increasing channel roughness is also encouraged through the use of in-stream woody debris in locations where creek intervention works are proposed. This aids the overall objective of floodplain engagement by effectively reducing the channel capacity and promoting more frequent overbank flows.

The combined effect of increasing channel and floodplain hydraulic roughness forms a key enabler in achieving the broader project objectives of driving more efficient use of the TDL through conversion of existing horizontal floodplain storage to vertical storage, whilst preserving the storage-discharge function of the floodplain. Further discussion of flood management outcomes and in particular the impact of the concept design on the storage-discharge function of the floodplain is provided in **Section 3.6**.

It is noted that during the establishment phase, a lower roughness and subsequently higher velocities are likely to occur compared to the ultimate design objectives and outcomes.

3.3.5 Riparian Rehabilitation

Vegetation management and the design of an appropriate vegetation strategy and landscape is an integral part of creek and floodplain design process. However, it should be noted that this was excluded from the scope of concept design and therefore this component has not been comprehensively addressed. Given its importance to overall creek rehabilitation outcomes, it is recommended that this additional work including preparation of a Vegetation Management Plan (VMP) be completed as a priority.

The approach to riparian rehabilitation would incorporate:

- Extensive weed control throughout the project site.
- Identifying pockets of resilience (intact vegetation communities) and revegetating with weeding to focus on these areas initially, and expanding from there. Areas of resilient pockets would be identified as reference sites, for monitoring and comparison.
- Soil testing will be required for specific locations where substantial works are required, and where the quality of topsoil may compromise rehabilitation efforts.

- Installing a fully structured native vegetation community, including canopy cover, mid-stratum (shrubs), ground cover and aquatic, along the whole project site. The vegetation management works are to protect and extend the existing EEC's within the Study Area.
- Establishing riparian tree cover as soon as possible. This has the following benefits:
    - Tree cover reduces weed growth by shading.
    - Shading allows algae to grow on the stream banks, helping to protect the cohesive clays of the stream bank from erosion.
- Introduction of riparian and habitat corridors and additional habitat features in-stream and on the floodplain throughout.
- Consideration of the requirements of bushfire hazard reduction zones (HRZs) and asset protection zones (APZs) in the planning of riparian revegetation and vegetation maintenance.

In regards the last dot point above, it is noted that preliminary advice was provided to Sydney Water on this issue and the implications for trunk drainage planning in March 2016 (refer **Appendix F**). Resolution of the issues identified will need to be addressed as part of the future VMP preparation and detailed design of the trunk drainage works.

3.3.6 Stream Stability

Stream stability will be provided differently through the establishment phase and in the long term.

The establishment phase poses the greatest risk to the stability of the channel works and retention of newly planted vegetation due to unsettled soils, less established plants and subsequent weaker root system and lower roughness (resulting in higher flow velocities).

Plant establishment is therefore a key factor in stabilising the stream. To help in providing a growth medium for plant establishment, erosion control matting, coir logs and brush matting would be used to assist in soil retention and sediment trapping.

Establishment phase: Until vegetation is established, stability will be provided with the following:

- Biodegradable erosion control matting (ECM) would be used to cover all areas of exposed soil that are likely to be exposed to flow during the vegetation establishment phase. The life span of erosion control matting (refer to **Figure 6**) can vary greatly (generally less than 2 years) during which time the groundcover vegetation will have matured sufficiently to cover and protect the soil from erosion. It is noted that erosion control matting could potentially disintegrate when subjected to constant flow conditions (for instance within the low flow channel). The erosion control matting specification should be selected to reduce risk of the ECM failing rapidly within the low flow channel.

Figure 6: Example of erosion control matting with densely planted tubestock within riparian zone

(Source: Winmalee Creek Erosion Protection Works, AAJV 2016)

- Temporary dewatering of the creek is required to enable initial plant growth and material settlement before planting zones are subjected to flows.
- Soil bioengineering – the use of coir logs (refer to **Figure 7**), logs and brush matting that would be anchored into the bed and banks of the stream in places to reduce scour and encourage sediment deposition.

Figure 7: Example of coir logs within channel

(Source: Winmalee Creek Erosion Protection Works, AAJV 2016)

Long-term:

Vegetated zones:

- Stability will be provided through vegetative cover where possible, with vegetation performing the following roles:
  - Groundcover protecting and holding surface soils in place
  - Mid-stratum species and tufted vegetation providing roughness to slow flows and reduce shear stresses
  - Trees, whose roots provide structural soil stability and resistance to bank erosion.

Rock zones:

- Where it is identified that shear stresses would exceed those typically permissible for bare soil, then rock linings will be used to protect against erosion.

3.3.7 Minimise Use of Rock

Where possible, the channel has been designed to reduce shear stresses and the need for rock. The requirement for rock armour for the stream bed and banks was determined by comparing predicted shear stresses and velocities with reference to typical allowable shear stresses and velocities for different channel surface coverings and soil types (based on BCC 2003, and USDT 2005). Shear stress calculations were based on estimated bankfull flows for the relevant reach.

3.3.8 Public Amenity

The design approach is to facilitate public amenity, liveability, access and interaction with the waterway and natural environment where possible. The design should provide high value public open space through the provision of many features that contribute to the recreational opportunities of the adjacent developments: greenery, shade, comfortable microclimate, diversity of vegetation, access tracks, water features and formal active or passive recreation areas.

Allowance for the installation of a shared path near Wenden Ave has been included, to be confirmed at detailed design. However, public access and the public domain / landscape were not part of this particular scope of works.

3.3.9 Approach to Flood Management

The AAJV TUFLOW model (refer **Section 2.6** for background) was the primary tool used to test and confirm the impact of proposed creek works, as well as specific flood management works, on flooding conditions along EMC.

The general design approach adopted to develop an overall flood management strategy that best achieved the project objectives was to:

1. Incorporate the necessary in-stream works outlined above in **Section 3.3**.

   It is noted these works were considered to be necessary, regardless of their potential impact on flood behaviour, on the basis of maintaining stream stability and reducing the risk of future scouring and erosion that could potentially cause damage to properties and infrastructure. However, some refinement of the proposed in-stream works was assessed using the TUFLOW model to ensure these worked towards the overall flood management objectives.

2. Incorporate future landfill to facilitate urban development up to the proposed TDL boundary.

   Note this landfill would extend to an elevation of at least peak 100 year ARI flood levels, and allow for some minor encroachment of fill into the TDL to afford an element of conservatism should developers overreach in future.

3. Increase hydraulic roughness within the proposed TDL to reflect Sydney Water's desired vegetation management outcomes.

   Typical increases in Mannings n values were as follows:

   - Creek channel: from 0.06-0.08 (existing conditions) to 0.10 (future conditions)
   - Overbank/floodplain: from 0.04-0.08 (existing conditions) to 0.08 (future conditions)

   Specific areas of the TDL where it was considered necessary to limit future increases in hydraulic roughness, so as to not exacerbate flooding adjacent to existing development, were also identified.

4. Incorporate future bridge crossings to facilitate road/pedestrian access through adjacent future urban development areas.

   The hydraulic performance of the bridge crossings were then optimised to either increase or reduce the resulting afflux as appropriate.

   Seven future bridge crossings were identified by both THSC and UrbanGrowth/TfNSW to support their future development plans. Generally downstream of Memorial Avenue it is desirable to reduce afflux as far as possible to avoid adverse flood impacts on existing development. Upstream of Memorial Avenue there is more scope to increase peak flood levels as there is little development adjacent to EMC, and future development can be set (through specification of fill levels) at the appropriate elevation.

5. Incorporate local flood management works as necessary to limit flood impacts or otherwise optimise flood outcomes.

6. Review changes to floodplain storage-discharge function and seek to improve where practical.

Some iteration was generally required both within each numbered item above and more holistically across all items to best address the various flood-related objectives whilst not compromising other

relevant objectives (e.g. environmental, ecological, property impacts, etc.). Design iterations also weighed up a balanced outcome for future landfill requirements, with the implications in terms of fill heights and extents considered at all locations where the need for filling was identified along the length of the creek corridor.

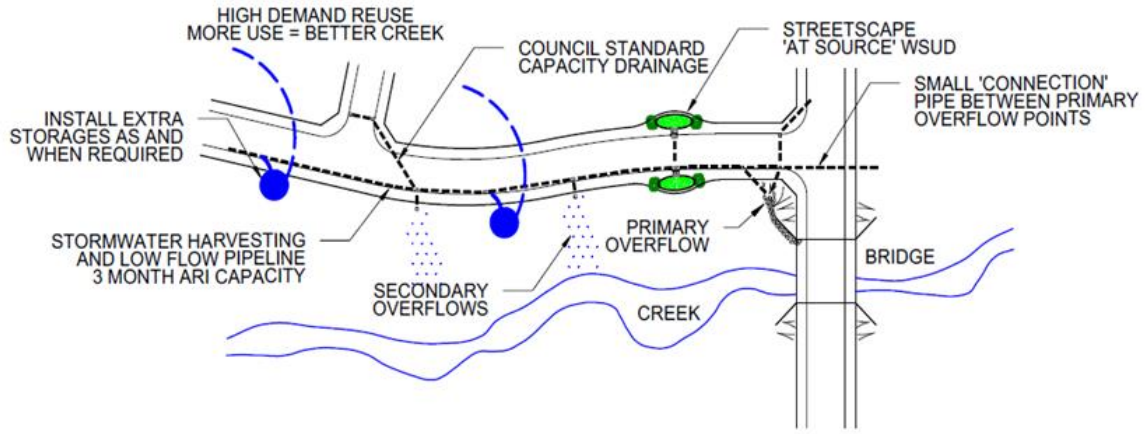
Further discussion on the approach and methodology, description of key flood management works, and flood management outcomes is provided in **Section 3.6**.

3.3.10 Regional Stormwater Harvesting Pipelines and Related Drainage Works

3.3.10.1 Background

Sydney Water has previously developed a high-level strategy for regional stormwater harvesting (see for example Parsell, 2015) that involves large diameter interceptor pipelines constructed generally parallel to and along both sides of creeklines, and which would accept piped stormwater discharges from adjacent urban development. The interceptor pipelines would be designed with the potential to be operated as a series of cascading storages, controlled by weirs/gates located within junction pits, to allow captured stormwater to be transferred by gravity to the most useful location. Offtakes and/or offline storages would also be able to be incorporated in close proximity to demand nodes to establish harvesting schemes at a range of spatial scales to suit. Figure 8 shows the intended strategy and its key components at a conceptual level.

Figure 8: Conceptual stormwater harvesting strategy



Source: Parsell (2015)

Stormwater harvesting in this way could potentially play a large role towards the overall objective of increasing stormwater retention within developed catchments. Whilst best achieved 'at-source', retention devices can be difficult to retrofit within developed lots, and the approach relies upon Council support for implementation at both lot and streetscape scales. Where this support is lacking, of which EMC is a prime example, stormwater harvesting pipelines located downstream of development are likely to be one of very few viable measures that could produce meaningful reductions in the volume of stormwater otherwise entering the creek. It is noted this strategy potentially serves several other related purposes, including:

- Improvements in water quality. For example, gross pollutant traps (GPT's) (and potentially other treatment devices) could be incorporated into stormwater harvesting pipelines at suitable/accessible locations.

- Removing the physical dominance of large piped outlets into natural waterways, particularly for creeks of low-incision and with broad flat floodplains that are common in western Sydney. Whilst piped outlets into waterways cannot be avoided altogether for stormwater harvesting pipelines, they can be consolidated and located at appropriate, stabilised locations (eg. bridge crossings).

3.3.10.2 Preliminary concept design of stormwater harvesting pipelines

As part of the current concept design process, this strategy has been applied to the EMC study area. The outcome of this exercise is a preliminary concept design and grading for a stormwater pipeline along each side of EMC. This is presented in the Concept Design Drawings as a series of plans and long-sections.

The main objective of this work was to establish proof-of-concept that large diameter pipelines could feasibly be constructed along the majority of the creek corridor, whilst achieving minimum cover, intercepting existing piped stormwater outlets, and being positively drained to the creek.

The WEST pipeline runs from the southern limit of works near Celebration Drive to Samantha Riley Drive. The EAST pipeline runs from Celebration Drive to a location just south of Wenden Avenue, avoiding the reach from Wenden Avenue to Samantha Riley Drive where it would be impractical to undertake works without significant disturbance to the creek given existing development and its close proximity.

A pipe diameter of 1800 mm was nominally adopted in general. This was reduced to twin 1200 mm diameter pipes (i.e. approximate equivalent waterway area) for selected reaches where cover was otherwise limited.

The horizontal alignment of each pipeline was notionally set along the proposed TDL boundary. Recommendations for future refinement of this alignment are noted below.

The vertical alignment was developed on the following basis:

- Ensure positive drainage to the creek at the pipeline outlet.
- Ensure pipeline can accept existing piped stormwater outlets (i.e. that are currently discharging direct to creek).
- Target minimum cover of 1m.
- Absolute minimum grade of 0.2%, with 0.5% preferred.
- Avoid clashes with known utilities, in particular those that are grade-sensitive (e.g. sewer).
- Where possible grade to locate the pipeline obvert below creek invert level, to assist in reducing the risk of potential seepage of stored water and associated waterlogging/salinity issues.

3.3.10.3 Future design development

Further design development is required to firm up the preliminary concept design, and in particular (though not limited) to:

- Consider potential demands for recycled stormwater and associated implications for pipeline alignments, pipeline sizing and offtake locations.
- Identify the preferred pipeline type/material and any specific requirements for special treatments (e.g. road and creek crossings).
- Identify operational infrastructure requirements to meet identified demands (eg. weir/gates, surcharge/relief points, offtakes/offline storages). This should also consider incorporation of GPT's at pipeline outlets. Design of these elements will also need to be undertaken.
- Refine the horizontal alignment to:

- Consider whether piped crossings under the creek at strategic locations could remove the need for pipelines along both sides of the TDL.
- Rationalise the number of junctions/manholes required. This will require some minor departures from the TDL boundary. This will also need to consider manhole locations required for operational needs (e.g. for locating weir/gates and surcharge/relief points) and maintenance access requirements.
- Determine the preferred alignment relative to the TDL boundary.

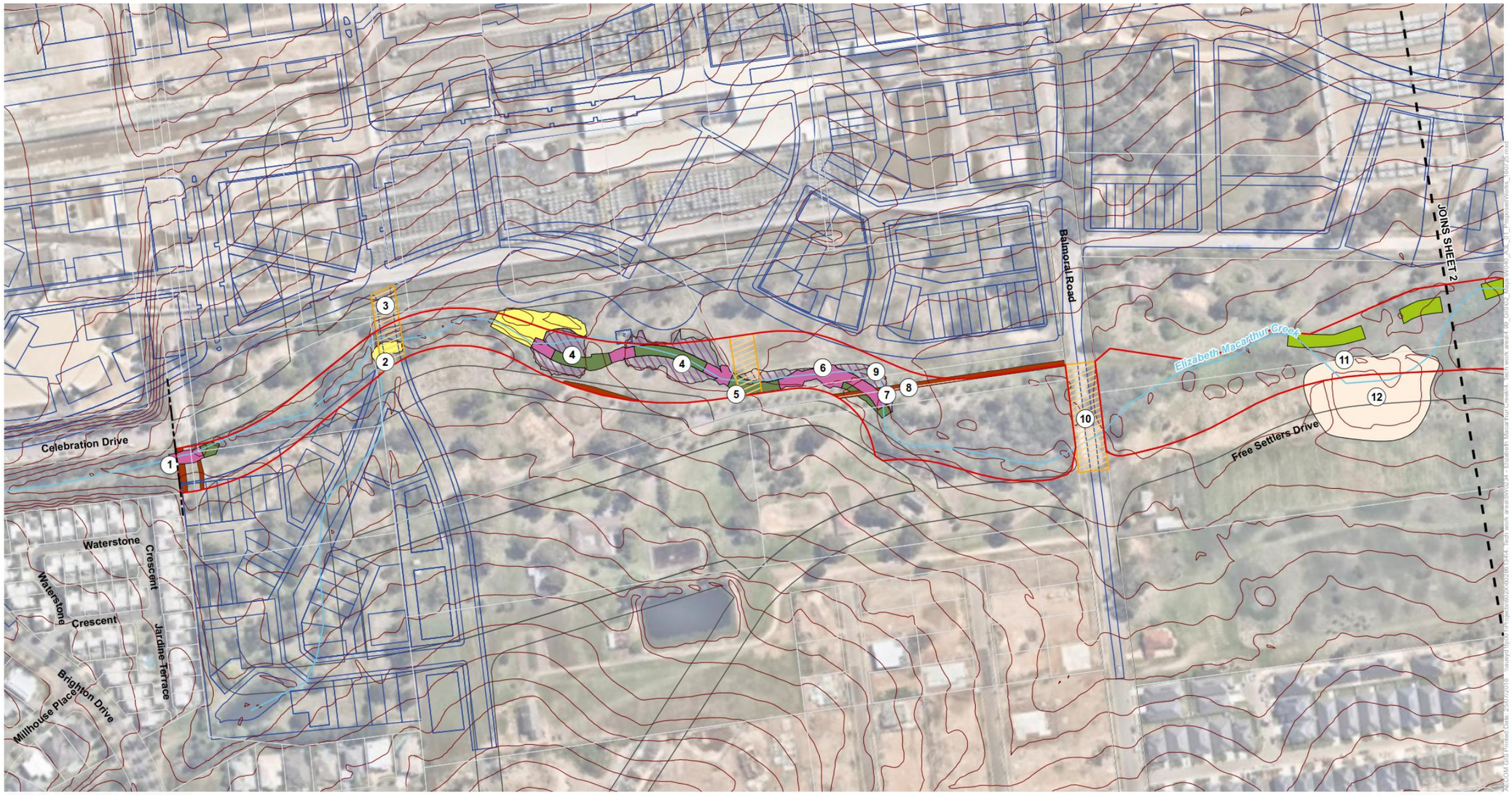
- Refine the vertical alignment to:
  - Suit changes in horizontal alignment.
  - Review cover requirements to suit the preferred pipeline type/material and potential loading.
  - Consider lifting the pipeline above creek invert level following more detailed consideration of potential risks related to waterlogging and salinity.

3.4 Concept Design Summary

The concept design for the creek works is summarised in **Figure 9** and **Table 7**. Note that **Figure 9** shows Works Identifiers that are cross-referenced in **Table 7**.

Key design features are outlined in **Section 3.5**. Refer to the Concept Design Drawings for further details.

Figure 9: Concept Design Reach Summary Overview Maps



SHEET 1: DESIGN SUMMARY

Date: 25/07/2016 Rev: A

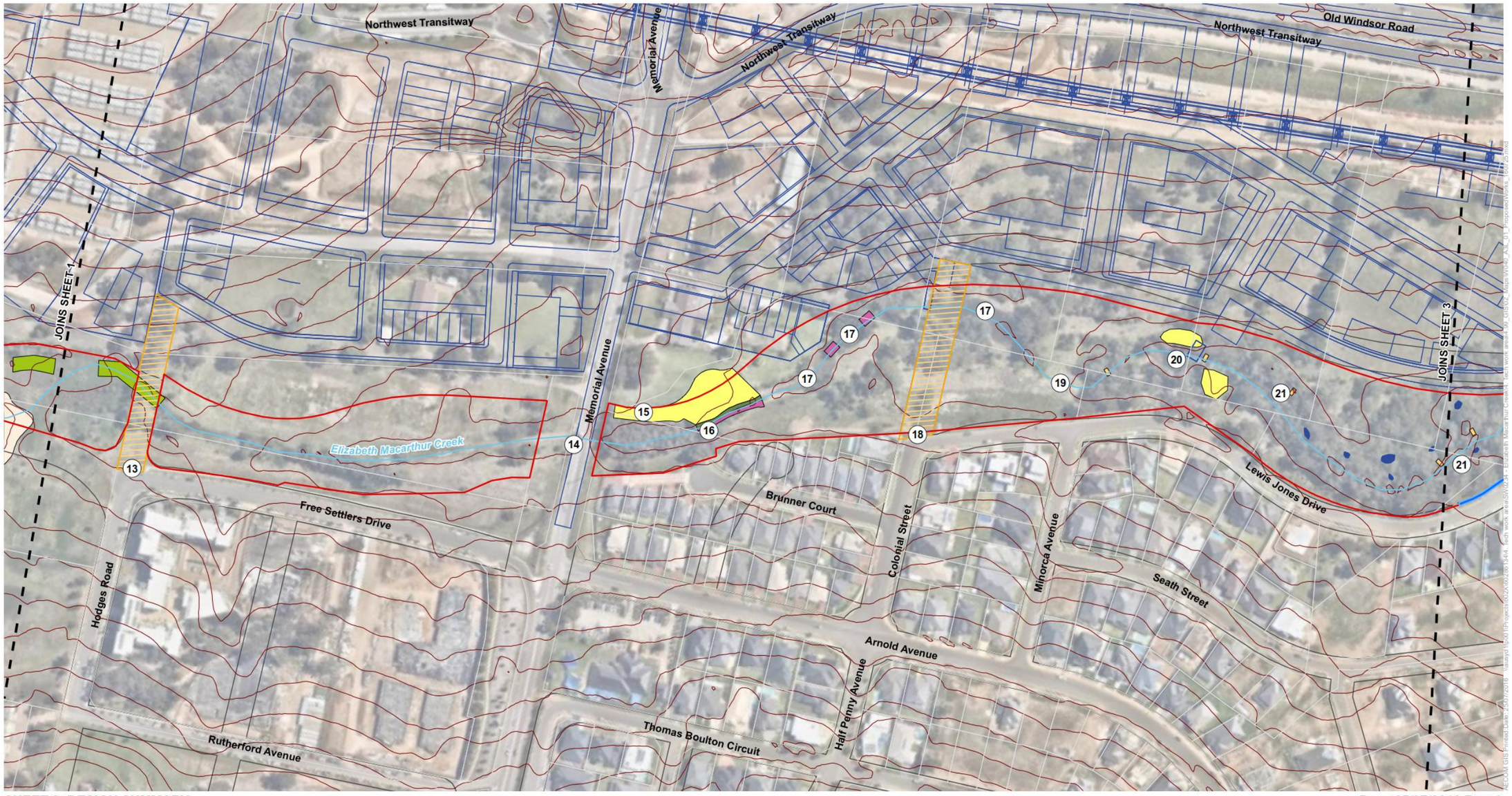
KEY

- Trunk drainage land boundary
- Limit of works
- Watercourse
- Cadastre
- 1m contour
- (1) Works identifier (refer seperate table)
- Priority vegetation management reach
- Future bridge crossing (By others)
- Bed control structures
- Concrete
- Dam / Channel Fill
- Dam removal and rehabilition
- Flood plain scour hole treatment
- Handstand removal
- Historic spoil/landfill material removal
- Riprap
- Upper banks works
- Vegetated channel
- Flood levee
- Bella Vista and Kellyville Stations Concept Plan Overlay
- Balmoral Road Release Area

0 50 100 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.



SHEET 2: DESIGN SUMMARY

Date: 25/07/2016 Rev: A

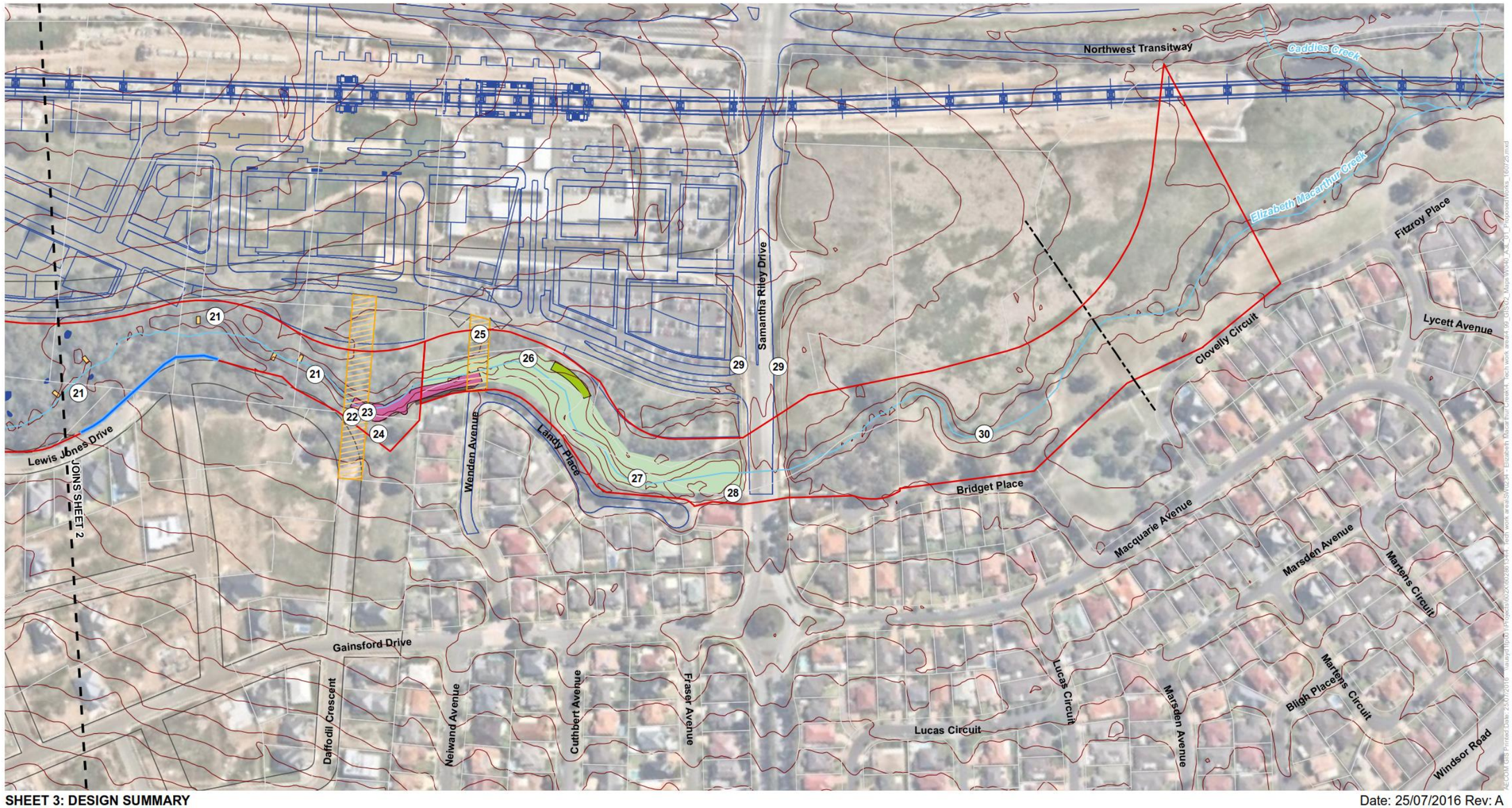
KEY

- Trunk drainage land boundary
- Limit of works
- Watercourse
- Cadastre
- 1m contour
- (1) Works identifier (refer seperate table)
- Priority vegetation management reach
- Future bridge crossing (By others)
- Bed control structures
- Concrete
- Dam / Channel Fill
- Dam removal and rehabilition
- Flood plain scour hole treatment
- Handstand removal
- Historic spoil/landfill material removal
- Riprap
- Upper banks works
- Vegetated channel
- Flood levee
- Bella Vista and Kellyville Stations Concept Plan Overlay
- Balmoral Road Release Area

0 50 100 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.



SHEET 3: DESIGN SUMMARY

Date: 25/07/2016 Rev: A

KEY

- Trunk drainage land boundary
- Limit of works
- Watercourse
- Cadastre
- 1m contour
- (1) Works identifier (refer seperate table)
- Priority vegetation management reach
- Future bridge crossing (By others)
- Bed control structures
- Concrete
- Dam / Channel Fill
- Dam removal and rehabilition
- Flood plain scour hole treatment
- Handstand removal
- Historic spoil/landfill material removal
- Riprap
- Upper banks works
- Vegetated channel
- Flood levee
- Bella Vista and Kellyville Stations Concept Plan Overlay
- Balmoral Road Release Area

0 50 100 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

Table 7: Concept Design Summary

Works Identifier	Description / Location	Concept Design	Key Assumptions	Justification	Further Consideration for Detailed Design	Outcome
Reach 1 – Zone A						
1	Upstream extent of project site at TDL boundary.	Within TDL removal of: - 1 x concrete culvert - 2 x concrete causeway - 1 x Willow tree - Removal of redundant services Reinstatement of ~35 m of creek channel. Rock riffle transitioning to a vegetated channel. Undertake a comprehensive weed management strategy throughout the TDL and install a full, dense, native riparian vegetation structure consisting of local species from the Sydney Coastal River-flat Forest and Cumberland Plain Woodland communities.	LiDAR contours appear to be inconsistent with onsite observations and aerial photography at upstream interface. Channel alignment upstream of TDL boundary indicative only, based on onsite observations. Works can occur in upstream property. Services are redundant and/or can be moved. All works extents have based on aerial photography.	The driveway crossings in this location are redundant. These structures impair environmental values and constrict the channel. Reinstate a more natural-like channel to improve environmental outcomes. Willow a non-native species.	Detailed survey required to confirm levels. Design to be modified accordingly. Detailed TDL Vegetation Management Plan and planting schedule. Comprehensive TDL community access and amenity plan.	Improved environment
2	Levee and confluence with unnamed tributary	Removal of the existing levee bund from the trunk drainage lands, with the final surface lowered to surrounding surface levels. Revegetation with native species.	No environmental constraints present	Levee reduces flood conveyance, elevating local peak flood levels.	Consideration to how levee removal works are integrated with bridge design.	Flood mitigation
3	Potential future bridge crossing #1	Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes. A bridge crossing is proposed as part of an expansion of the local road network. A bridge structure will be required to satisfy the desired flooding and riparian corridor outcomes for the creek line.	Bridge to be designed by others.	The bridge will be designed and constructed by others, the timing of which is currently unknown. No works capital works required.	Bridges may compromise the trunk drainage strategy if not designed in accordance with Sydney Water's desired outcomes.	Future success of trunk drainage works
Reach 1 – Zone B						
4	Two large online dams (Dam 1 and Dam 2)	Construction of a new meandering channel comprising: • intermittent sections of a shallow graded vegetated channel and steep graded rock riffles with energy dissipation pools; • partial infill of online dams to create a wide high-flow bench zone; Landfill / spoil adjacent (west) of first online dam to removed. Works to extend outside trunk drainage corridor to facilitate smooth transition to local surface level. Specification of landfill removal guidance for adjacent developable land.	Existing dam base level was assumed to be 0.5 m below the indicative water surface level (as indicated by LiDAR). Suitable subgrade material present near invert level. In order to reduce the length of the rock riffles, the rock riffle slope was set at a steeper slope than that recommended for fish passage (creek is not within key fish habitat). No environmental constraints present.	The dam embankments elevate local peak flood levels and increase the extent of floodplain currently required to convey floodwaters, as well as future fill levels required for development purposes. The resulting waterway and riparian corridor would however provide Sydney Water with a lower risk asset to maintain.	Geotechnical investigations required to understand the level of risk and scope of required remedial works. Detailed survey required to confirm levels. Design to be modified accordingly.	Improved environment/habitat. Low risk asset. Low maintenance
5	Potential future bridge crossing #2	Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes. A bridge crossing is proposed as part of an expansion of the local road network. A bridge structure will be required to satisfy the desired flooding and riparian corridor outcomes for the creek line.	Bridge to be designed by others.	The bridge will be designed and constructed by others, the timing of which is currently unknown. No works capital works required.	Bridges may compromise the trunk drainage strategy if not designed in accordance with Sydney Water's desired outcomes.	Future success of trunk drainage works
6	Existing straightened channel adjacent to historic residential driveway downstream of Dam #2	Reconstruction of the creek channel (as per 4) will allow the existing excavated channel and adjacent landform to be rehabilitated (filled in and revegetated). Local rock riprap armouring of low flow channel and left hand (outer) bank on bend where shear stresses exceed acceptable limits for a vegetated channel. Infill of existing channel where new channel has changed alignment.	Driveway no longer in use. Services are suitable distance away not to impede works. No environmental constraints present.	The existing creek is an excavated channel, with steep and poorly vegetated banks that are highly susceptible to erosion and scouring. Provide a low risk, low maintenance asset of high habitat value.	Detailed survey required to confirm levels. Design to be modified accordingly.	Low risk asset Low maintenance Improved environment/habitat
7	Concrete piped culvert crossing under driveway	Removal of existing piped crossing under driveway Reconstruction of the creek channel (as per 4 & 6).	As above.	The driveway (residential access) will become redundant following Sydney Water's acquisition of land within the proposed trunk drainage corridor. Provide a low risk, low maintenance asset of high habitat	Detailed survey required to confirm levels. Design to be modified accordingly.	Lower risk asset Simplified maintenance Improved

Works Identifier	Description / Location	Concept Design	Key Assumptions	Justification	Further Consideration for Detailed Design	Outcome
				value. The driveway crossing poses a barrier to fish migration and impairs habitat values		environment/habitat
8	Driveway/hardstand and date palms	Removal of hardstand and date palm trees. Revegetate with local native vegetation from the Sydney Coastal River-flat Forest and Cumberland Plain Woodland communities.	Driveway no longer in use. Services are suitable distance away not to impede works. Works outside the TDL boundary required where driveway spans across the boundary. Works extent based on aerial photography.	Driveway impairs floodplain habitat values	Detailed survey required to confirm levels. Design to be modified accordingly.	Improved environment/habitat
10	Future bridge crossing #3 at Balmoral Road	The trunk drainage strategy will accommodate a future upgrade of the Balmoral Road crossing. Balmoral Road is a local road maintained by The Hills Shire Council. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	The bridge will be designed and constructed by others.	The bridge will be designed and constructed by others, the timing of which is currently unknown. The existing piped crossing has multiple failings, including: • Permanent submergence at both the inlet and outlet creating maintenance difficulties and public safety risks • Extensive fencing (for safety) increases the risk of blockage and potential upstream flood impacts. • Low flood immunity afforded to the road. • Low habitat and amenity value.	Bridges may compromise the trunk drainage strategy if not designed in accordance with Sydney Water's desired outcomes.	Future success of trunk drainage works
Reach 2						
11	Modified, straightened creek.	Regrade upper section of channel where steep unstable banks occur. Banks to be regraded to form a stable batter slope (minimum 1V:2H) and whilst retaining the lower 1/3rd of the channel.	LiDAR contours did not pick up steep banks observed onsite. Therefore extent of works indicative only.	Provide a low risk, low maintenance asset. Earthworks may be required to remove noxious weeds (blackberries) from this zone. Therefore creek works could potentially be conducted in conjunction with these works. Significant earthworks would be required to realign the straight sections of channel into a meandering form. Existing channel alignment was therefore retained. To avoid potential establishment issues and the need for rock, no works are proposed within lower 1/3rd of channel.	Detailed survey required to confirm extent of steep banks to be regraded. Design to be modified accordingly.	Low risk asset Low maintenance Improved environment/habitat
12	Dam 3 - Offline Dam	Dam to be removed/filled and rehabilitated as part of adjacent land development and road construction. Works to include full removal of existing embankments. Rehabilitation to be undertaken in accordance with Sydney Water's desired outcomes	Works to be undertaken by others.	The dam is located within the proposed road alignment. No capital works required as apart from vegetation management.	Rehabilitation may compromise the trunk drainage strategy if not designed in accordance with Sydney Water's desired outcomes.	Simplified maintenance
13	Future bridge crossing #4 at extension of Hodges Road	The trunk drainage strategy will accommodate a future bridge crossing required as part of an expansion of the local road network. The crossing location is identified in THSC DCP for the Balmoral Road Release Area. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	The bridge will be designed and constructed by others.	The bridge will be designed and constructed by others, the timing of which is currently unknown.	Bridges may compromise the trunk drainage strategy if not designed in accordance with Sydney Water's desired outcomes.	Future success of trunk drainage works
14	Memorial Avenue culvert	Raising road levels and installation of larger box culverts to improve the flood immunity of the road to 100 year ARI.	No further works will be undertaken by Sydney Water at this location (apart from vegetation management).	The existing culvert crossing will soon be upgraded as part of the Memorial Avenue Upgrade, to be undertaken by RMS, the timing of which is unknown.	Culvert may compromise the trunk drainage strategy if not designed in accordance with Sydney Water's desired outcomes.	Culvert upgrade to Memorial Avenue crossing (by RMS)
Reach 3 – Zone A						
15	Spoil / Landfill downstream of Memorial Avenue	Spoil / landfill material to be removed down to surrounding surface level and area revegetated with native vegetation. Works to extend outside corridor to enable smooth transition to local ground surface. Removal of Colourbond fence and rehabilitation of area with native vegetation.	No environmental or access constraints present.	Landfill impacts on flood conveyance and storage. Colour bond fence redundant. Removing landfill will assist in creating additional flood conveyance / storage.	Detailed survey required to confirm extent of landfill to be removed. Design to be modified accordingly.	Flood mitigation
16	Concrete channel base	Removal of existing concrete base slab in channel.	Depth of online dam at upstream	Reinstate a more natural-like channel to improve	Detailed survey required to	Improved

Works Identifier	Description / Location	Concept Design	Key Assumptions	Justification	Further Consideration for Detailed Design	Outcome
		Removal of concrete which has spilled into dam. Construction of a low flow rock riffle to replace the concrete channel section with ephemeral vegetated bench on left bank. Right bank to be retained in order for the existing stand of Casuarinas to be retained. Riffle to cease at toe of online dam embankment to avoid need for removal of unsuitable sediments within dam.	point assumed to be 0.3 m below indicative water surface level (as represented by LIDAR). No environmental or access constraints present.	environmental outcomes. Due to existing channel grade, vegetated low flow channel unsuitable.	confirm depth and extent of the dam. Design to be modified accordingly.	environment
17	Three online dams (Dam 4, Dam 5, Dam 6)	Dams to be retained. Removal of existing concrete causeway between Dam 4 and 5 and at the downstream end of Dam 5. Replacement of concrete causeways with rock riffles. Rock riffles to replicate the existing hydraulic control within the dams.	Depth of dam unknown. No environmental or access constraints present.	Extensive works would be required to fill dam and reconstruct channel through dam. Riffle to maintain hydraulic control to minimise reduction in water level and subsequent potential for scour and mobilisation of dam sediments. Structural integrity of existing causeway unknown.	Detailed survey required to confirm upstream and downstream dam depth and riffle location and extent. Design to be modified accordingly. Geotechnical investigations required to understand potential unsuitable material within dam.	Lower risk asset
18	Future bridge crossing #5 at Lewis Jones Drive	The trunk drainage strategy will accommodate a future bridge crossing required as part of an expansion of the local road network. The crossing location is identified in THSC DCP for the Balmoral Road Release Area. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	As for (3)	As for (3)	As for (3)	As for (3)
Reach 3 – Zone B						
19	Creek between Dam 6 and Dam 7	Installation of bed control structures at one location to control headcut. Bed control structures to comprise either a rock riprap or log bundle	Headcut location and profile unable to be confirmed from LIDAR contours or aerial photograph. Headcut treatment location and extent indicative only. No environmental or access constraints present.	Intervention in this reach of creek is warranted due to the relatively high value of the riparian corridor and threatened ecological communities in this area. Left unattended the headcuts will continue to move upstream and lead to further bed incision, bank slumping and lateral expansion of the creek channel. It is proposed to use plant and materials that can avoid the need for heavy machinery to access the creek channel as far as possible, or at least limit the number of locations at which access through the riparian corridor is required to minimise the required footprint for construction works and damage to the existing vegetation.	Detailed survey required to confirm headcut location and profile. Design to be modified accordingly. Or works to be directed onsite by an appropriate qualified and experienced creek rehabilitation designer.	
20	Dam 7	Removal of landfill to surrounding surface level within the proposed TDL. Revegetation of area where landfill removed.	Landfill unable to be identified by LiDAR contours. Excavation within the trunk drainage corridor will not be preferred where the existing creek form is stable where there is high value remnant riparian vegetation.	Removing landfill will assist in creating additional flood conveyance / storage.	Detailed survey required to confirm extent of landfill to be removed.	Flood mitigation
21	Various head cuts and creek incision downstream of Dam 7	Installation of bed control structures at about 8 locations along the creek. Bed control structures to comprise either a rock riprap or log bundle. Installation of floodplain scour hole/erosion treatment at approximately seven locations. Treatment to include coir logs, rock riprap, brush matting and dense native vegetation plantings.	Headcut and scour hole locations and profile unable to be confirmed from LiDAR contours or aerial photograph. Headcut treatment location and extent indicative only.	Intervention in this reach of creek is warranted due to the relatively high value of the riparian corridor and threatened ecological communities in this area. Left unattended the headcuts will continue to move upstream and lead to further bed incision, bank slumping and lateral expansion of the creek channel. It is proposed to use plant and materials that can avoid the need for heavy machinery to access the creek channel as far as possible, or at least limit the number of locations at which access through the riparian corridor is required to minimise the required footprint for construction works and damage to the existing vegetation.	Detailed survey required to confirm headcut location and profile. Design to be modified accordingly. Or works to be directed onsite by an appropriate qualified and experienced creek rehabilitation designer.	Low risk asset Low maintenance Improved environment/habitat
Reach 3 – Zone C						
31	New flood protection levee along western side of Lewis Jones Drive	New flood protection levee to be constructed along the western side of Lewis Jones Drive, to prevent overtopping of the road for floods up to 100 year ARI.	-Understanding of existing ground levels based on LiDAR. Road levels based on WAE and approved	Design road levels in this area are based on previous advice from Sydney Water. Flood modelling undertaken as part of the present study estimates higher peak flood	Detailed survey required to confirm extent, tie in points, and crest level for levee.	Flood mitigation

Works Identifier	Description / Location	Concept Design	Key Assumptions	Justification	Further Consideration for Detailed Design	Outcome
			subdivision plans.	levels that overtop the road. There is limited opportunity to raise the road as it is partially constructed with houses located along its eastern side. The proposed levee would provide an equivalent level of protection to the road and existing residences consistent with the intent of the original road design.		
22	Future bridge crossing #6	The trunk drainage strategy will accommodate a future bridge crossing required as part of an expansion of the local road network. The crossing location is identified in The Hills Shire Council's Development Control Plan for the Balmoral Road Release Area. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	Bridge to be designed by others.	Bridges may compromise the trunk drainage strategy if not designed in accordance with Sydney Water's desired outcomes. A bridge structure will be required to satisfy the desired flooding and riparian corridor outcomes for the creek. Sydney Water will identify key hydraulic parameters to inform future design of the bridge and associated creek stabilisation works. The bridge will be designed and constructed by others, the timing of which is currently unknown.		Future success of trunk drainage works
23	Stream erosion near Wenden Avenue	Rock riprap batter on eastern bank around bend, adjacent to property and downstream of property (approximate 90 m length of works). Retain western bank where slope is a stable grade. Large wood to be embedded into rock riprap. Incorporate provision for a future pedestrian and cycle path along the eastern bank connecting Lewis Jones Drive and Landy Place. Development of performance requirements for the future bridge crossing envisaged by THSC at Wenden Avenue (refer 25), including the extent of required creek bed or bank protection works that would be associated with those works. Large undercut tree with roots exposed to be removed by an arborist. Existing power pole to be relocated and adjoining overhead and underground services to be reconnected.	Assumed that TDL boundary is located on the edge of the property.	Protection of private property from erosion. Stop erosion that will be more costly to address if left unchecked. Improvements to the level of flood protection afforded to nearby properties. A pedestrian/cycle path would add significant value to recreational/transport links along the trunk drainage corridor.	LiDAR contours may underestimate the depth of the channel invert which may compromise the use of a stable rock rip rap batter (1V:2H) within confined areas (e.g. adjacent to the proposed footpath). In this instance a sandstone block wall should be adopted. Works to be integrated with future bridge crossings (refer to 23 and 25). Location of TDL boundary to be confirmed adjacent to the property.	Substantial avoided future costs Low risk asset Low maintenance Improved environment/habitat
24	Erosion resulting from lateral overland flows near Wenden Avenue	Remediate existing gully headcut with rock riprap. Area to be topsoiled and revegetated.	Extent of erosion unable to be confirmed from LIDAR contours or aerial photography.	Stop erosion that will be more costly to address if left unchecked.	Detailed survey required to confirm gully headcut extent. Design to be modified accordingly.	Substantial avoided future costs Low risk asset Low maintenance Improved environment/habitat
25	Future bridge crossing #7	The trunk drainage strategy will accommodate a future bridge crossing required as part of an expansion of the local road network. The crossing location is identified in THSC DCP for the Balmoral Road Release Area. Development of design criteria for bridge and culvert structures for flooding and riparian corridor outcomes.	Bridge to be designed by others.	Bridges may compromise the trunk drainage strategy if not designed in accordance with Sydney Water's desired outcomes. Sydney Water will identify key hydraulic parameters to inform future design of the bridge and associated creek stabilisation works. The bridge will be designed and constructed by others, the timing of which is currently unknown.		Future success of trunk drainage works
26	Upper bank erosion on western, outer bend near Landy Place	Upper bank erosion to be controlled with coir logs, brush matting and native vegetation.	Extent of erosion unable to be confirmed from LIDAR contours or aerial photography. .	Stop erosion that will be more costly to address if left unchecked. It is proposed to use plant and materials that can avoid the need for heavy machinery to access the creek channel as far as possible, to minimise the required footprint for construction works and damage to the existing vegetation. Retain lower portion of channel to avoid establishment issues within low flow zone.	Detailed survey required to confirm erosion extent. Design to be modified accordingly.	Substantial avoided future costs Lower risk asset Lower maintenance Improved environment/habitat

Works Identifier	Description / Location	Concept Design	Key Assumptions	Justification	Further Consideration for Detailed Design	Outcome
Reach 4						
30	Downstream (north) of Samantha Riley Drive.	Minor maintenance works, ongoing monitoring and vegetation management.		Flood mitigation measures not required. Reach relatively stable with only minor active scouring		Improved environment/habitat

3.5 Key Design Features for the Creek Works

Design features common to all stream interventions:

- **Batters:** Batter slopes to be typically shaped to 1V:3H grade or less steep (flatter) where possible. 1V:2H the steepest permissible in constrained locations. Stacked sandstone walls could be utilised where steeper batter is required.
- **Deposited material/silts:** must be removed to provide geotechnically suitable material for rehabilitation works.
- **Low flow channel:** This creates a discrete wet zone that can be planted with moisture preferring/wetland species. Robust plantings help to exclude weed establishment and control erosion. The low flow channel incorporates rock protection where erosive velocities exceed the allowable velocity for the given soil conditions. The low flow channel was designed to convey between 1 to 10 times the estimated trickle flow rate (trickle flow rate estimated based upon Figure 3.12 of the BCC Natural Channel Design Guidelines).
- **Vegetation:** Dense planting and high biodiversity required to ensure establishment of a robust plant community. Plant species to be appropriate to location in channel and expected hydrology.
- **Large wood:** Large woody debris should be used on site as much as possible to increase roughness where required and to provide habitat. Increasing roughness protects the stream bed and banks by reducing flow velocities and encouraging sedimentation. Buried wood helps to protect the stream bed and banks during the establishment phase of the vegetation.
- **Erosion control matting:** Erosion control matting (e.g. jute mat) would be used as bank protection material for all groundcover vegetation during the establishment phase. Erosion control matting is also proposed for vegetated sections of the low flow channel. The risks associated with the use of erosion control matting within constant flow environment are discussed in Section 3.3.8.
- **Clay liner:** Saline, sodic and dispersive sub soils may occur within the creek and floodplain. Should these be encountered during geotechnical investigations (as part of detailed design) then a clay liner (nominally 500 mm) may need to be incorporated into the design where earthworks are proposed. Clay liner to be scarified at the interface between the topsoil and clay - clay roughened to hold topsoil in place. The concept designs do not include a clay liner.

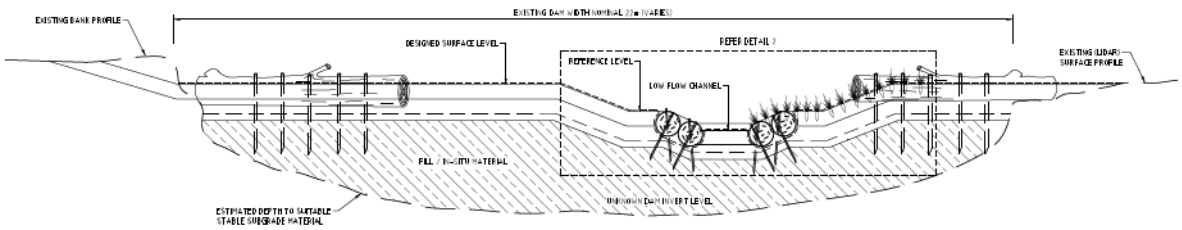
The following sections describe design features developed for specific conditions within the site.

3.5.1 Vegetated channel through existing online dams

It is proposed to provide a vegetated channel through the existing large dams upstream of Balmoral Road between rock riffle and pool sections. The channel grade has been reduced to approximately 0.5% through the vegetated channel sections to reduce local shear stresses and the likelihood of erosion impacts.

A summary of this design feature is outlined in Table 8 and shown in Figure 10.

Figure 10: Vegetated channel through existing online dams



Note: Refer to Concept Design Drawings for full details

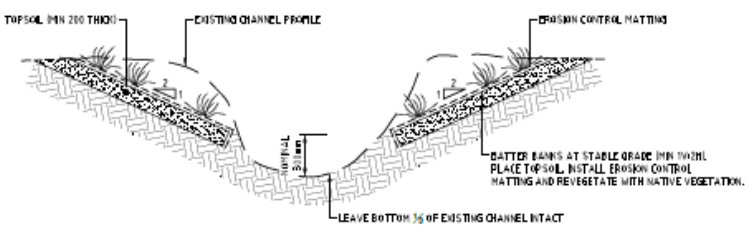
Table 8: Vegetated channel through existing online dams

Section Type	Vegetated channel through existing online dam
Purpose	Low shear stress environments
Constraints	Large volume of unsuitable deposited silts expected in existing dams needs to be removed, therefore channel invert could potentially be constructed on fill material. Where existing grade is steep (nominally >0.5%) rock riffle grade control structures are required to enable a flatter grade to be provided within vegetated channel zones.
Opportunity	Shallow, confined channel and wide high flow / floodplain bench allows flow depth to be kept shallow and floodplain to be engaged regularly. Installation of native vegetation.
Key Design Features	Material to be layered to improve stability. Fill or in-situ material (if suitable) shall be overlain by a layer of ameliorated roughened fill followed by ameliorated B horizon subsoil and a topsoil layer at the surface. The layering of soils will help to bind the soils together, increase soil stability and reduce the risk of erosion. Low flow channel dimensions to provide conveyance for baseflows. Low flow channel to be densely vegetated with fast growing local native mature aquatic vegetation to reduce the risk of erosion during the establishment period. Coir logs, planted with ephemeral vegetation to be installed within the batter of the low flow channel to provide protection during the establishment period. Low flow channel likely to meander over time. Erosion and sediment deposition will be features of an actively meandering stream.
Construction Issues	Large online dams with unknown depth, sediment / subgrade material. Dewatering and water management for the works duration. Significant depth / fill may have settlement issues. Erosion and sediment control (ESC) – situation specific ESC design required for construction of on-line with persistent baseflows.
Establishment Issues	Infill/replacement planting critical during establishment phase to replace any failed plantings.

3.5.2 Upper bank erosion control by bank regrading

Some areas of eroding banks can be laid back to a shallower bank slope (1V:3H preferred, minimum 1V:2H) to improve conveyance and bank stability. A summary of this design feature is outlined in Table 9 and shown in Figure 11.

Figure 11: Upper bank erosion treatment



Note: Refer to Concept Design Drawings for full details

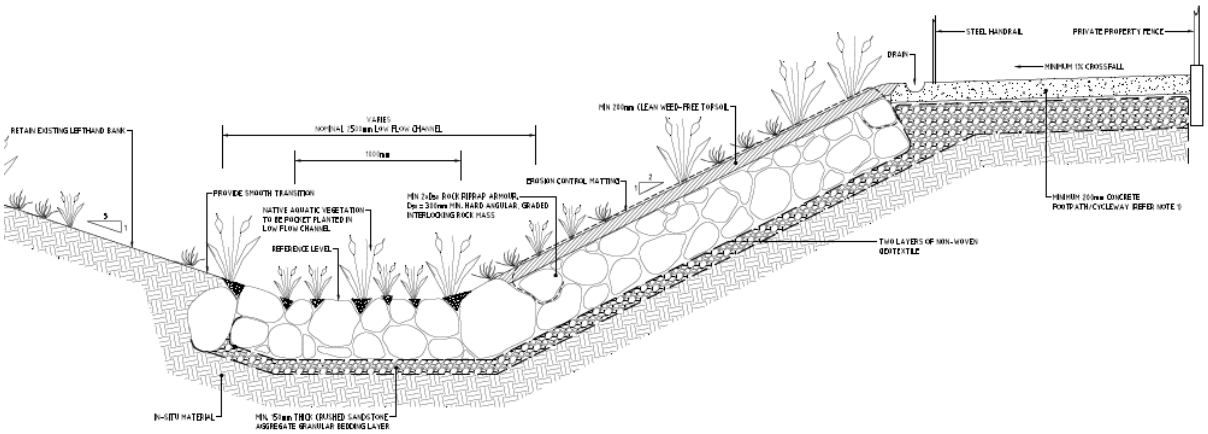
Table 9: Upper bank erosion treatment

Section Type	Upper bank erosion treatment
Purpose	Low shear stress environments
Constraints	Access. Established native trees; or EEC's; or high value environmental values, present could impair access / works.
Opportunity	Shallow low-flow channel and wide floodplain allows flow depth to be kept shallow, eliminating the need for rock armour. Installation of native vegetation and EEC's.
Key Design Features	Bank to be battered back at stable grade and revegetated. The lower 1/3rd of the channel to be retained to prevent potential establishment issues associated with baseflows. Low flow channel likely to meander over time. Erosion and sediment deposition will be features of an actively meandering stream.
Construction Issues	Erosion and sediment control (ESC) – situation specific ESC design required for construction on-line with persistent baseflows. Access due to surrounding established native vegetation.
Establishment Issues	Infill/replacement planting critical during establishment phase to replace any failed plantings.

3.5.3 Rock lining on bed and banks

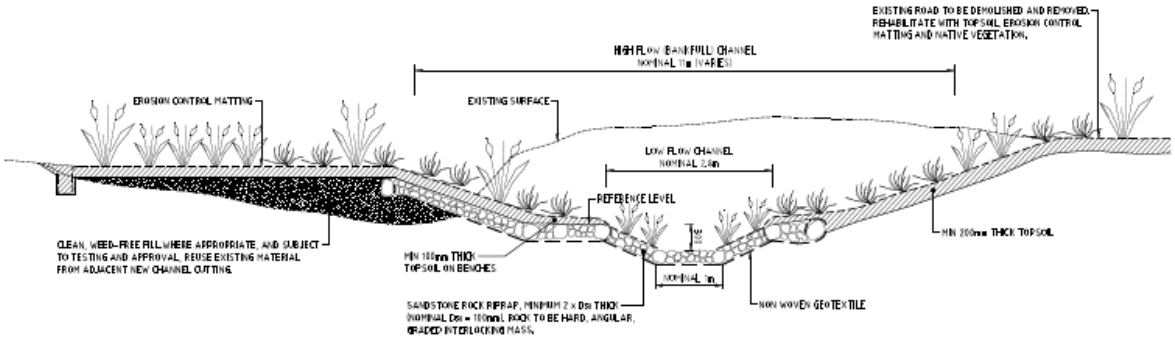
Rock-lined channels are required where shear stresses are high (for instance on sharp bends) and the channel is constrained or cannot be readily modified to reduce shear stresses. A summary is provided in Table 10 and shown in Figure 12.

Figure 12: Rock lining on bed and banks



Note: Refer to Concept Design Drawings for full details

(Figure continued)



Note: Refer to Concept Design Drawings for full details

Table 10: Rock lined channel

Section Type	**Rock lined channel**
Purpose	High shear stress environments
Constraints	High shear stress environment requires rock armour to protect soil. Established native vegetation.
Opportunity	Ephemeral bench incorporated into the channel where space available.
Key Design Features	Rock graded to resist expected shear stresses. Rock backfilled with soil to support extensive planting within ephemeral zones. Pocket planting in low flow channel where suitable. Erosion control matting to be installed to protect topsoil within ephemeral and high flow portions of the channel. Non-woven geotextile to be installed between rock rip rap and in-situ material to prevent underlying material from being washed out. Where a bedding layer is specified below the rock rip rap, bedding material is to be protected by wrapping in geotextile.
Construction Issues	Rock riprap characteristics (shape, type) and placement (final surface grade and need for interlocking mass) have a significant impact on the stability of the bed and bank. Access due to surrounding established native vegetation.
Establishment Issues	Infill/replacement planting during establishment phase to replace any failed plantings within planting zones. Where opportunistic pocket planting is proposed within the low flow channel, flows may need to be diverted during initial establishment. Alternative planting methods (for example ecoblanket) may be required where plants are unable to establish.
Features requiring special attention.	In-situ or imported foundation material to provide sufficient bearing capacity (in accordance with Technical Specifications).

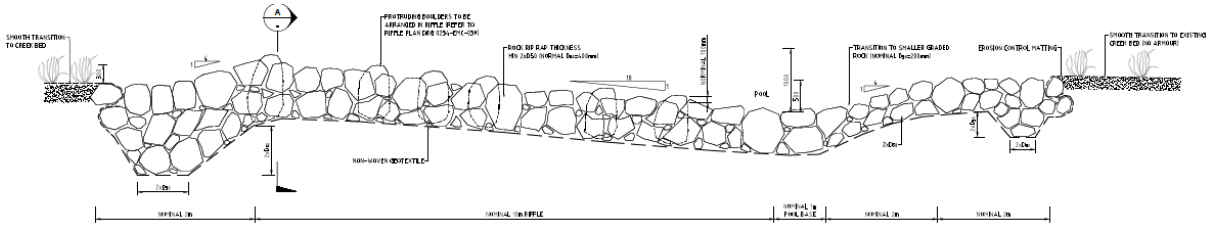
3.5.4 Grade control structures – rock riffles and pools

Rock riffles and pools are required where:

- the channel grade needs to be controlled to facilitate a flatter vegetated channel downstream of the riffle; and
- in channel works to remove existing infrastructure (concrete base slab or road crossing) is required and site constraints prohibit the use of vegetated channel.

A summary is provided in Table 11 and shown in Figure 13.

Figure 13: Grade control structures - rock riffles and pools



Note: Refer to Concept Design Drawings for full details

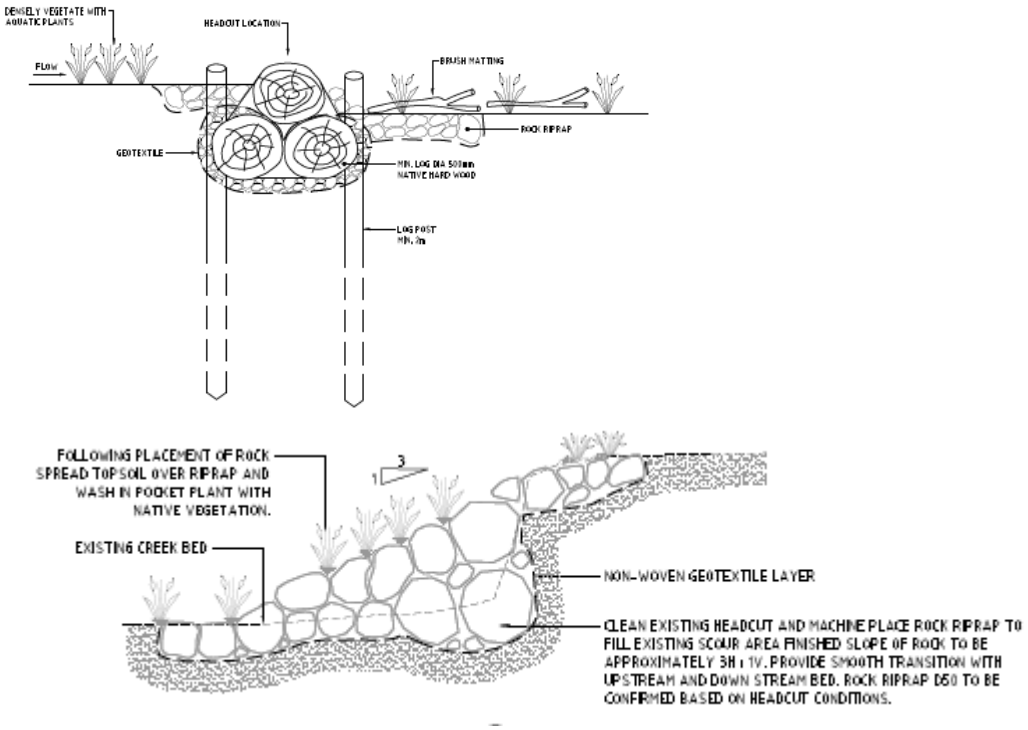
Table 11: Grade control structures - rock riffles and pools

Section Type	**Rock riffle and pool**
Purpose	High shear stress environments
Constraints	High shear-stress environment requires rock armour to protect soil. Access - Established native (EEC) vegetation.
Opportunity	Where specified, pools will provide ecological habitat as well as providing an energy dissipation function.
Key Design Features	Rock graded to resist expected shear stresses. Pocket planting within ephemeral bench zone. Low flow channel and interspersed large boulders to be incorporated into riffle design to improve. Non-woven geotextile to be installed between rock rip rap and in-situ material to prevent underlying material from being washed out.
Construction Issues	Rock rip rap characteristics (shape, type) and placement (final surface grade and need for interlocking mass) have a significant impact on the stability of the rock riffle. Rock rip rap to be constructed in accordance with technical specifications. Access due to surrounding established native vegetation.
Establishment Issues	Infill/replacement planting during establishment phase to replace any failed plantings within ephemeral planting zones.
Features requiring special attention.	In-situ or imported foundation material to provide sufficient bearing capacity (in accordance with Technical Specifications).

3.5.5 Head-cut controls

A variety of treatments can be used to prevent headcuts from propagating upstream depending on site specific head cut dimensions. The proposed treatment should be selected and adjusted to suit the specific site conditions. Proposed treatments include a log bundle and rock riprap. A summary of the proposed treatments are provided in Table 12 and shown in Figure 14.

Figure 14: Head cut controls



Note: Refer to Concept Design Drawings for full details

Table 12: Head cut controls

Control Type	**Log bundle**
Purpose	To prevent headcut erosion from propagating upstream
Constraints	Access due to surrounding established native vegetation. Head-cuts vary in size and form and will require site specific treatment. High scour potential upstream and downstream of log bundle.
Opportunity	Large wood provides ecological habitat benefits.
Key Design Features	Large wood / log bundle to be staked at head-cut location. Rock riprap armour to surround log bundle to protect the surrounding soils at log bundle interface from scour. Non woven geotextile to protect underlying soils from being washed out. Dense aquatic vegetation to be planted within channel to rehabilitate local disturbance and increase roughness to reduce local flow velocities. Brush matting to be used to protect plants during establishment.
Construction Issues	Access due to surrounding established native vegetation. Stakes require adequate purchase into in-situ material to keep coir logs in place.
Establishment issues	Infill/replacement planting during establishment phase to replace any failed plantings within planting zones.

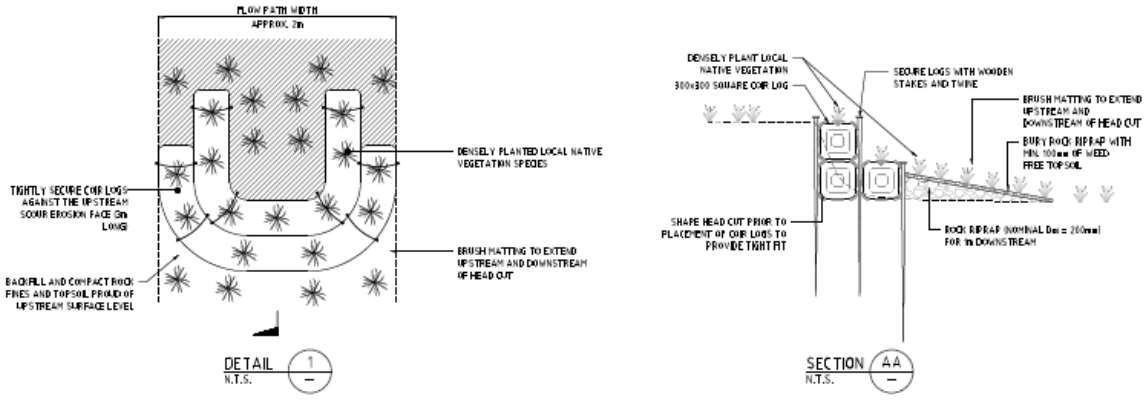
(Table continued)

Control Type	**Rock riprap**
Purpose	To prevent headcuts from propagating upstream
Constraints	Head cuts vary in size and form and will require site specific treatment. High scour potential upstream and downstream of rock.
Key Design Features	Graded rock rip rap to fill scour area and enable sharp drop in bed level across head cut. Rock armour to extend (nominally 2 x D_{50}) upstream and downstream of head-cut location. Rock grading to be selected based upon head-cut conditions Rock riprap to be densely pocket planted.
Construction Issues	Rock riprap characteristics (shape, type) and placement (final surface grade and need for interlocking mass) have a significant impact on the stability of the rock formation. Rock riprap to be constructed in accordance with technical specifications. Access due to surrounding established native vegetation.
Establishment issues	Infill/replacement planting during establishment phase to replace any failed plantings within planting zones.

3.5.6 Floodplain scour hole treatment

Coir logs can be used in scour holes on the floodplain where scour results from sporadic overland and flood flows. A summary of this treatment method is provided in Table 13 and shown in Figure 15. Rock riprap can also be used if larger floodplain scour holes are identified (refer to Section 3.5.5).

Figure 15: Scour hole treatment



Note: Refer to Concept Design Drawings for full details

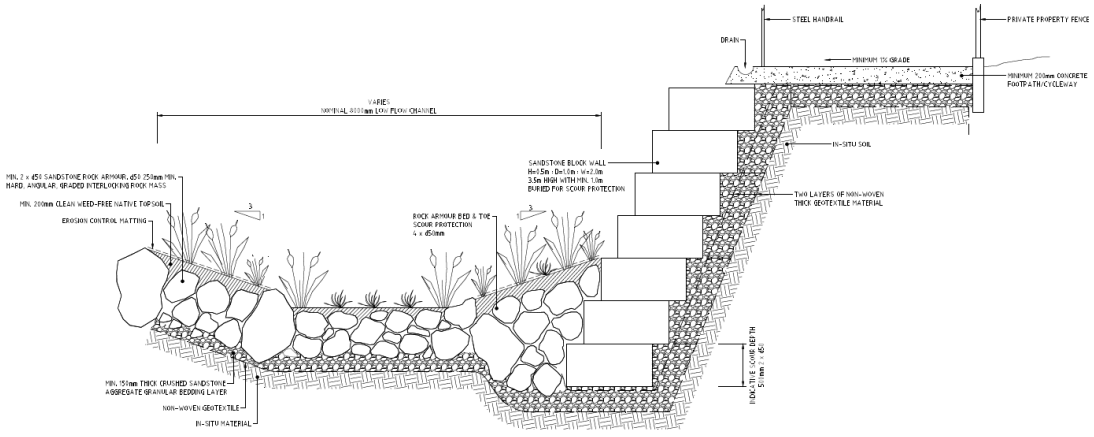
Table 13: Scour hole treatment

Control Type	**Coir Logs with rock riprap and brush matting**
Purpose	To prevent headcuts from propagating upstream
Constraints	Scour holes vary in size and form and will require site specific treatments. Established native vegetation.
Opportunity	Vegetation can be established in coir logs.
Key Design Features	Coir logs to wrap around scour hole. Coir logs to be staked in place. Rock riprap armour to be placed downstream of coir logs to control scour. Area to be planted out with native vegetation. Brush matting to be used to protect plants during establishment.
Construction Issues	Stakes require adequate purchase into in-situ material to keep coir logs in place. Access due to surrounding established native vegetation.

3.5.7 Sandstone block wall

Sandstone block walls are used in highly constrained, high energy environments. They are needed when batter slopes need to be built at grades greater than 1V:2H, usually to protect property of utilities. Based on the LiDAR contours, it is unlikely that sandstone block walls will be required within the study area, however, in the instance that detailed survey at detailed design indicates the need for a steeper bank treatment, a sandstone block wall can be adopted. A summary of this alternative treatment is provided in Table 14 and shown in Figure 16.

Figure 16: Sandstone block wall treatment



Note: Refer to Concept Design Drawings for full details

Table 14: Sandstone block wall treatment

Section Type	Sandstone block wall and rock bed protection
Purpose	High shear stress environments where undercutting present near private property or infrastructure (highly space constrained).
Constraints	High shear-stress environment requires rock armour to protect soil. Sandstone blocks do not support growth of vegetation. Access Services
Key Design Features	Block wall to be embedded on granular material. Granular material to be used to backfill behind wall. Double layer of geotextile to protect granular bedding and backfill material from being washed out. Rock rip rap to be placed on channel bed to protect the wall from scour and potential undermining.
Construction Issues	Earthmoving equipment needed in a tightly confined space close to private property. Access due to surrounding established native vegetation. Close proximity to residential houses. Services present.

3.5.8 Earthworks quantities

Bulk earthworks quantities for the creek works were estimated as follows:

- Total Cut 3,400 m^3
- Total Fill 900 m^3

Assuming fill material can be sourced from cut, this leaves a balance of 2,500 m^3 in excess material potentially requiring removal/disposal. There is considerable uncertainty in these figures that could be reduced through additional survey (eg. to determine the invert level of existing dams) and geotechnical investigation (eg. to improve understanding of ground conditions and likely extent of unsuitable material).

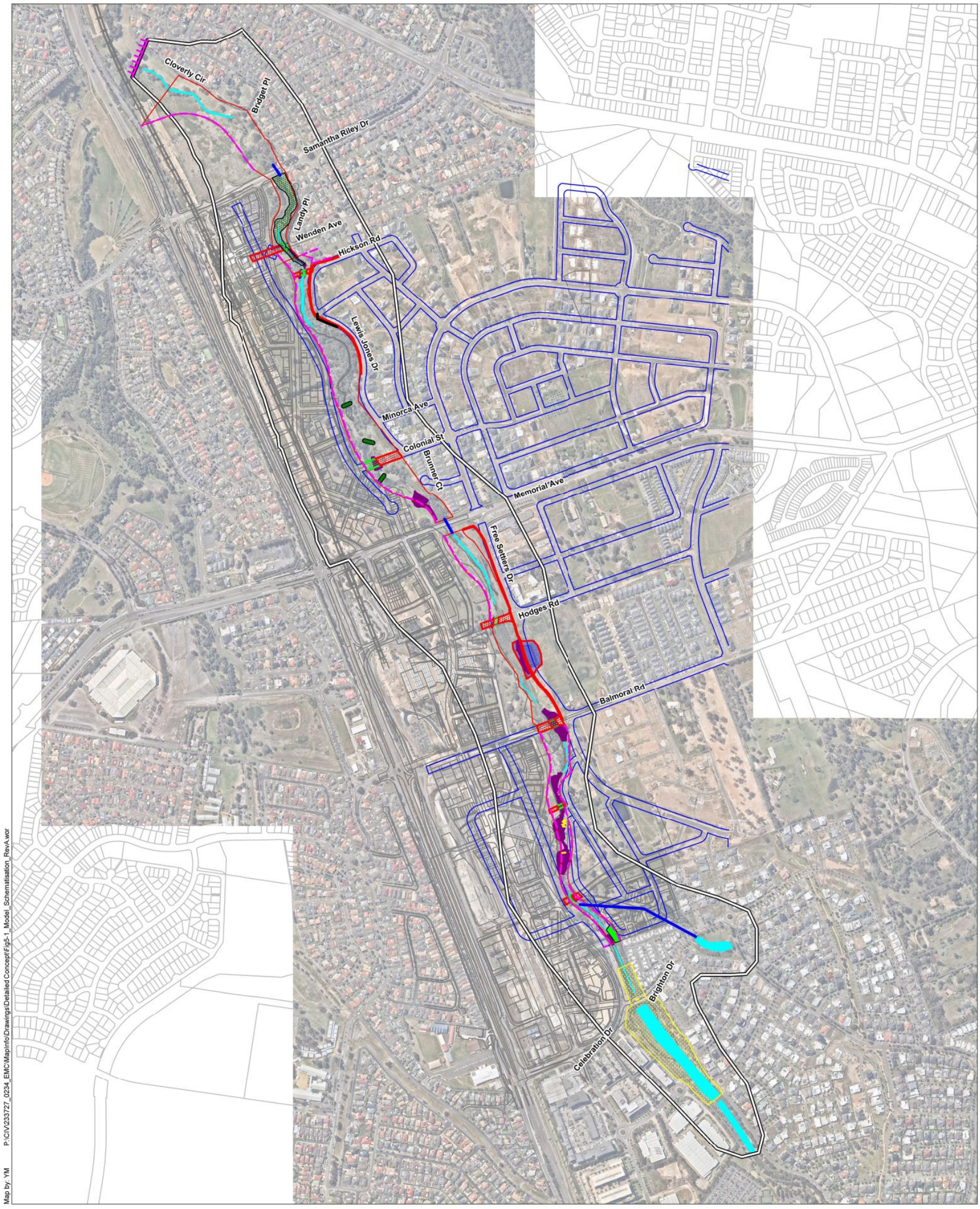
Given the requirements for landfill identified as part of the concept design process, as well as other development in the area, Sydney Water may find opportunities to dispose of suitable clean fill in relatively close proximity to the study area. There may also be opportunities to dispose of fill within the TDL where already in Sydney Water ownership.

3.6 Flood Management

3.6.1 Key design features

Brief descriptions of key flood management features and their representation in the AAJV TUFLOW Model are provided below. The structure of the AAJV TUFLOW Model as modified to include the various design components is shown on **Figure 17**.

Figure 17: AAJV TUFLOW Model Structure – Design Conditions



Representation of in-stream works

Design of the proposed in-stream creek works was undertaken using the 12d model software. A 3D representation of the design surface incorporating the various design elements was generated in 12d and then read directly by TUFLOW to modify the flood model topography.

The Concept Design Drawings present a series of plans, longsections, cross sections and typical details associated with the in-stream works.

Representation of future landfill to facilitate development

Future landfill was represented in the TUFLOW model by raising land outside the proposed TDL to an elevation above peak 100 year ARI flood levels throughout the Study Area. As mentioned previously a minor encroachment of 2 m into the TDL was also allowed for.

The Concept Design Drawings include design flood profiles that define peak 100 year ARI flood levels along both eastern and western sides of the proposed TDL. The flood levels defined in these profiles were subsequently used to develop an indicative landfill design to guide future urban development in areas adjacent to the TDL. The landfill design is presented on the Concept Design Drawings by way of indicative finished ground level contours where filling will be necessary to elevate ground levels above design peak 100 year ARI flood levels.

The Concept Design Drawings also show delineation of preferred edge treatments at the TDL boundary where future landfill abuts the TDL. Typical details of either a vegetated batter (for a fill height up to 1 m) or retaining wall (fill height of greater than 1 m) are also included in the Drawings. Whilst conceptual in nature and subject to detailed design, the design intent shown and in particular encroachment into the TDL, would be considered by Sydney Water as acceptable outcomes and consistent with the flood modelling methodology adopted here.

Impact of vegetation management on hydraulic roughness

Typical increases in Mannings n values applied throughout the Study Area within the proposed TDL were as follows:

- Creek channel: from 0.06-0.08 (existing conditions) to 0.1 (future conditions)
- Overbank/floodplain: from 0.04-0.08 (existing conditions) to 0.08 (future conditions)

The values for future conditions are representative of the intended vegetation management outcomes for the TDL, key principles of which include:

- Generally low maintenance, in particular within the creek channel. A high degree of vegetation build-up has therefore been allowed for. This build-up within the creek channel will be further enhanced by promoting woody debris and other in-stream habitat throughout.
- Bushland restoration for floodplain areas, again with generally low maintenance so that relatively dense vegetation will be encouraged over the longer term.

Photos showing examples of representative creek channel and overbank/floodplain areas are shown in **Figure 18**.

The reach of EMC between Samantha Riley Drive and Wenden Avenue runs adjacent to existing development that lies only marginally above peak 100 year ARI flood levels. In this specific area (highlighted as Priority Vegetation Management Reach on **Figure 9**) it is desirable to limit the build-up of vegetation within the TDL such that hydraulic roughness remains essentially at present day levels. Refer **Figure 19** for photos showing examples of the current creek condition in this area for reference.

Figure 18: Representative channel and overbank/floodplain vegetation for future conditions

Representative channel vegetation for future conditions (Mannings n value = 0.1):

Highly sinuous, vegetated, with woody debris

Highly sinuous, vegetated, with woody debris

Heavily vegetated channel

Channel with lighter vegetation plus woody debris

Representative overbank/floodplain vegetation for future conditions (Mannings n value = 0.08):

Typical vegetation structure to comprise mix of mature canopy with intact mid-storey and groundcover species resistant to flow.

Figure 19: Existing channel and overbank/floodplain vegetation for Priority Vegetation Management Reach

Representative channel vegetation for existing conditions (Mannings n value = 0.06):

Looking downstream near Wenden Avenue

Looking downstream near Landy Place

Looking upstream near Landy Place

Looking upstream from Samantha Riley Drive

Future bridge crossings

Conceptual design of the seven future bridge crossings was undertaken using the TUFLOW model, with various bridge span configurations and waterway openings tested for each crossing site. The bridge crossings were represented in TUFLOW in 2D with appropriate form loss coefficients and reductions in waterway area used to represent solid features such as abutments and piers. No blockage factors were applied on account of the relatively large waterway openings of the proposed structures.

In the case of Balmoral Road, substantial creek works will also be required to reinstate EMC across the road corridor beneath a future bridge structure. Other crossing locations will not require such substantial creek intervention. It is however noted that all future crossings will require appropriate erosion and scour protection measures that protect not only the integrity of the bridge structures but that of the creekline and riparian environment as well.

The ability to use the future bridge crossings to induce afflux as a potential means of translating existing horizontal floodplain storage to vertical storage was generally found to be limited. Downstream (north) of Memorial Avenue it is desirable to reduce afflux as far as possible to avoid adverse flood impacts on existing development.

Upstream of Memorial Avenue there is more scope to increase peak flood levels as there is little existing development adjacent to EMC and future development can be set (through specification of fill levels) at an appropriate elevation above peak 100 year ARI flood levels. However, it was found that allowing for future increases in Mannings n values generally achieved the result of lifting peak flood levels, such that further significant increases were not required to engage the full width of the TDL, nor warranted from a floodplain storage-discharge performance perspective (refer **Section 3.6.2** for presentation and further discussion of flood management outcomes for the concept design).

Bridge design optimisation process

Initial concept designs for the future bridge crossings were prepared on the basis of identifying clear spans that did not contemplate any (or minimal) earthworks within the creek channel or floodplain. An optimisation process was subsequently undertaken to investigate whether more efficient designs, in the form of shorter bridge spans, were possible at the cost of some relatively minor compensatory earthworks on the floodplain. The earthworks were considered generally in the form of a high-level bench adjacent to the creek channel to add waterway area under a shortened bridge span, and were considered only in locations where disturbance of the creek invert could be avoided. The geometry of the benches responded to existing landforms as far as practicable to minimise disturbance footprints, and were contoured to grade toward the creek at 1% to promote drainage, with transitions back to existing surface levels typically at 1V:6H (max.).

Table 15 provides a summary of the initial and optimised bridge designs.

The Concept Design Drawings present a plan and elevation for each future bridge structure, as well as a table of key bridge design parameters that relate to minimum bridge waterway area, span and soffit levels, as well as modelled flow and flood level. It is noted these reflect the optimised designs where relevant. **Appendix H** contains several initial bridge designs that were superseded by the optimisation process, which may be useful for future reference.

It is expected that future detailed design of all bridges, as well as the adjacent road approaches, will develop designs that are consistent with the intent of the concept designs. It is acknowledged that further refinement opportunities (eg. shorter spans with additional compensatory earthworks) likely exist and may be explored further as part of the detailed design process. This will need to demonstrate and document to Sydney Water's satisfaction that an equivalent flood performance can be achieved.

Table 15: Summary of bridge optimisation outcomes

Bridge	Type	Initial (Unoptimised) Concept Design		Final (Optimised) Concept Design	
		Bridge Structure	Floodplain Works	Bridge Structure	Floodplain Works
Wenden Avenue	Pedestrian/ cycle only	Single span bridge Total span length = 23 m	Nil	Single span bridge Total span length = 14 m	Nil
Future Road E	Road	Twin-span bridge Total span length = 30 m	Nil	Single span bridge Total span length = 18 m	Bench on left (west) overbank. Up to 1.0m reduction in ground levels required.
Colonial Street Extension	Road	Three-span bridge Total span length = 54 m	Nil	Twin-span bridge Total span length = 36 m	Bench on right (east) overbank under eastern span. Up to 0.3m reduction in ground levels required.
Hodges Road Extension	Road	Single span bridge Total span length = 18 m	Nil	Single span bridge Total span length = 14 m	Bench on left (west) overbank. Up to 0.3m reduction in ground levels required
Balmoral Road	Road	Single span bridge Total span length = 18 m	Major works required to remove existing culverts and reinstate creek	Single span bridge Total span length = 18 m Bridge shifted slightly west away from future intersection.	Major works required to remove existing culverts and reinstate creek. Creek alignment shifted slightly west to suit bridge location and minimise riparian disturbance as far as practicable.
Future Road B	Road	Single span bridge Total span length = 18 m	Nil (Note: creek to be reconstructed by SW at this location as part of initial trunk drainage works)	Single span bridge Total span length = 18 m	Nil (Note: creek to be reconstructed by SW at this location as part of initial trunk drainage works) Allowance for minor flood control structure in the form of signage, raised boardwalk, etc on right (east) floodplain. Refer Section 3.6.1 for details.
Future Road A	Road	Single span bridge Total span length = 18 m	Existing informal levee on right (east) overbank to be removed.	Single span bridge Total span length = 12 m	Existing informal levee on right (east) overbank to be removed.

Local flood management works

The following additional local flood management works were also investigated and incorporated into the overall flood management strategy.

Flood control levee at Lewis Jones Drive

Two design options were considered for the proposed levee:

1. Vegetated earth bund, or
2. Reinforced concrete/block wall

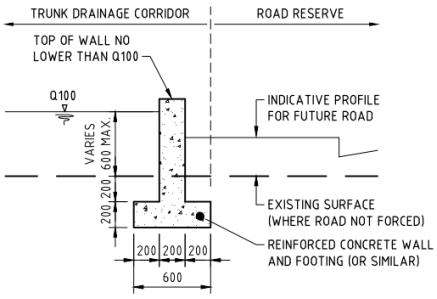
Planting of an earth bund would be limited to grasses only to ensure the integrity of the structure over time. A reinforced concrete/block wall type structure was therefore considered a better outcome in terms of complementing the desired vegetation management outcomes for the TDL, since the overall footprint is minimised, allowing planting of trees/shrubs closer to the TDL boundary.

Proposed crest elevations for the levee range from 51.0 m AHD (downstream extent) to 51.6 m AHD (upstream extent), which correspond to peak 100 year ARI flood levels under design conditions (i.e. account for future implementation of the trunk drainage works and long-term vegetation management within the TDL). This would provide an equivalent level of flood protection to the full length of Lewis Jones Drive and adjoining properties consistent with the intent of the original/approved road design.

The levee was represented in the TUFLOW model by raising ground levels along the line of the levee above peak 100 year ARI flood levels.

The Concept Design Drawings show the intended location and extent of levee required to prevent outflanking, with the levee tied into future back-of-footpath levels. A typical section is also provided to illustrate the proposed relativity to the TDL boundary (refer **Figure 20**).

Figure 20: Proposed levee at Lewis Jones Drive



Note: Refer to Concept Design Drawings for full details

Future detailed design will need to confirm the required length, tie in points and crest levels for the levee with the benefit of detailed survey to confirm existing ground levels in this area.

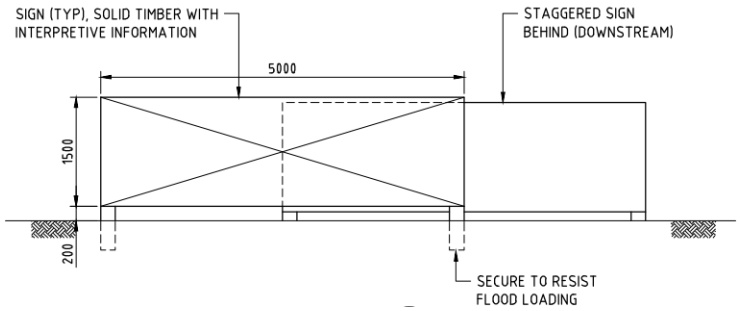
Minor flood control structures upstream of Future Road (B)

The incorporation of additional minor flood control structures within the TDL was considered beneficial within the reach of EMC upstream of Future Road (B), which is located towards the southern end of the study area. In other creek reaches, increases in peak design flood levels as a result of floodplain roughening (i.e. due to longer term vegetation management) and allowance for future bridge crossings was sufficient to achieve desired flood management outcomes and result in reasonable floodplain storage outcomes (refer Section 3.6.2 for further discussion). However, the removal of existing dams and associated creek reinstatement works upstream of Future Road (B) will result in more substantial reductions in existing floodplain storage that is not easily recovered without significant floodplain reshaping/earthworks.

Furthermore, incorporation of additional afflux at the Future Road (B) bridge to assist in offsetting this reduction in floodplain storage is not desirable as the intended future waterway opening is well-matched to the proposed creek section and profile.

Various structure types, configurations and locations were tested using the TUFLOW model. Ultimately an array of five interpretive signs (each sign nominally 5m wide by 1.5m wide and elevated 0.2m off the ground, with adjacent signs offset to increase the blocking effect on out-of-bank flows) was selected for inclusion in the concept design. The Concept Design Drawings show the intended location and configuration of the signage array, along with a typical detail (refer **Figure 21**). These works are estimated to result in additional afflux of approximately 0.07m, which assists in offsetting the loss of storage associated with the dam removal and creek reinstatement works.

Figure 21: Proposed signage array as minor flood control structure



Note: Refer to Concept Design Drawings for full details

It is noted that this minor flood control structure could be readily adapted to take the form of an alternative structure (eg. raised section of boardwalk with solid railings, observation/look out deck, etc), with the ultimate form requiring further consideration as part of future detailed design in conjunction with proposed landscaping and revegetation plans.

3.6.2 Flood management outcomes

Design Flooding Conditions and Impacts

Figure 22 and **Figure 23** show design flooding conditions in terms of extents and depths of inundation for the 2 and 100 year ARI events, respectively. **Figure 24** shows the combined impact of the proposed trunk drainage works and future works (i.e. landfill to facilitate development, future bridge crossings, future vegetation management) on peak 100 year ARI flood levels. **Figure 25** shows design 100 year ARI flood profiles for both existing and design conditions.

The approximate hydrologic standards achieved for the major road crossings in the Study Area are as follows:

- Samantha Riley Drive – exceeds 100 year ARI (existing condition)
- Memorial Avenue – exceeds 100 year ARI (once proposed RMS road upgrade is completed)
- Balmoral Road – exceeds 100 year ARI (once future road upgrade is implemented)

Figure 22: Design Flooding Conditions – 2 year ARI

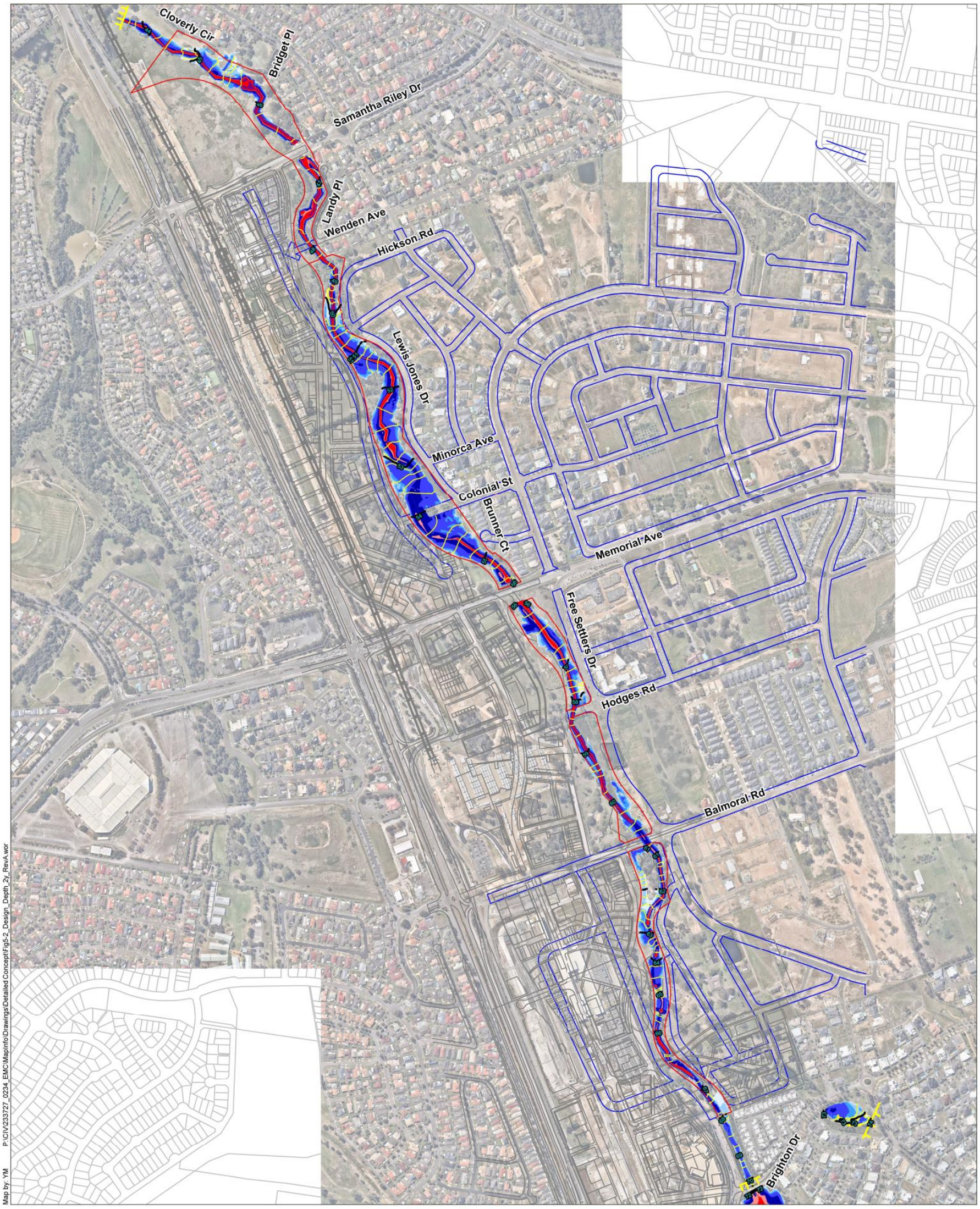


Figure 23: Design Flooding Conditions – 100 year ARI

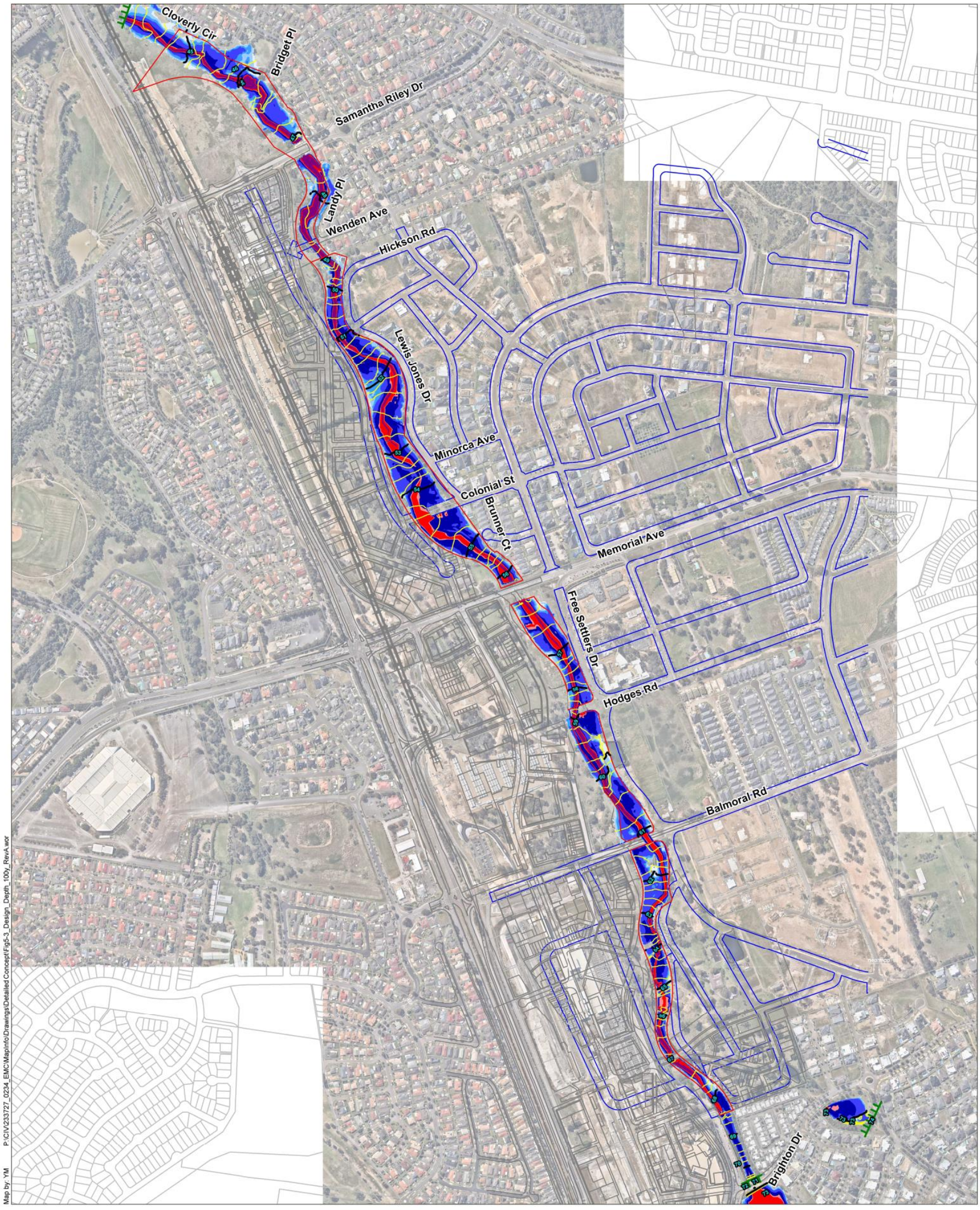


Figure 24: Impact of Combined Trunk Drainage Works and Future Works on Baseline Flooding Conditions – 100 year ARI

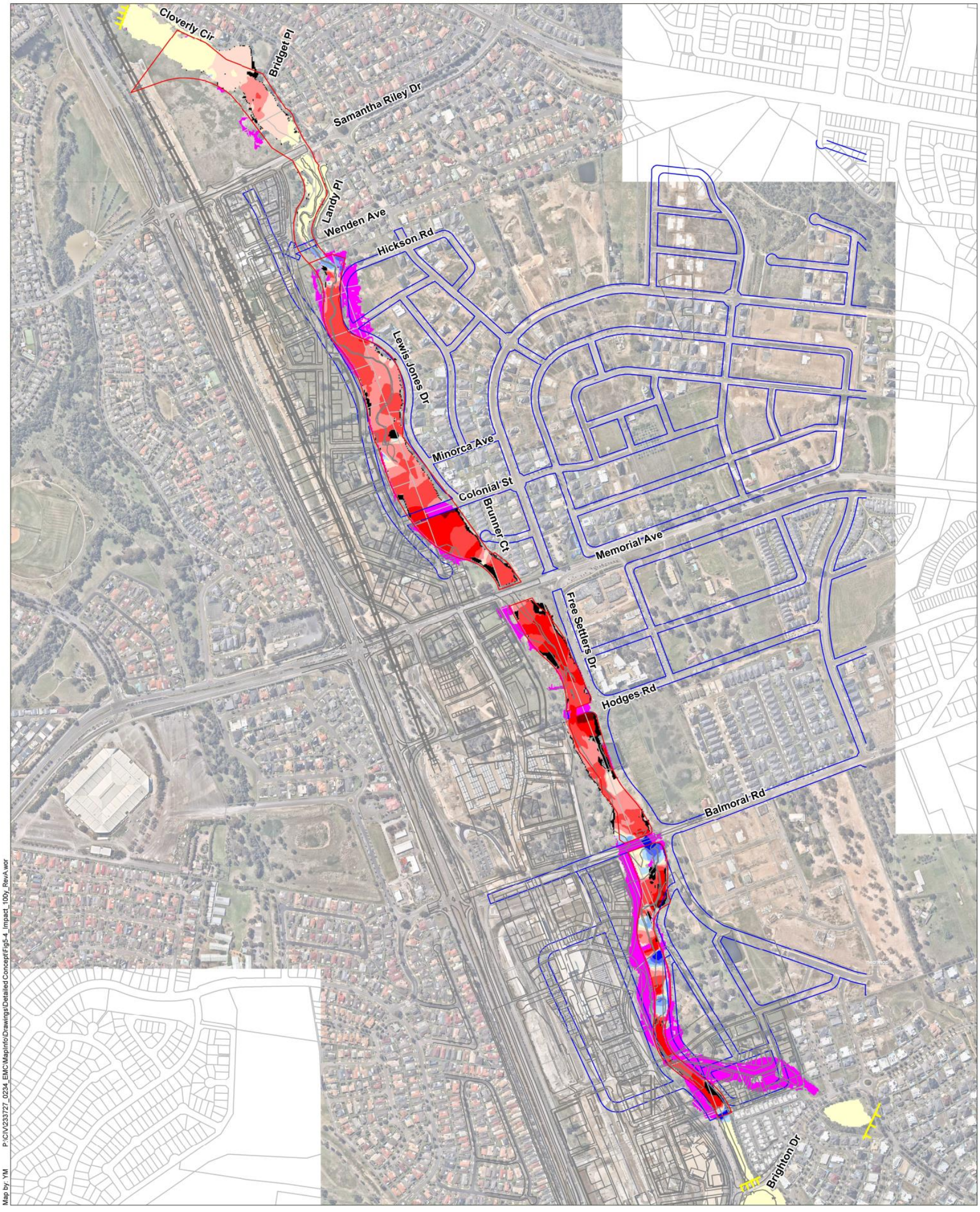
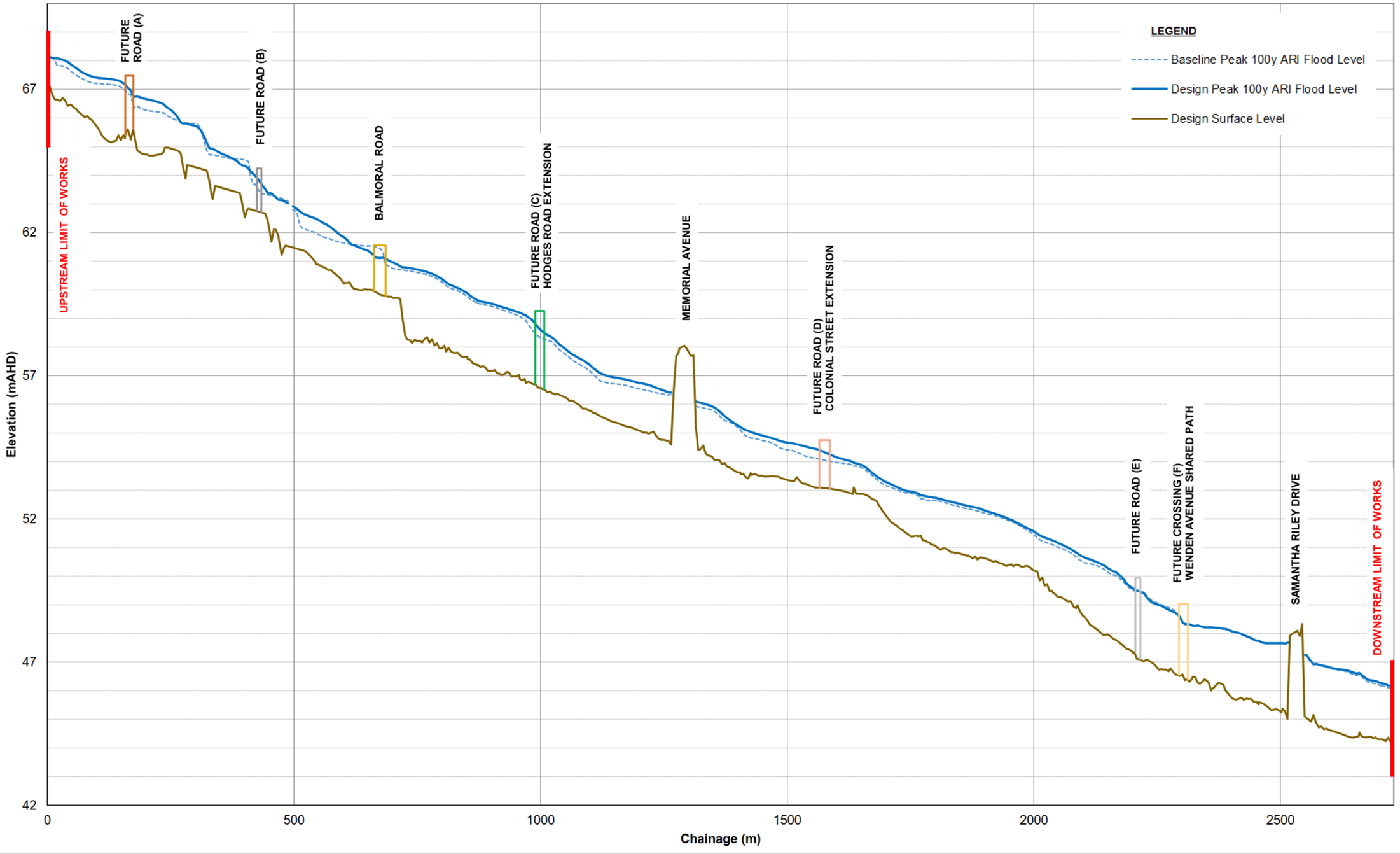


Figure 25: Design flood profiles – 100 year ARI



As shown on **Figure 23**, floodwaters will generally be contained within the proposed TDL for events up to 100 year ARI with only a few minor exceptions where existing or future roads adjoin the TDL (e.g. Free Settlers Drive, Lewis Jones Drive, Landy Place). In these cases shallow inundation of the roadway may occur, but would not impact on adjacent existing development.

Figure 21 more clearly identifies those areas outside the TDL where future landfill to facilitate development will push floodwaters back into the TDL (refer pink regions bordering the TDL denoted "was wet now dry").

Figure 24 also shows that peak 100 year ARI flood levels are generally increased throughout the TDL, typically in the order of 0.2-0.3 m but up to approximately 0.5 m in isolated areas. Reductions in peak flood levels do occur but are generally associated with proposed removal of existing hydraulic controls (e.g. Balmoral Road, embankments around existing online dams, minor channel widening in the vicinity of Wenden Avenue).

With reference to the flood management priorities identified in **Section 2.6.5** it should be noted that:

- Peak 100 year ARI flood levels in the vicinity of Nos. 14 and 16 Wenden Avenue are reduced such that property flooding is avoided.

- Peak 100 year ARI flood levels in the vicinity of Landy Place, and Brunner Court and No. 10 Colonial Street, are increased slightly (by less than 0.05 m) but not to the point where floodwaters would encroach into existing residential properties in these areas.

- Peak 100 year ARI flood levels at the upstream (southern) end of the approved Stage 1 dwelling on No. 21 Balmoral Road are approximately RL 60.8 m AHD, which is 0.5m below the approved ground floor level of RL 61.3 m AHD. Whilst Stages 2 and 3 located further to north adopt a slightly lower floor level of RL 61.2 m AHD, peak flood levels are shown to be at least 0.5m lower here due to the prevailing flood slope from south to north along EMC.

  Peak 100 year ARI flood levels within the property are increased by up to approximately 0.1m along its eastern boundary (i.e. adjacent to EMC). However there is no appreciable change in flood hazard within the property.

  It is recommended that review of design flood levels against proposed floor levels and basement carpark protection levels is undertaken prior to future issue of construction certificates to reconcile any minor residual level differences.

- The proposed flood control levee at Lewis Jones Drive prevents overtopping of the road for events up to 100 year ARI.

Future detailed design of the trunk drainage works (by Sydney Water) and future bridge crossings (by others) will need to review flooding conditions and impacts throughout the study area, but in particular should pay close attention to the locations identified above and the related flooding issues and concept design objectives.

Change to Floodplain Storage-Discharge Function

To examine the impact of the proposed trunk drainage works on the storage-discharge function of the floodplain required a customised methodology to post-process TUFLOW results and present results, as this is not a typical output or consideration applied to trunk drainage or floodplain management.

Essentially the TDL was split up into eight discrete *floodplain compartments* defined by both existing road crossings and future bridge crossings. This extended downstream as far as Wenden Avenue, below which no trunk drainage works are proposed. Compartment boundaries are shown on **Figure** 26 at the end of this section. Characteristic discharge and storage were then assessed for each compartment under existing and design conditions, where:

- Discharge was defined as the outflow from a given compartment, extracted as a flow hydrograph over the duration of the flood of interest.

- Storage was defined as the stored volume of floodwaters in a given compartment, calculated from the difference between the flood surface and ground surface at each model time step over the duration of the flood of interest.

Figure 27 at the end of this section presents the resulting discharge and storage time series for each floodplain compartment for the 100 year ARI design flood event. Discharge results are shown on the left hand side whilst storage results are on the right hand side. Baseline conditions are shown in blue whilst design conditions are shown in orange.

Consideration was given to plotting discharge against storage for each model time step to simplify the analysis, however the resulting relationships were no more useful to help understand changes in floodplain dynamics in this case. For this reason separate plots of discharge and storage were maintained. *[It is however noted that combined discharge-storage plots could be of value to other/future projects, in particular where a broad flow range and highly variable floodplain storage characteristics are being considered. Some further details of this approach are intended to be documented in the accompanying Guidelines for Release Area Floodplain Development Strategy.]*

Reviewing the results presented in **Figure 27** in terms of discharge, there is little change in modelled flows that can be attributed to the proposed trunk drainage works, both in terms of peak flow rate and overall shape and timing of the flood hydrographs. This finding applies to all locations along EMC.

In terms of storage, little change is again observed for Compartments 1, 3 and 8. However more substantial differences are evident for the remaining compartments which are further discussed below.

- Compartment 2 (Future Bridge A to Future Bridge B)
  - Loss of storage associated with proposed removal of existing online dams and associated creek reinstatement works.
  - Interpretive signage array incorporated into this compartment to assist in offsetting the loss of storage for 100 year ARI flood, with peak flood levels for this event increased by up to 0.07m.
  - The proposed creek works already give consideration to minimising earthworks and maximising use of the existing dam landforms where possible. Further refinement of the concept design is not warranted, but could be further considered at detailed design with the benefit of detailed survey information.
- Compartments 4 (Balmoral Road to Future Hodges Road Extension) and 5 (Future Hodges Road Extension to to Memorial Avenue)
  - Gain in storage associated with increased peak flood levels, which can be attributed to the combined effect of increasing hydraulic roughness generally within the TDL and afflux associated with future bridge crossings.
  - Lowering design peak flood levels to gain a better match to existing floodplain storage would work against other design principles such as maximising floodplain engagement and vegetation management objectives.
- Compartment 6 (Memorial Avenue to Future Colonial Street Extension)
  - Gain in storage associated with increased peak flood levels, which can be attributed to the combined effect of increasing hydraulic roughness generally within the TDL and afflux associated with future bridge crossings.
  - Design peak flood levels already maintained as low as possible, whilst allowing for downstream bridge crossings and vegetation management objectives, in order to minimise property impacts. Further reductions in peak flood levels to reduce storage are not practical without compromise on these objectives or substantial earthworks.
- Compartment 7 (Future Colonial Street Extension to Future Bridge E)
  - Gain in storage associated with increased peak flood levels, which can be attributed to the combined effect of increasing hydraulic roughness generally within the TDL and afflux associated with future bridge crossings.

- Design peak flood levels already maintained as low as possible, whilst allowing for downstream bridge crossings and vegetation management objectives, in order to minimise property impacts. Further reductions in peak flood levels to reduce storage are not practical without compromise on these objectives or substantial earthworks. The presence of EEC's in this area also make floodplain works undesirable.

In general, it is considered that the proposed trunk drainage works strike a reasonable balance between the various competing design objectives. There are no clear refinements available that can readily and significantly improve the ability of the concept design to preserve the existing storage-discharge function of the floodplain.

Figure 26 Floodplain storage compartment boundaries

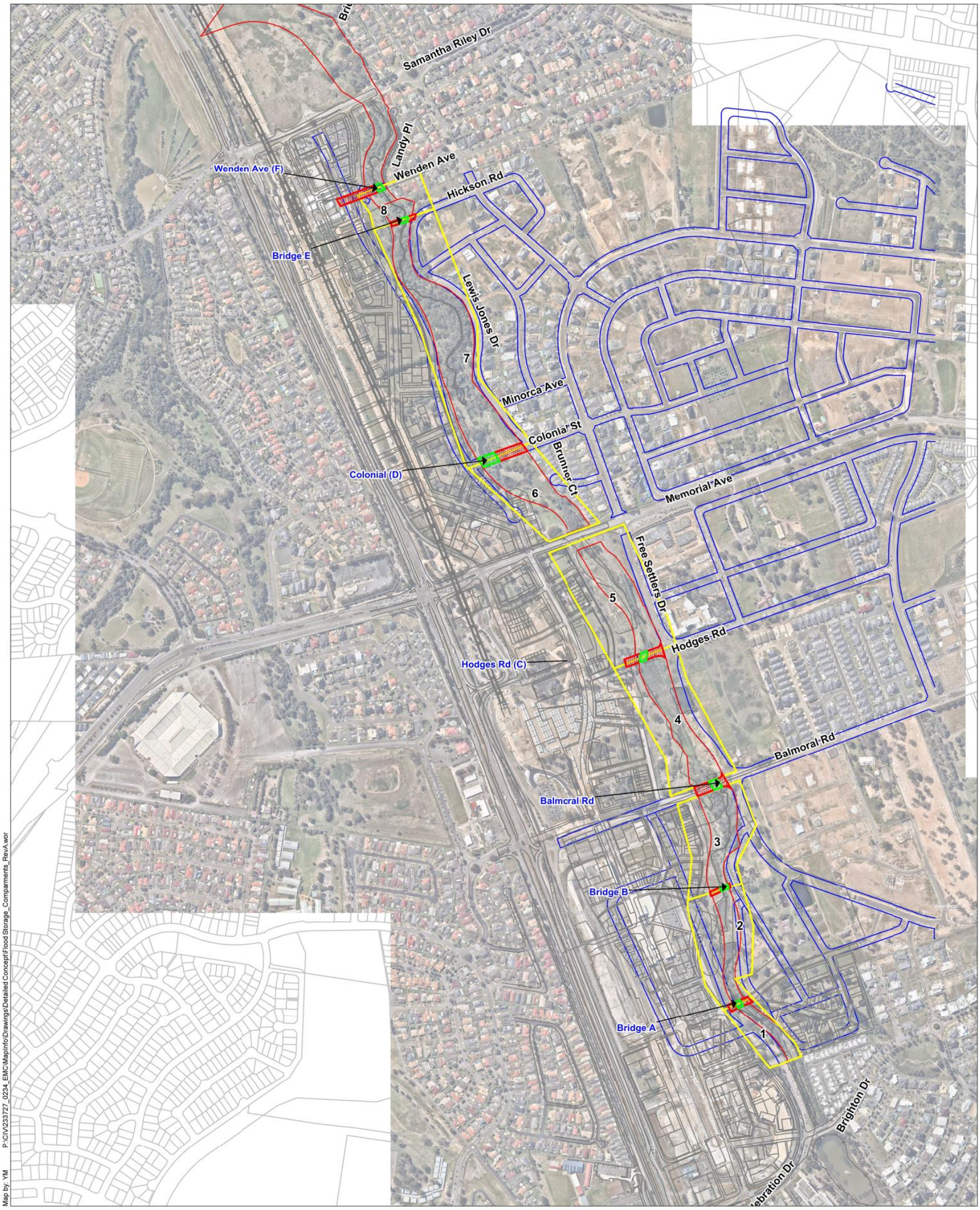
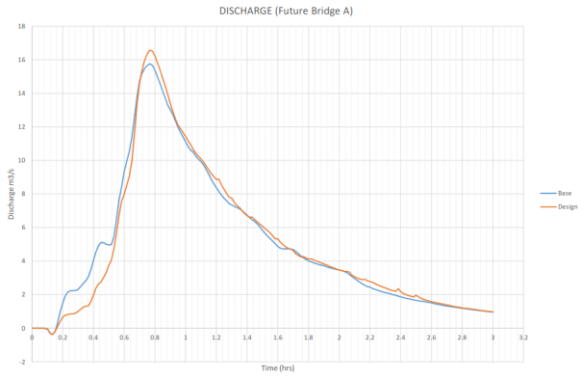
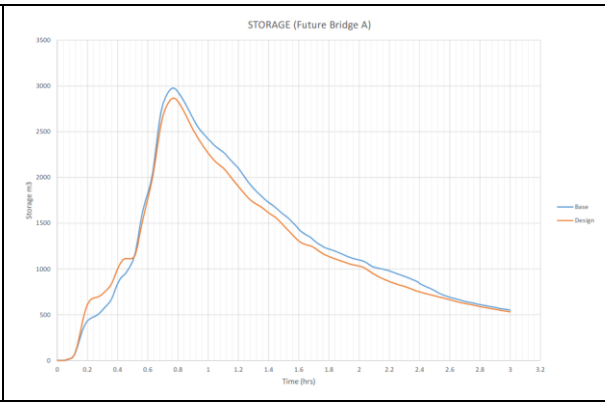


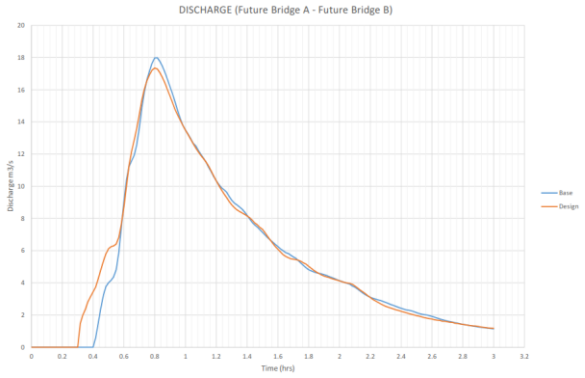
Figure 27: Floodplain discharge-storage results – 100 year ARI flood

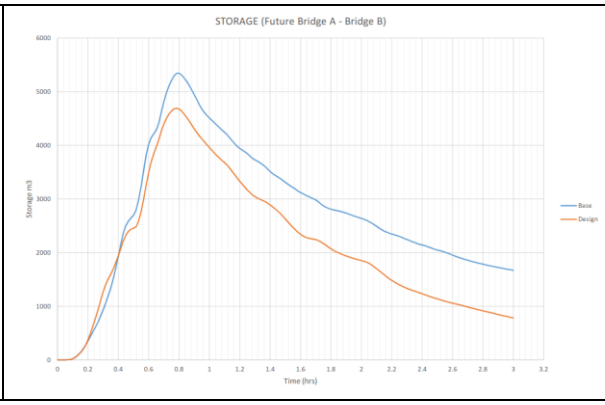
Compartment 1 – Upstream limit of works to Future Bridge A:



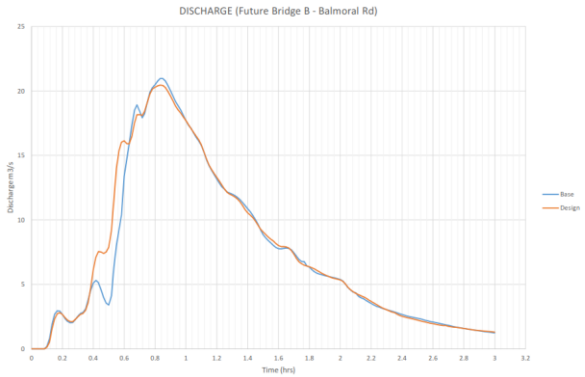


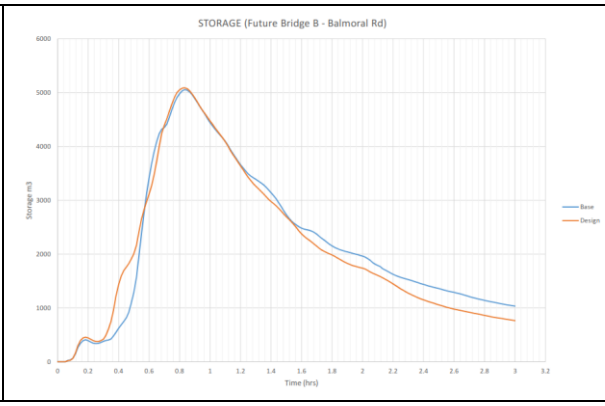
Compartment 2 – Future Bridge A to Future Bridge B:



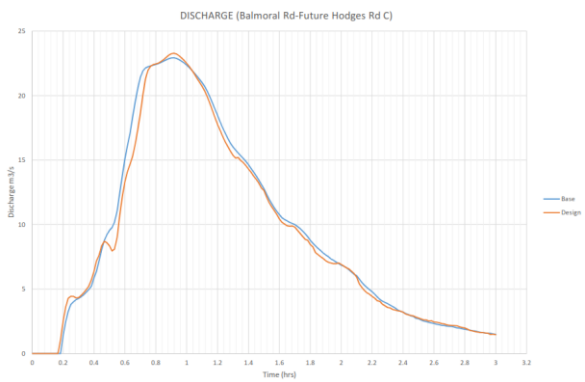


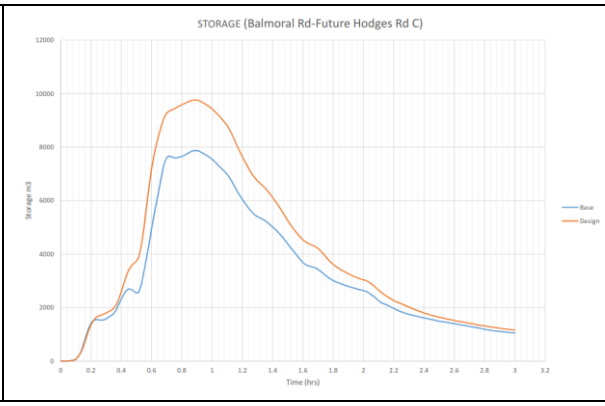
Compartment 3 – Future Bridge B to Balmoral Road:



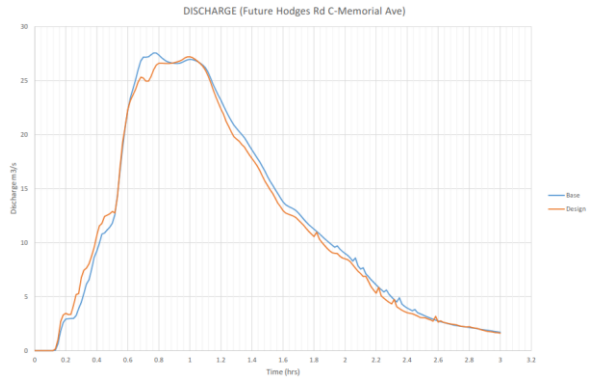
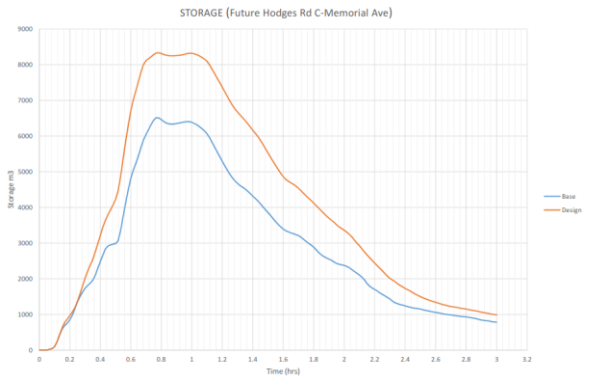
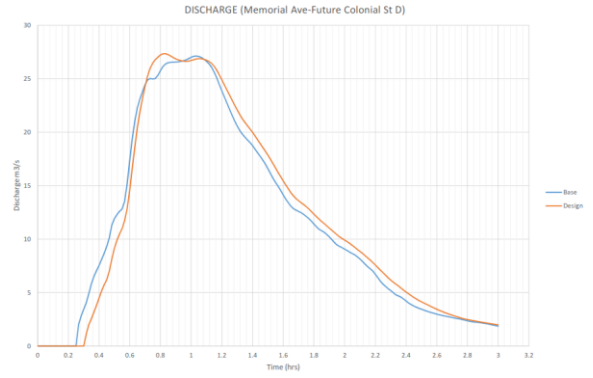
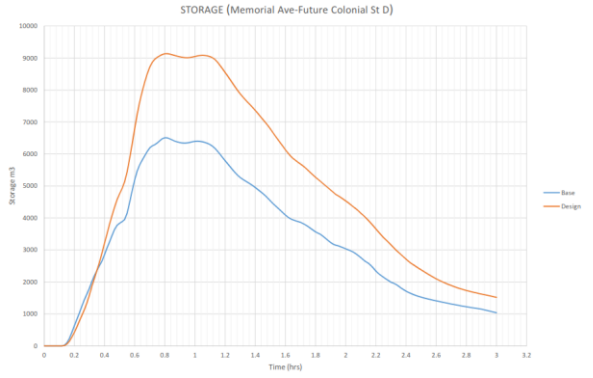
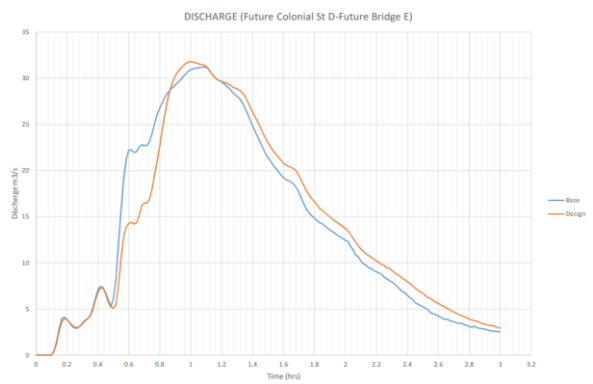
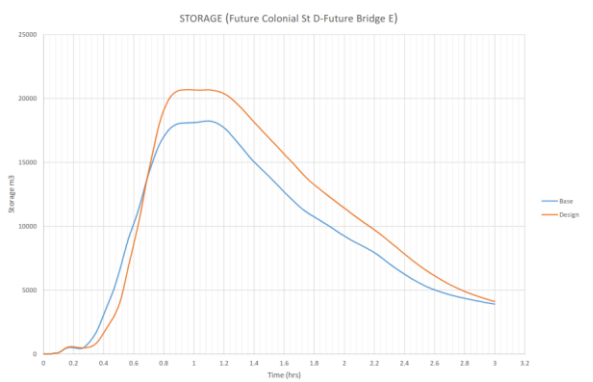
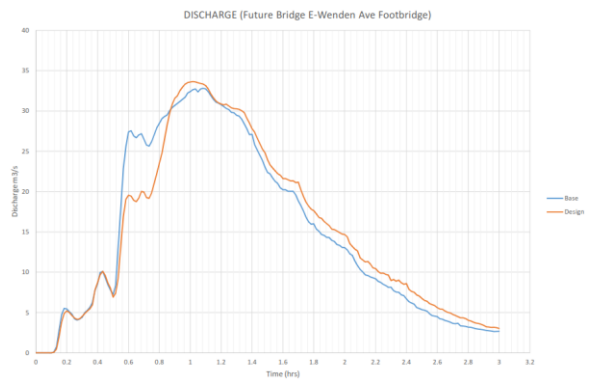
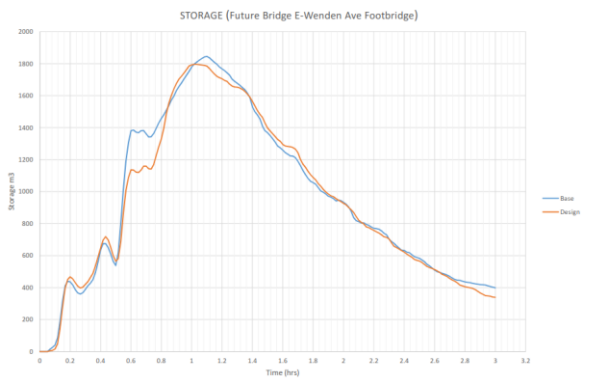


Compartment 4 – Balmoral Road to Future Hodges Road Extension:





(Figure continued)

Compartment 5 – Future Hodges Road Extension to Memorial Avenue:	
	
Compartment 6 – Memorial Avenue to Future Colonial Street Extension:	
	
Compartment 7 – Future Colonial Street Extension to Future Bridge E:	
	
Compartment 8 – Future Bridge E to Future Wenden Avenue Shared Path Bridge :	
	

4 Safety in Design

4.1 Introduction

AAJV is committed to maximising the opportunity for safer delivery and use of our environmental and planning services for the EMC Trunk Drainage Concept Design project. The key goal is to provide safer designs for construction and operation / maintenance phases throughout the project's life cycle.

The Safe Design process used on this project is based on systematic risk assessment that includes identification of alternative mitigation arrangements to be incorporated into the design, or if appropriate, incorporated during construction, operations/maintenance and demolition phases. The Safe Design process is intended to maximise the likelihood of project safety objectives being achieved and to document the Safe Design work undertaken and record associated outcomes.

4.2 Statutory and Regulatory Obligations

AAJV's Safe Design process is intended to comply with relevant occupational health and safety legislation in Australia.

4.3 Safety Objectives

Safety objectives relevant to the concept design phase include:

- To identify hazards and assess the risks that might be realised in the construction and operation/maintenance of the project life cycle, and associated mitigation arrangements through the design process, preferably by designing them out (eliminate).
- To communicate to Sydney Water risks that have not been eliminated in the design and need to be managed during the construction and operation / maintenance phases.

4.4 Affected Groups

Current groups potentially affected by the Project are:

- Sydney Water
- Head delivery contractor (and its subcontractors)
- Maintenance contractors
- The Hills Shire Council (and its subcontractors).
- Roads and Maritime Services (and its subcontractors).
- Transport for NSW (and its subcontractors).
- Utility owners and related service providers.
- Land owners adjoining or in close proximity to the TDL.
- General public, including local residents.

4.5 Safe Design Process

4.5.1 Overview

The Safe Design process requires identification of hazards and assessment of risks in the context of the design proposed at the time of assessment known as the current mitigation arrangement. Any

further control measures to mitigate risks (identified during the process) will be applied in a future mitigation arrangement.

4.5.2 Safe Design Workshop

In May 2016 AAJV convened a CHAIR 1 (Construction Hazard Assessment and Implication Review) workshop. The workshop involved key members of the AAJV project team plus representatives of several internal departments of Sydney Water including:

- Land and Waterways
- Delivery Management
- Community Relations
- Environmental Representatives
- Asset Planning

The emphasis of the workshop was to identify the hazards and assess the associated risks, i.e. construction and operation/maintenance that could be addressed during the concept design phase. The workshop also established appropriate mitigation measures for the identified risks, or marked these for further action by AAJV.

4.5.3 Outputs

Key outputs of the Safe Design process are:

- Risk register (refer to **Appendix G**).
- Safe Design report (this report chapter).

4.6 Responsibilities and Reporting Arrangements

4.6.1 AAJV Responsibilities

AAJV's overall responsibility in regard to Safe Design is to ensure, so far as is reasonably practicable, that the design of the product, including incorporation of Sydney Water's requirements, does not create a risk to the health and safety of persons involved in the construction or use of the product. AAJV is required to consider the reasonably foreseeable risks pertinent to construction, use of and demolition of the product. The potential risks have ideally been designed out (eliminated), however where this has not been possible, risks need to be controlled to a level, as low as reasonably practicable.

The AAJV has a responsibility to:

- Advise Sydney Water of identified hazards, assessed risks and proposed risk mitigation arrangements (through this report chapter and the risk register in **Appendix G**).
- Incorporate agreed risk mitigation arrangements into the concept design.

4.6.2 Sydney Water Responsibilities

Sydney Water has a responsibility to:

- Communicate this report including the Safe Design risk register (refer **Appendix G**) submitted separately to key stakeholders, contractors and owners of control measures.

4.7 Assumptions, Constraints and Dependencies

4.7.1 Assumptions

The following assumptions were made during the Safe Design process:

- This Safe Design risk assessment was completed based on current industry good practice and knowledge.
- A competent and experienced Delivery Contractor will employ competent and experienced Delivery Sub-contractors to carry out the works.
- The Delivery Contractor will review and update/incorporate any new risks in the contract risk register(s) as required.
- The Delivery Contractor will communicate to the appropriate Consultant and the Client when/if they need any amendments to the design relating to improved safety.
- The process considers reasonably foreseeable risks pertinent to the construction and use of the asset (i.e. the creek and TDL). The risks have ideally been designed out (eliminated), however where this has not been possible, risks need to be controlled to a level, as low as reasonably practicable.

4.7.2 Constraints

The following constraints were identified during the Safe Design process:

- AAJV has only identified foreseeable risks at this stage of the design at this site and its immediate vicinity.
- Limited access / egress points to certain parts of the site (in the event of an emergency)
- Site within natural/restored bushland prone to natural hazards (e.g. fire, flood, etc.)
- Working within a waterway or adjacent to a waterway
- Limited space to conduct construction activities (due to environmental constraints)
- The use of large machinery that would be required to import and place materials (e.g. rock work, large woody debris, etc.)

4.7.3 Dependencies

The achievement of project health and safety objectives is dependent upon:

- Consultant, Client and Stakeholder commitment to the safety management process.
- Communication of this report, risk rating matrix and risk register to those parties with nominated actions.
- Incorporation of recommended actions by nominated parties.

5 Future Implementation

5.1 Land Acquisition and Access

5.1.1 Land Acquisition

Sydney Water intends to ultimately own all land within the TDL, and has commenced an acquisitions process to purchase land portions not currently owned. GIS-based mapping and figures identifying the subject land portions has been provided to Sydney Water under separate cover to support the acquisitions process.

It is noted that several properties already owned by Sydney Water extend beyond the proposed TDL. The portions of these properties that are located outside the Proposed TDL Boundary are surplus to long-term requirements for trunk drainage purposes, and therefore represent a potential divestment opportunity. However, in the short term these sites may prove useful during construction of the trunk drainage works (e.g. as site compounds, layover areas, for site access, etc.). It is recommended Sydney Water review the divestment potential of these surplus areas following completion of the trunk drainage works.

5.1.2 Temporary Construction-Phase Property Access

It is understood that acquisition of parcels not currently owned by Sydney Water will occur prior to the commencement of trunk drainage works, which generally avoids the need to negotiate with land owners for site access and to undertake works.

The trunk drainage concept design has, to the extent possible, attempted to limit the permanent works footprint to land within the proposed TDL. However, there are several locations where works may be required outside the proposed TDL in order to produce a satisfactory landform outcome. In particular this includes the following locations shown on **Figure 8 – Sheet 1**:

- Works Identifier 1 – the subject land is drainage reserve administered by THSC.
- Works Identifier 4 – the subject land is State Government owned.
- Works Identifier 12 – the subject land is privately owned.

The design of works in the above locations in particular should be reviewed during detailed design with the benefit of detailed survey to consider whether local adjustments could be made to fully accommodate the permanent works footprint, as well as the required construction footprint, within the TDL. If such adjustment is not possible then Sydney Water will be required to negotiate with the affected land owners to gain permission to undertake works.

It may also be desirable to gain temporary vehicle access to intermediate locations along the TDL (i.e. remote from existing road crossings) for ease of construction. Such requirements, as well as agreement with affected land owners, will need to be confirmed as part of future construction planning.

5.2 Land Rezoning

Sydney Water originally understood that a separate rezoning process would be required to facilitate rezoning of all land within the proposed TDL to a suitable under THSC LEP 2012. As part of the concept design process, allowance was made for preparation of a planning proposal to THSC to support such a rezoning application.

However, through consultation with DP&E undertaken over the course of the concept design process the proposed trunk drainage rezoning was incorporated into a concurrent rezoning process being driven by DP&E for the priority precincts of Bella Vista and Kellyville Stations. The priority precincts are intended to support delivery of the Sydney Metro Northwest, which has been deemed a Priority Urban Renewal Corridor by the State Government. The full extent of rezoning for trunk drainage purposes that is required along EMC falls within the boundaries of the Bella Vista and Kellyville Stations precincts.

To facilitate this process, GIS-based mapping and figures identifying the extent of the proposed TDL (i.e. the extent of land to be zoned for trunk drainage purposes) was supplied to DP&E for incorporation into their precinct proposals. Further Sydney Water input to the precinct proposal was also provided by way of written submission to DP&E following exhibition over the period December 2015 to February 2016.

It is recommended that Sydney Water continue consultation with DP&E as required through to finalisation of the precinct proposals and their subsequent adoption/gazettal.

5.3 Vegetation Management

As noted in **Section 3.3.5**, preparation of a VMP should be completed as a priority component (or in advance of) the future D&C delivery contract to support the proposed trunk drainage works given its importance to overall creek rehabilitation outcomes. Various linkages, assumptions and recommendations have been made during preparation of the trunk drainage concept design, as documented in this report and in the accompanying REF, which will need to be addressed.

5.4 Staging Implications

It is noted that flood modelling undertaken to develop the current concept design assumes ultimate catchment conditions including completion of the initial trunk drainage works (by Sydney Water), future filling, bridge crossings and related works (by others), plus longer term increases in floodplain roughness as a result of Sydney Water's desired vegetation management practices. Whilst no specific staging implications are foreseen, this should be reviewed as part of the next stage of design with the benefit of any improved understanding of the relative timing of works within the study area.

6 References

AAJV (2016a). *Review of Environmental Factors - Elizabeth Macarthur Creek Trunk Drainage*. In prep.

AAJV (2016b). *Phase 1 and Targeted Phase 2 Contamination Investigation - Elizabeth Macarthur Creek Trunk Drainage Design*. Report dated 1 June 2016.

AAJV (2016c). *Elizabeth Macarthur Creek – Desktop Geotechnical Assessment*. Memo dated 14 June 2016.

AAJV (2016d). *Preliminary Planning Advice – Elizabeth Macarthur Creek Corridor, Kellyville/Bella Vista*. Memo dated 3 February 2016.

AAJV (2016e). *Review of Bushfire Protection and Hazard Reduction Zone Creation Assessment (Travers, 2013) and implications for trunk drainage planning along Elizabeth Macarthur Creek*. Memo dated 29 March 2016.

AAJV (2015). *Elizabeth Macarthur Creek Trunk Drainage Design - Aboriginal Archaeological Heritage Due Diligence Assessment*.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2016, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia

BCC (2003). *Natural Channel Design Guidelines*. Table 3.6 and Table 3.7. Brisbane City Council.

BCC (2004). *Erosion Treatments for Urban Creek Guidelines*. Version 3. Brisbane City Council.

CRCCH (2000). *A Rehabilitation Manual for Australian Streams*. Rutherfurd, I, Jerie, K & Marsh, N. Cooperative Research Council for Catchment Hydrology.

Eco Logical Australia (2016). *Flora and Fauna Assessment: Instream Works – Elizabeth Macarthur Creek*. Report prepared for AAJV, August 2016.

ICC (2010). *Waterway and Channel Rehabilitation Guidelines*. Ipswich City Council.

Parsell (2015). *Stormwater Retention 'at source' – A Key to Successful Urban Creek Rehabilitation*. Paper submitted to 2015 WSUD & IECA Conference.

Sydney Water (2013). *Plan of Management for the Sydney Water Trunk Drainage Lands in the Rouse Hill Development Area*.

Sydney Water (2013). *Stormwater connections to waterways in the Rouse Hill Development Area*.

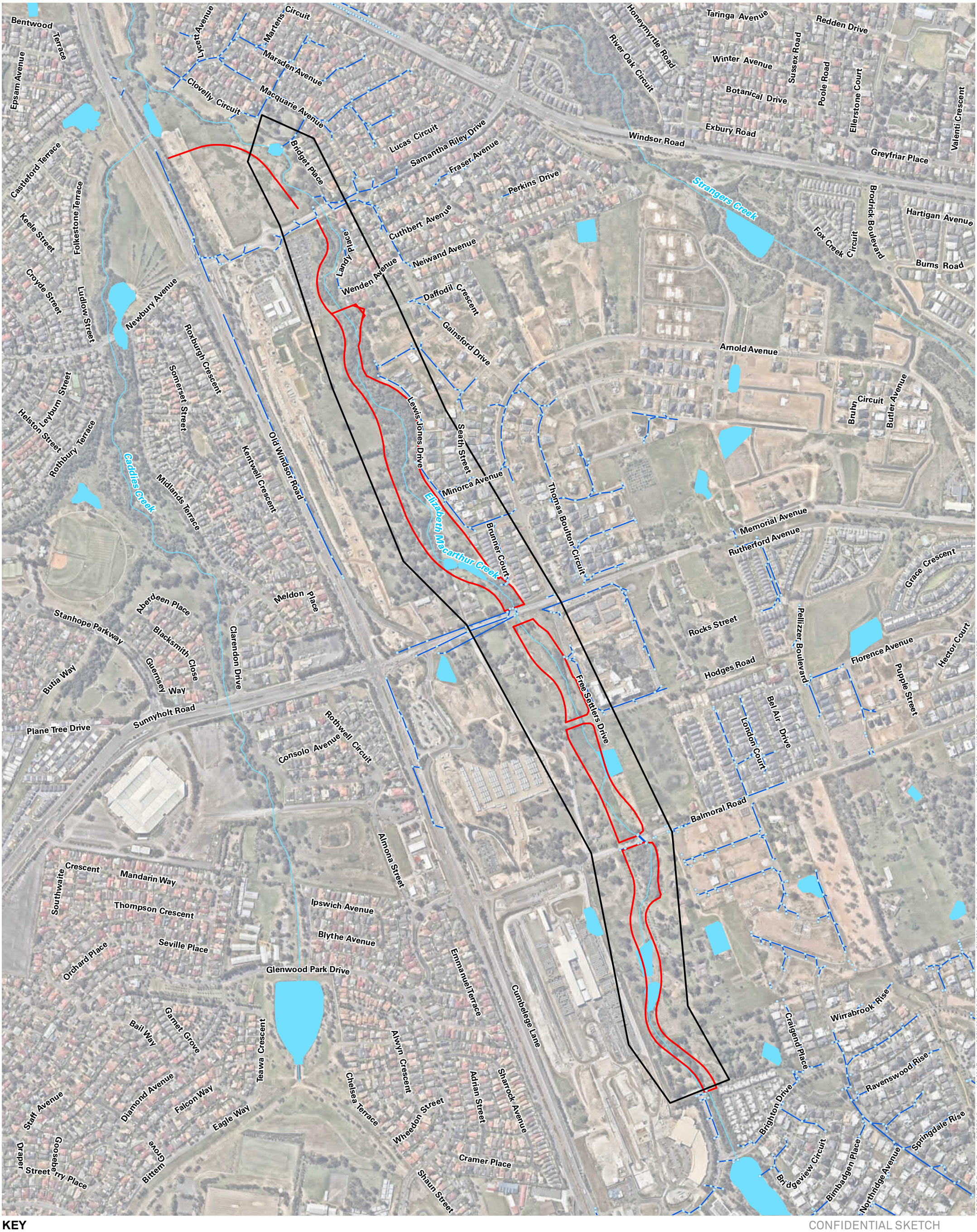
Travers Bushfire and Ecology (2013). *Vegetation Assessment – Rouse Hill Trunk Drainage Lands*. Report and mapping prepared for Sydney Water.

USDT (2005). *Design of Roadside Channels with Flexible Linings* Publication No. FHWA-NHI-05-114. Federal Highway Administration Hydraulic Engineering Circular No. 15, Third Edition. Table 2.3. U.S. Department of Transportation (September 2005).

Appendix A

Constraint Mapping

Map Ref.	Map Title
W007	Existing drainage features
W008	Existing infrastructure
W009	Soil Landscapes
W010	Geology
W011	Existing land zoning
W012	Terrain
W015	Existing underground utilities
W018	Existing vegetation condition
W019	Existing vegetation types
W020	Sensitive heritage and AHIMS sites
W026	Proposed Future Priority Precinct Development
W028	Land ownership
W033	Salinity potential



KEY

- Study area
- SWC Proposed Land Boundary Adjustments
- Named watercourse
- Waterbody
- Stormwater pit
- Stormwater pipe

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE 1:8,000	SIZE A3
SHEET 01 of 01	COORDINATE SYSTEM GDA 1994 MGA Zone 56

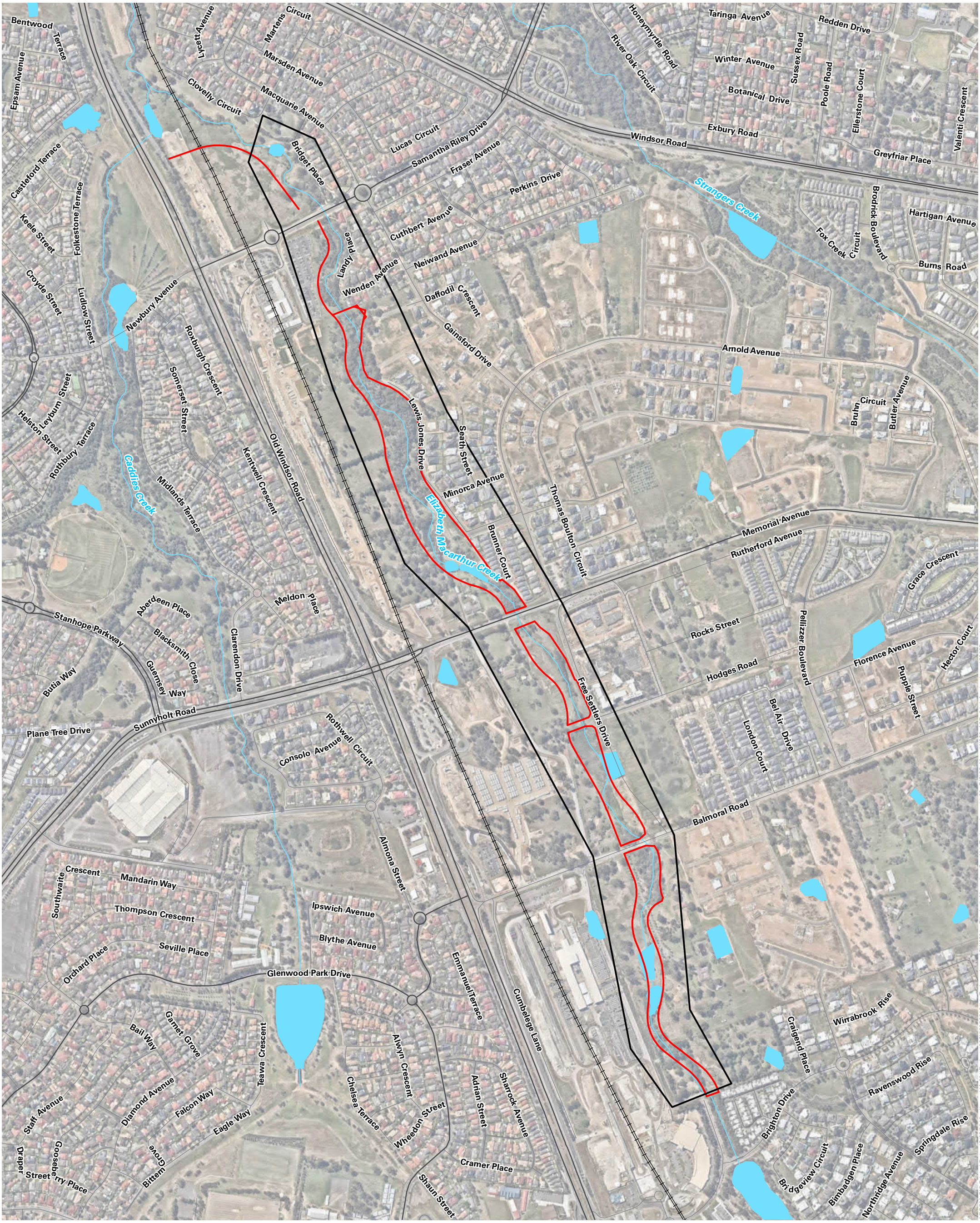
TITLE
Existing drainage features

PROJECT
ELIZABETH MACARTHUR CREEK

CLIENT
SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SC	15/02/2016	W007 01		60286134
CHECK	DATE			

AECOM GIS Printed:Date: 15/02/2016 \\ausyd1fp001\Projects\602X\60286134\4. Tech work area\SW0234 - Elizabeth Macarthur Creek\4. Tech work area4.99_GIS\02_Maps\W007_A3P_01_Watercourses_150827.mxd



KEY

- Study area
- SWC Proposed Land Boundary Adjustments
- Primary road
- Local road
- Sydney Metro Northwest (under construction)
- Named watercourse
- Waterbody

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE 1:8,000	SIZE A3
SHEET 01 of 01	COORDINATE SYSTEM GDA 1994 MGA Zone 56

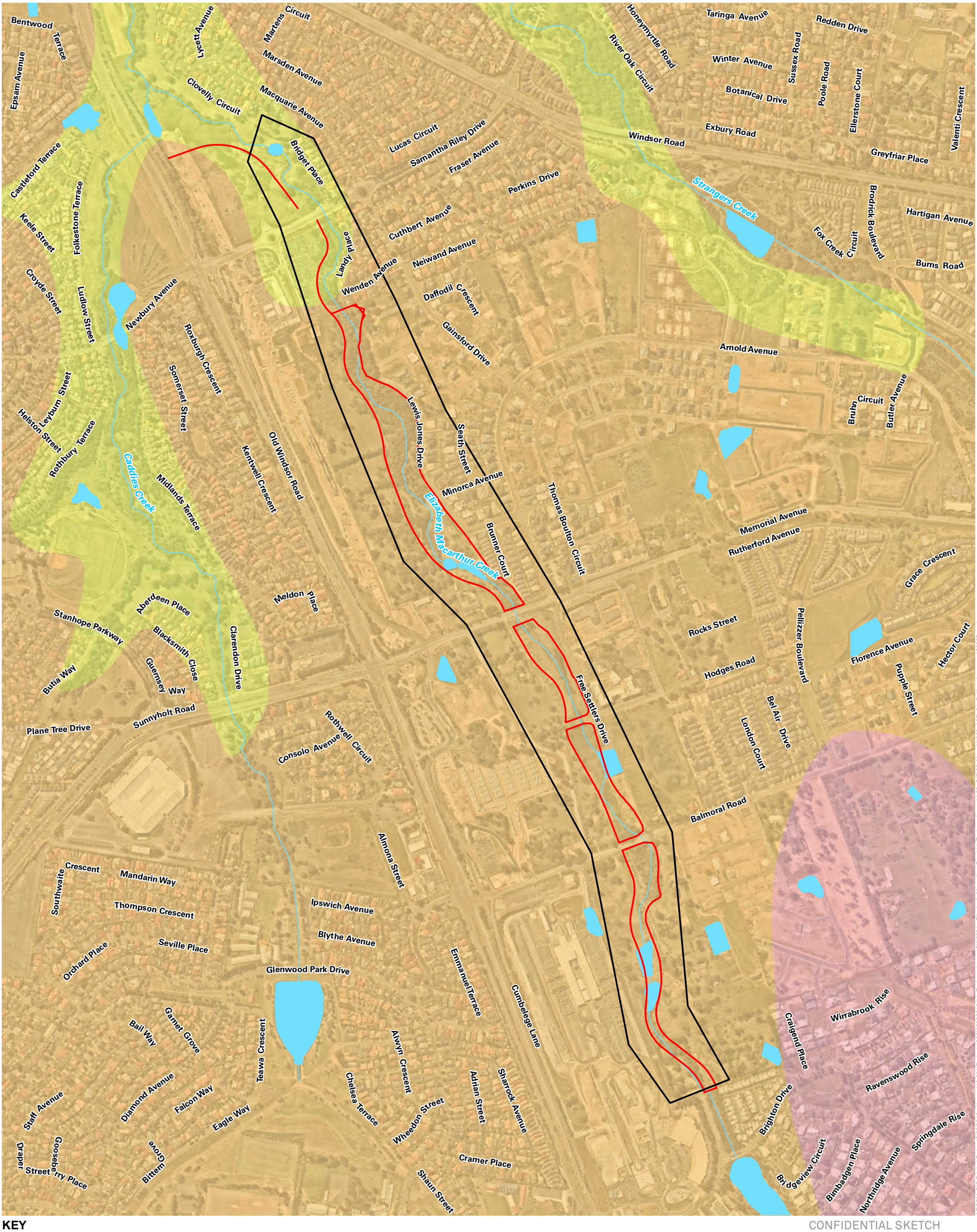
TITLE
Existing infrastructure

PROJECT
ELIZABETH MACARTHUR CREEK

CLIENT
SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SC	15/02/2016	W007 01		60286134
CHECK	DATE			

AECOM GIS Printed:Date: 15/02/2016 \\ausyd1fp001\Projects\60X\60286134\4. Tech work area\SW0234 - Elizabeth Macarthur Creek\4.99_GIS\02_Maps\W008_A3P_01_Infrastructure_150827.mxd



KEY

- Study area
- SWC Proposed Land Boundary Adjustments
- Blacktown
- Luddenham
- South Creek
- Named watercourse
- Waterbody

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

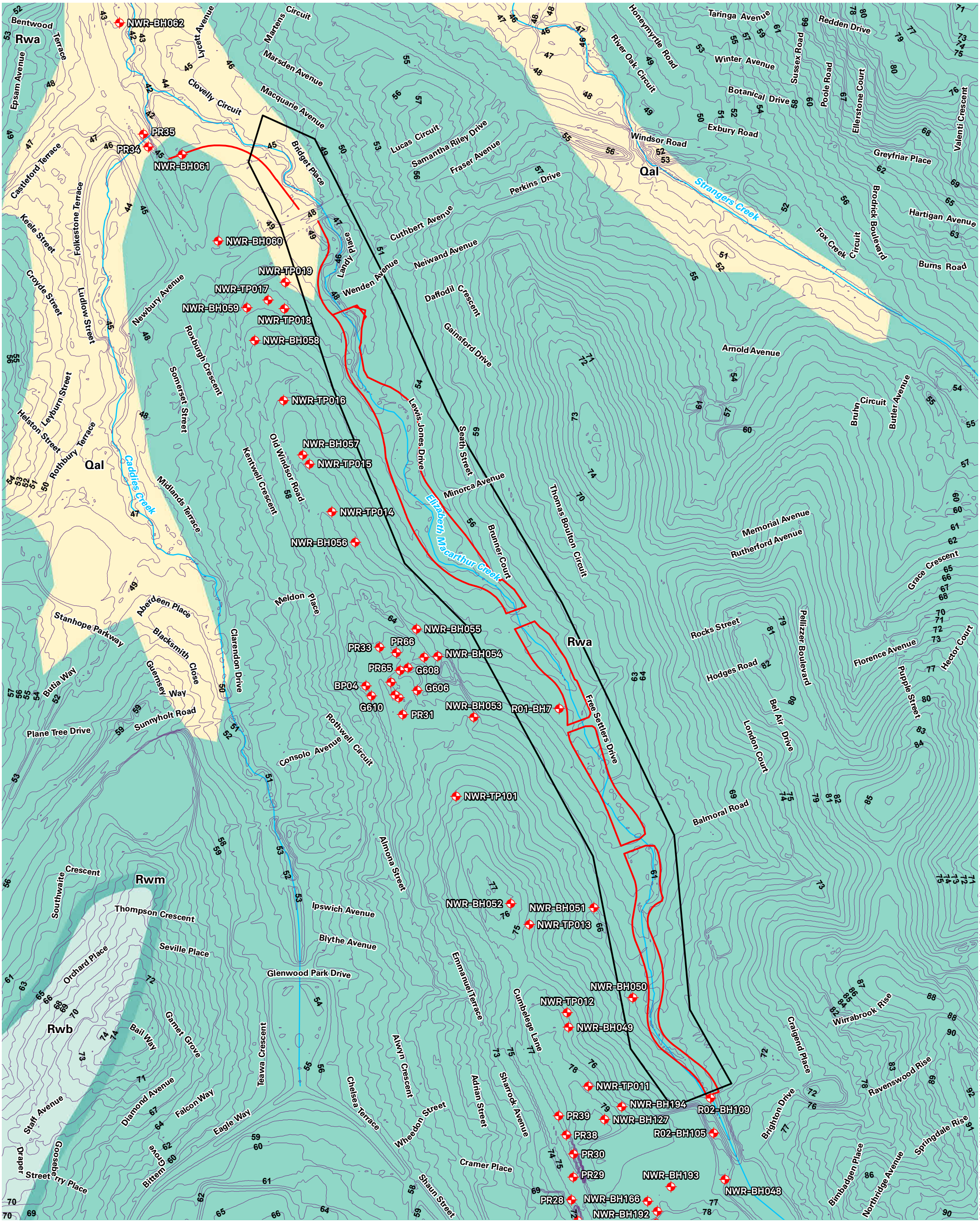
AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE	1:8,000
SIZE	A3
SHEET	01 of 01
COORDINATE SYSTEM	GDA 1994 MGA Zone 56
TITLE	Soil landscapes
PROJECT	ELIZABETH MACARTHUR CREEK
CLIENT	SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SC	15/02/2016	W009	01	60286134
CHECK	DATE			

AECOM GIS Printed:Date: 15/02/2016 \\ausyd1fp001\Projects\602X\60286134\4. Tech work area\SW0234 - Elizabeth Macarthur Creek\4. Tech work area\4.99_GIS\02_Maps\W009_A3P_01_SoilLandscapes_150827.mxd



KEY

- Study area
- SWC Proposed Land Boundary Adjustments
- Named watercourse
- Borehole (Source: NWRL investigations)
- 1m contour

Regional 1:100000 scale mapping

- Qal
- Rwa
- Rwb
- Rwm

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE 1:8,000	SIZE A3
SHEET 01 of 01	COORDINATE SYSTEM GDA 1994 MGA Zone 56

TITLE
Geology

PROJECT
ELIZABETH MACARTHUR CREEK

CLIENT
SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SC	15/02/2016	W010 02		60286134
CHECK	DATE			

AECOM GIS Printed Date: 15/02/2016 \\ausyd1fp001\Projects\60X\60286134\4. Tech work area\SW0234 - Elizabeth Macarthur Creek\4.99_GIS\02_Maps\W010_A3P_01_Geology_151102.mxd

KEY

- Study area
- SWC Proposed Land Boundary Adjustments

The Hills Shire Local Environmental Plan 2012

- B5 Business Development
- B7 Business Park
- R1 General Residential
- R2 Low Density Residential
- R3 Medium Density Residential
- R4 High Density Residential
- RE1 Public Recreation
- RE2 Private Recreation
- SP1 Special Activities
- SP2 Infrastructure
- W1 Natural Waterways

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE 1:8,000	SIZE A3
SHEET 01 of 01	COORDINATE SYSTEM GDA 1994 MGA Zone 56

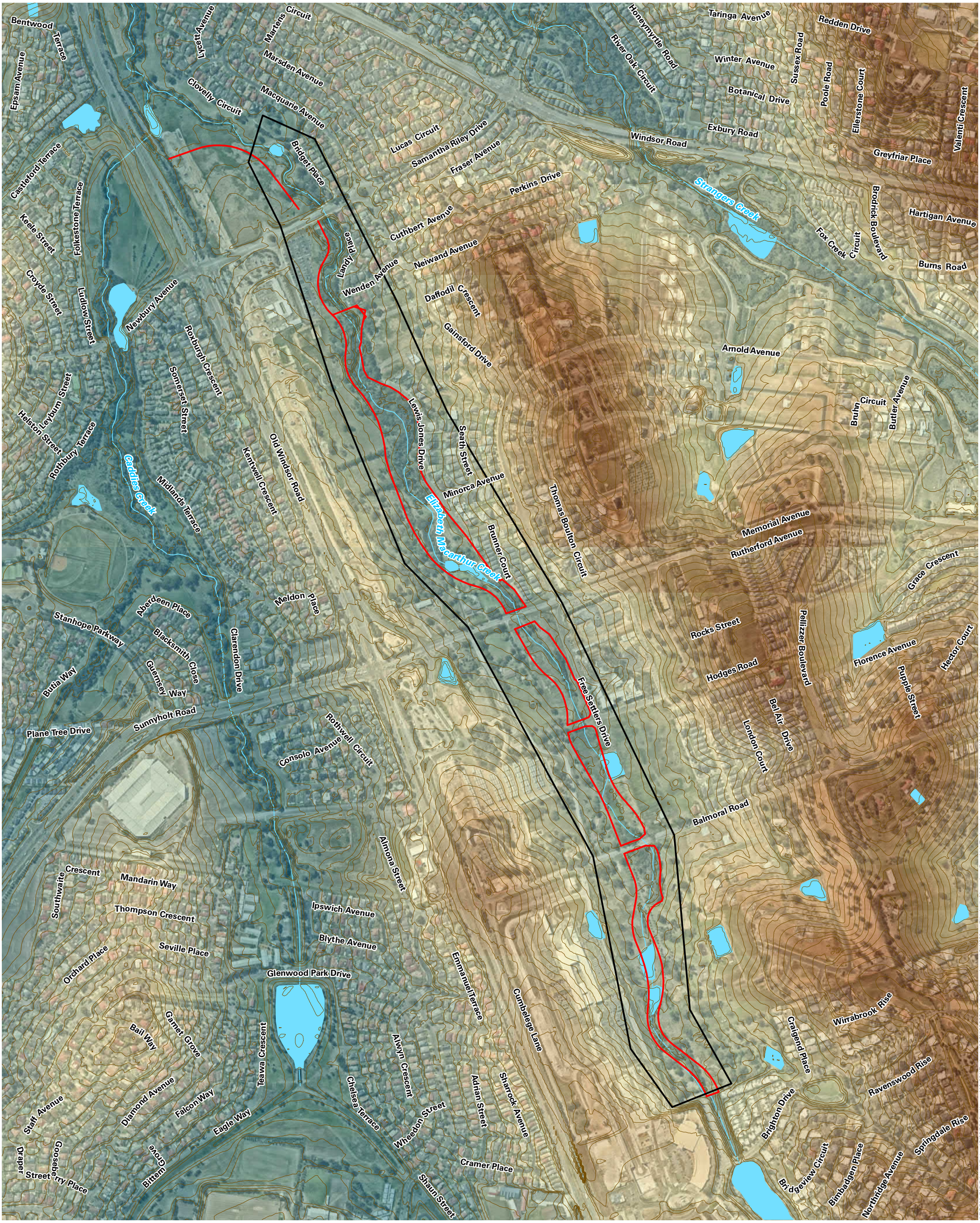
TITLE
Existing land zoning

PROJECT
ELIZABETH MACARTHUR CREEK

CLIENT
SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SC	18/12/2015	W011 01		60286134
CHECK	DATE			

AECOM GIS Printed:Date: 15/02/2016 \\ausyd1fp001\Projects\602X\60286134\4. Tech work area\4.99_GIS\02_Maps\W011_A3P_01_Planning_150827.mxd



KEY

- Study area
- SWC Proposed Land Boundary Adjustments
- 1m contour
- Named watercourse
- Waterbody

N

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

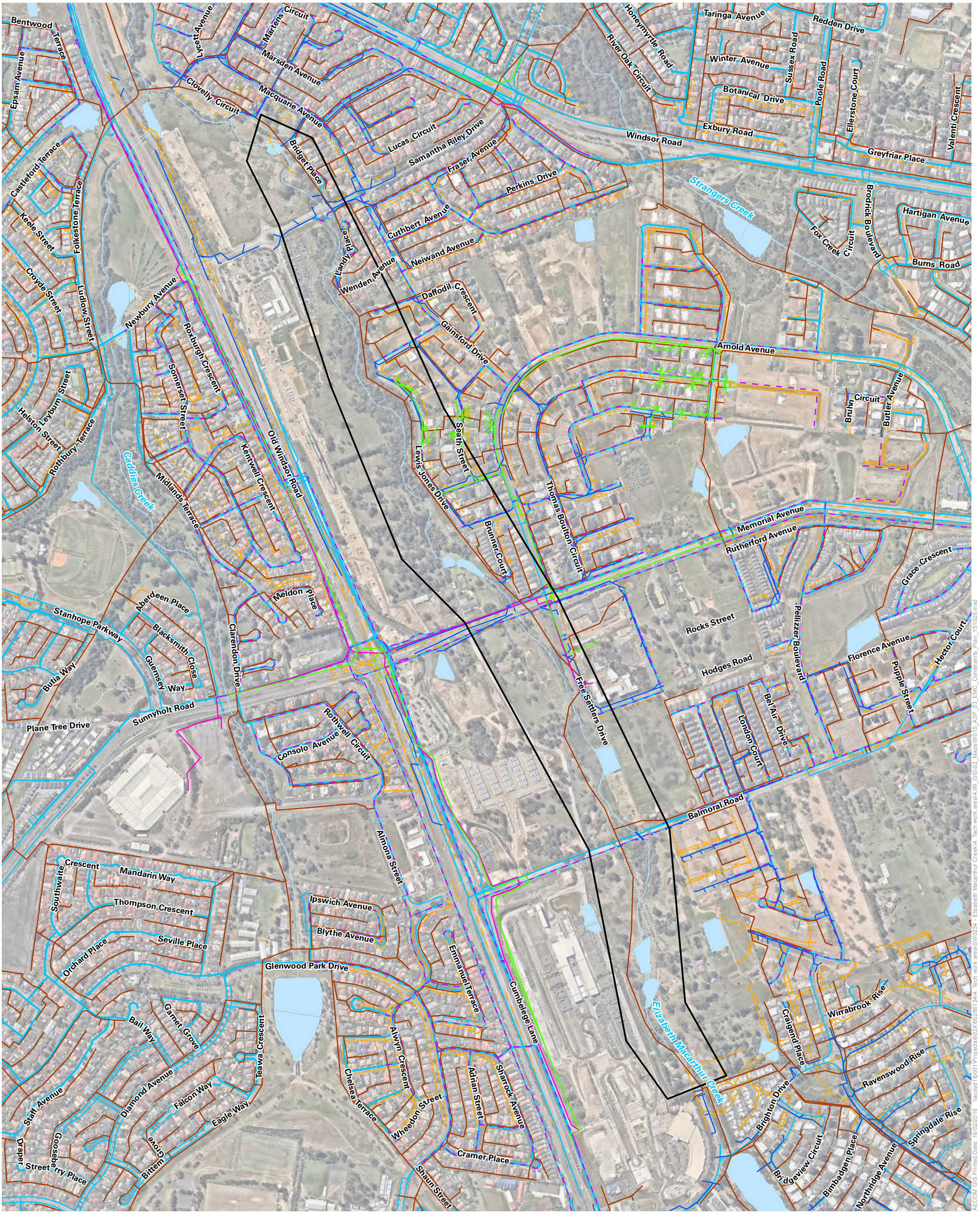
AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE	1:8,000
SIZE	A3
SHEET	01 of 01
COORDINATE SYSTEM	GDA 1994 MGA Zone 56
TITLE	Terrain
PROJECT	ELIZABETH MACARTHUR CREEK
CLIENT	SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SC	27/08/2015	W012 01		60286134
CHECK	DATE			

AECOM GIS Printed:Date: 15/02/2016 \\ausyd1fp001\Projects\602X\60286134\4. Tech work area\4.99_GIS\02_Maps\W012_A3P_01_Terrain_150827.mxd



KEY

- Study area
- Named watercourse
- Waterbody
- NBN
- Optus
- Jemena Gas
- Hills Shire Council Stormwater
- Sydney Water wastewater
- Uecomm
- Sydney Water watermain
- Recycled watermain

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

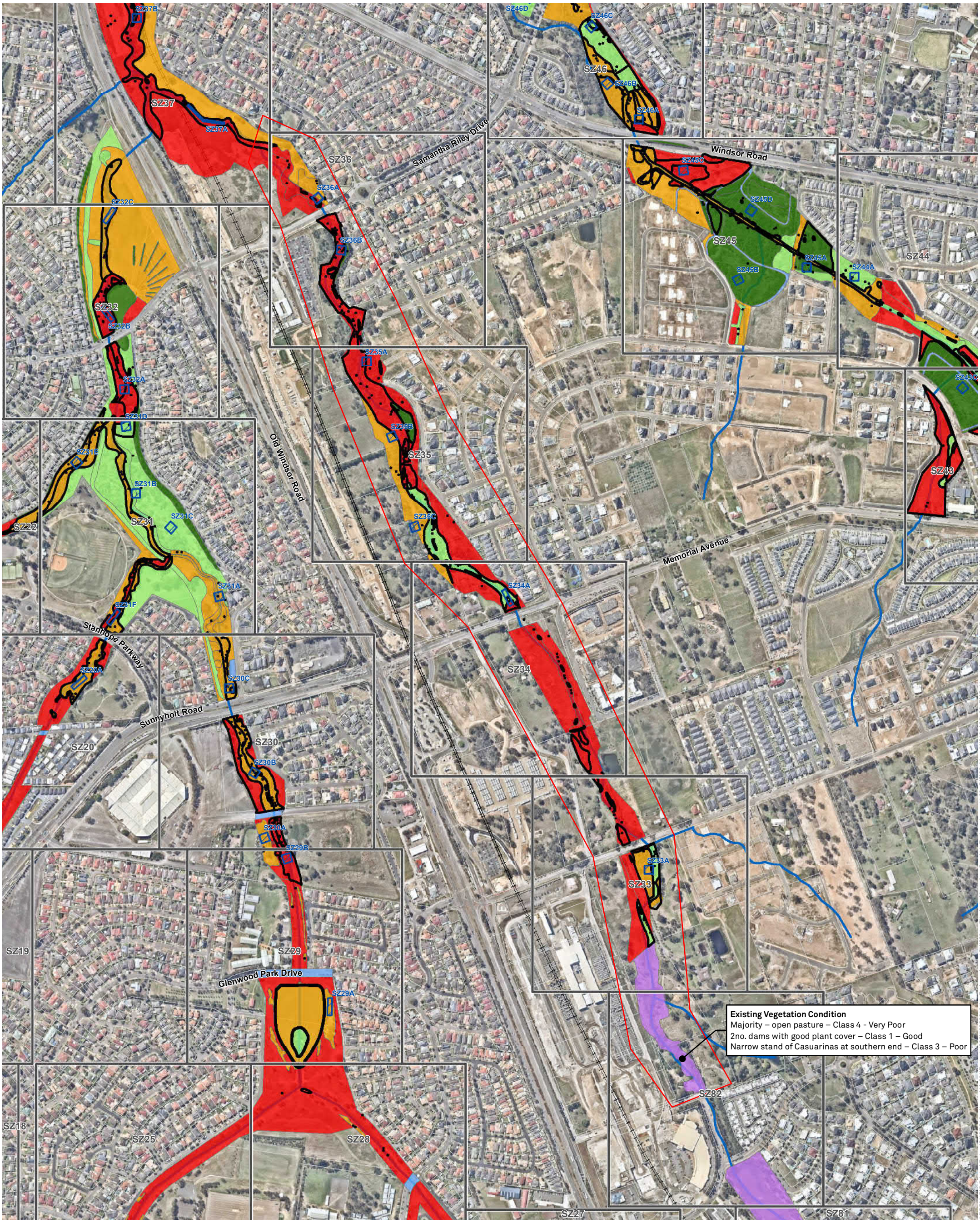
AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE	1:8,000
SIZE	A3
SHEET	01 of 01
COORDINATE SYSTEM	GDA 1994 MGA Zone 56
TITLE	Existing underground utilities
PROJECT	ELIZABETH MACARTHUR CREEK
CLIENT	SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SG	16/02/2016	W015	03	60286134
CHECK	DATE			

AECOM GIS Printed:Date: 16/02/2016 \\ausyd1fp001\Projects\602X\60286134\4. Tech work area\SW0234 - Elizabeth Macarthur Creek\4. Tech work area\4.99_GIS\02_Maps\W015_A3P_03_EMC_Constraints_Plan_151026.mxd



KEY

Vegetation Condition - Overall Class

- Currently unclassified
- Class 0 - No vegetation present/cleared
- Class 1 - Good
- Class 2 - Fair
- Class 3 - Poor
- Class 4 - Very Poor

- Railway
- Waterway
- Study zones
- Target weeds
- Biometric quadrat
- Cadastre lot boundary
- Study Zone (SZ) boundary

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE 1:8,000	SIZE A3
SHEET 01 of 01	COORDINATE SYSTEM GDA 1994 MGA Zone 56

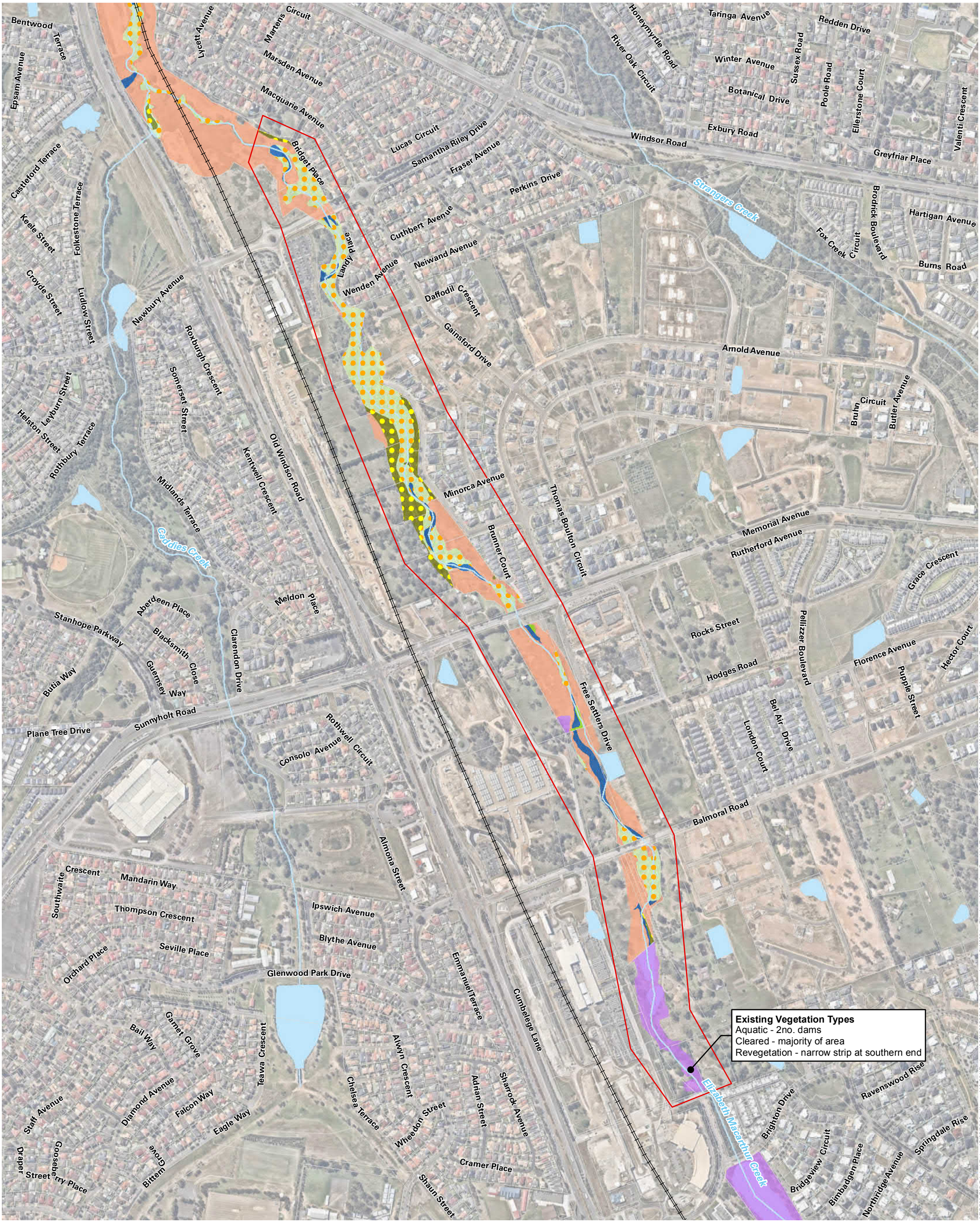
TITLE
Existing vegetation condition

PROJECT
ELIZABETH MACARTHUR CREEK

CLIENT
SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SG	2/12/2015	W018	03	60286134
CHECK NB	DATE 2/12/2015			

AECOM GIS Printed:Date: 15/02/2016 \\ausyd1fp001\Projects\60X\60286134\4. Tech work area\4.99_GIS\02_Maps\W018_A3P_03_EMC_Vegetation_Condition_Constraints_Plan_151201.mxd



KEY

- Project area boundary
- Named watercourse
- Waterbody
- Cumberland Plain Woodland
- River-flat Eucalypt Forest on Coastal Floodplains
- Aquatic
- Cleared
- Cumberland Plain Woodland
- River-flat Eucalypt Forest on Coastal Floodplains
- Revegetation
- Unclassified

Source: Travers Bushfire and Ecology 2013; Study Zones 33-36

N

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE	1:8,000
SIZE	A3
SHEET	01 of 01
COORDINATE SYSTEM	GDA 1994 MGA Zone 56

TITLE

Endangered ecological vegetation communities identified along the creek

PROJECT

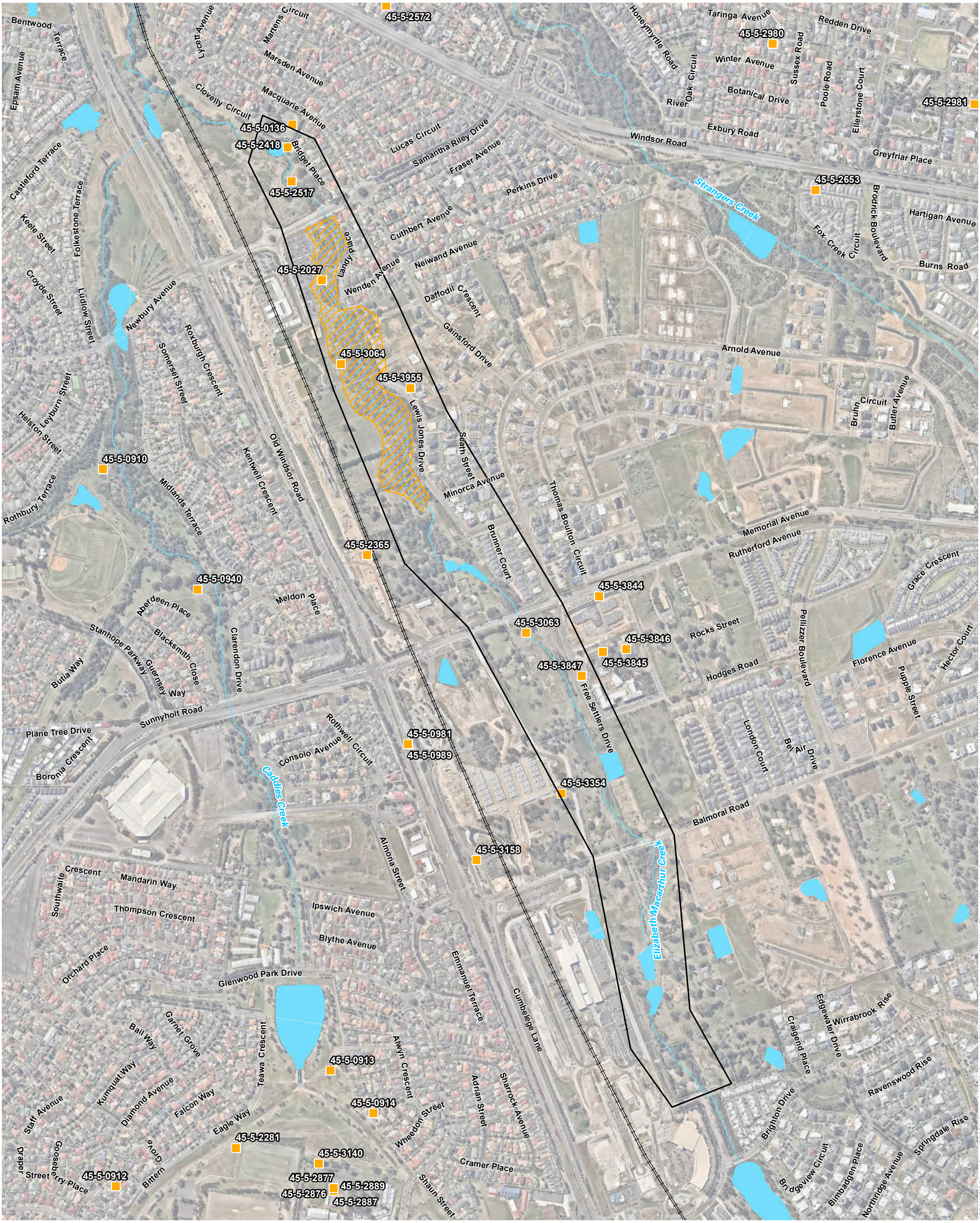
ELIZABETH MACARTHUR CREEK

CLIENT

SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SC	15/02/2016	W019 05		60286134
CHECK	DATE			

AECOM GIS Printed:Date: 15/02/2016 \\ausyd1fp001\Projects\602X\60286134\4. Tech work area\SW0234 - Elizabeth Macarthur Creek\4. Tech work area\4.99_GIS\02_Maps\W019_A3P_05_EMC_Vegetation_Types_Constraints_Plan_160120.mxd



KEY

- Study area
- AHIMS sites
- Railway
- Cadastre lot boundary
- Archaeological sensitivity area
- Named watercourse
- Waterbody

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE	1:8,000
SIZE	A3
SHEET	01 of 01
COORDINATE SYSTEM	GDA 1994 MGA Zone 56

TITLE
Sensitive heritage and AHIMS sites

PROJECT
ELIZABETH MACARTHUR CREEK

CLIENT
SYDNEY WATER

DRAWN	SG	DATE	15/02/2016	MAP #	W020
CHECK	NB	DATE	15/02/2016	REV	01
				Project	60286134

AECOM GIS Printed Date: 15/02/2016 \\ausyd1fp001\Projects\602X\60286134\4. Tech work area\SW0234 - Elizabeth Macarthur Creek\4.99_GIS\02_Maps\W020_A3P_01_EMC_Heritage_Constraints_Plan_151121.mxd

Samantha Riley Drive
Windsor Road
Old Windsor Road
Memorial Avenue
Stanhope Parkway
Sunnyholt Road
Glenwood Park Drive

KEY

- Railway
- Study area
- Cadastre lot boundary
- Bellyville Concept Plan (Preliminary Only)
- Bellyville Concept Plan Open Space
- Memorial Avenue upgrade

N

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE 1:8,000	SIZE A3
SHEET 01 of 01	COORDINATE SYSTEM GDA 1994 MGA Zone 56

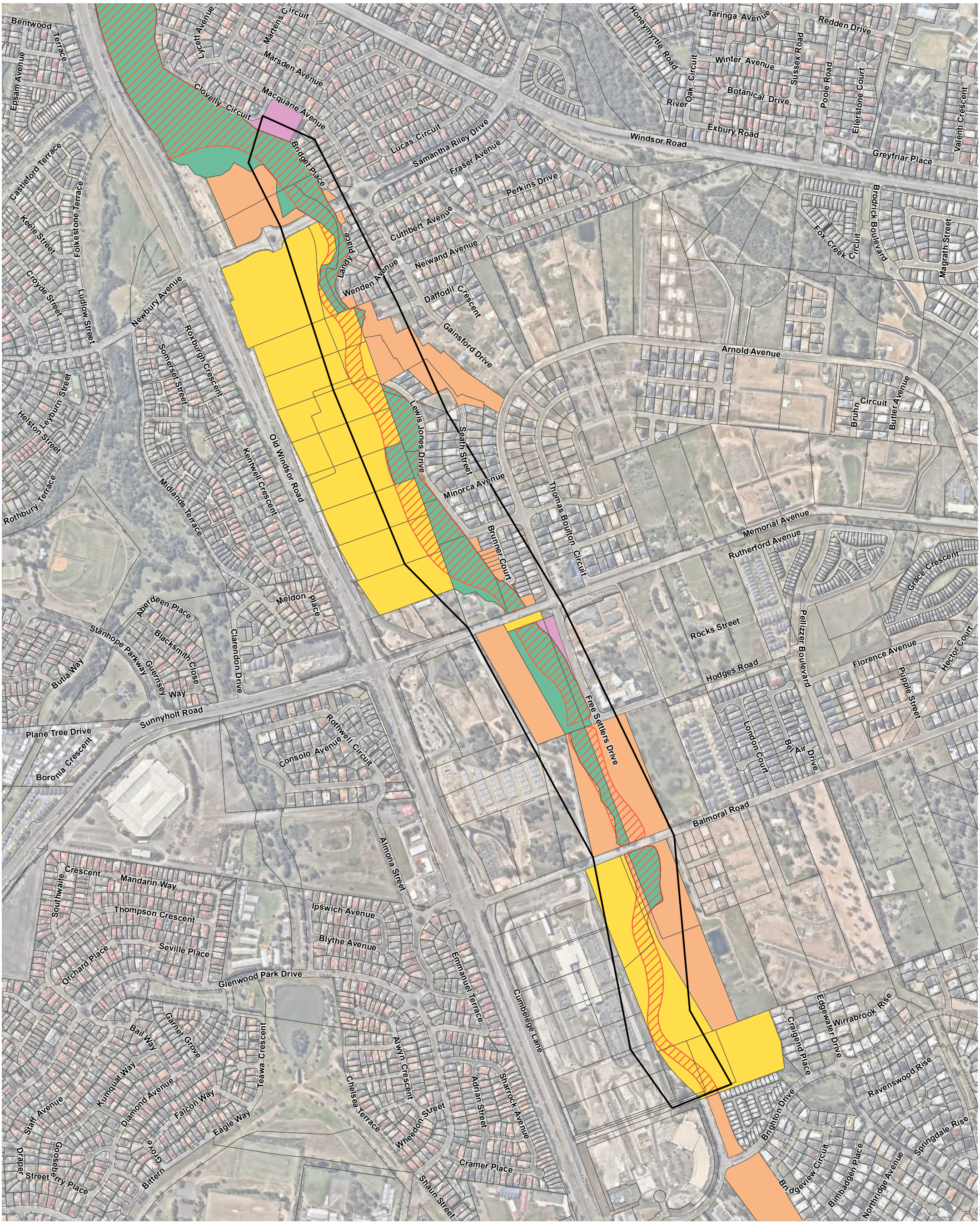
TITLE
Future development

PROJECT
ELIZABETH MACARTHUR CREEK

CLIENT
SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SG	15/02/2016	W02	02	60286134
CHECK NB	DATE 15/02/2016			

AECOM GIS Printed:Date: 15/02/2016 \\ausyd1fp001\Projects\602X\60286134\4. Tech work area\4.99_GIS\02_Maps\W026_A3P_02_EMC_Bellyville_Zoning_Veg_160215.mxd



KEY

- Study area
- Proposed Sydney Water Trunk Drainage Lands
- Sydney Water land
- Private land
- Local government land
- State government land
- Named watercourse
- Waterbody

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE 1:8,000	SIZE A3
SHEET 01 of 01	COORDINATE SYSTEM GDA 1994 MGA Zone 56

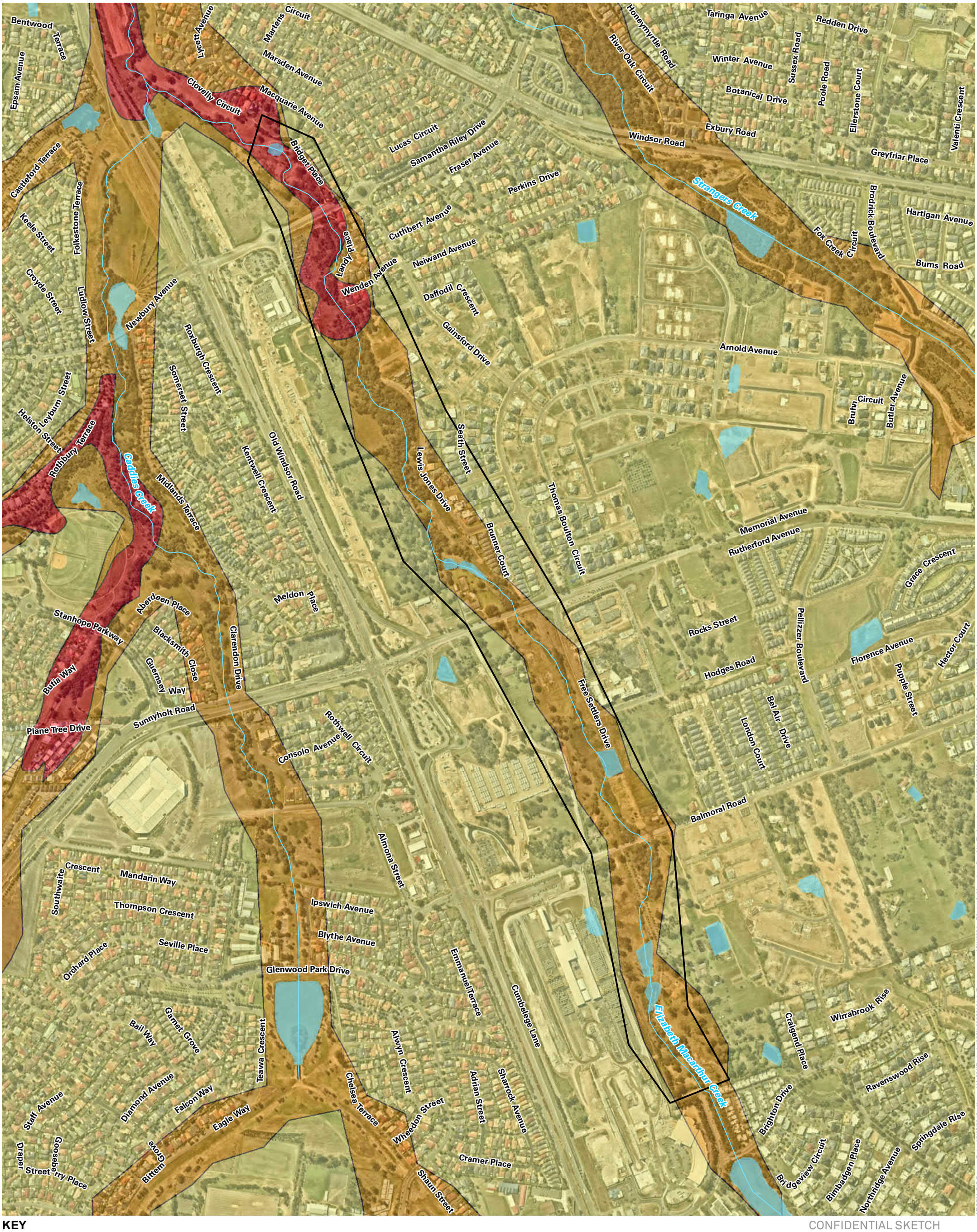
TITLE: Land ownership

PROJECT: ELIZABETH MACARTHUR CREEK

CLIENT: SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SC	14/03/2016	W028 01		60286134
CHECK	DATE			

AECOM GIS Printed:Date: 14/03/2016 P:\602X\60286134\4. Tech work area\SW0234 - Elizabeth Macarthur Creek\4. Tech work area\4.99_GIS\02_Maps\W028_A3P_01_LandOwnership_160314.mxd



KEY

- Study area
- Named watercourse
- Waterbody
- High
- Moderate
- Known salinity

Source: Office of Environment and Heritage (OEH)

0 50 100 200 m

Disclaimer Spatial data used under licence from Land and Property Management Authority, NSW © 2015.

AECOM makes no representations or warranties of any kind, about the accuracy, reliability, completeness, suitability or fitness for purpose in relation to the map content.

CONFIDENTIAL SKETCH

SCALE 1:8,000	SIZE A3
SHEET 01 of 01	COORDINATE SYSTEM GDA 1994 MGA Zone 56

TITLE
Salinity potential

PROJECT
ELIZABETH MACARTHUR CREEK

CLIENT
SYDNEY WATER

DRAWN	DATE	MAP #	REV	Project
SC	29/01/2016	W033 01		60286134
CHECK	DATE			

AECOM GIS Printed:Date: 15/02/2016 \\ausyd1fp001\Projects\602X\60286134\4. Tech work area\SW0234 - Elizabeth Macarthur Creek\4. Tech work area\4.99_GIS\02_Maps\W033_A3P_01_Salinity_160129.mxd

Appendix B

Site Photographs

DELETED BY WOOD & GRIEVE ENGINEERS DUE TO SIZE

NOT PERTINENT TO SSDA

Appendix C

Desktop Geotechnical Assessment

DELETED BY WOOD & GRIEVE ENGINEERS DUE TO SIZE

NOT PERTINENT TO SSDA

Appendix D

Phase 1 and Targeted Phase 2 Contamination Investigation

DELETED BY WOOD & GRIEVE ENGINEERS DUE TO SIZE

NOT PERTINENT TO SSDA

Appendix E

Preliminary Planning Advice

AAJV
ABN 14 821 636 099
2 Palmer Street
North Parramatta NSW 2151
Australia

T +61 2 8896 4100
F +61 2 9890 3558

Memorandum

To	**Nick Bartho**	From	**Jessica Kite**
Copy		Reference	**SW0234**
Date	**3 February 2016**	Pages (including this page)	**6**
Subject	**Preliminary Planning Advice – Elizabeth Macarthur Creek Corridor, Kellyville/ Bella Vista**		

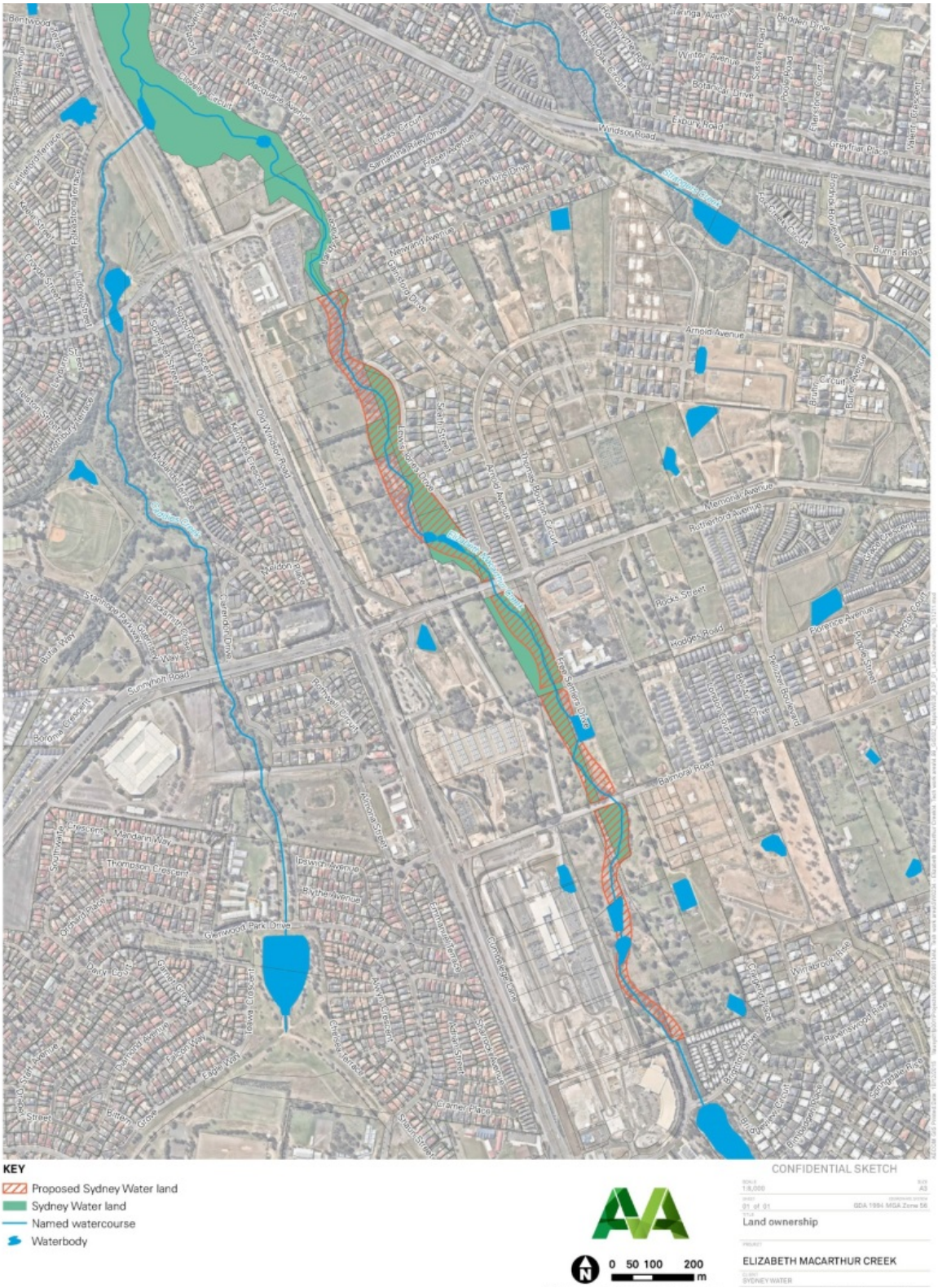
1 Introduction

The following provides preliminary planning advice relating to the future development of part of the Elizabeth Macarthur Creek (EMC) riparian corridor located in parts of Kellyville and Bella Vista, and which is located within the Local Government Area (LGA) of The Hills Shire.

1.1 Elizabeth Macarthur Creek Corridor

As shown in Figure 1, Sydney Water currently owns much of the land within this portion of the EMC corridor (shown in green), with other landowners including UrbanGrowth NSW, Department of Planning and Environment (DP&E) and private entities as other respective owners of smaller portions of the corridor.

Figure 1 Land ownership along Elizabeth Macarthur Creek Corridor as currently required by Sydney Water for the purposes of implementing the Trunk Drainage Strategy



2 Planning Overview

Currently under The Hills Local Environment Plan 2012 (LEP 2012) a corridor of land for drainage purposes is zoned SP2 (Stormwater Management System) along the EMC corridor (see Figure 2). Portions of this land are also nominated under clause 5.1 of the LEP 2012 to be acquired by Sydney Water (see Figure 3).

In accordance with the SP2 zoning only roads are permitted development without consent. Additionally the only development permitted with consent is that for the purposes shown in the map (being Stormwater Management System) or that is 'ordinarily incidental or ancillary' to that development. It should be noted that 'Stormwater Management Systems' are not specifically defined under LEP 2012.

Pursuant to clause 111 of State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) stormwater management development for the purpose of stormwater management systems is 'development permitted without consent' on any land regardless of its underlining land use zoning. This includes provision permits for construction works, routine maintenance works and environmental management works in association within stormwater management systems.

Clause 110 of the ISEPP defines stormwater management systems as:

"(a) works for the collection, detention, distribution or discharge of stormwater (such as channels, aqueducts, pipes, drainage works, embankments, detention basins and pumping stations), and

(b) stormwater quality control devices (such as waste entrapment facilities, artificial wetlands, sediment ponds and riparian management), and

(c) stormwater reuse schemes."

Following environmental impact assessment, if the proposed works are unlikely to pose significant environmental impacts; the activity can be assessed and determined by Sydney Water under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act) in accordance with clause 11 of the ISEPP.

Alternatively, if the works are likely to cause significant environmental impacts, Part 5.1 State Significant Infrastructure provisions are triggered and preparation of an Environmental Impact Statement (EIS) and approval from the Minister (or their delegate) is required. It is noted that a rezoning will not be required to enable the proposed activity, whether it is undertaken under Part 5 or Part 5.1.

The EMC corridor is also situated adjacent to the proposed Sydney Metro Northwest Station Precincts of Kellyville and Bella Vista. DP&E has recently placed the draft Precinct Plans for these station precinct areas on public exhibition. Principally these draft plans propose to amend the current zonings to increase development densities and permit for additional land uses in and around the future rail stations of Kellyville and Bella Vista. The proposals also alter the extent to which the SP2 zoned land is configured along the EMC corridor (see Figure 4). On comparison with the current zoning under LEP 2012 and that proposed by the draft precinct planning for the stations, it would appear the zoning along the corridor has been widened in places and edges of the boundaries of the SP2 zone have been sought to be smoothed out. It is understood that this altered SP2 zone boundary along the EMC corridor generally reflects the proposed boundaries for the corridor as previously provided to DP&E by Sydney Water.

The draft plans for the Bella Vista and Kellyville Station Precincts will be on public exhibition until 28 February 2016.

Figure 2 Current zoning

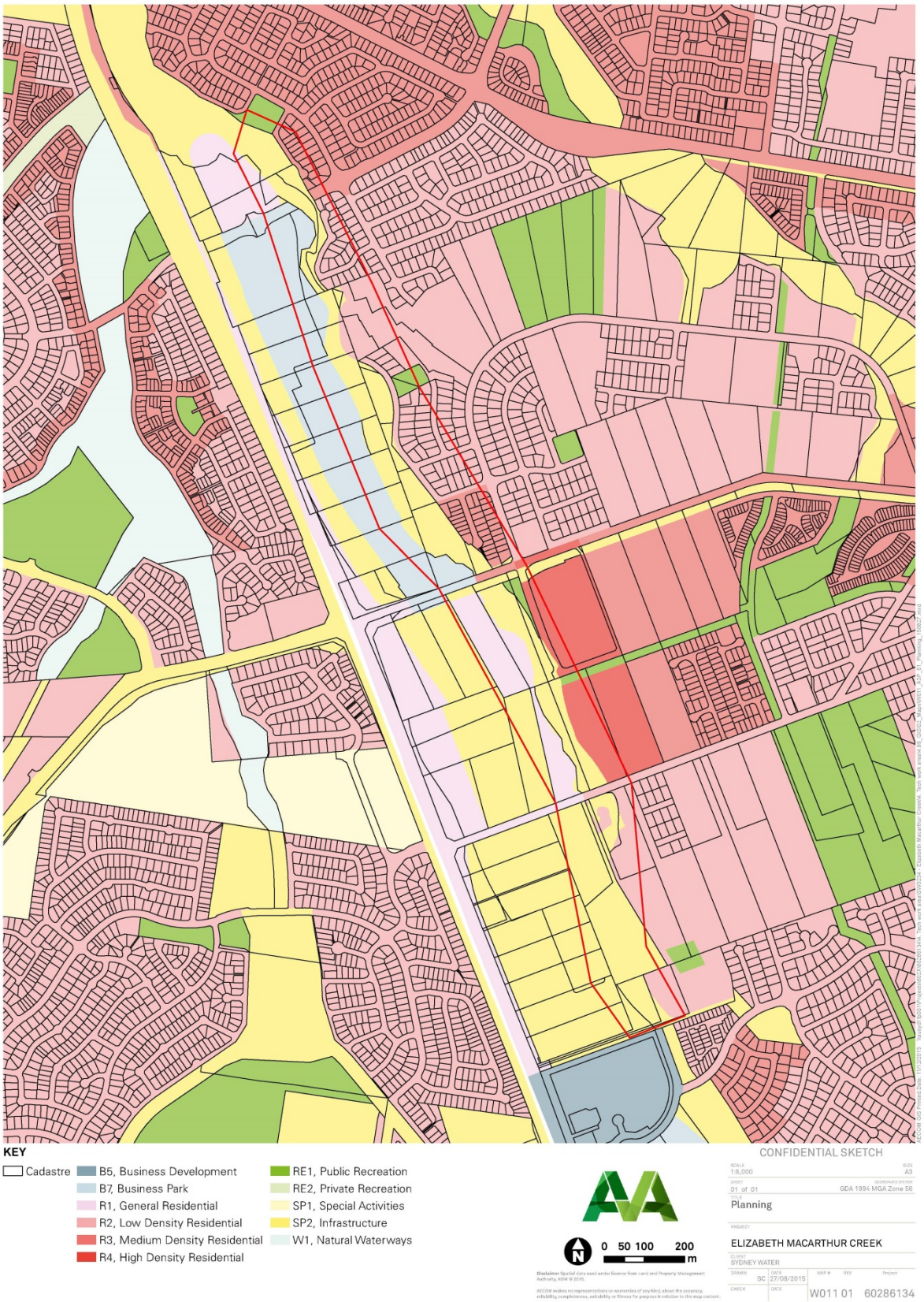


Figure 3 Land Reservation Acquisition map (Hills Shire LEP 2012)

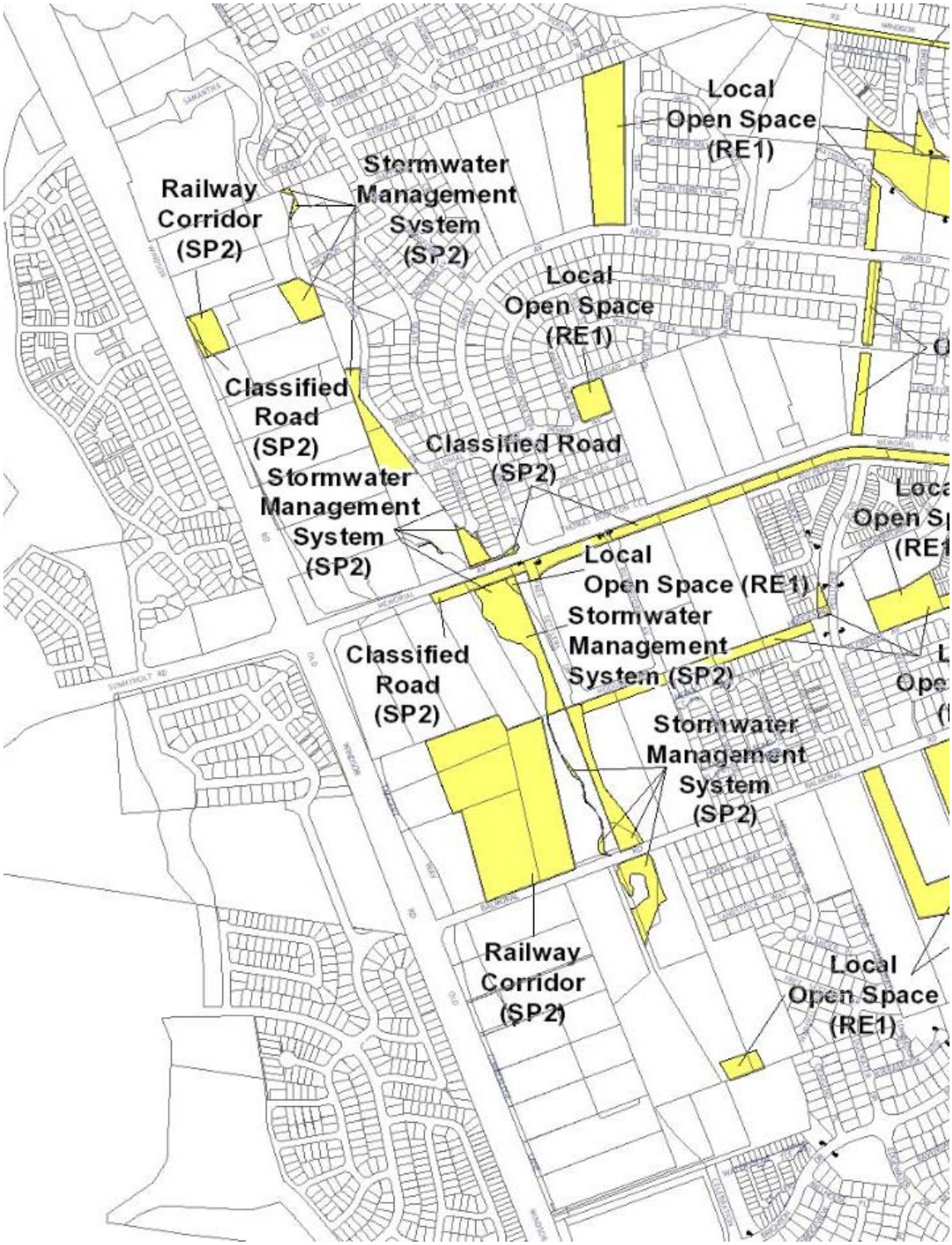
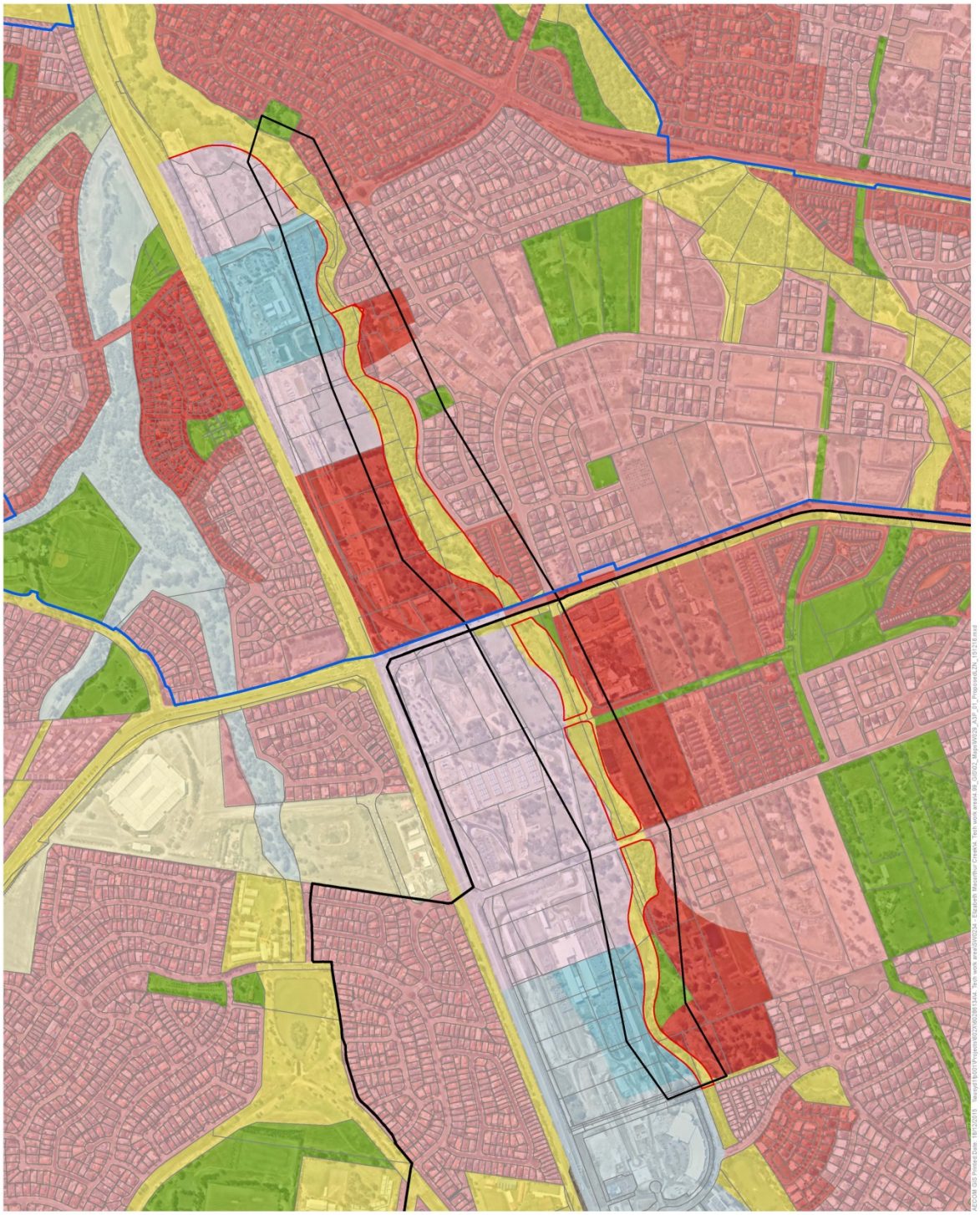


Figure 4 Proposed Zoning – Kellyville Station and Bella Vista Station Precincts



3 Current and Proposed Trunk Drainage Strategy

Sydney Water in collaboration with the AECOM Aurecon Joint Venture (AAJV) is currently reviewing the overall design for the trunk drainage strategy for the subject portion of the EMC corridor. The consequence of this work may or may not mean that the land required to implement the strategy aligns with the zoning boundaries now proposed by DP&E for the station precincts. Upon completion of the initial concept planning stage of this work it is expected that the Provisional Land Take Boundary previously identified by Sydney Water as required to implement the strategy (refer Figure 4) will be able to be confirmed or otherwise adjusted. This initial work is anticipated to be completed by end of February 2016.

4 Preliminary Planning Advice

Based on the above and given the timing for the trunk drainage strategy and the exhibition of the Station Precinct Planning Proposals, it is considered that there is an opportunity to negotiate post exhibition refinements with DP&E to alter the extent of SP2 zoned EMC corridor land to align with the trunk drainage strategy that is currently being developed.

In the scenario where DP&E does not wish to alter the extent of the SP2 zone boundaries to suit the revised drainage strategy, Sydney Water still has the ability to rely upon clause 111 of the ISEPP to obtain development approval for carry out trunk drainage works in the corridor, irrespective of the land's zoning.

Because of this provision of the ISEPP there is strictly no planning reason to rezone land required for the purposes of the drainage strategy if not already zoned SP2 (Stormwater Management Systems) under LEP 2012. However, a planning proposal to adjust the boundaries of the SP2 zone could be prepared and submitted before, during or after development approval is obtained for the trunk drainage works in the EMC corridor to ensure that the zoning boundaries align with the land needed to implement the strategy.

Given that this advice is based on a preliminary review of the planning provision and the exhibited documents for the relevant station precincts it is recommended that the exhibition documentation that accompanies the draft planning proposals be reviewed in more detail and further advice provided by AAJV to Sydney Water as the consequences of the proposals for future works, especially as the development of the precincts is expected to be intensified which may have consequences for the trunk drainage strategy.

Additionally we recommend Sydney Water seeks to continue consultation with DP&E to make them aware of the forthcoming strategy, potential boundary changes and the timing for this. This engagement will help Sydney Water to gauge DP&E's likely willingness to alter the SP2 zoning to accommodate the revised drainage strategy post exhibition (if required). A written submission should also be prepared and issued to DP&E to formerly register any issues and/or recommendations to the DP&E for amendments to the zoning and relevant provisions under LEP 2012 (if relevant and required also).

Appendix F

Review of Bushfire Protection and Hazard Reduction Zone Creation Assessment

DELETED BY WOOD & GRIEVE ENGINEERS DUE TO SIZE

NOT PERTINENT TO SSDA

Appendix G

Safe Design Risk Register

DELETED BY WOOD & GRIEVE ENGINEERS DUE TO SIZE

NOT PERTINENT TO SSDA

Appendix H

Superseded Concept Designs for Future Bridge Crossings

DELETED BY WOOD & GRIEVE ENGINEERS DUE TO SIZE

NOT PERTINENT TO SSDA

Appendix I

Flood Mapping (High Resolution)

Sydney WATER

Cloverly Cir
Bridget Pl
Samantha Riley Dr
Landy Pl
Wenden Ave
Hickson Rd
Lewis Jones Dr
Minorca Ave
Colonial St
Brunner Ct
Memorial Ave
Free Settlers Dr
Hodges Rd
Balmoral Rd
Brighton Dr

Map by: YM
P:\CIV\233727_0234_EMC\MapInfo\Drawings\Detailed Concept\Fig2-3_Base_Depth_100y_RevA.wor

Legend

Peak Flood Depth (m)
- 0.00 to 0.03
- 0.03 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- 0.50 to 0.90
- 0.90 to 1.00
- 1.00 to 1.50
- >1.50

Mapping Limit

Sydney Water Trunk Drainage Boundary

64 Flood Height Contour & Elevation (1m interval)

Flood Height Contour (0.2m interval)

Notes:

A3 scale 1:8,000

0 200 m 400 m

Date: 30/11/2016 Rev: A Job No: 233727-0234

Projection: MGA Zone 56

ELIZABETH MACARTHUR CREEK
Rouse Hill Development Area
Trunk Drainage Concept Design
Baseline Flooding Conditions - 100 year ARI

Sydney WATER

Cloverly Cir
Bridget Pl
Samantha Riley Dr
Landy Pl
Wenden Ave
Hickson Rd
Lewis Jones Dr
Minorca Ave
Colonial St
Brunner Ct
Memorial Ave
Free Settlers Dr
Hodges Rd
Balmoral Rd
Brighton Dr

P:\CIV\233727_0234_EMC\MapInfo\Drawings\Detailed Concept\Fig5-3_Design_Depth_100y_RevA.wor

Map by: YM

Legend

Peak Flood Depth (m)
- 0.00 to 0.03
- 0.03 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- 0.50 to 0.90
- 0.90 to 1.00
- 1.00 to 1.50
- >1.50

Mapping Limit

Sydney Water Trunk Drainage Boundary

Bella Vista and Kellyville Precinct layouts

Balmoral Road Release Area DCP Road Layout

64 Flood Height Contour & Elevation (1m interval)

Flood Height Contour (0.2m interval)

Notes:

A3 scale 1:8,000

0 200 m 400 m

Date: 30/11/2016 Rev: A Job No: 233727-0234

Projection: MGA Zone 56

ELIZABETH MACARTHUR CREEK
Rouse Hill Development Area
Trunk Drainage Concept Design
Design Flooding Conditions - 100 year ARI

AAJV
2 Palmer Street
North Parramatta NSW 2151
Australia

T +61 2 8896 4100
F +61 2 9890 3558

Appendix D - Elizabeth Macarthur Creek – Trunk Drainage Concept Drawings

CONCEPT DESIGN ONLY

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN

TITLE SHEET 1 OF 2

DRAWING INDEX

DRAWING No.	TITLE
0234-EMC-001	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TITLE SHEET - SHEET 1 OF 2
0234-EMC-002	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TITLE SHEET - SHEET 2 OF 2
0234-EMC-003	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - NOTES & LEGEND
0234-EMC-005	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - KEY PLANS
0234-EMC-011	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 1 OF 15
0234-EMC-012	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 2 OF 15
0234-EMC-013	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 3 OF 15
0234-EMC-014	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 4 OF 15
0234-EMC-015	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 5 OF 15
0234-EMC-016	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 6 OF 15
0234-EMC-017	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 7 OF 15
0234-EMC-018	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 8 OF 15
0234-EMC-019	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 9 OF 15
0234-EMC-020	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 10 OF 15
0234-EMC-021	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 11 OF 15
0234-EMC-022	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 12 OF 15
0234-EMC-023	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 13 OF 15
0234-EMC-024	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 14 OF 15
0234-EMC-025	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN -GENERAL ARRANGEMENT - SHEET 15 OF 15
0234-EMC-030	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TYPICAL DETAILS - SHEET 1 OF 10
0234-EMC-031	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TYPICAL DETAILS - SHEET 2 OF 10
0234-EMC-032	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TYPICAL DETAILS - SHEET 3 OF 10
0234-EMC-033	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TYPICAL DETAILS - SHEET 4 OF 10
0234-EMC-034	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TYPICAL DETAILS - SHEET 5 OF 10
0234-EMC-035	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TYPICAL DETAILS - SHEET 6 OF 10

DRAWING INDEX

DRAWING No.	TITLE
0234-EMC-036	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TYPICAL DETAILS - SHEET 7 OF 10
0234-EMC-037	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TYPICAL DETAILS - SHEET 8 OF 10
0234-EMC-038	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TYPICAL DETAILS - SHEET 9 OF 10
0234-EMC-039	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - TYPICAL DETAILS - SHEET 10 OF 10
0234-EMC-050	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - STORMWATER HARVESTING PIPES PLAN & LONGITUDINAL SECTIONS EAST - SHEET 1 OF 4
0234-EMC-051	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - STORMWATER HARVESTING PIPES PLAN & LONGITUDINAL SECTIONS EAST - SHEET 2 OF 4
0234-EMC-052	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - STORMWATER HARVESTING PIPES PLAN & LONGITUDINAL SECTIONS EAST - SHEET 3 OF 4
0234-EMC-053	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - STORMWATER HARVESTING PIPES PLAN & LONGITUDINAL SECTIONS EAST - SHEET 4 OF 4
0234-EMC-054	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - STORMWATER HARVESTING PIPES PLAN & LONGITUDINAL SECTIONS WEST - SHEET 1 OF 4
0234-EMC-055	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - STORMWATER HARVESTING PIPES PLAN & LONGITUDINAL SECTIONS WEST - SHEET 2 OF 4
0234-EMC-056	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - STORMWATER HARVESTING PIPES PLAN & LONGITUDINAL SECTIONS WEST - SHEET 3 OF 4
0234-EMC-057	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - STORMWATER HARVESTING PIPES PLAN & LONGITUDINAL SECTIONS WEST - SHEET 4 OF 4
0234-EMC-060	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - DESIGN FLOOD PROFILE - EAST BOUNDARY - SHEET 1 OF 4
0234-EMC-061	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - DESIGN FLOOD PROFILE - EAST BOUNDARY - SHEET 2 OF 4
0234-EMC-062	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - DESIGN FLOOD PROFILE - EAST BOUNDARY - SHEET 3 OF 4
0234-EMC-063	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - DESIGN FLOOD PROFILE - EAST BOUNDARY - SHEET 4 OF 4
0234-EMC-064	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - DESIGN FLOOD PROFILE - WEST BOUNDARY - SHEET 1 OF 4
0234-EMC-065	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - DESIGN FLOOD PROFILE - WEST BOUNDARY- SHEET 2 OF 4
0234-EMC-066	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - DESIGN FLOOD PROFILE - WEST BOUNDARY - SHEET 3 OF 4
0234-EMC-067	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - DESIGN FLOOD PROFILE - WEST BOUNDARY - SHEET 4 OF 4
0234-EMC-070	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK LONGITUDINAL SECTIONS - SHEET 1 OF 3
0234-EMC-071	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK LONGITUDINAL SECTIONS - SHEET 2 OF 3

CONTINUED ON DRG 0234-EMC-002

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED G.KIRBY AAJV 15.04.16
DRAWN C.RUSINGAH AAJV 15.04.16
VERIFIED B. WITHNALL AAJV 24.01.17
APPROVED N.BARTHO AAJV 24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TITLE SHEET

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 001
ISSUE A | SHEET No. 1 OF 2

SWAT-EXT AUG 2014

CONCEPT DESIGN ONLY

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN

TITLE SHEET 2 OF 2

DRAWING INDEX

DRAWING No.	TITLE
0234-EMC-072	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK LONGITUDINAL SECTIONS - SHEET 3 OF 3
0234-EMC-085	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK CROSS SECTIONS - SHEET 1 OF 10
0234-EMC-086	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK CROSS SECTIONS - SHEET 2 OF 10
0234-EMC-087	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK CROSS SECTIONS - SHEET 3 OF 10
0234-EMC-088	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK CROSS SECTIONS - SHEET 4 OF 10
0234-EMC-089	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK CROSS SECTIONS - SHEET 5 OF 10
0234-EMC-090	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK CROSS SECTIONS - SHEET 6 OF 10
0234-EMC-091	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK CROSS SECTIONS - SHEET 7 OF 10
0234-EMC-092	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK CROSS SECTIONS - SHEET 8 OF 10
0234-EMC-093	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK CROSS SECTIONS - SHEET 9 OF 10
0234-EMC-094	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - CREEK CROSS SECTIONS - SHEET 10 OF 10
0234-EMC-110	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - FUTURE BRIDGE CROSSINGS - FUTURE ROAD A - SHEET 1 OF 8
0234-EMC-111	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - FUTURE BRIDGE CROSSINGS - FUTURE ROAD B - SHEET 2 OF 8
0234-EMC-112	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - FUTURE BRIDGE CROSSINGS - BALMORAL ROAD - SHEET 3 OF 8
0234-EMC-113	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - FUTURE BRIDGE CROSSINGS - BALMORAL ROAD - SHEET 4 OF 8
0234-EMC-114	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - FUTURE BRIDGE CROSSINGS - HODGES ROAD - SHEET 5 OF 8
0234-EMC-115	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - FUTURE BRIDGE CROSSINGS - COLONIAL STREET - SHEET 6 OF 8
0234-EMC-116	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - FUTURE BRIDGE CROSSINGS - FUTURE ROAD E - SHEET 7 OF 8
0234-EMC-117	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - FUTURE BRIDGE CROSSINGS - WENDEN AV PATH - SHEET 8 OF 8

DRAWING INDEX

DRAWING No.	TITLE
0234-EMC-121	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - LANDFILL EXTENTS GENERAL ARRANGEMENT - SHEET 1 OF 7
0234-EMC-122	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - LANDFILL EXTENTS GENERAL ARRANGEMENT - SHEET 2 OF 7
0234-EMC-123	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - LANDFILL EXTENTS GENERAL ARRANGEMENT - SHEET 3 OF 7
0234-EMC-124	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - LANDFILL EXTENTS GENERAL ARRANGEMENT - SHEET 4 OF 7
0234-EMC-125	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - LANDFILL EXTENTS GENERAL ARRANGEMENT - SHEET 5 OF 7
0234-EMC-126	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - LANDFILL EXTENTS GENERAL ARRANGEMENT - SHEET 6 OF 7
0234-EMC-127	ELIZABETH MACARTHUR CREEK - ROUSE HILL DEVELOPMENT AREA - TRUNK DRAINAGE CONCEPT DESIGN - LANDFILL EXTENTS GENERAL ARRANGEMENT - SHEET 7 OF 7

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16	
DRAWN	C.RUSINGAH AAJV	15.04.16	
VERIFIED	B. WITHNALL AAJV	24.01.17	
APPROVED	N.BARTHO AAJV	24.01.17	

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TITLE SHEET

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 002
ISSUE A | SHEET No. 2 OF 2

SWA1-EXT AUG 2016
554
801

CONCEPT DESIGN ONLY

NOTES:

GENERAL

1. CONCEPT DESIGN PLANS PREPARED BY AAJV, 2 PALMER STREET, PARRAMATTA, NSW 2124, TELEPHONE: (02) 88964100.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH OTHER PROVIDED REPORTS, TECHNICAL SPECIFICATIONS AND WRITTEN INSTRUCTIONS ISSUED BY SYDNEY WATER OR IT'S REPRESENTATIVE.
3. ALL CONDITIONS CONTAINED WITHIN THE REVIEW OF ENVIRONMENTAL FACTORS AND ALL OTHER PLANNING APPROVAL DOCUMENTS FOR THIS PROJECT MUST BE COMPLIED WITH.
4. ALL CONSTRUCTION MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE RELEVANT SPECIFICATION FOR THE WORKS TOGETHER WITH THE REQUIREMENTS OF ALL RELEVANT CODES OF PRACTICE REFERRED TO THEREIN AND THE REQUIREMENTS OF STATUTORY AUTHORITIES WHERE APPLICABLE.
5. ALL LOCATIONS, ORIENTATION AND LEVELS SHALL BE VERIFIED ON SITE BEFORE COMMENCING ANY CONSTRUCTION OR FABRICATION WORK. REFER DISCREPANCIES TO THE PRINCIPAL FOR CLARIFICATION BEFORE PROCEEDING WITH WORK. DO NOT OBTAIN DIMENSIONS FROM SCALING. EXISTING SURFACE LEVELS SHOWN ON THE DRAWINGS ARE INDICATIVE ONLY.
6. THE DOCUMENTED DESIGN IS DETAILED ONLY FOR THE PERMANENT WORKS CONFIGURATION. UNLESS NOTED OTHERWISE ANY TEMPORARY/CONSTRUCTION REQUIREMENTS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
7. UNLESS NOTED OTHERWISE:

   ALL DIMENSIONS ARE IN MILLIMETRES

   ALL CHAINAGES, STATIONS AND CO-ORDINATES ARE IN METRES

   ALL REDUCED LEVELS ARE QUOTED RELATIVE TO AUSTRALIAN HEIGHT DATUM (AHD)

CREEK WORKS

1. MAKE SMOOTH TRANSITIONS THROUGHOUT.
2. LOCATIONS AND EXTENT OF CHANNEL AND FLOODPLAIN FEATURES ARE INDICATIVE ONLY AND SHOULD BE CONFIRMED DURING DETAILED DESIGN AND BEFORE COMMENCING ANY CONSTRUCTION WORK.
3. AT SOME ISOLATED LOCATIONS CREEK WORKS MAY NEED TO EXTEND OUTSIDE THE SW PROPOSED LAND BOUNDARY ADJUSTMENT AREA TO PHYSICALLY ENABLE CONSTRUCTION AND ACCESS.
4. RIPARIAN AND FLOODPLAIN HABITAT FEATURES (E.G. LARGE WOOD) TO BE INCORPORATED THROUGHOUT THE TRUNK DRAINAGE LANDS WHERE WORKS ARE PROPOSED.
5. FLOODPLAIN AND RIPARIAN WORKS FINAL SURFACE TO INCORPORATE A NOMINAL GRADE TO PROMOTE DRAINAGE TOWARDS CREEK AND INHIBIT PONDING. EXISTING OVERLAND FLOW PATHS TO BE RETAINED.
6. CONCEPT DESIGN INCLUDES THE USE OF EROSION CONTROL MATTING AND DENSELY PLANTED NATIVE VEGETATION TO STABILISE THE BED AND BANKS WITHIN SECTIONS OF THE CHANNEL. THE USE OF EROSION CONTROL MATTING AND VEGETATION FOR STABILISATION IS RELIANT ON CORRECT INSTALLATION AND TEMPORARY DEWATERING OF THE CREEK TO ENABLE PLANT GROWTH AND MATERIAL SETTLEMENT. EROSION CONTROL MATTING PERFORMANCE AND SPECIFICATION AND THE REQUIRED DEWATERING TIME PERIOD ARE TO BE CONFIRMED DURING THE DETAILED DESIGN PHASE.

HEAD CUT AND SCOUR HOLES

1. THE LOCATION AND EXTENT OF ALL HEADCUT AND FLOODPLAIN SCOUR HOLE TREATMENTS ARE INDICATIVE ONLY.
2. HEADCUT AND FLOODPLAIN SCOUR HOLE TREATMENT LOCATION, EXTENT AND TYPE TO BE CONFIRMED AT DETAILED DESIGN WITH THE BENEFIT OF DETAILED SURVEY.

DESIGN FLOOD PROFILES

1. DESIGN FLOOD PROFILES SHOW ESTIMATED 100 YEAR ARI PEAK FLOOD LEVELS UNDER ULTIMATE CATCHMENT DEVELOPMENT CONDITIONS.
2. DESIGN FLOOD PROFILES DO NOT INCORPORATE FREEBOARD, REQUIREMENTS FOR WHICH SHALL BE CONFIRMED WITH SYDNEY WATER PRIOR TO ADOPTION OF DESIGN FLOOD PROFILES FOR DEVELOPMENT PURPOSES.

CONTROL AND MANAGEMENT OF STORMWATER

1. THE CONTROL AND MANAGEMENT OF EXISTING STORMWATER FLOWS THROUGH AND AROUND ALL WORK SITES DURING CONSTRUCTION SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
2. 2.ANY REQUIRED PERMITS FOR DEWATERING, DIVERSION WORKS OR RELEASE OF WATERS DURING CONSTRUCTION SHALL BE OBTAINED BY THE CONTRACTOR.

UTILITIES

1. EXISTING SERVICES SHOWN ON THE DRAWINGS ARE NOT GUARANTEED COMPLETE NOR CORRECT AND HAVE BEEN SOURCED FROM INFORMATION SUPPLIED BY THE RELEVANT AUTHORITIES AND/OR FIELD INVESTIGATIONS. THE CONTRACTOR IS TO CONFIRM THE LOCATION AND LEVEL OF ALL EXISTING SERVICES PRIOR TO COMMENCING CONSTRUCTION AND MAKE ARRANGEMENTS WITH THE RELEVANT AUTHORITY TO RELOCATE OR ADJUST IF NECESSARY.

SURVEY

1. CADASTRAL INFORMATION IS FROM SYDNEY WATER'S HYDRA DATABASE AND IS APPROXIMATE ONLY. NO BOUNDARIES HAVE BEEN SURVEYED.
2. SURFACE LEVELS SHOWN ON THE DRAWINGS AND USED TO INFORM THE DESIGN OF WORKS ARE BASED ON LIDAR DATA AND WILL NEED TO BE CONFIRMED WITH DETAILED SURVEY AS PART OF FUTURE DETAILED DESIGN.

FENCING

1. ALL EXISTING FENCES WITHIN THE TRUNK DRAINAGE CORRIDOR TO BE REMOVED UNLESS NOTED OTHERWISE.
2. EXISTING SAFETY RAILINGS AROUND STORMWATER OUTLET STRUCTURES TO BE RETAINED, AND REPAIRED WHERE NECESSARY.
3. NEW SAFETY RAILING TO BE PROVIDED WHERE SHOWN ON THE DRAWINGS.

SAFETY IN DESIGN

1. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE PROJECT SAFETY IN DESIGN REPORT, WHICH IDENTIFIES DESIGN RELATED HEALTH AND SAFETY HAZARDS ASSOCIATED WITH THE PROJECT DESIGN, CONSTRUCTION AND OPERATION, AND PROPOSED AND ADOPTED CONTROL MEASURES

VEGETATION MANAGEMENT

1. ALL TRUNK DRAINAGE WORKS TO BE COORDINATED WITH ASSOCIATED VEGETATION MANAGEMENT WORKS AS DOCUMENTED IN APPROVED VEGETATION MANAGEMENT PLAN (YET TO BE DEVELOPED AT CONCEPT DESIGN STAGE). IT IS ANTICIPATED THE VEGETATION MANAGEMENT WORKS WILL INCLUDE WEED CONTROL/REMOVAL, LOCAL NATIVE VEGETATION PLANTING AND BUSH REGENERATION THROUGHOUT THE PROJECT SITE.

EROSION AND SEDIMENT CONTROL

1. THE CONTRACTOR SHALL CONTROL EROSION AND THE TRANSPORT OF SEDIMENT OFF-SITE DURING CONSTRUCTION IN ACCORDANCE WITH THE REQUIREMENTS OF THE REF, THE CONTRACTOR'S APPROVED CEMP AND THE CURRENT EDITION OF THE 'SOILS AND CONSTRUCTION - MANAGING URBAN STORMWATER' HANDBOOK (OTHERWISE REFERRED TO AS THE 'BLUE BOOK'.

FUTURE BRIDGE CROSSINGS

1. PURPOSE OF DRAWINGS IS TO SHOW WATERWAY CROSSING DESIGN PARAMETERS THAT WOULD BE CONSIDERED A 'DEEMED TO COMPLY' SOLUTION BY SYDNEY WATER, SUBJECT TO CONFIRMATION AS PART OF FUTURE DETAILED DESIGN.
2. BRIDGE CROSSING LOCATIONS AND CONFIGURATIONS BASED ON INFORMATION AVAILABLE AT JUNE 2016 AND SUBJECT TO CONFIRMATION WITH THE RELEVANT AUTHORITY PRIOR TO COMMENCEMENT OF DESIGN.
3. ALL BRIDGE AND BENCHING DETAILS SHOWN ARE INDICATIVE ONLY AND SUBJECT TO CONFIRMATION AS PART OF THE FUTURE DETAILED DESIGN.
4. EXISTING SURFACE LEVELS SHOWN ARE APPROXIMATE ONLY (SOURCED FROM LIDAR) AND MUST BE CONFIRMED BY DETAILED SURVEY TO ENSURE THE WATERWAY DESIGN INTENT SHOWN ON THE DRAWINGS IS ABLE TO BE ACHIEVED TO THE SATISFACTION OF SYDNEY WATER.
5. REQUIREMENTS FOR CREEK BED AND BANK SCOUR PROTECTION MEASURES NOT SHOWN. THE EXTENT AND SCOPE OF SUCH WORKS IS TO BE DETERMINED AS PART OF THE DESIGN PROCESS AND IS SUBJECT TO APPROVAL BY SYDNEY WATER.

FUTURE LANDFILL AND EDGE TREATMENTS

1. CONCEPT DESIGN OF FUTURE LANDFILL ADOPTS PEAK 100 YEAR ARI FLOOD LEVELS AT THE TRUNK DRAINAGE CORRIDOR BOUNDARY AND GRADES AWAY FROM BOUNDARY AT APPROX. 2%. CONTOURING REMOTE FROM BOUNDARY IS THEREFORE INDICATIVE ONLY AND SUBJECT TO CONFIRMATION AS PART OF FUTURE DETAILED DESIGN.
2. REFER TYPICAL DETAILS FOR CONCEPTUAL BATTER AND RETAINING WALL TREATMENTS.

LEGEND:

EXISTING FEATURES

- EXISTING ELIZABETH MACARTHUR CREEK CENTRELINE
- INDICATIVE IRRIGATION PIPE LOCATION
- EXISTING FENCE
- EXISTING SEWER
- EXISTING WATER
- EXISTING GAS
- EXISTING ELECTRICITY
- EXISTING TELECOMMUNICATIONS
- EXISTING TELECOMMUNICATIONS
- EXISTING STORMWATER
- LOT NUMBER (4 / 1182446)
- FUTURE ROAD RESERVE BOUNDARY (PER BALMORAL ROAD RELEASE AREA DCP)
- BELLYVILLE CONCEPT LAYOUT
- BELLYVILLE CONCEPT LAYOUT (INDICATIVE, SUBJECT TO CONFIRMATION)
- EXISTING CONTOURS (56.2)

PROPOSED TRUNK DRAINAGE WORKS (BY SYDNEY WATER):

- PROPOSED TRUNK DRAINAGE LAND (TDL) BOUNDARY
- PROPOSED EXTENT OF DESIGN SURFACE
- NEW FLOOD LEVEE
- LOW FLOW CHANNEL CENTRE LINE
- VEGETATED CHANNEL
- DAM FILL
- HISTORIC SPOIL/LANDFILL MATERIAL REMOVAL
- UPPER BANK WORKS
- LARGE ROCK RIPRAP
- SMALL ROCK RIPRAP
- BED CONTROL STRUCTURES
- FLOOD PLAIN SCOUR HOLE TREATMENT
- CONCRETE
- HARDSTAND REMOVAL
- PROPOSED CREEK CONTOURS (56.2)

FUTURE WORKS (BY OTHERS)

- FUTURE ROAD LEVEL (FRL 61.75)
- PROPOSED LANDFILL CONTOURS (56.2)
- PROPOSED BRIDGE EARTHWORKS CONTOURS (56.2)
- PROPOSED BRIDGE STRUCTURE
- PROPOSED BATTER - EDGE TREATMENT
- PROPOSED RETAINING WALL - EDGE TREATMENT

WARNING:
SERVICES SHOWN ARE INDICATIVE ONLY. CURRENCY AND ACCURACY ARE NOT TO BE PRESUMED. A CURRENT SERVICES SEARCH INCLUDING DIAL BEFORE YOU DIG SERVICES PLANS AND SITE CHECKING OF ALL EXISTING SERVICES WILL BE NECESSARY PRIOR TO COMMENCING ANY WORK. APPROPRIATE PROCEDURES, PRECAUTIONS AND CARE TO BE TAKEN WHEN IN CLOSE PROXIMITY TO ANY SERVICE.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
NOTES & LEGEND

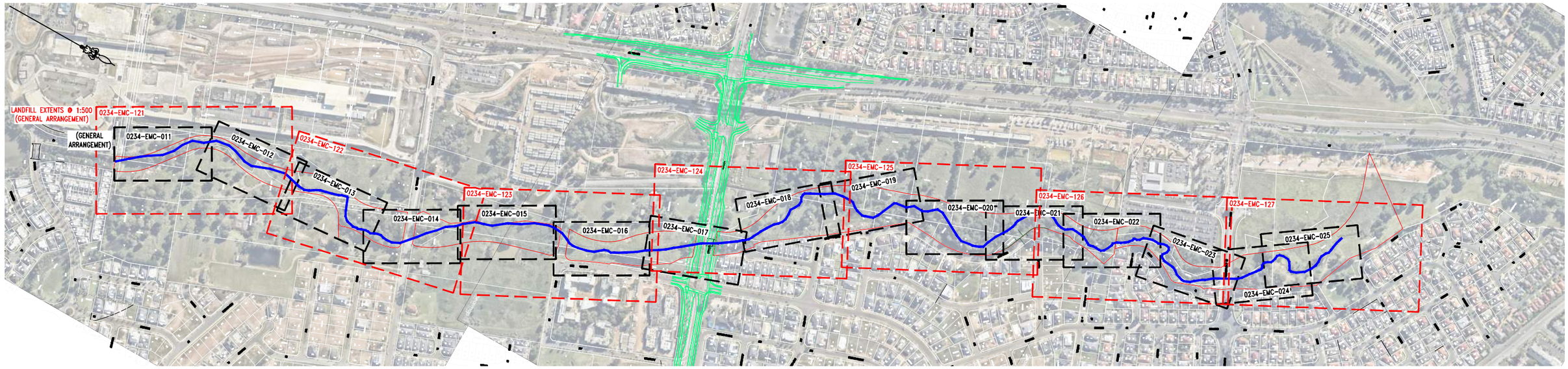
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 003

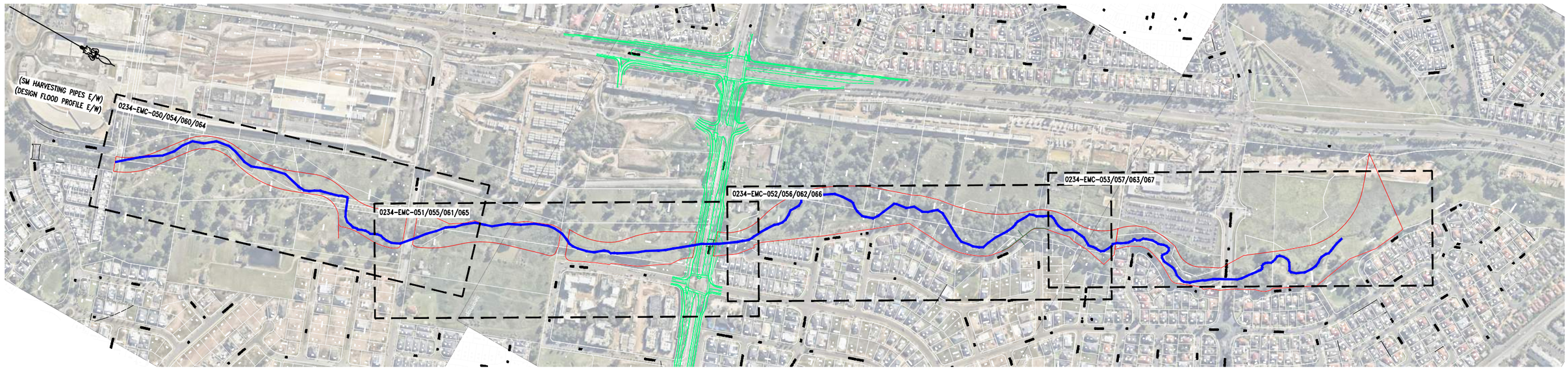
ISSUE A | SHEET No. --

SWA1-EXT AUG 2014
554
801
RL1

CONCEPT DESIGN ONLY



GENERAL ARRANGEMENT
SCALE: 1:4000



'STORMWATER HARVESTING PIPES' & 'DESIGN FLOOD PROFILE'
SCALE: 1:4000

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
KEY PLANS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 005

ISSUE A | SHEET No. - - -

SWA1-EXT AUG 2014
554
801

CONCEPT DESIGN ONLY

CURRENTLY PROPOSED FUTURE ROAD LEVELS ALONG CONTINUATION OF CELEBRATION DRIVE AS SHOWN LIE WELL ABOVE 100 YEAR ARI FLOOD LEVELS. FUTURE BRIDGE DECK LEVEL COULD BE RAISED TO SUIT

FRL 70.00

FRL 69.50

FRL 68.50

FRL 69.00

FRL 69.50

REMOVE CONCRETE CULVERT AND ROAD CROSSING

RELOCATE SERVICES CROSSING CREEK

REMOVE REDUNDANT IRRIGATION PIPE CROSSING CREEK

WORKS TO EXTEND INTO UPSTREAM PRIVATE PROPERTY (NOMINAL 5m) TO FACILITATE CHANNEL AND CROSSING REMOVAL WORKS AND TO PROVIDE SMOOTH TRANSITION AT UPSTREAM INTERFACE.

REMOVE CONCRETE CAUSEWAY AND ASSOCIATED ROAD CROSSING

TREAT AND REMOVE WILLOW TREE RETAIN ROOT SYSTEM FOR BANK STABILISATION

ELIZABETH MACARTHUR CREEK

REFER DRG 0234-EMC-110 FOR DETAILS OF FUTURE BRIDGE CROSSING (BY OTHERS)

LIMIT OF WORKS

MD05

ROCK RIFFLE TO TRANSITION INTO VEGETATED CHANNEL. REFER TO DRG 0234-EMC-037 FOR CHANNEL PROFILE

REMOVE LEVEE BUND FROM WITHIN THE RIPARIAN ZONE FROM THE CREEK BANK TO THE TDL BOUNDARY. EXCAVATE LEVEE DOWN TO EXISTING SURROUNDING SURFACE LEVEL. FINAL SURFACE TO INCORPORATE CROSSFALL TOWARDS CREEK. REFER TO DRG 0234-EMC-033 DETAIL 1

2m TRANSITION MATCH TO EXISTING

PROTECT EXISTING GAS MAIN

RECONSTRUCT CREEK CHANNEL AND RIPARIAN AREA AROUND ROAD REMOVAL AREA REFER TO TYPICAL DETAILS DRG (0234-EMC-039)

ENSURE SMOOTH TRANSITION BETWEEN EXISTING CHANNEL AND PROPOSED NEW CONSTRUCTED CHANNEL. INTERFACE TO BE KEYED/TIED-IN TO MINIMISE FAILURE RISKS.

UNNAMED TRIBUTARY

REMOVE AND REHABILITATE ALL REDUNDANT HARDSTAND AREAS WITHIN TRUNK DRAINAGE LANDS

JOINS SHEET 02

PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

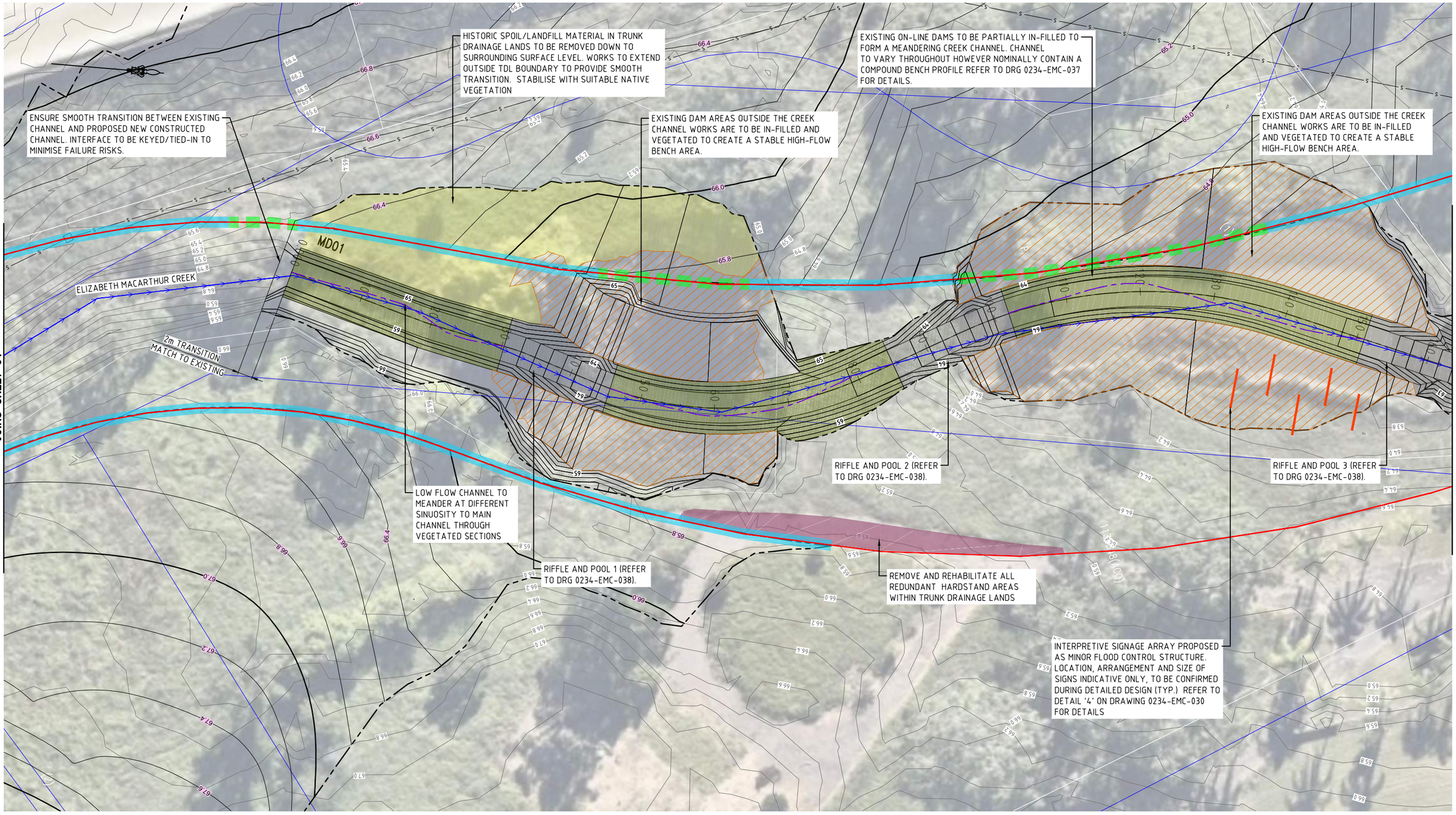
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 011
ISSUE A | SHEET No. 1 OF 15

SWATH EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.P.ARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER
ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

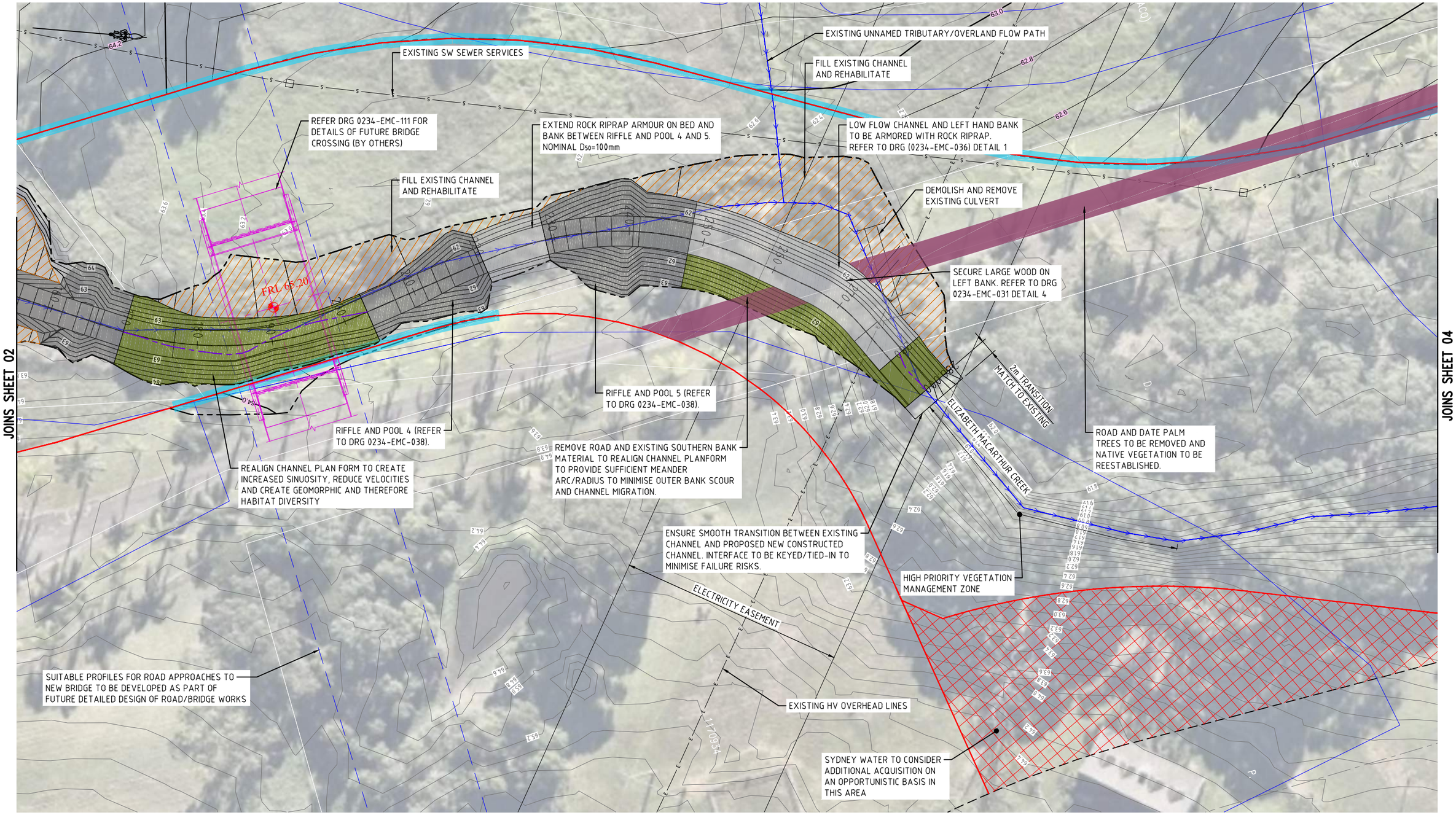
ELIZABETH MACARTHUR CREEK ROUSE HILL DEVELOPMENT AREA TRUNK DRAINAGE CONCEPT DESIGN GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 012
ISSUE A
SHEET No. 2 OF 15

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER
ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

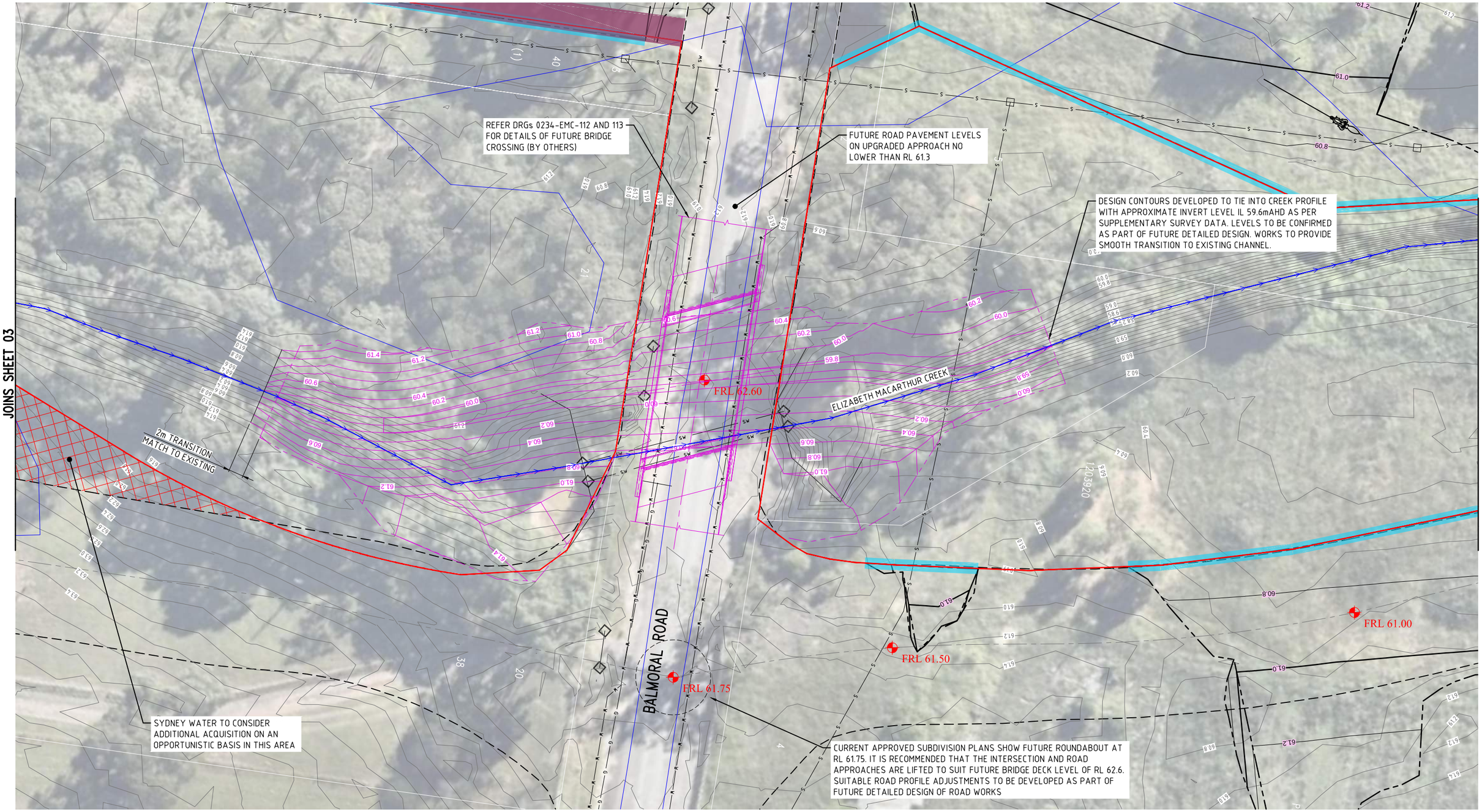
ELIZABETH MACARTHUR CREEK ROUSE HILL DEVELOPMENT AREA TRUNK DRAINAGE CONCEPT DESIGN GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 013
ISSUE A | SHEET No. 3 OF 15

SWATH-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

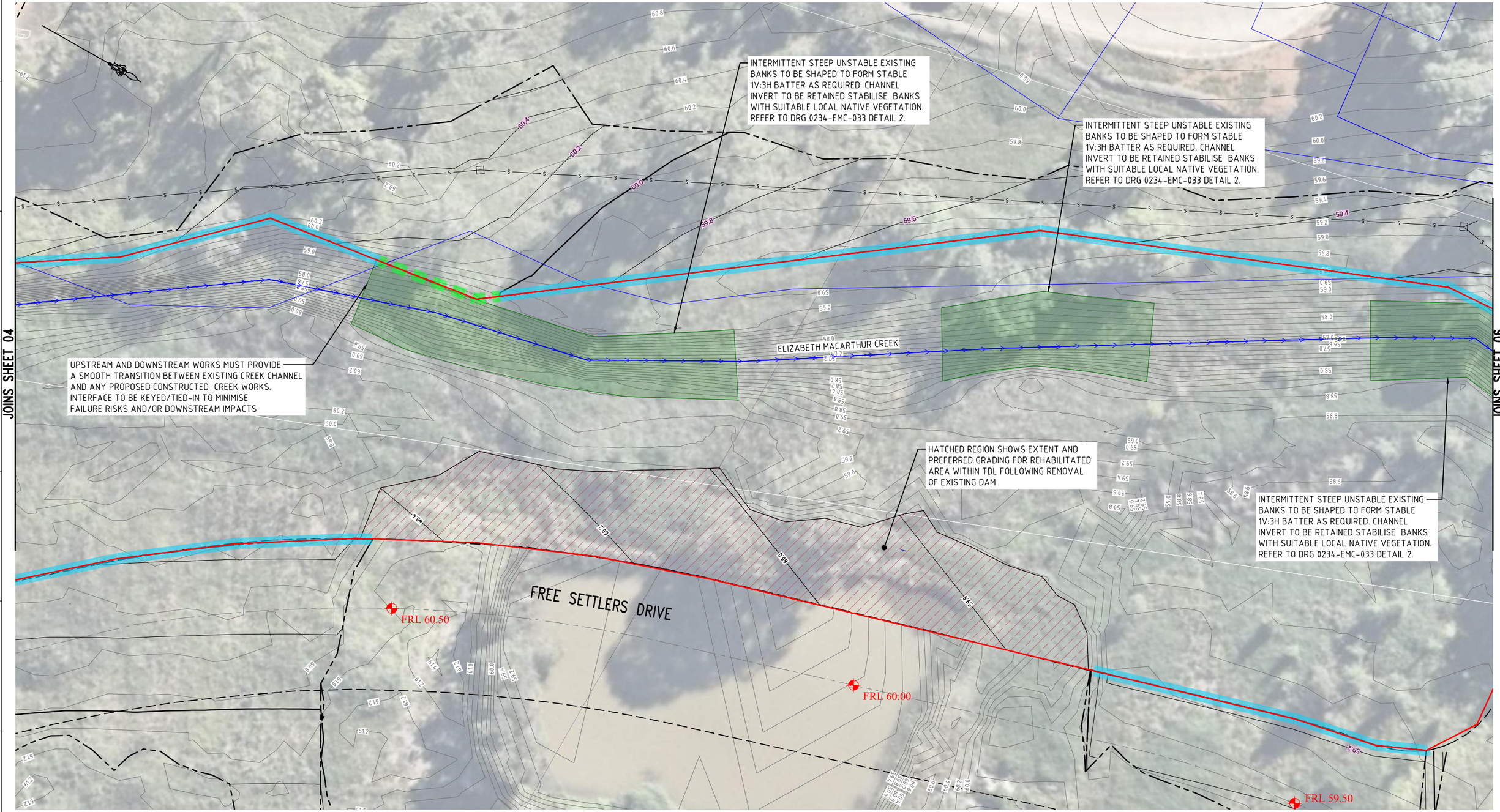
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 014
ISSUE A
SHEET No. 4 OF 15

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.P.ARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER
ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

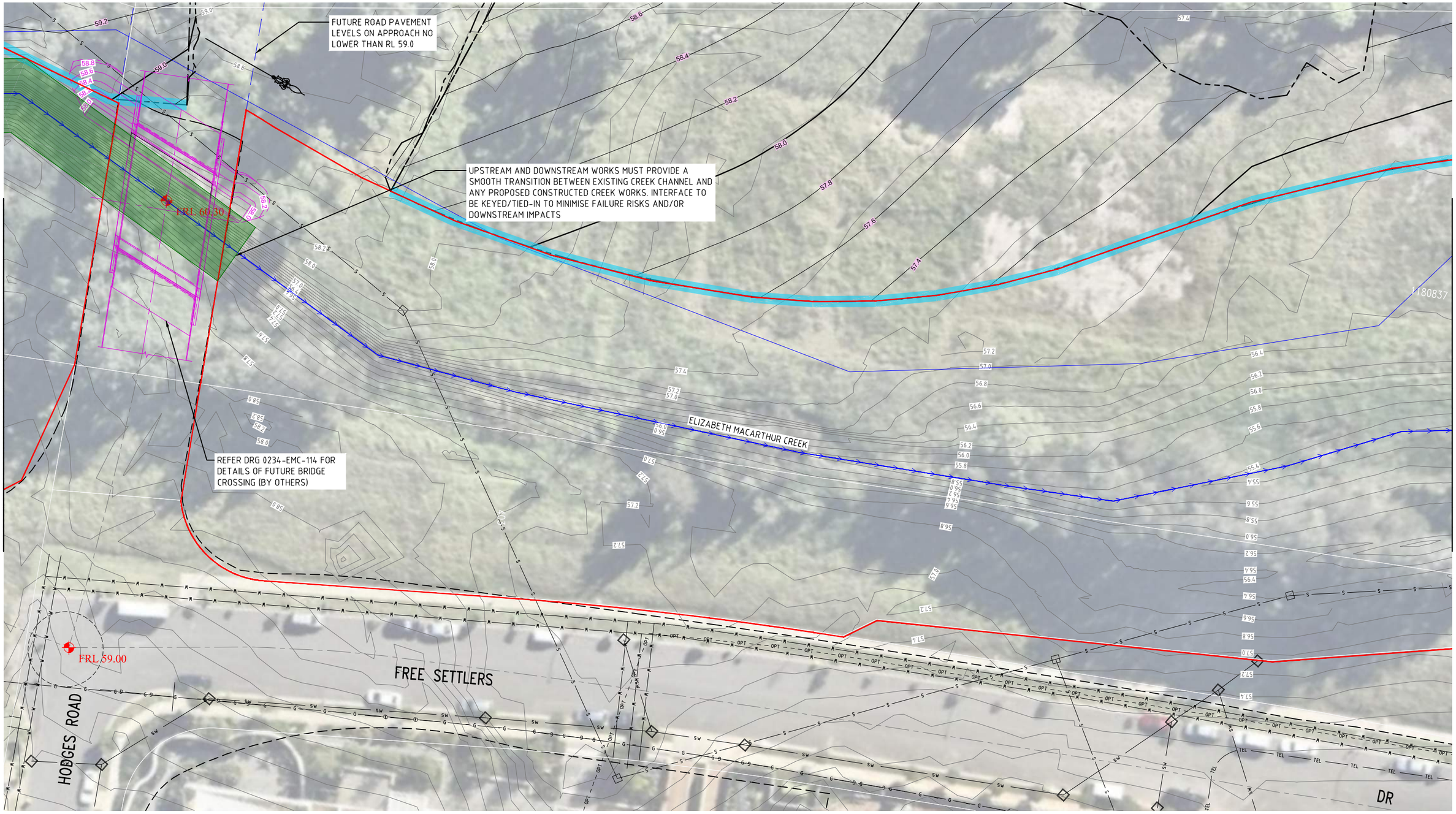
ELIZABETH MACARTHUR CREEK ROUSE HILL DEVELOPMENT AREA TRUNK DRAINAGE CONCEPT DESIGN GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 015
ISSUE A | SHEET No. 5 OF 15

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

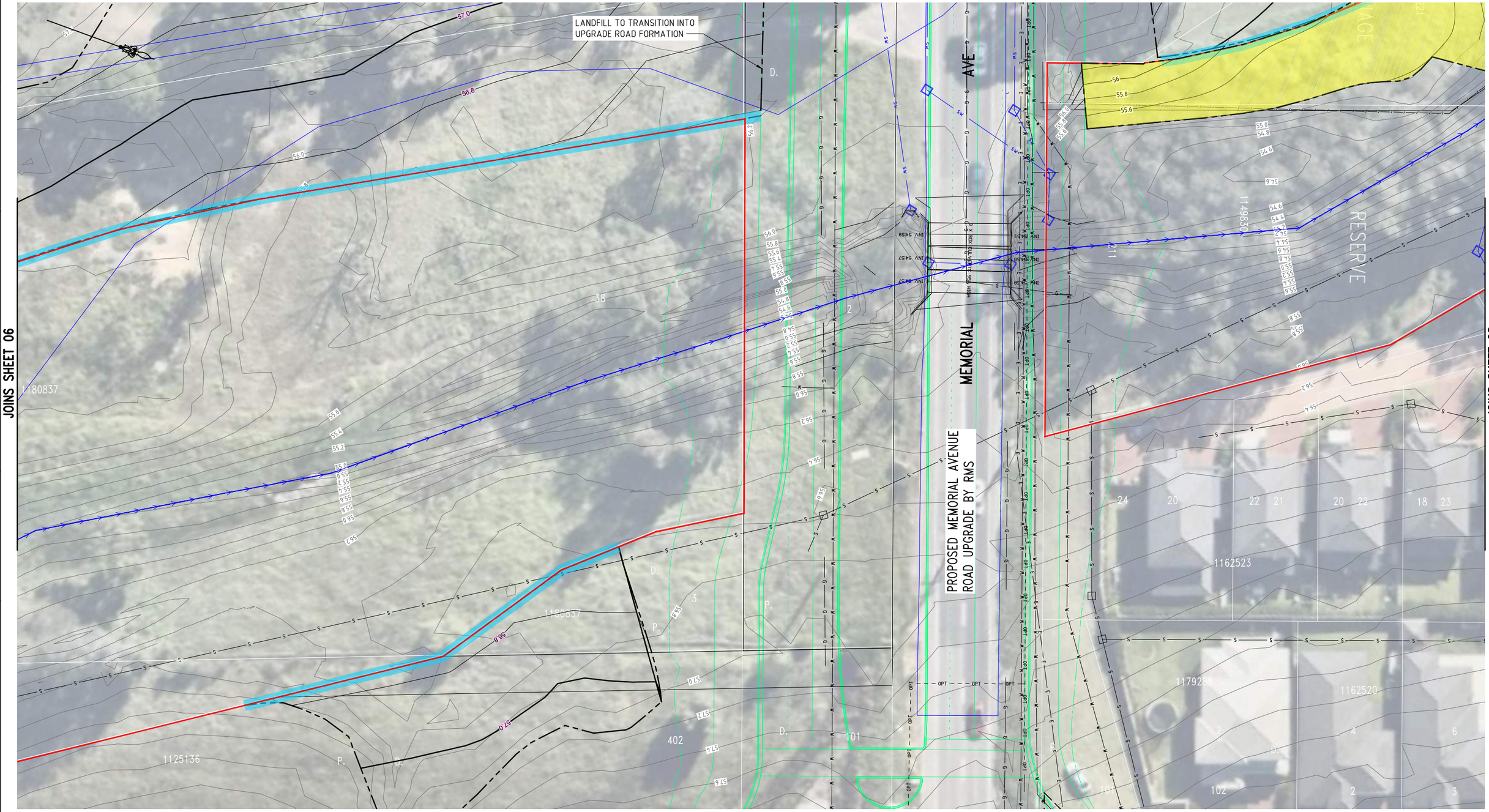
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 016
ISSUE A | SHEET No. 6 OF 15

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

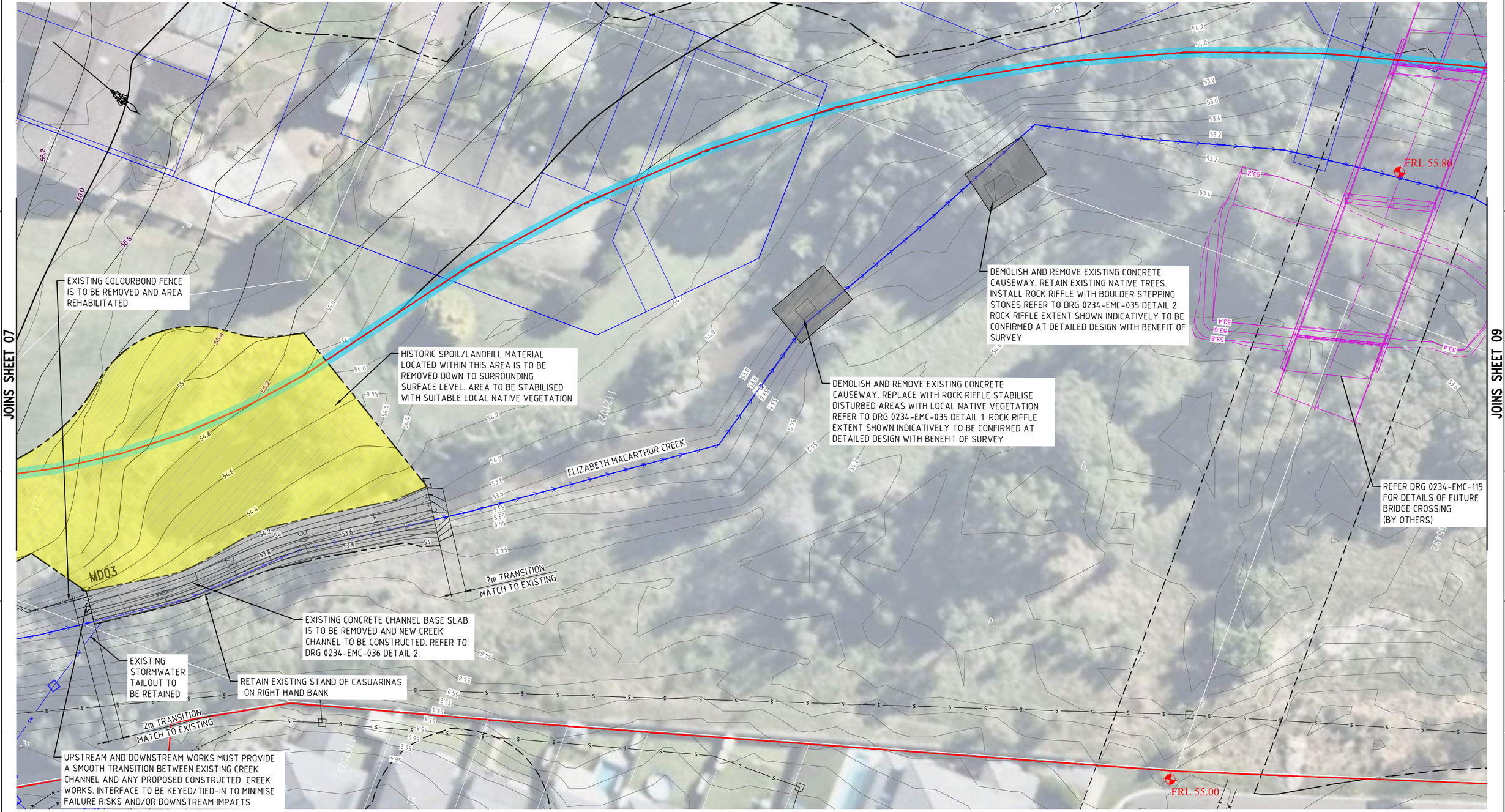
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 017
ISSUE A | SHEET No. 7 OF 15

SWAT-EXT AUG 2016

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.P.ARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

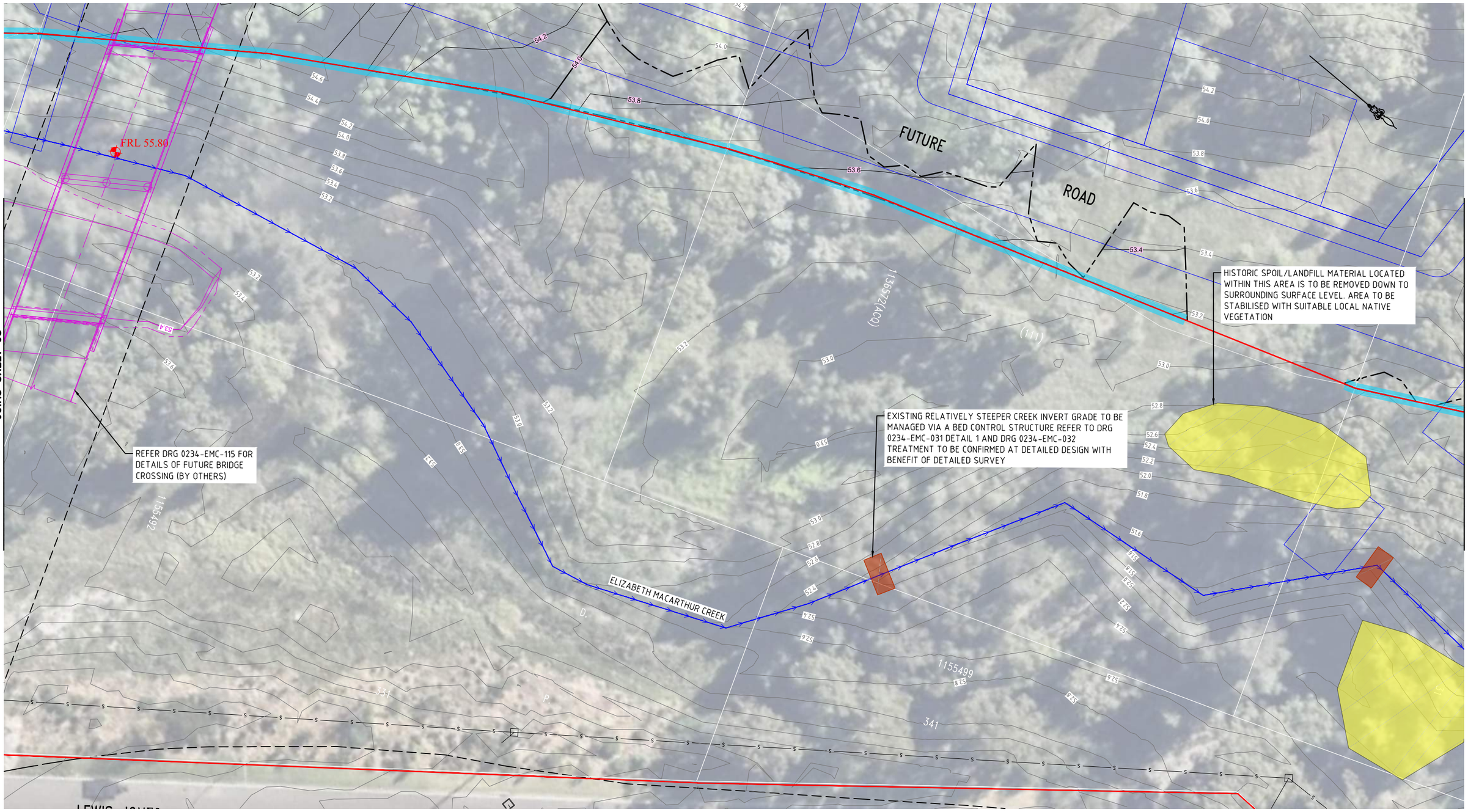
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 018
ISSUE A | SHEET No. 8 OF 15

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

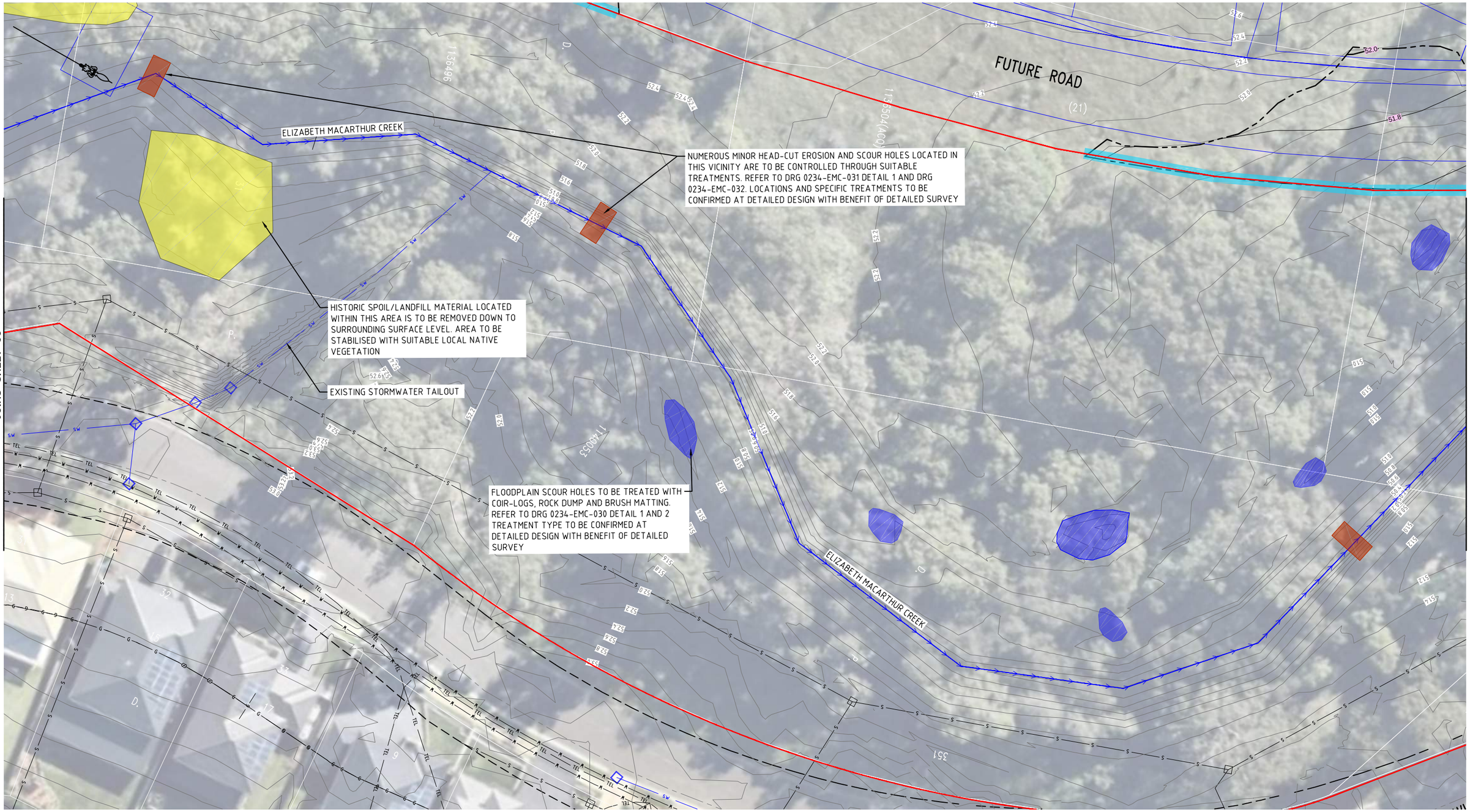
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 019
ISSUE A
SHEET No. 9 OF 15

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

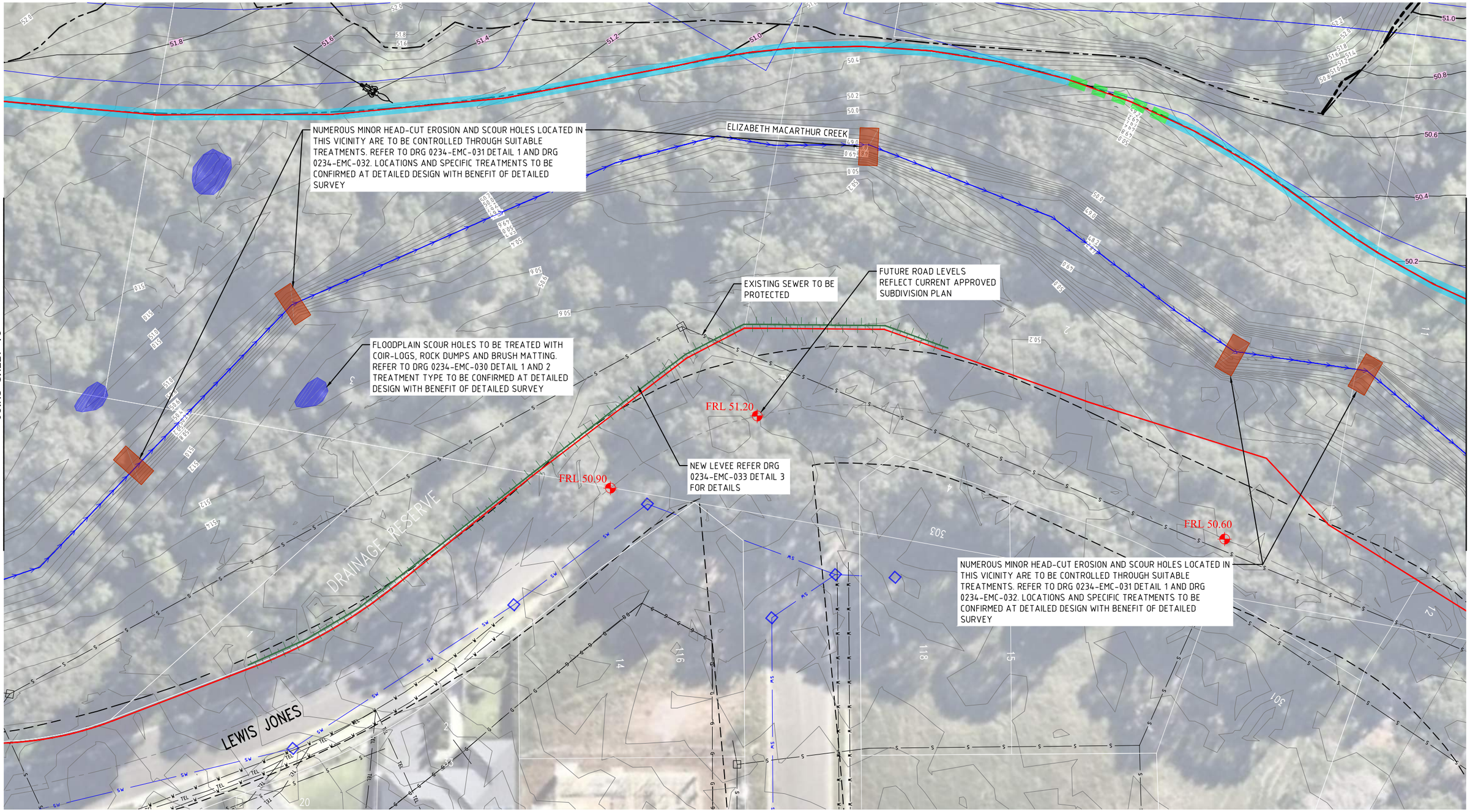
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 020
ISSUE A | SHEET No. 10 OF 15

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



JOINS SHEET 10

JOINS SHEET 12

PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

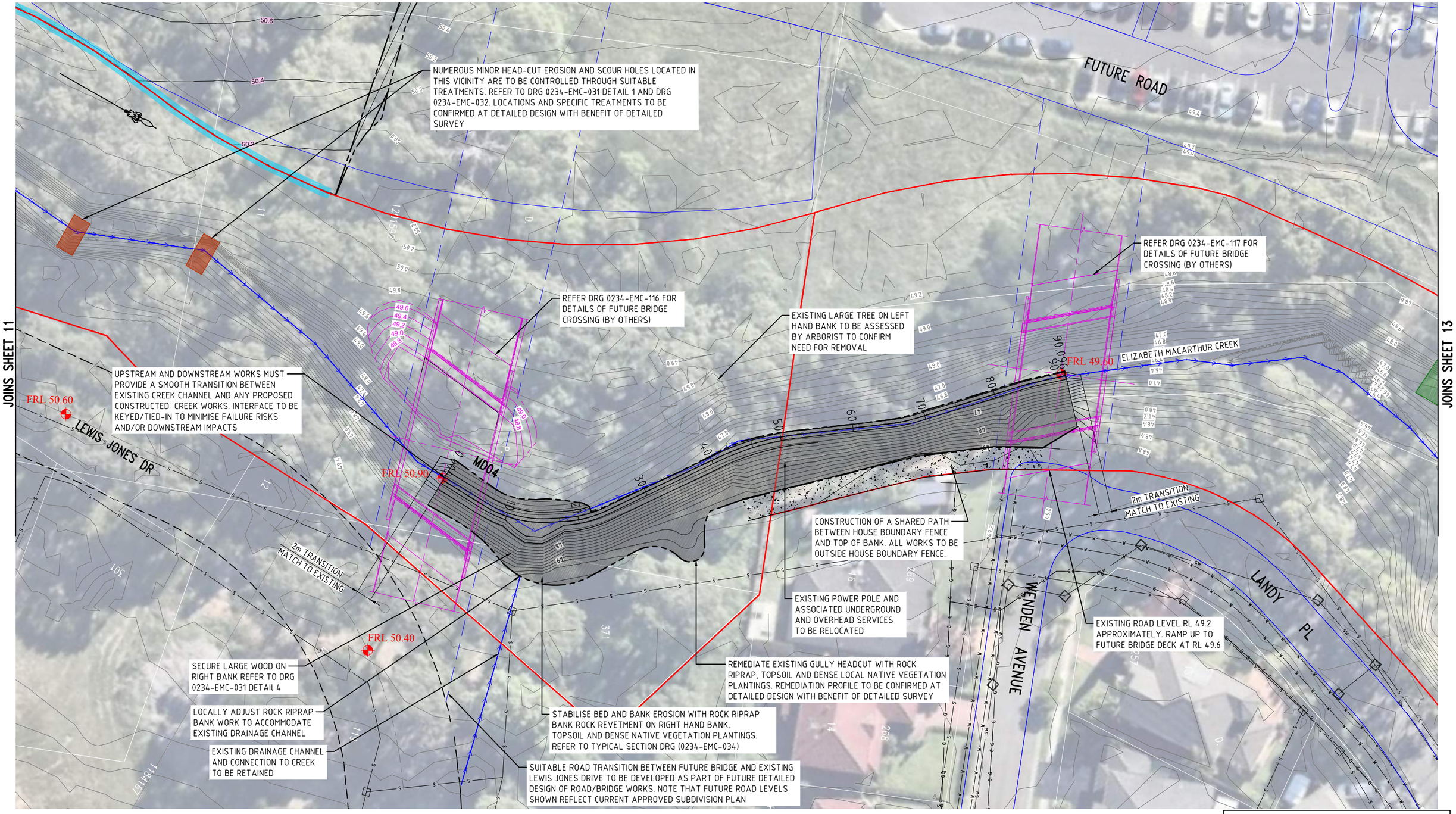
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 021

ISSUE A | SHEET No. 11 OF 15

SWAN-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED	R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER	15.02.17
ACCEPTED	R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER	15.02.17

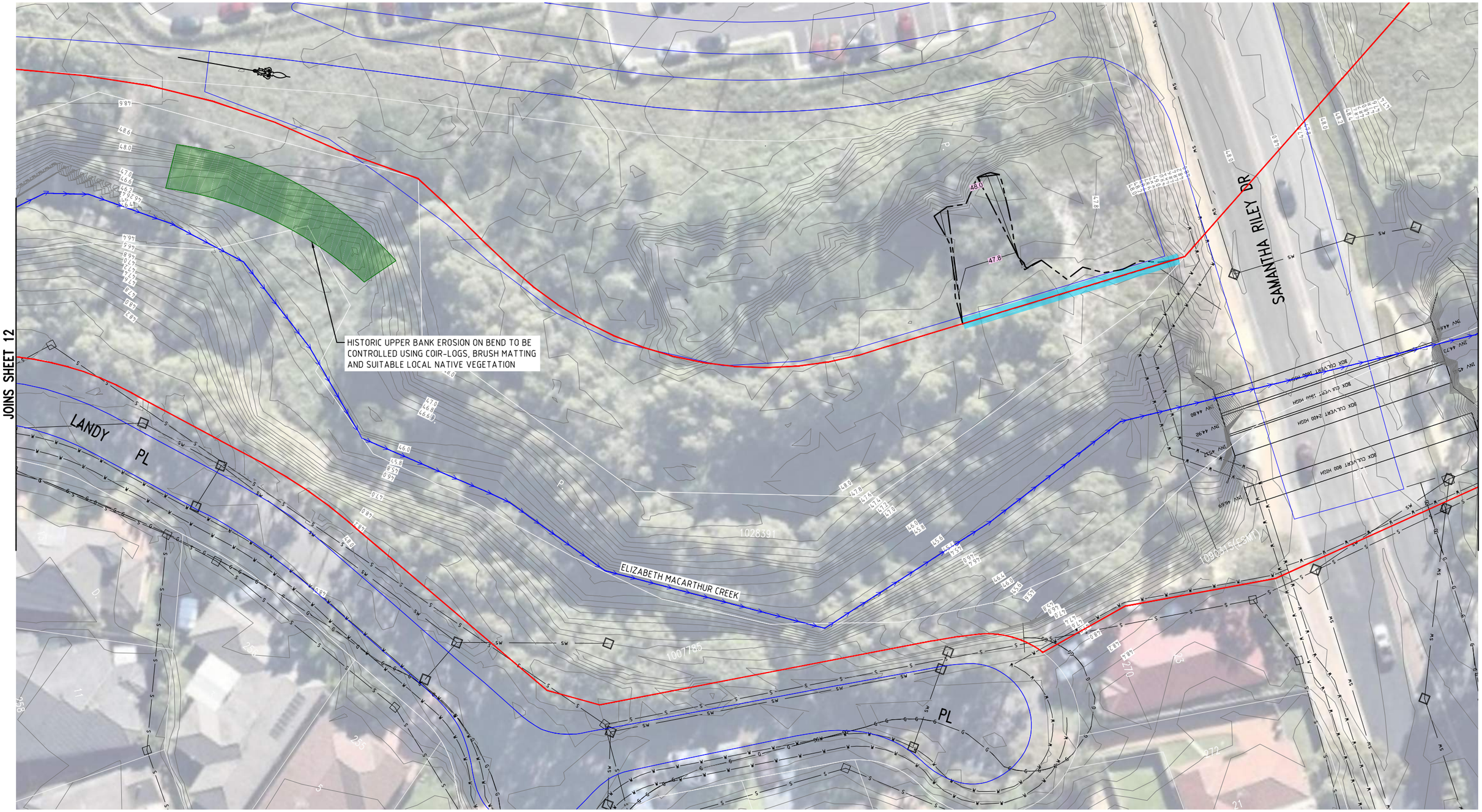
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 022
ISSUE A | SHEET No. 12 OF 15

SWATH EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

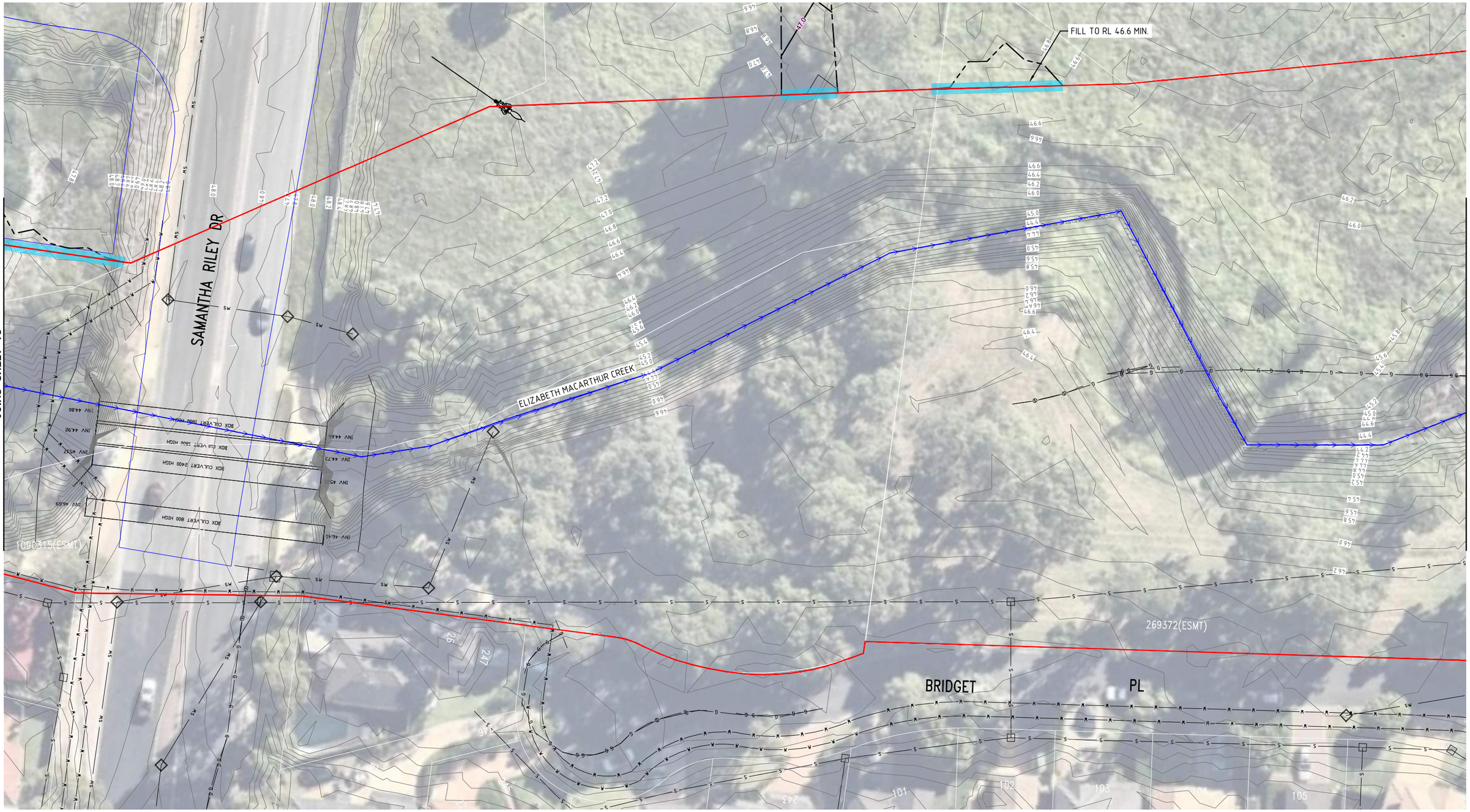
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 023
ISSUE A | SHEET No. 13 OF 15

SWAL-EXT AUG 2016

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

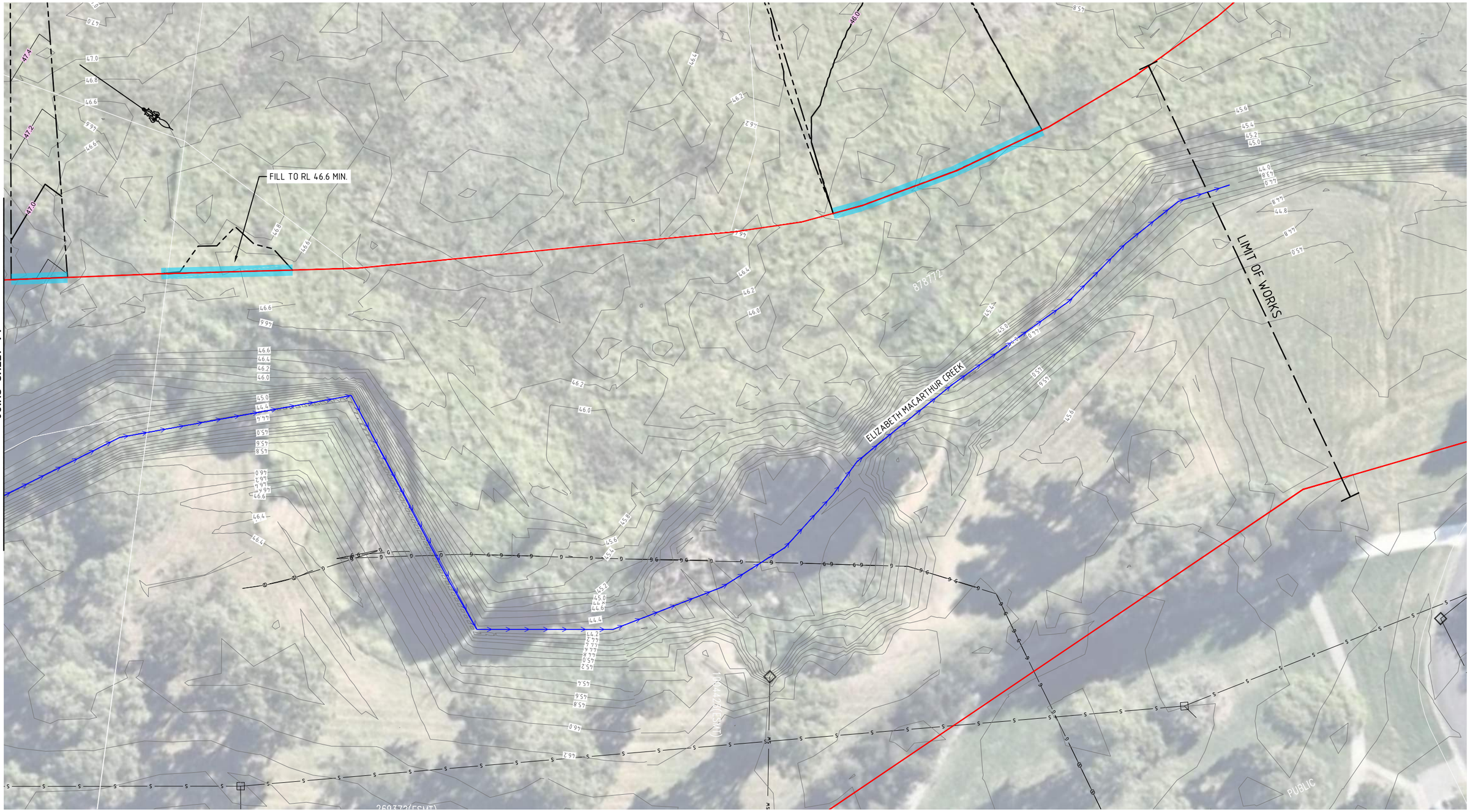
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 024
ISSUE A | SHEET No. 14 OF 15

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:250

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234-EMC-121 TO 0234-EMC-127.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 5 10 12.5m
1 : 500 (A3) 1 : 250 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

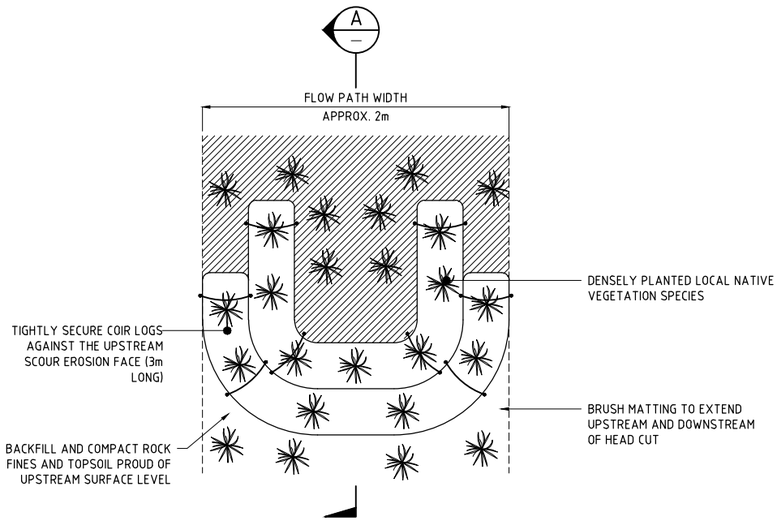
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 025
ISSUE A | SHEET No. 15 OF 15

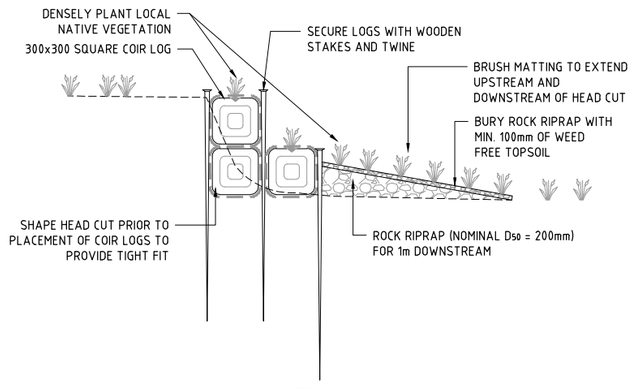
SWAT-EXT AUG 2014

CONCEPT DESIGN ONLY

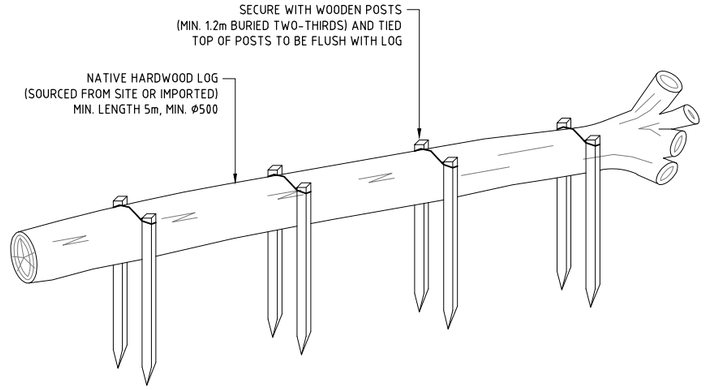


DETAIL 1 — N.T.S.

FLOODPLAIN SCOUR HOLE TREATMENT - TYPE 1

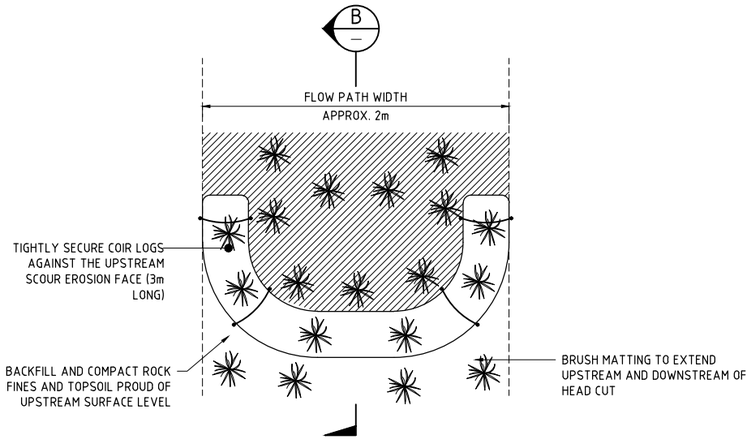


SECTION A — N.T.S.



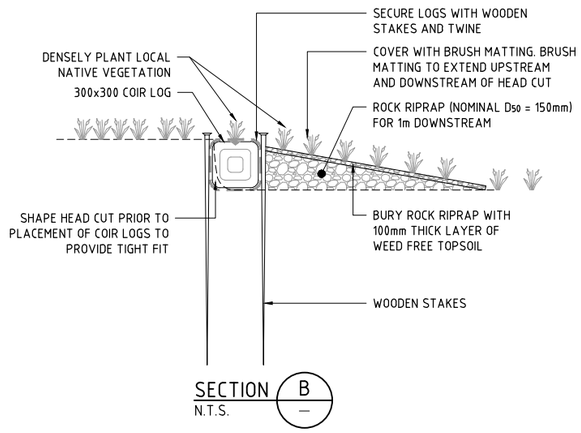
DETAIL 3 — N.T.S.

SECURED HABITAT LOGS (TOP OF BANK)

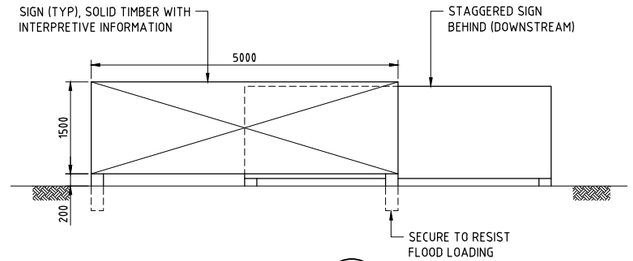


DETAIL 2 — N.T.S.

FLOODPLAIN SCOUR HOLE TREATMENT - TYPE 2



SECTION B — N.T.S.



DETAIL 4 — N.T.S.

INTERPRETATIVE SIGNAGE ARRAY AS MINOR FLOOD CONTROL STRUCTURE

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TYPICAL DETAILS

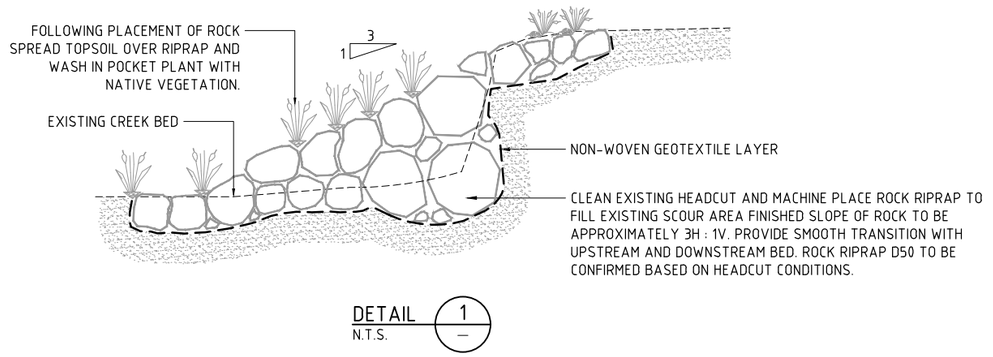
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 030

ISSUE A | SHEET No. 1 OF 10

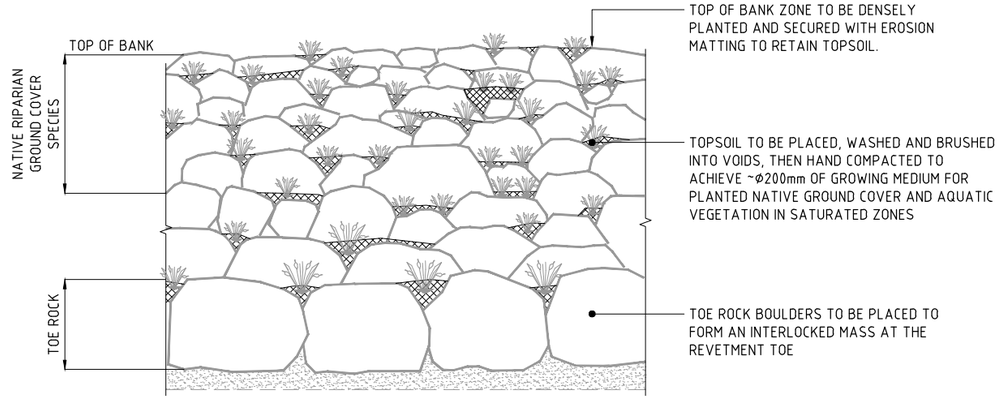
SWA:EXT AUG 2014 554 801 841 37m

CONCEPT DESIGN ONLY



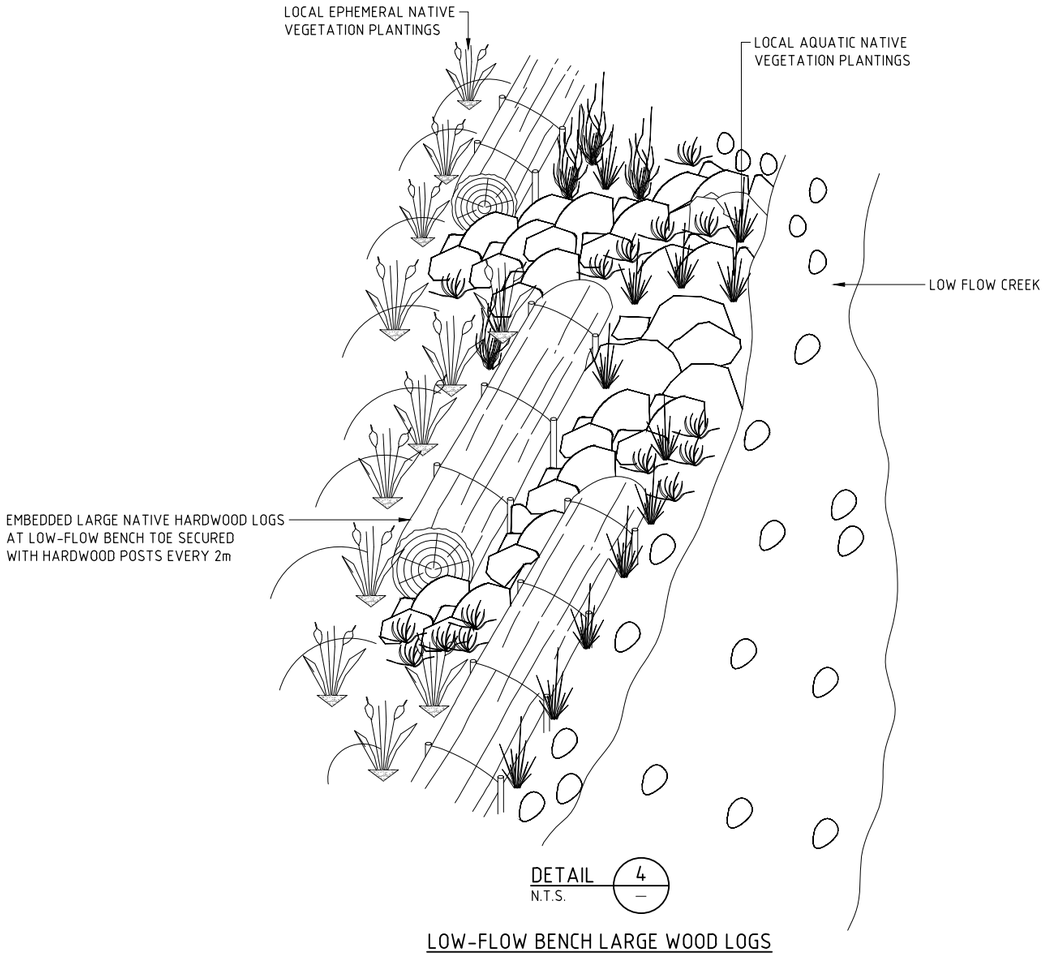
DETAIL 1 — N.T.S.

HEAD CUT ROCK RIPRAP



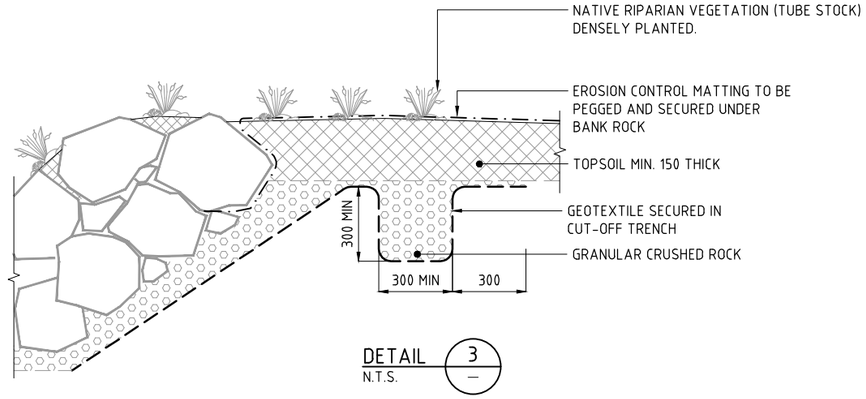
DETAIL 2 — N.T.S.

ELEVATION - POCKET PLANTING BANK ROCK RIP RAP



DETAIL 4 — N.T.S.

LOW-FLOW BENCH LARGE WOOD LOGS



DETAIL 3 — N.T.S.

SECURING GEOTEXTILE AT TOP OF BANK

NOTE:

ALL DETAILS ARE SCHEMATIC ONLY, AND SUBJECT TO DETAIL DESIGN.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT

THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TYPICAL DETAILS

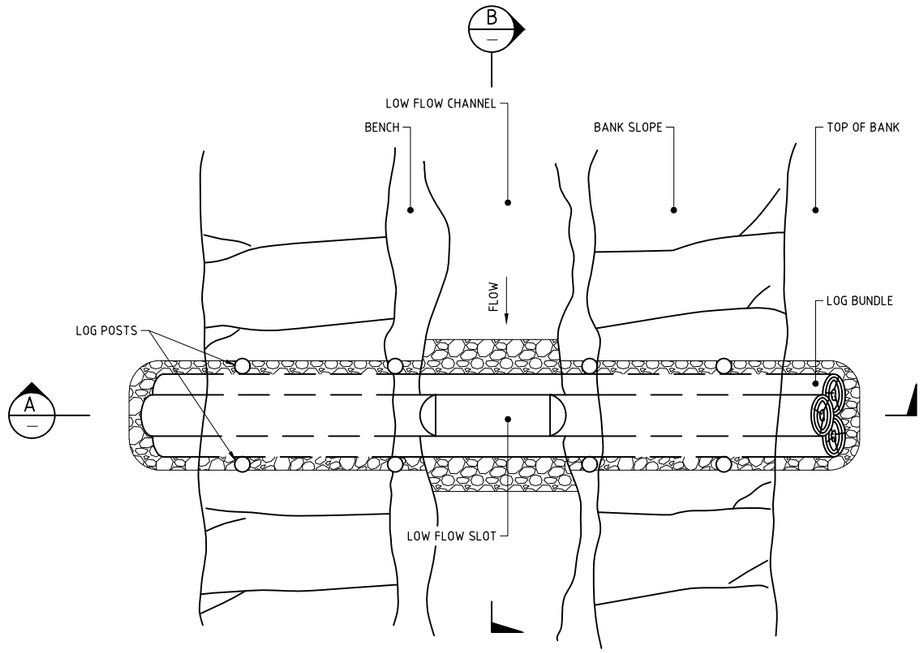
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 031

ISSUE A | SHEET No. 2 OF 10

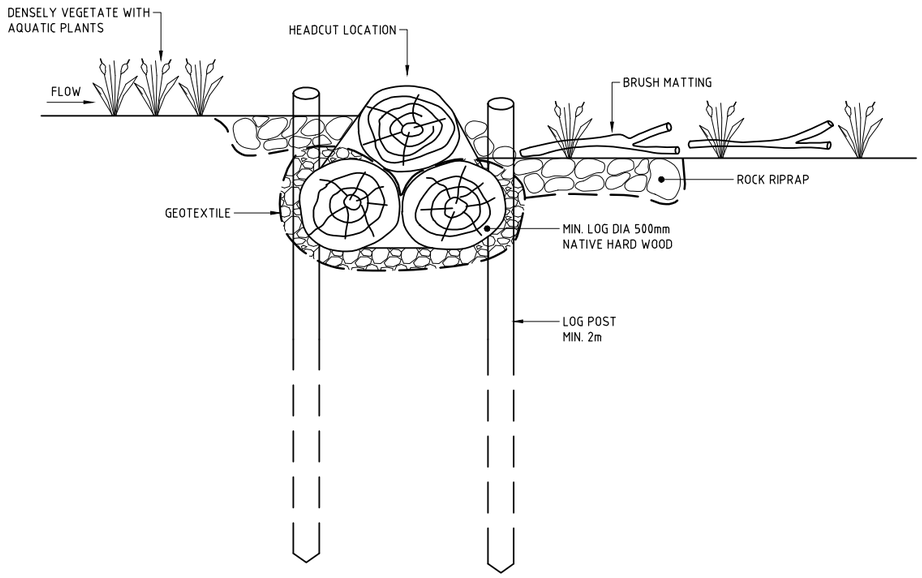
SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY

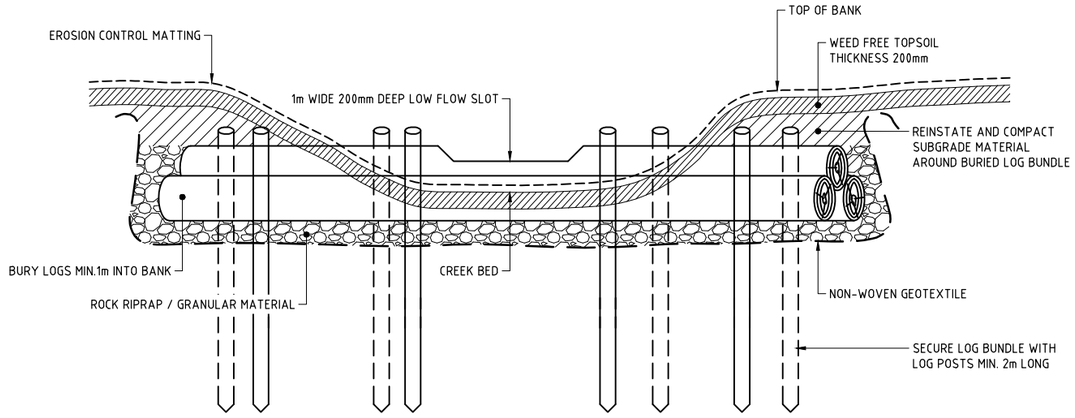


DETAIL 1
N.T.S.

PLAN - LOG BED CONTROL STRUCTURE



SECTION B
N.T.S.



SECTION A
N.T.S.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER
ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

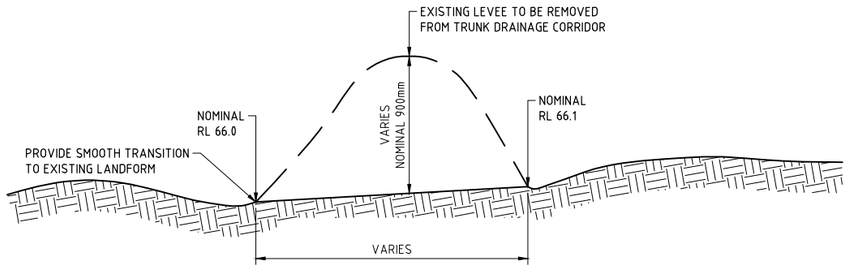
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TYPICAL DETAILS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 032
ISSUE A | SHEET No. 3 OF 10

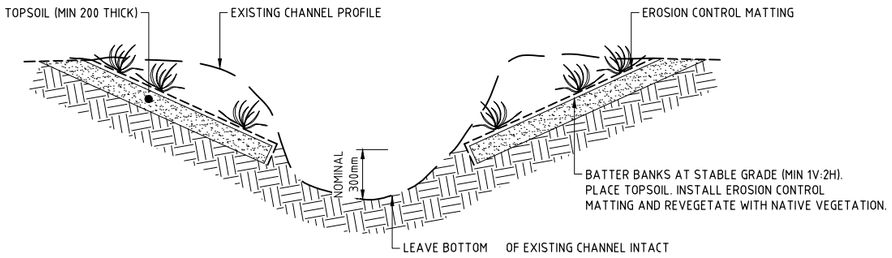
SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



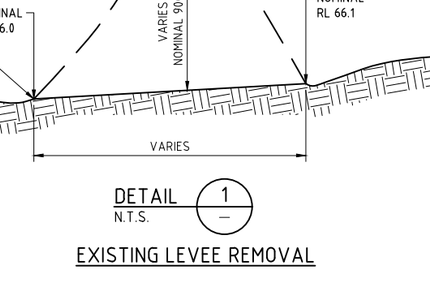
DETAIL 1
N.T.S.

EXISTING LEVEE REMOVAL



DETAIL 2
N.T.S.

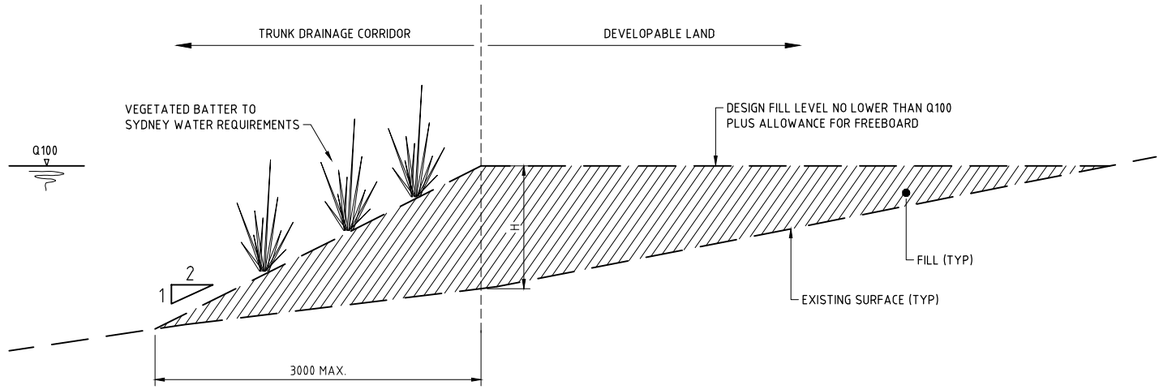
BANK REGRADE



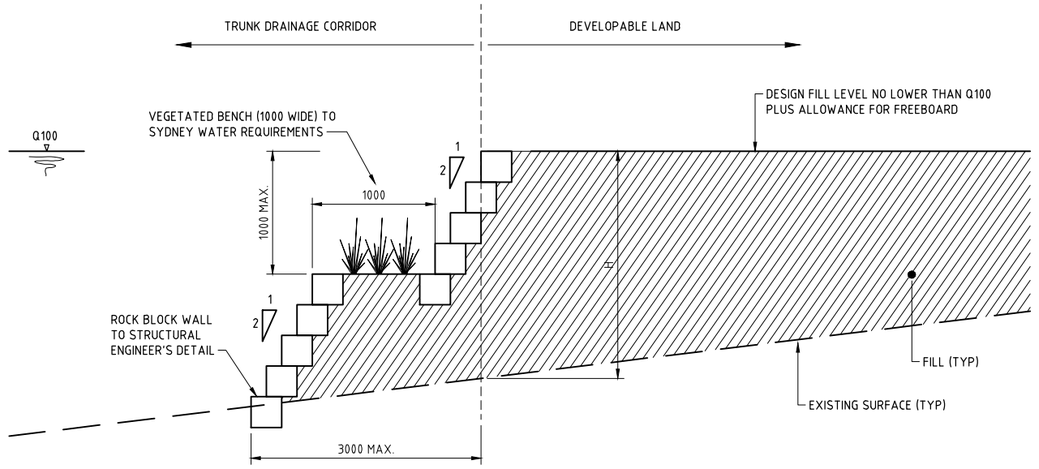
NOTE: LEVEE PROFILE AND DIMENSIONS INDICATIVE ONLY SUBJECT TO DETAILED DESIGN

DETAIL 3
NTS

LEWIS JONES DRIVE LEVEE



FILL HEIGHT 'H' UP TO 1.0m



FILL HEIGHT 'H' GREATER THAN 1.0m AND LESS THAN 4.0m

DETAIL 4
N.T.S.

FILL EDGE TREATMENTS AT TRUNK
DRAINAGE CORRIDOR BOUNDARY

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16	
DRAWN	M. CONRADIE AAJV	15.04.16	
VERIFIED	B. WITHNALL AAJV	24.01.17	
APPROVED	N.BARTHO AAJV	24.01.17	

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

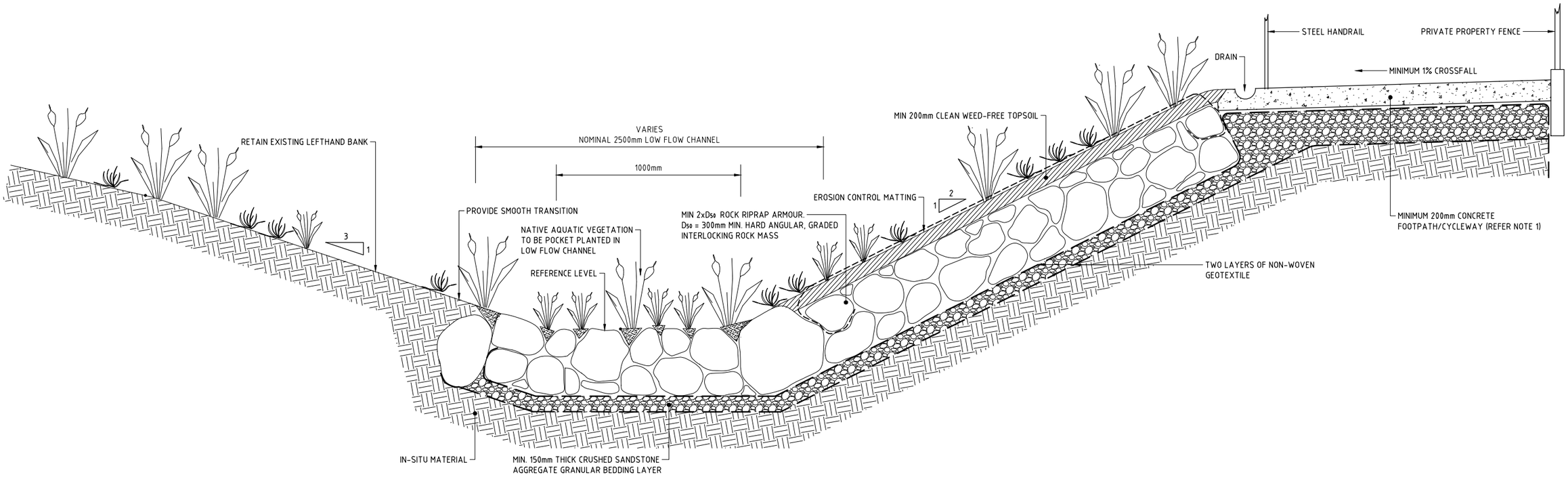
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TYPICAL DETAILS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 033
ISSUE A | SHEET No. 4 OF 10

SWAL-EXT AUG 2016

CONCEPT DESIGN ONLY



NOTES:
1. THE FOOTPATH AND ITS FOUNDATION DESIGN TO BE CONFIRMED AT DETAILED DESIGN.
2. DESIGN TO BE ASSESSED BY A GEOTECHNICAL ENGINEER AT DETAIL DESIGN.

DETAIL 1/—
N.T.S.

WENDEN AVENUE CHANNEL PROTECTION

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	M. CONRADIE AAJV	12.07.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER
ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

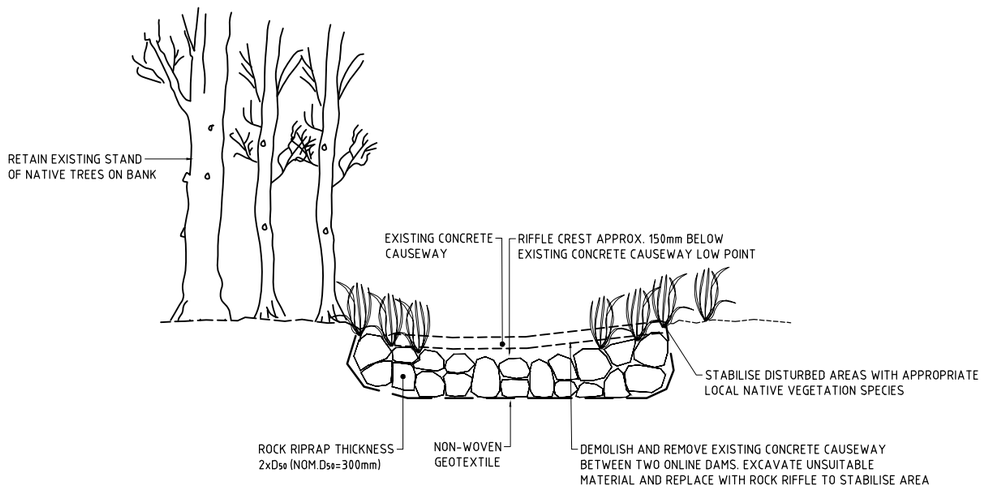
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TYPICAL DETAILS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 034
ISSUE A | SHEET No. 5 OF 10

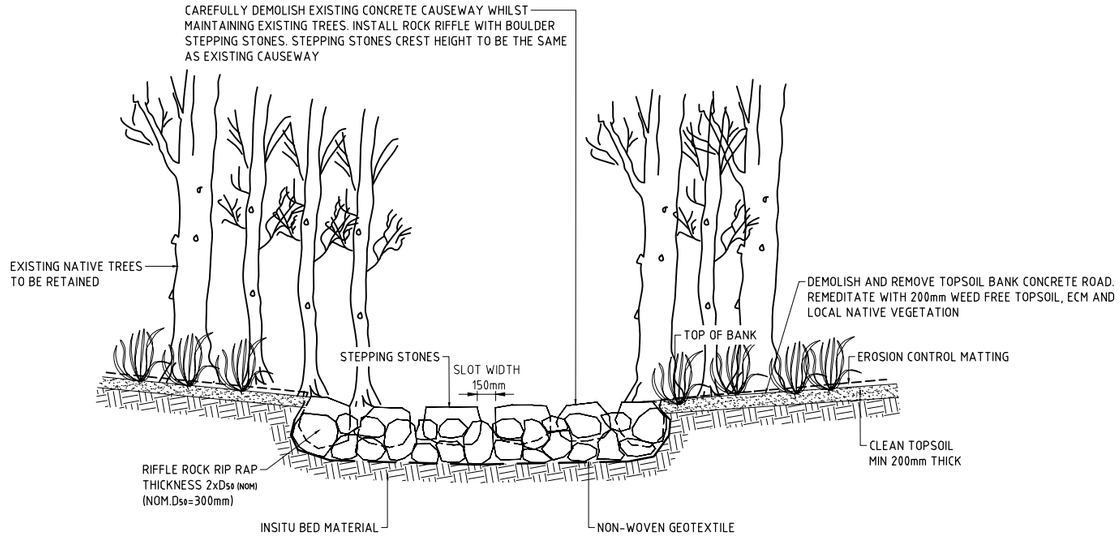
SWA1-EXT AUG 2014
554
801

CONCEPT DESIGN ONLY



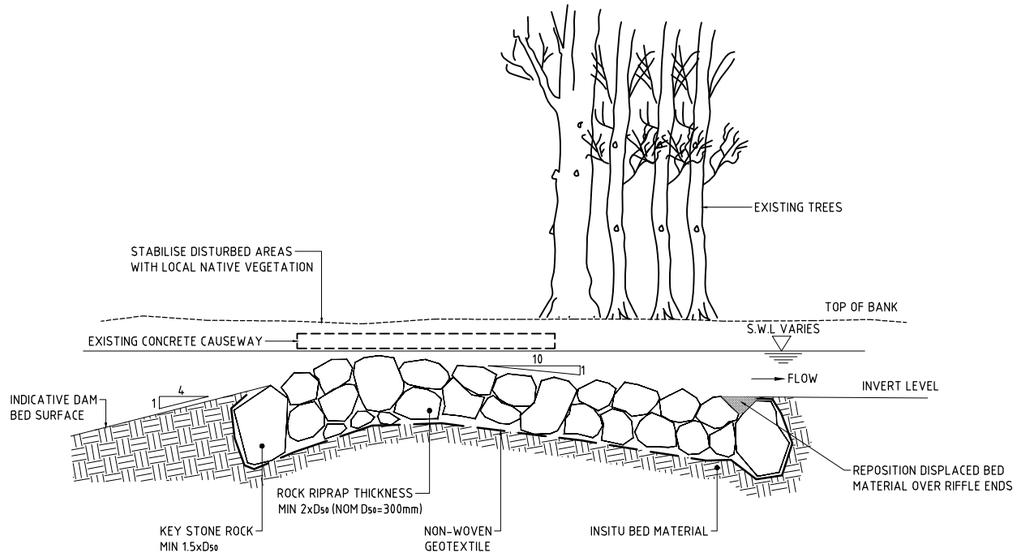
DETAIL 1 — N.T.S.

CROSS SECTION - DAM CAUSEWAY ROCK RIFFLE



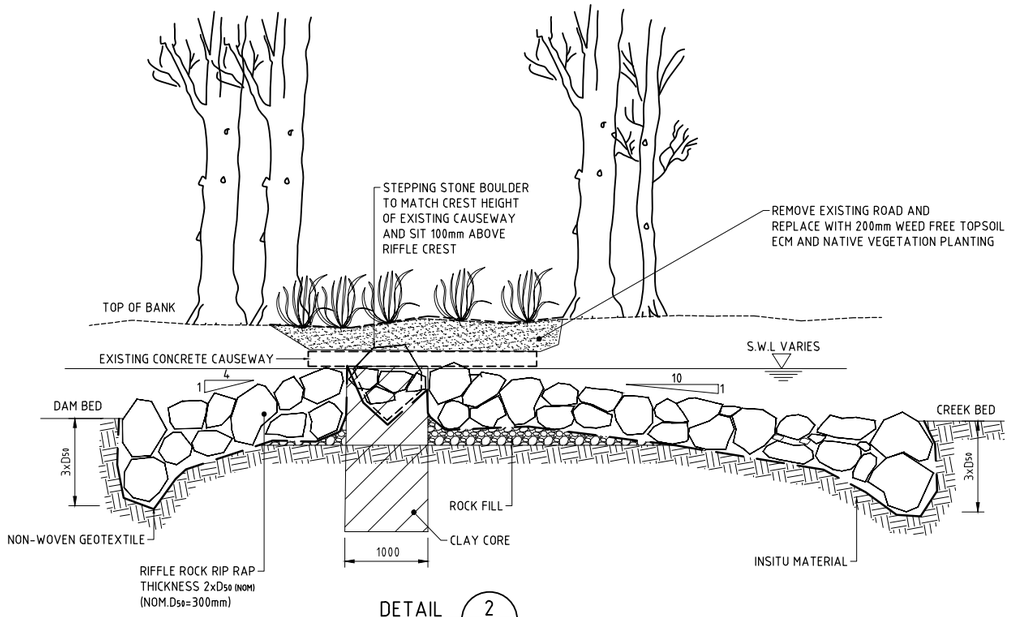
DETAIL 2 — N.T.S.

CROSS SECTION - DAM CAUSEWAY ROCK RIFFLE D/S CONTROL



DETAIL 1 — N.T.S.

LONG SECTION - DAM CAUSEWAY ROCK RIFFLE



DETAIL 2 — N.T.S.

LONG SECTION - DAM CAUSEWAY ROCK RIFFLE D/S CONTROL

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	M. CONRADIE AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TYPICAL DETAILS

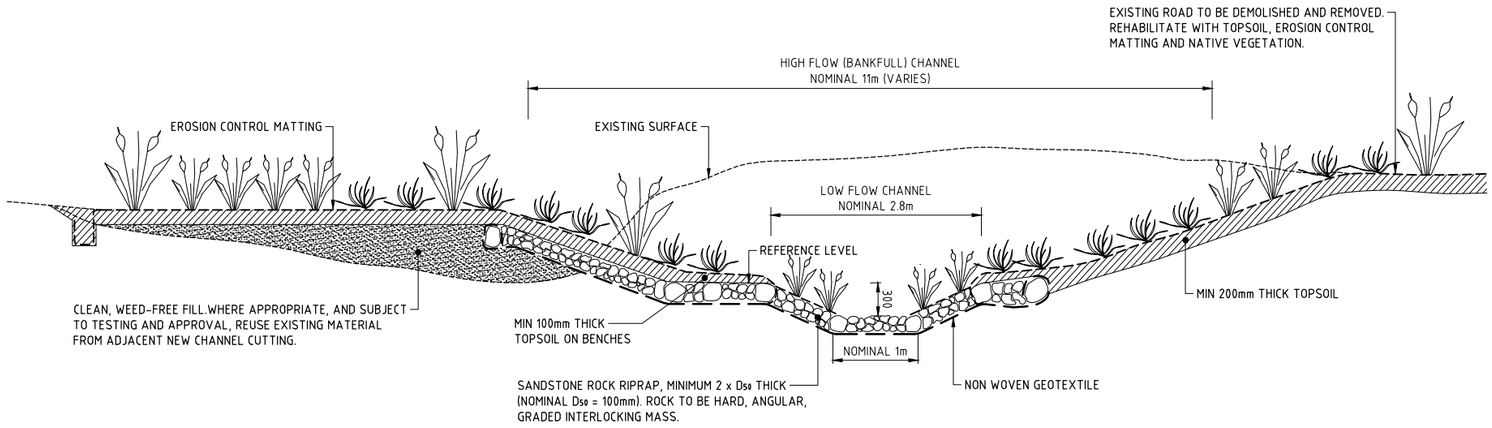
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 035

ISSUE A | SHEET No. 6 OF 10

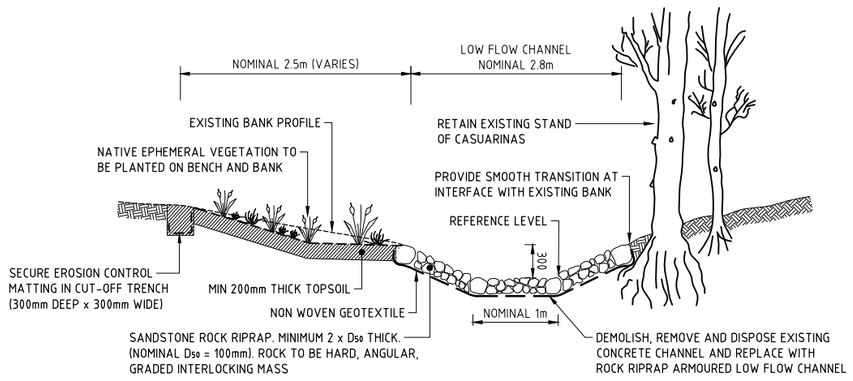
SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



DETAIL 1 / — N.T.S.

MD01 OUTER BEND PROTECTION CROSS SECTION



DETAIL 2 / — N.T.S.

MD03 CHANNEL WORKS CROSS SECTION

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16	
DRAWN	M. CONRADIE AAJV	15.04.16	
VERIFIED	B. WITHNALL AAJV	24.01.17	
APPROVED	N.BARTHO AAJV	24.01.17	

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TYPICAL DETAILS

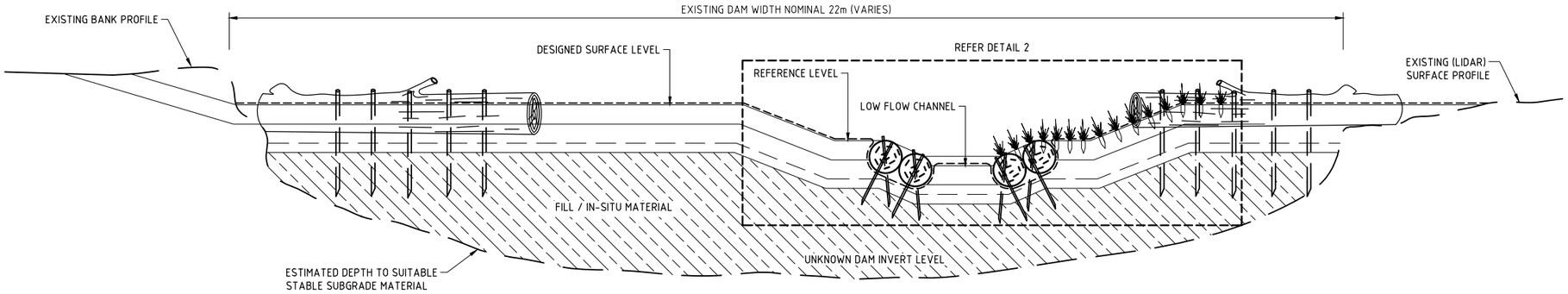
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 036

ISSUE A | SHEET No. 7 OF 10

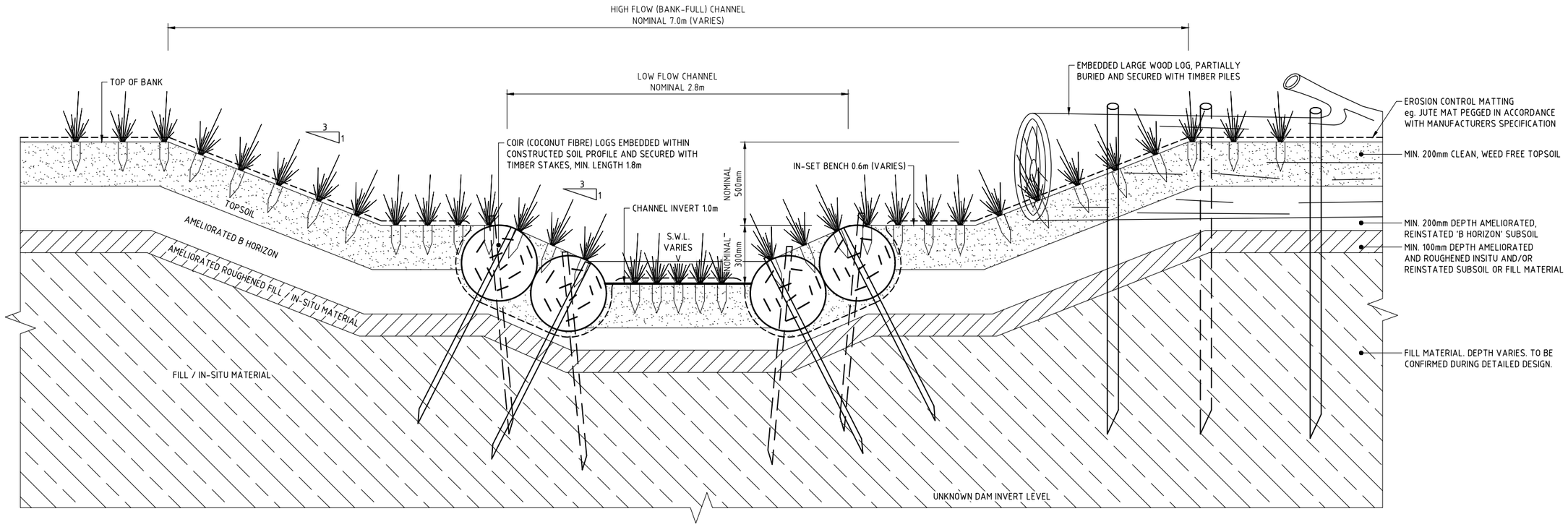
SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



DETAIL 1 — N.T.S.

ON-LINE DAM DESIGNED IN-FILLED CHANNEL CROSS SECTION



NOTE :
1. COIR LOGS TO BE PLANTED (8/LOG) WITH EPHEMERAL NATIVE VEGETATION.
2. CHANNEL INVERT TO BE DENSELY PLANTED (200mm CENTRES) WITH FAST GROWING LOCAL NATIVE MATURE AQUATIC VEGETATION.

DETAIL 2 — N.T.S.

ON-LINE DAM DESIGNED CHANNEL PROFILE

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16	
DRAWN	C.RUSINGAH AAJV	15.04.16	
VERIFIED	B. WITHNALL AAJV	24.01.17	
APPROVED	N.BARTHO AAJV	24.01.17	

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED	R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER	15.02.17
ACCEPTED	R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER	15.02.17

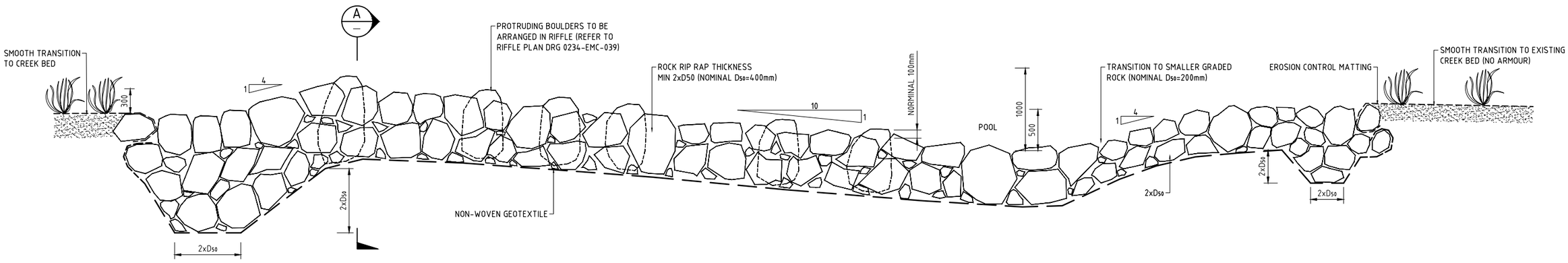
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TYPICAL DETAILS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 037
ISSUE A | SHEET No. 8 OF 10

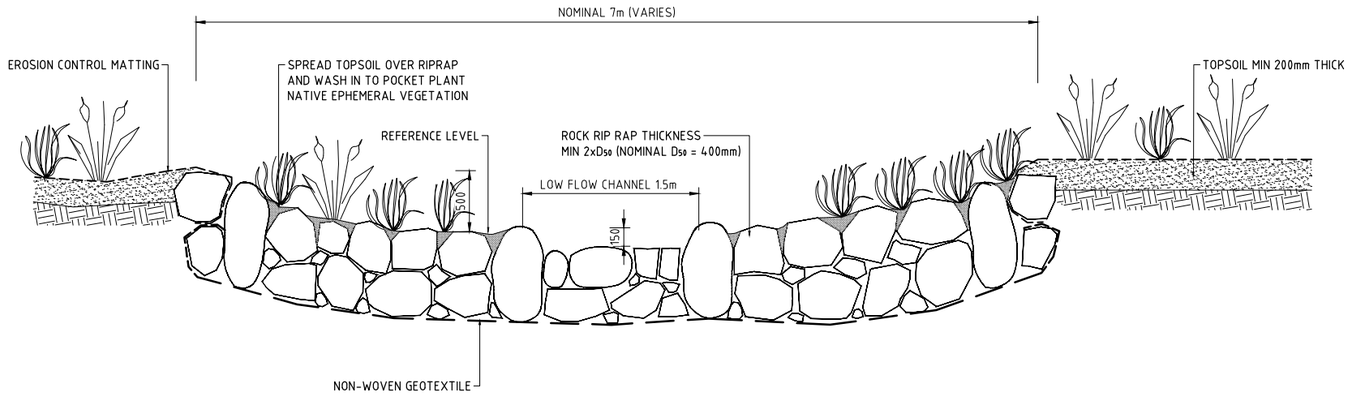
SWAL-EXT AUG 2016

CONCEPT DESIGN ONLY



DETAIL 1 / N.T.S.

RIFFLE AND POOL LONG SECTION



SECTION A / N.T.S.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	M.CONRADIE AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK ROUSE HILL DEVELOPMENT AREA TRUNK DRAINAGE CONCEPT DESIGN TYPICAL DETAILS

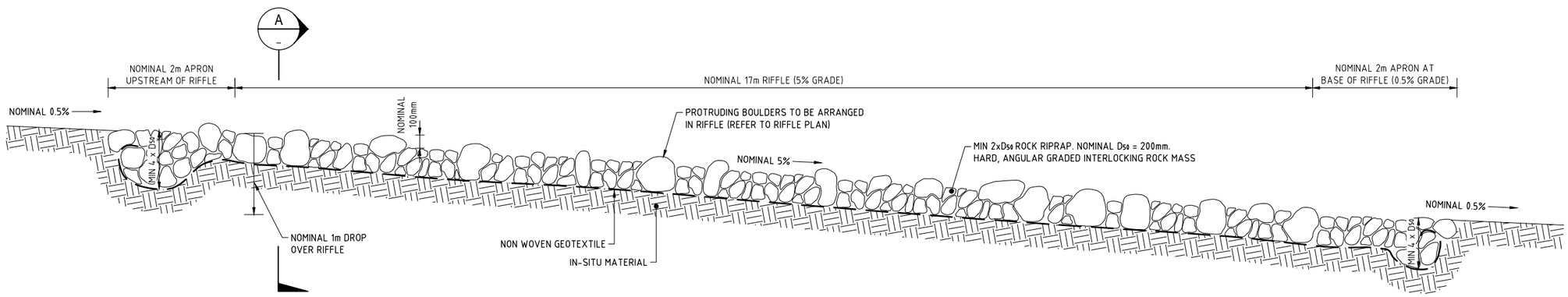
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 038

ISSUE A | SHEET No. 9 OF 10

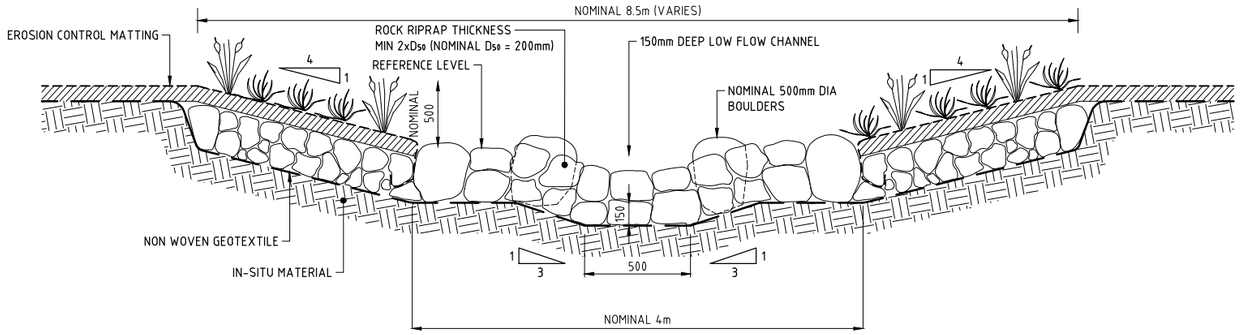
SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY

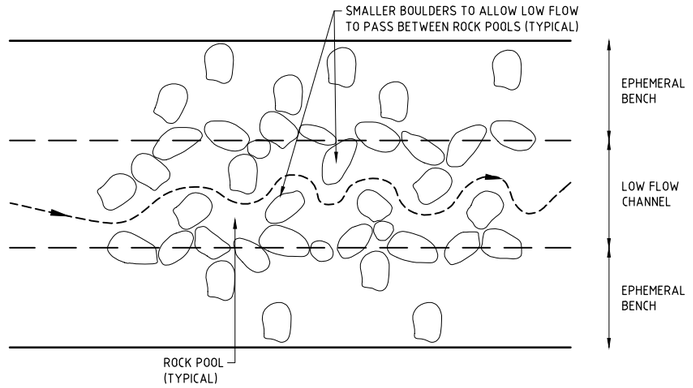


DETAIL 1 / N.T.S.

RIFFLE LONG SECTION



SECTION A / N.T.S.



DETAIL 2 / N.T.S.

PLAN - GENERIC RIFFLE ARRANGEMENT

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	M. CONRADIE AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT

THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
TYPICAL DETAILS

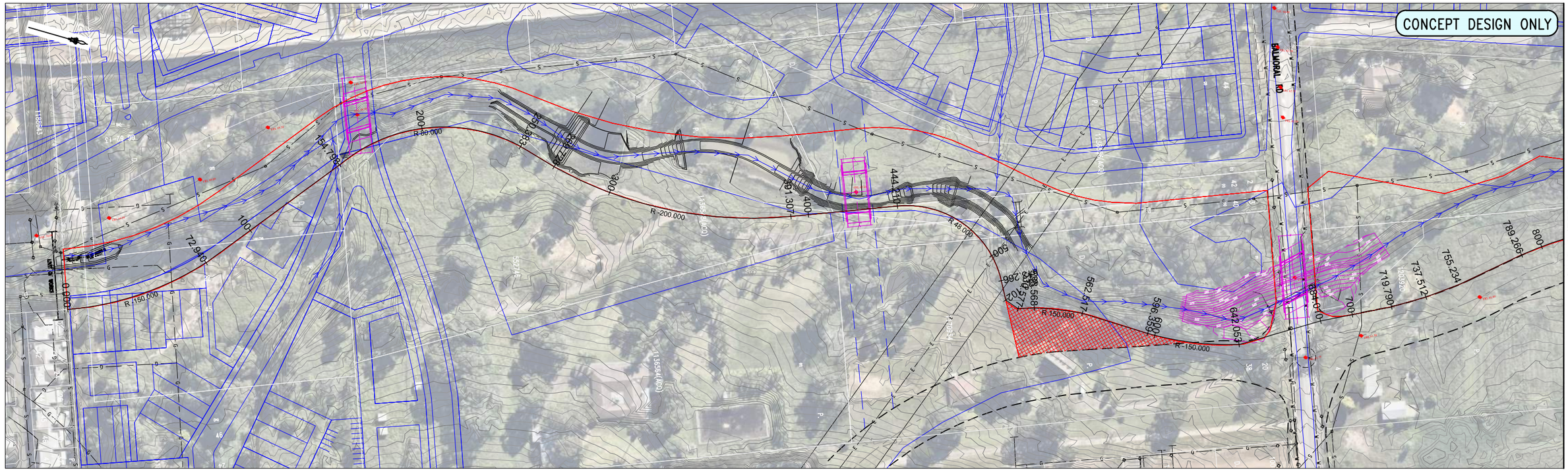
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 039

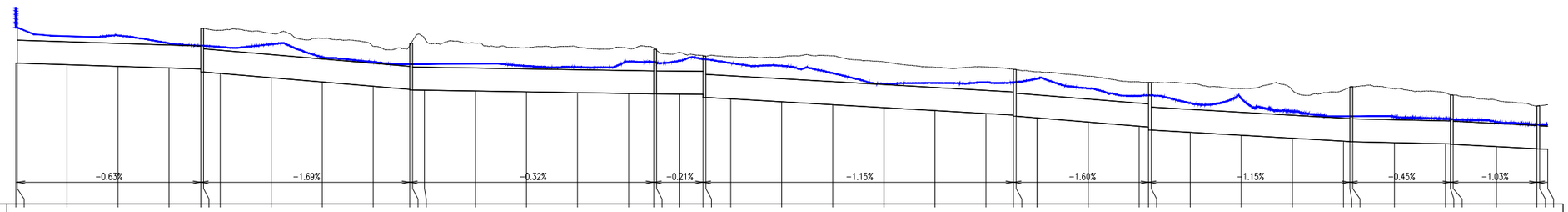
ISSUE A | SHEET No. 10 OF 10

SWAI-EXT AUG 2016
554
801

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:1000

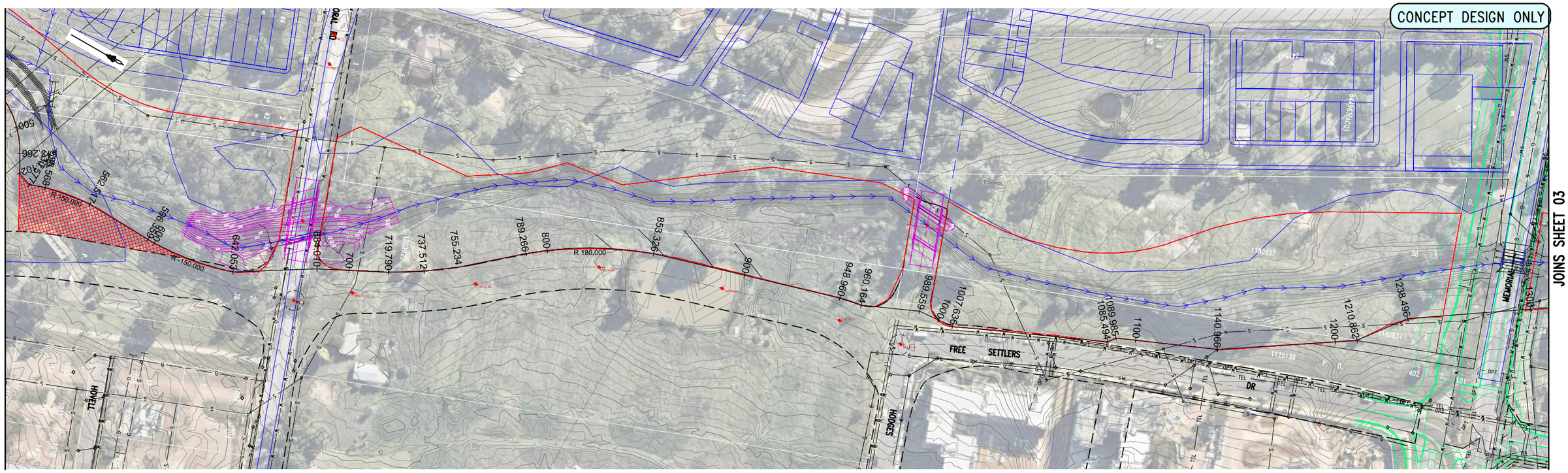


| | | |

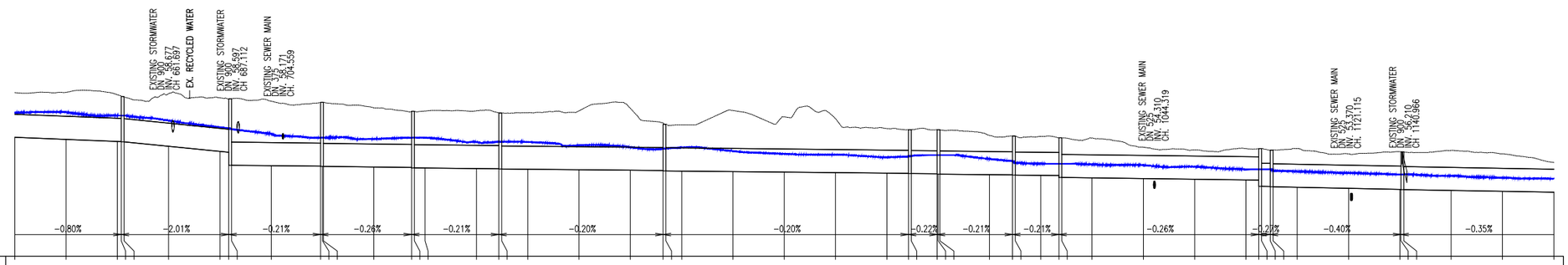
CONCEPT DESIGN ONLY

JOINS SHEET 01

JOINS SHEET 03



PLAN
SCALE: 1:1000

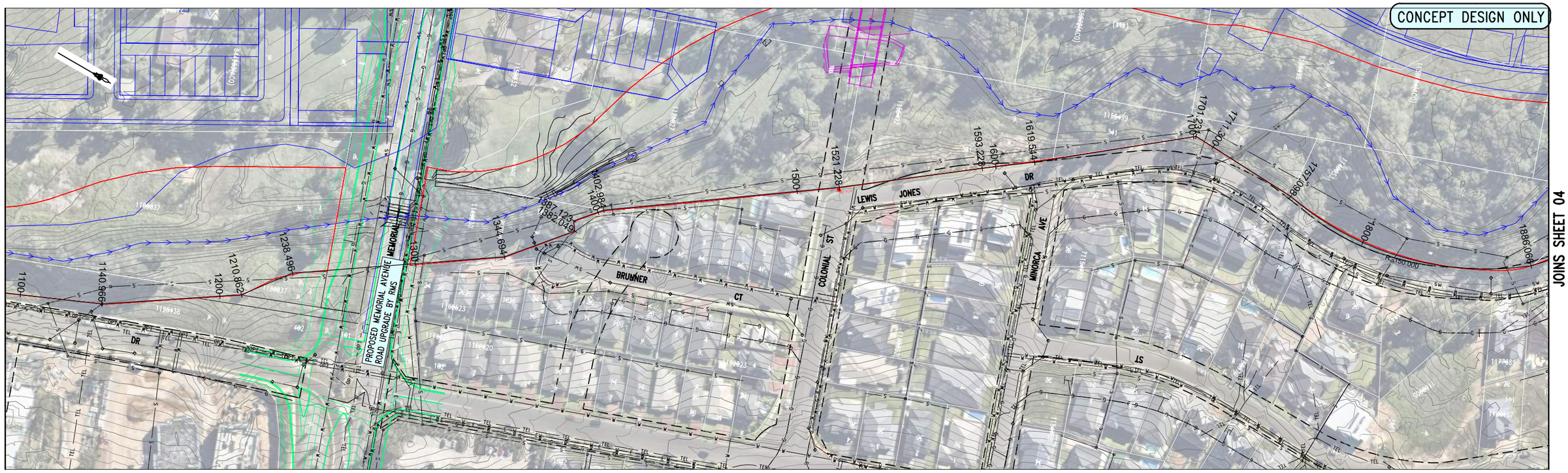


| | | |

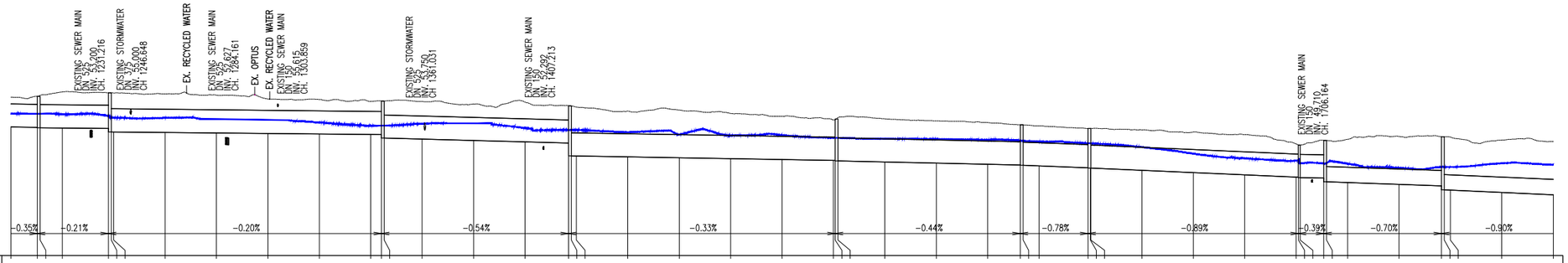
CONCEPT DESIGN ONLY

JOINS SHEET 02

JOINS SHEET 04



PLAN
SCALE: 1:1000

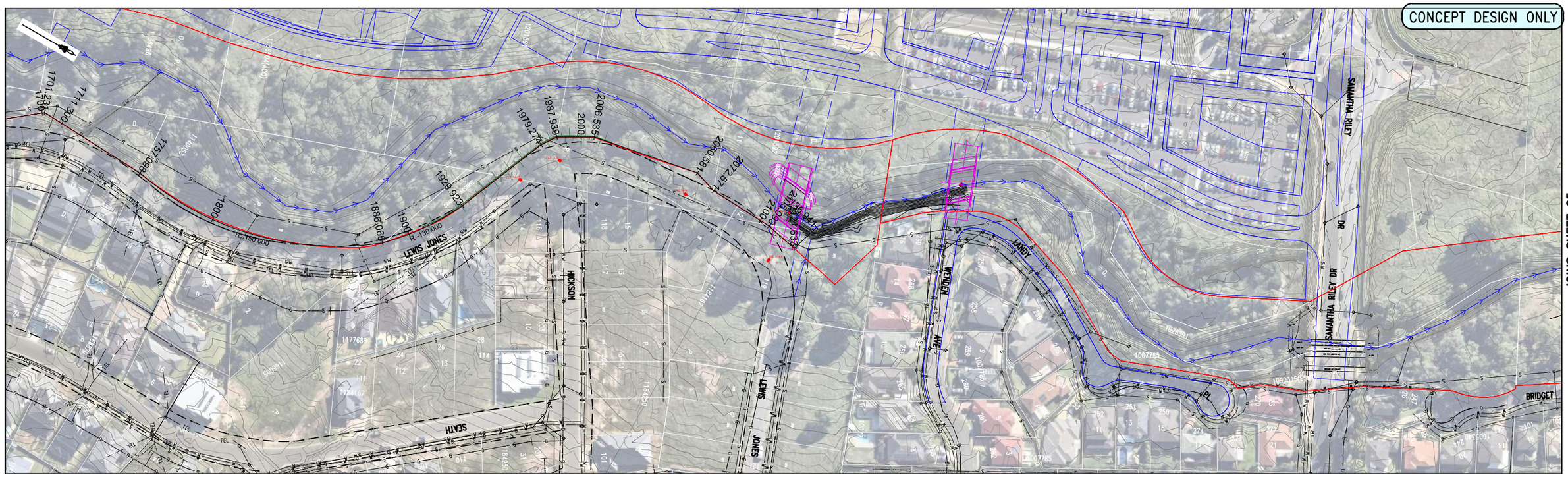


| | | |

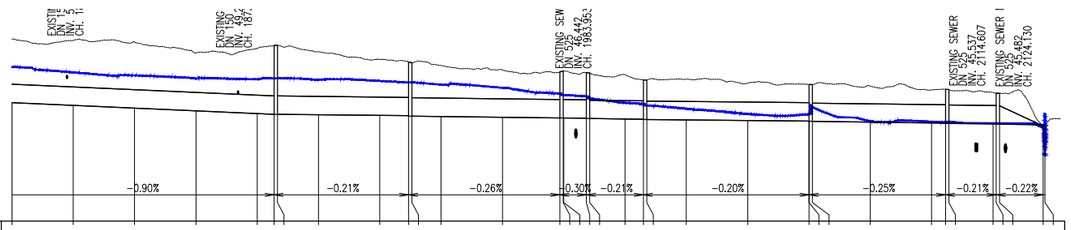
CONCEPT DESIGN ONLY

JOINS SHEET 03

JOINS SHEET 05

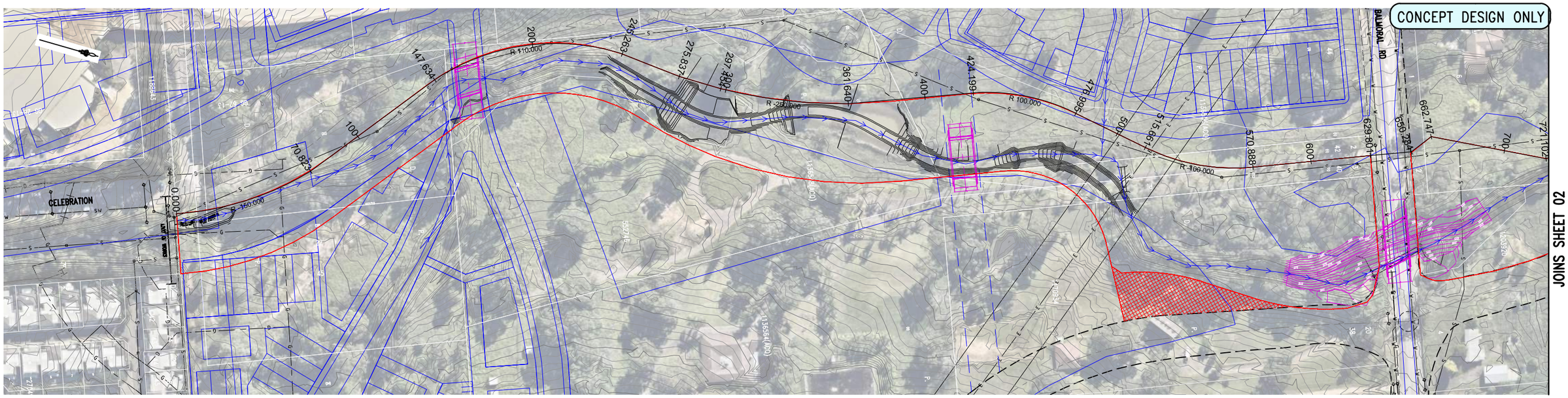


PLAN
SCALE: 1:1000

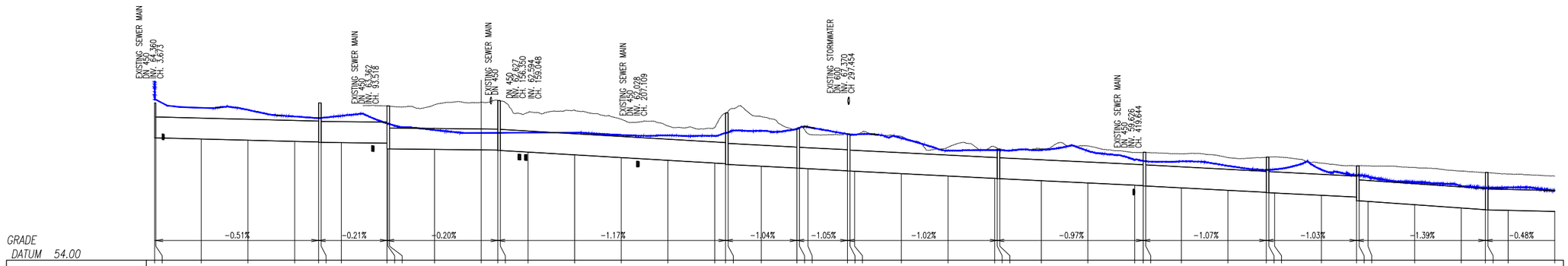


GRADE
DATUM 41.00

| | | |

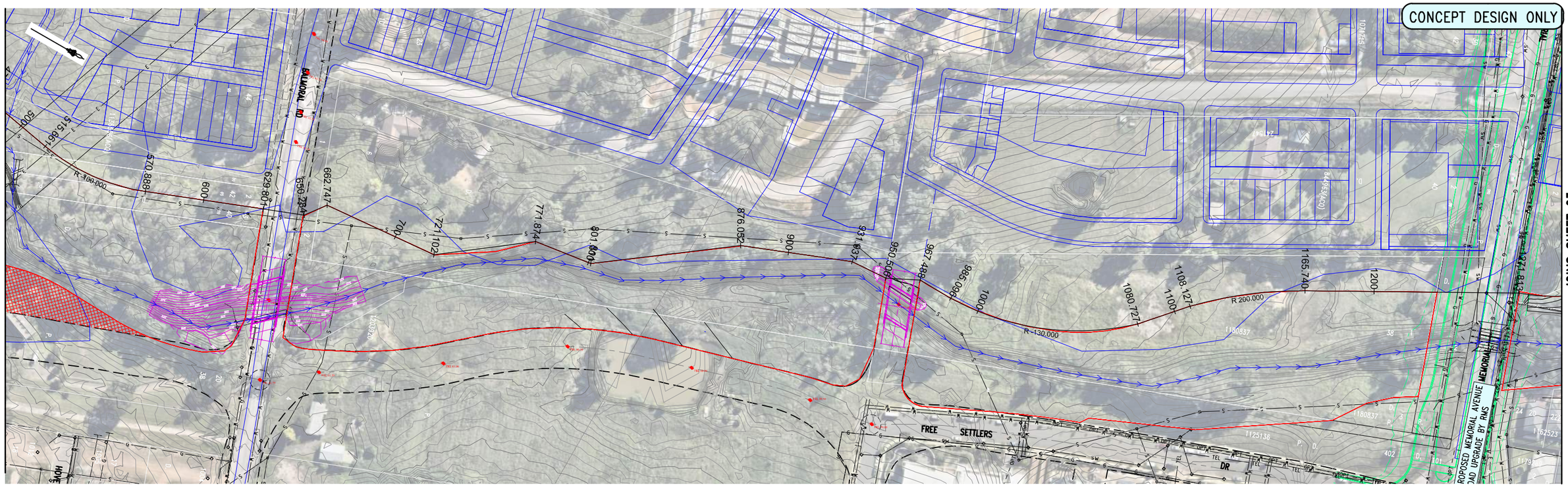


PLAN
SCALE: 1:1000

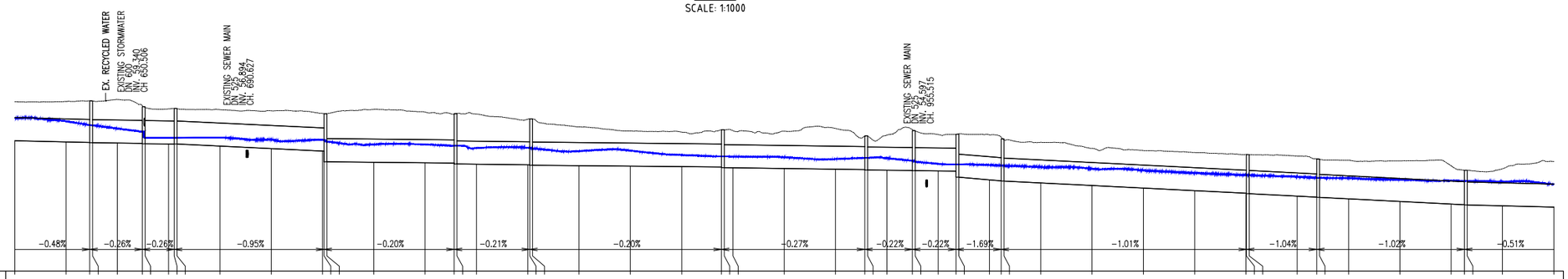


| | | |

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:1000



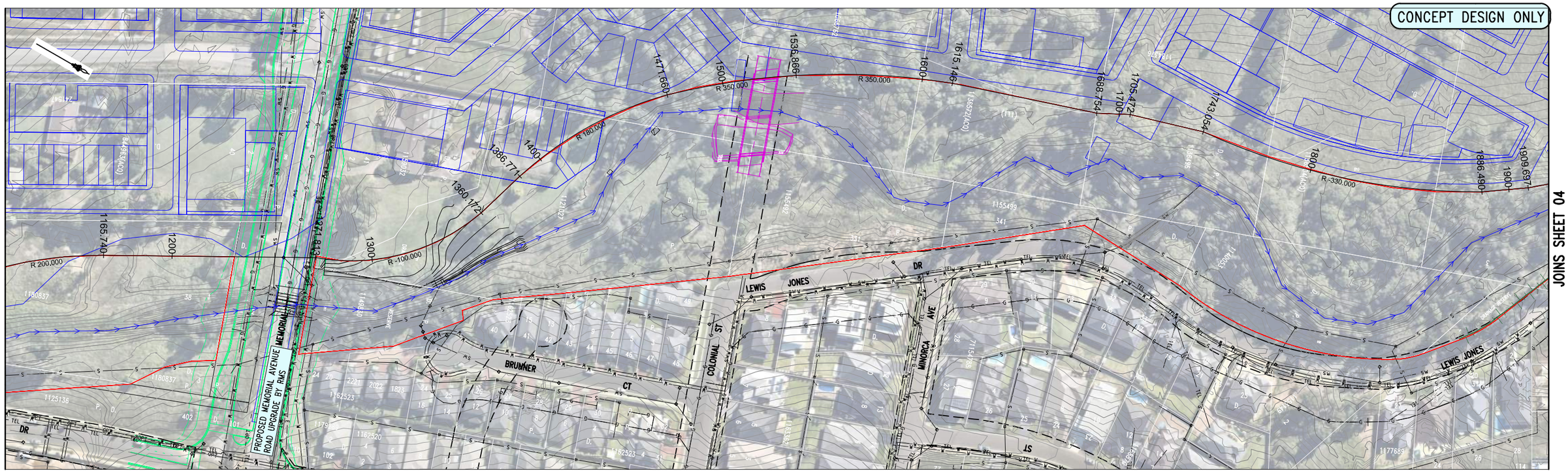
GRADE
DATUM 48.00

| | | |

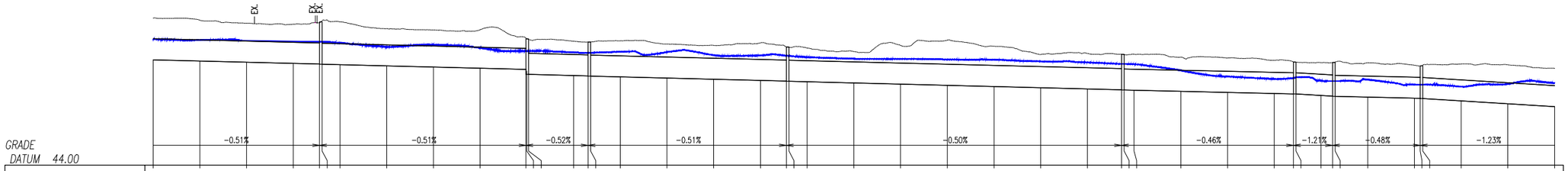
CONCEPT DESIGN ONLY

JOINS SHEET 02

JOINS SHEET 04



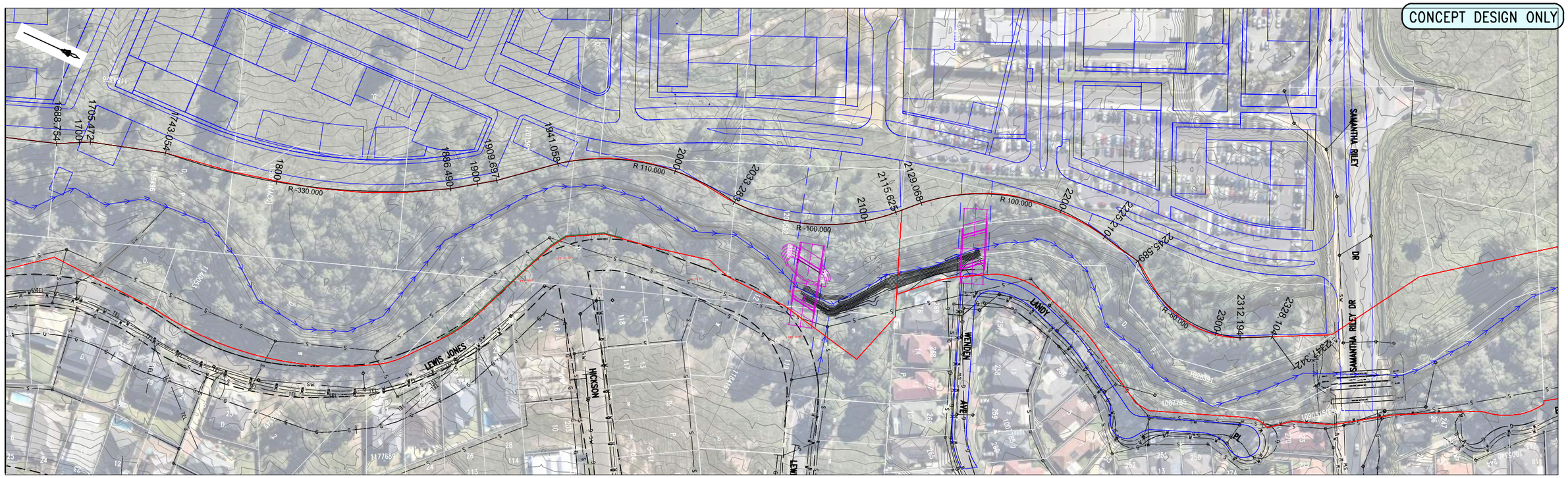
PLAN
SCALE: 1:1000



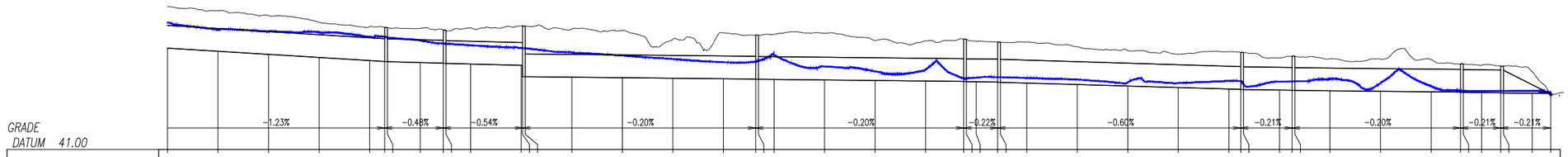
| | | |

CONCEPT DESIGN ONLY

JOINS SHEET 03



PLAN
SCALE: 1:1000



CHAINAGE	DEPTH TO INVERT	EXISTING CREEK INVERT LEVELS	PIPE INVERT LEVELS	EXISTING SURFACE LEVELS
1800.000	3.278	51.005	48.994	52.272
1820.000	3.197	50.453	48.749	51.945
1840.000	3.056	50.328	48.503	51.559
1860.000	2.781	50.246	48.258	51.038
1880.000	2.677	49.888	48.012	50.689
1885.940	2.707	49.889	47.939	50.646
1887.040	2.682	49.839	47.919	50.601
1900.000	2.695	49.592	47.857	50.552
1909.147	2.645	49.363	47.814	50.459
1910.247	2.577	49.338	47.794	50.371
1920.000	2.855	49.213	47.741	50.597
1940.000	3.121	49.003	47.634	50.754
1940.000	3.061	49.003	47.674	50.754
1941.608	3.388	48.983	46.741	50.729
1960.000	3.800	48.634	46.704	50.504
1980.000	3.715	48.421	46.663	50.379
2000.000	3.072	48.134	46.623	49.695
2020.000	3.620	47.887	46.583	50.203
2032.733	3.472	47.913	46.557	50.029
2033.833	3.477	48.010	46.537	50.014
2040.000	3.562	48.463	46.524	50.086
2060.000	3.698	47.554	46.484	50.182
2080.000	3.160	47.161	46.443	49.603
2100.000	3.173	47.311	46.403	49.575
2115.075	3.350	46.617	46.372	49.722
2116.175	3.311	46.584	46.332	49.663
2120.000	3.200	46.869	46.344	49.544
2128.518	3.163	46.701	46.325	49.489
2129.618	3.155	46.707	46.305	49.460
2140.000	3.225	46.646	46.243	49.468
2160.000	2.979	46.514	46.124	49.104
2180.000	2.806	46.301	46.005	48.811
2200.000	2.633	46.241	45.886	48.520
2220.000	2.951	46.406	45.767	48.718
2224.660	2.928	46.388	45.739	48.667
2225.760	2.931	46.150	45.719	48.650
2240.000	2.538	46.389	45.689	48.227
2245.139	2.681	46.530	45.679	48.360
2246.139	2.696	46.132	45.659	48.355
2260.000	2.518	46.560	45.630	48.148
2280.000	2.547	46.250	45.590	48.137
2300.000	2.555	45.993	45.549	48.104
2311.644	2.224	45.648	45.525	47.749
2312.744	2.241	45.623	45.505	47.746
2320.000	2.171	45.579	45.490	47.661
2327.554	2.120	45.504	45.474	47.593
2328.654	2.128	46.020	45.464	47.582
2340.000	1.712	45.647	45.430	47.142
2347.342	−0.040	45.469	45.415	45.375

LONGITUDINAL SECTION – WEST PIPELINE
A1 HORIZONTAL SCALE 1:1000
A1 VERTICAL SCALE 1:200

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

1 : 2000 (A3) 1 : 1000 (A1)
1 : 400 (A3) 1 : 200 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN:STORMWATER HARVESTING PIPES
PLAN AND LONGITUDINAL SECTION - WEST

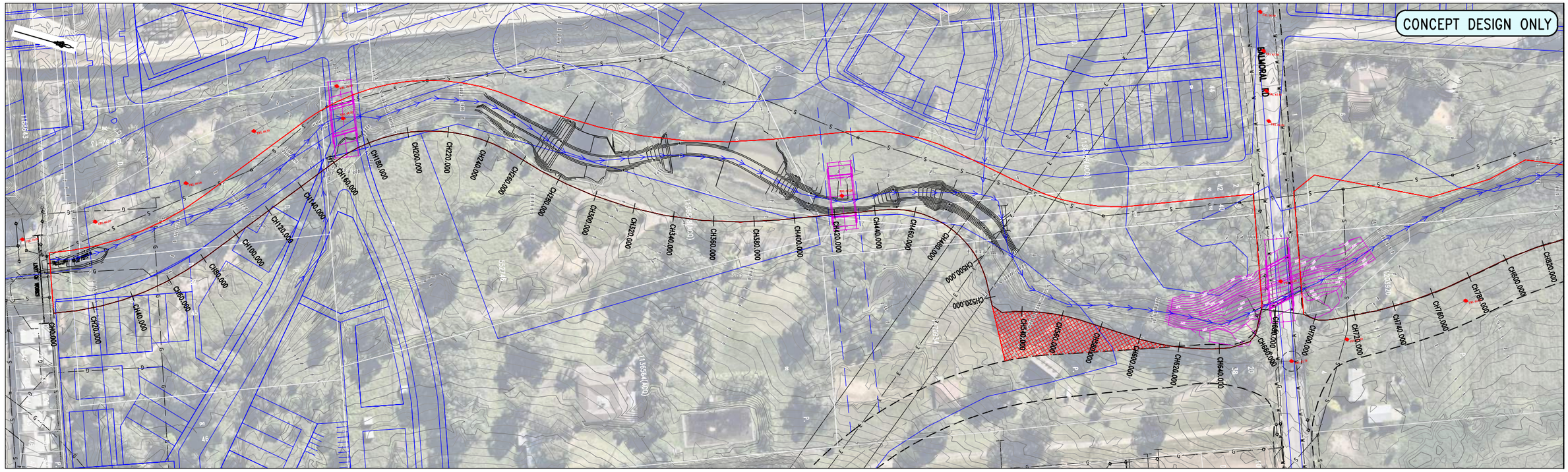
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 057
ISSUE A | SHEET No. 4 OF 4

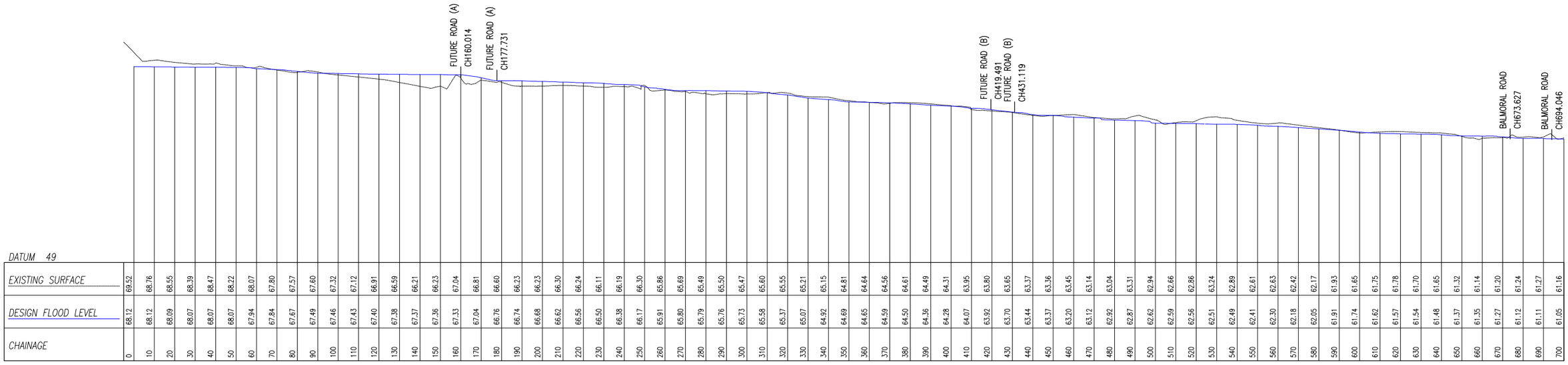
SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY

JOINS SHEET 02



PLAN
SCALE: 1:1000



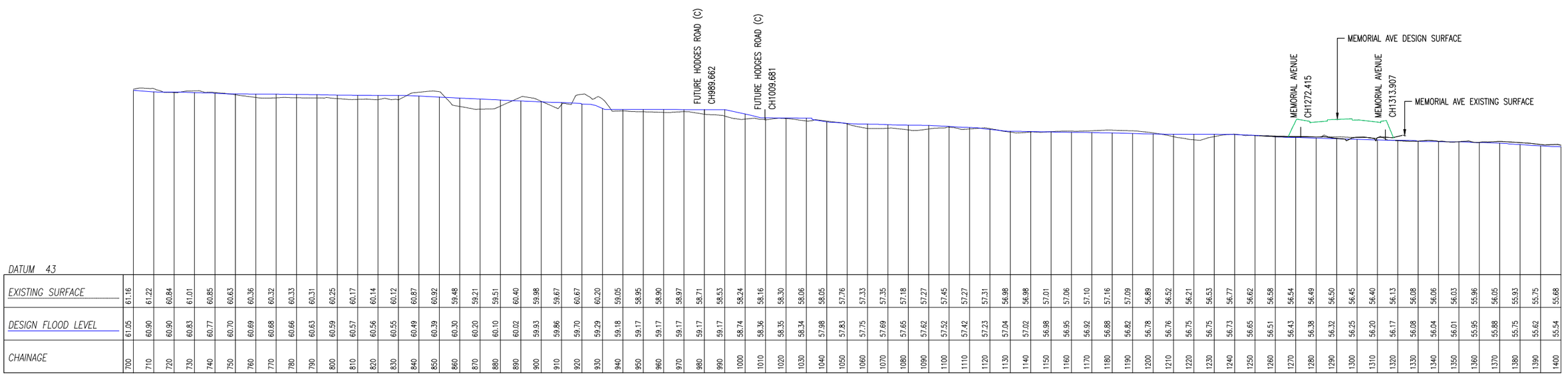
| DATUM 49 | | |

CONCEPT DESIGN ONLY

JOINS SHEET 01

JOINS SHEET 03

PLAN
SCALE: 1:1000



LONGITUDINAL SECTION – OCH–FLOOD–BDY–EAST
A1 HORIZONTAL SCALE 1:1000
A1 VERTICAL SCALE 1:200

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234–EMC–003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

10000 0 10000 20000 30000 40000mm
1 : 2000 (A3) 1 :1000 (A1)

2000 0 2000 4000 6000 8000mm
1 :400 (A3) 1 :200 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
DESIGN FLOOD PROFILE - EAST BOUNDARY

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

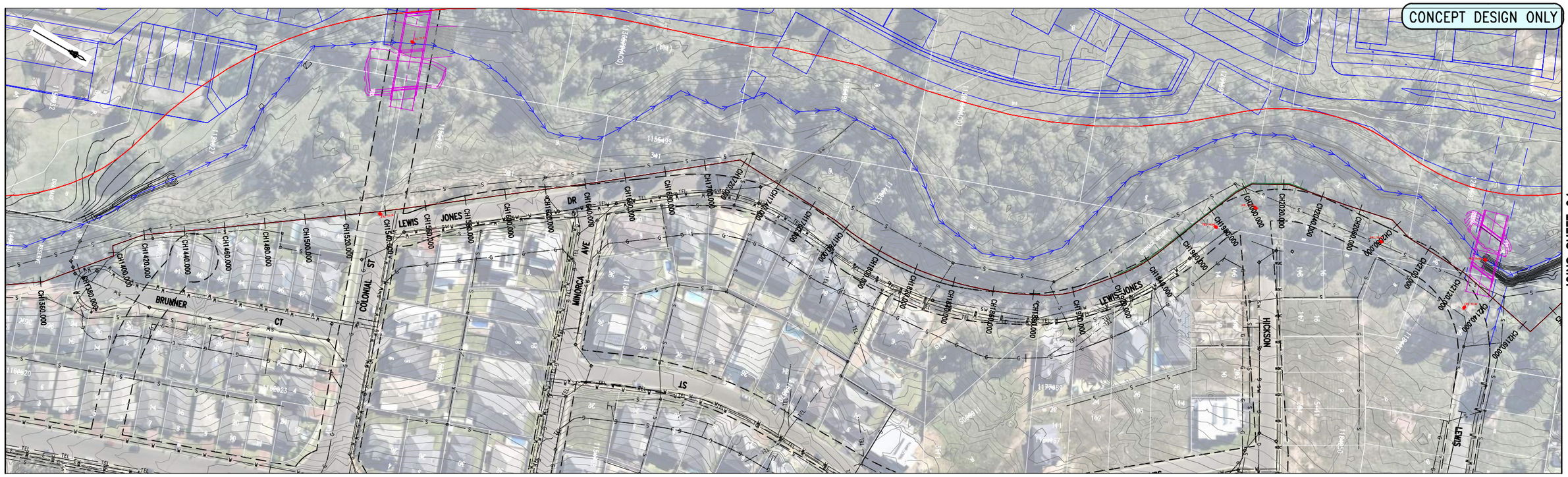
DRAWING No. 0234-EMC 061
ISSUE A | SHEET No. 2 OF 4

SWATI-EXT AUG 2014

CONCEPT DESIGN ONLY

JOINS SHEET 02

JOINS SHEET 04



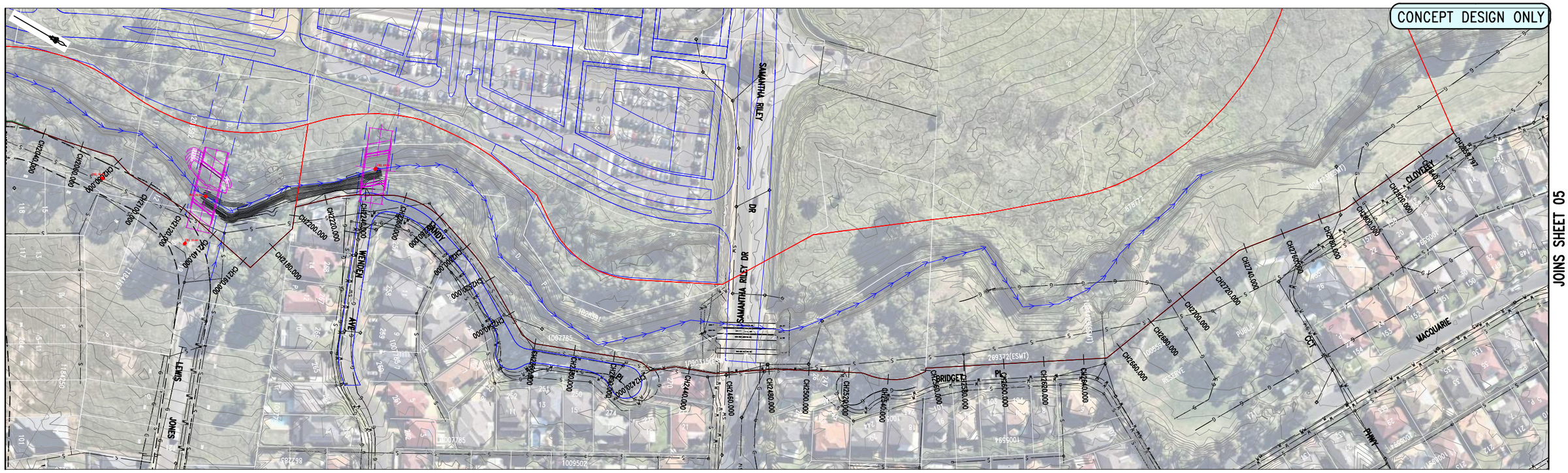
PLAN
SCALE: 1:1000

FUTURE COLONIAL ROAD (D) CH1526.577

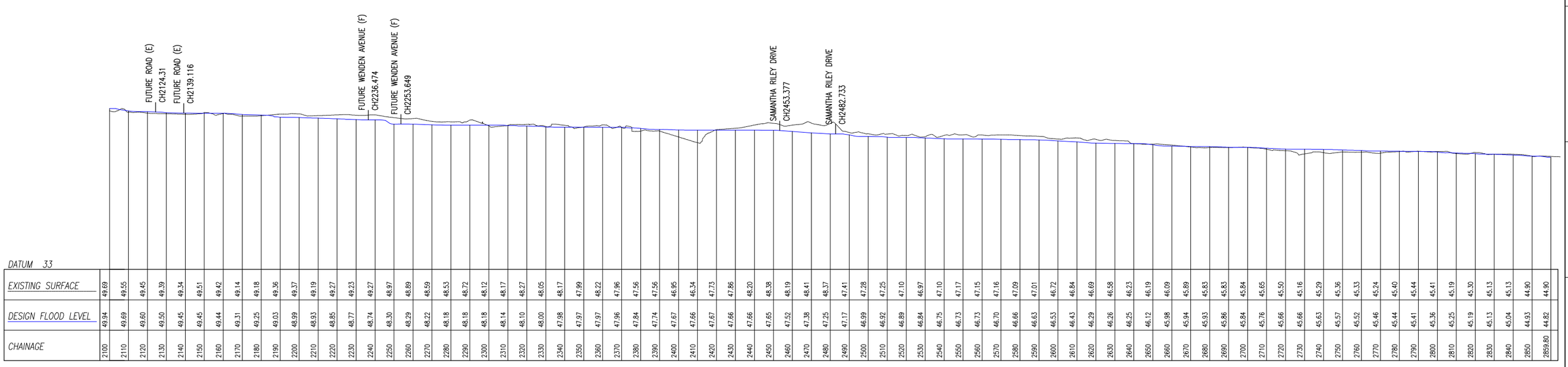
FUTURE COLONIAL ROAD (D) CH1552.295

| | | |

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:1000



LONGITUDINAL SECTION – OCH-FLOOD-BDY-EAST
A1 HORIZONTAL SCALE 1:1000
A1 VERTICAL SCALE 1:200

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

10000 0 10000 20000 30000 40000mm
1 : 2000 (A3) 1 :1000 (A1)
2000 0 2000 4000 6000 8000mm
1:400 (A3) 1 :200 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

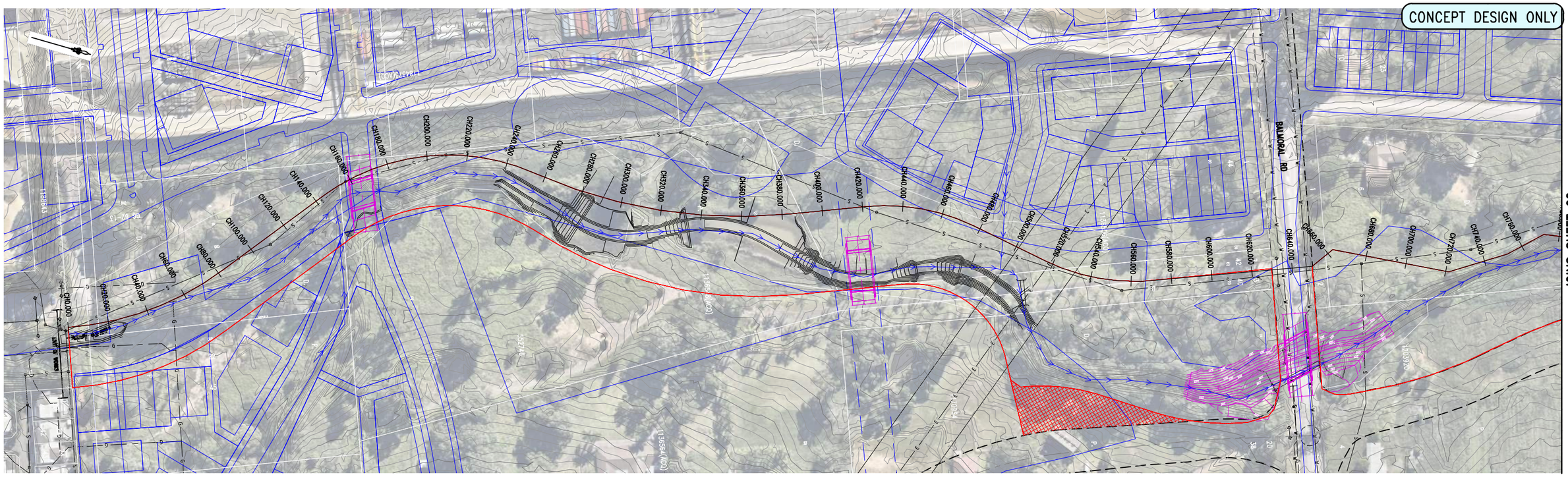
RECOMMENDED	R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER	15.02.17
ACCEPTED	R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER	15.02.17

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
DESIGN FLOOD PROFILE - EAST BOUNDARY

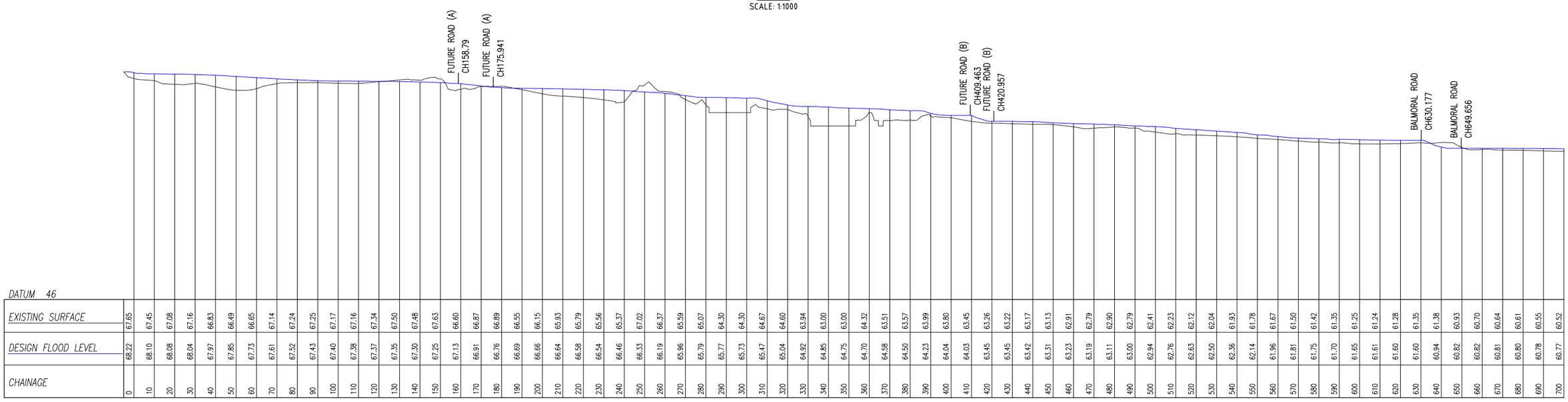
A1	PROJ No. 20029728	DRAWING STATUS: FINAL CONCEPT	DRAWING No. 0234-EMC 063	ISSUE A	SHEET No. 4 OF 4

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:1000



DATUM 46

CHAINAGE	EXISTING SURFACE	DESIGN FLOOD LEVEL
0	67.65	68.22
10	67.45	68.10
20	67.08	68.08
30	67.16	68.04
40	66.83	67.97
50	66.49	67.85
60	66.65	67.73
70	67.14	67.61
80	67.24	67.52
90	67.25	67.43
100	67.17	67.40
110	67.16	67.38
120	67.34	67.37
130	67.50	67.35
140	67.48	67.30
150	67.63	67.25
160	66.60	67.13
170	66.87	66.91
180	66.89	66.76
190	66.55	66.69
200	66.15	66.66
210	65.93	66.64
220	65.79	66.58
230	65.56	66.54
240	65.37	66.46
250	67.02	66.33
260	66.37	66.19
270	65.59	65.96
280	65.07	65.79
290	64.30	65.77
300	64.30	65.73
310	64.67	65.47
320	64.60	65.04
330	63.94	64.92
340	63.00	64.85
350	63.00	64.75
360	64.32	64.70
370	63.51	64.58
380	63.57	64.50
390	63.99	64.23
400	63.80	64.04
410	63.45	64.03
420	63.26	63.45
430	63.22	63.45
440	63.17	63.42
450	63.13	63.31
460	62.91	63.23
470	62.79	63.19
480	62.90	63.11
490	62.79	63.00
500	62.41	62.94
510	62.23	62.76
520	62.12	62.63
530	62.04	62.50
540	61.93	62.36
550	61.78	62.14
560	61.67	61.96
570	61.50	61.81
580	61.42	61.75
590	61.35	61.70
600	61.25	61.65
610	61.24	61.61
620	61.28	61.60
630	61.35	61.60
640	61.38	60.94
650	60.93	60.82
660	60.70	60.82
670	60.64	60.81
680	60.61	60.80
690	60.55	60.78
700	60.52	60.77

LONGITUDINAL SECTION – OCH-FLOOD-BDY-WEST
A1 HORIZONTAL SCALE 1:1000
A1 VERTICAL SCALE 1:200

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

10000 0 10000 20000 30000 40000mm
1 : 2000 (A3) 1 : 1000 (A1)
2000 0 2000 4000 6000 8000mm
1 : 400 (A3) 1 : 200 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
DESIGN FLOOD PROFILE - WEST BOUNDARY

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 064
ISSUE A | SHEET No. 1 OF 4

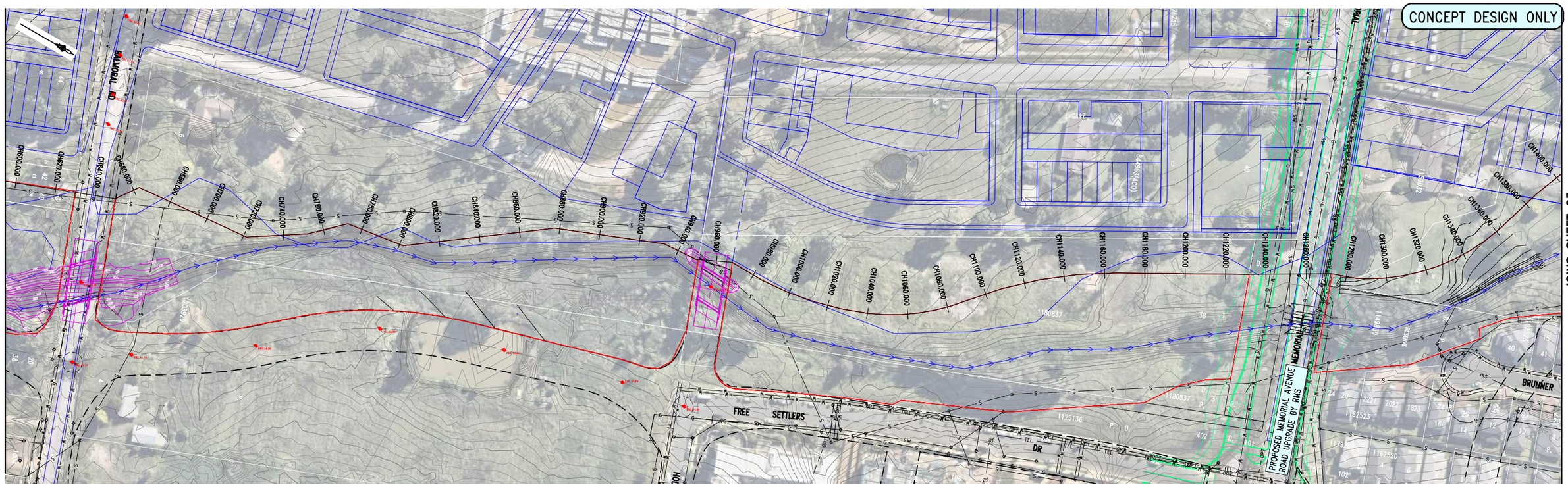
JOINS SHEET 02

SWA1-EXT AUG 2014

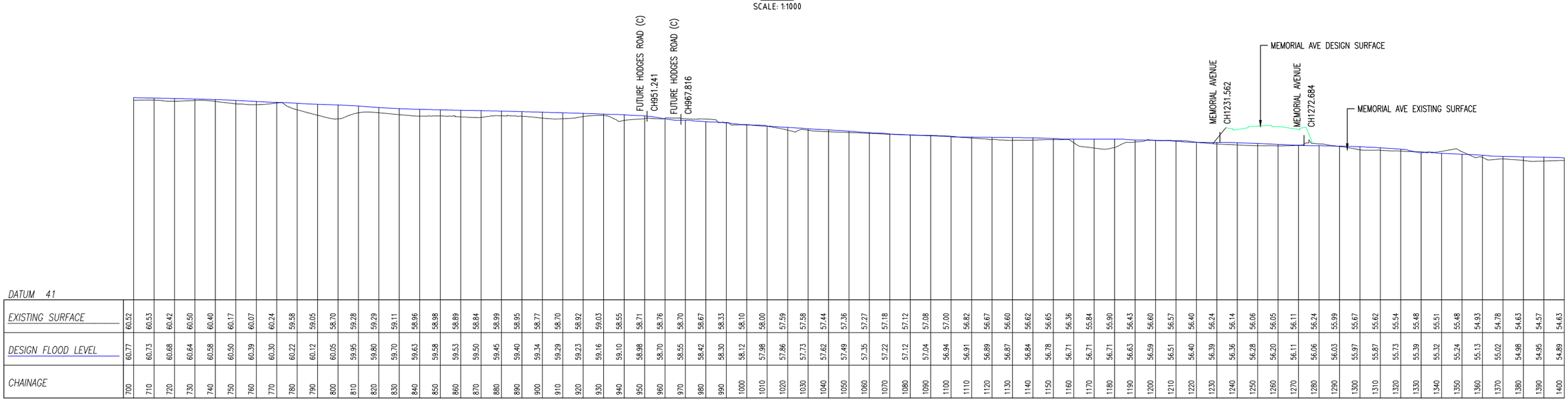
CONCEPT DESIGN ONLY

JOINS SHEET 01

JOINS SHEET 03



PLAN
SCALE: 1:1000



DATUM 41

CHAINAGE	EXISTING SURFACE	DESIGN FLOOD LEVEL
700	60.52	60.77
710	60.53	60.73
720	60.42	60.68
730	60.50	60.64
740	60.40	60.58
750	60.17	60.50
760	60.07	60.39
770	60.24	60.30
780	59.58	60.22
790	59.05	60.12
800	58.70	60.05
810	59.28	59.95
820	59.29	59.80
830	59.11	59.70
840	58.96	59.63
850	58.98	59.58
860	58.89	59.53
870	58.84	59.50
880	58.99	59.45
890	58.95	59.40
900	58.77	59.34
910	58.70	59.29
920	58.92	59.23
930	59.03	59.16
940	58.55	59.10
950	58.71	58.98
960	58.76	58.70
970	58.70	58.55
980	58.67	58.42
990	58.33	58.30
1000	58.10	58.12
1010	58.00	57.98
1020	57.59	57.86
1030	57.58	57.73
1040	57.44	57.62
1050	57.36	57.49
1060	57.27	57.35
1070	57.18	57.22
1080	57.12	57.12
1090	57.08	57.04
1100	57.00	56.94
1110	56.82	56.91
1120	56.67	56.89
1130	56.60	56.87
1140	56.62	56.84
1150	56.65	56.78
1160	56.36	56.71
1170	55.84	56.71
1180	55.90	56.71
1190	56.43	56.63
1200	56.60	56.59
1210	56.57	56.51
1220	56.40	56.40
1230	56.24	56.39
1240	56.14	56.36
1250	56.06	56.28
1260	56.05	56.20
1270	56.11	56.11
1280	56.24	56.06
1290	55.99	56.03
1300	55.67	55.97
1310	55.62	55.87
1320	55.54	55.73
1330	55.48	55.39
1340	55.51	55.32
1350	55.48	55.24
1360	54.93	55.13
1370	54.78	55.02
1380	54.63	54.98
1390	54.57	54.95
1400	54.63	54.89

LONGITUDINAL SECTION – OCH-FLOOD-BDY-WEST
A1 HORIZONTAL SCALE 1:1000
A1 VERTICAL SCALE 1:200

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

10000 0 10000 20000 30000 40000mm
1 : 2000 (A3) 1 :1000 (A1)

2000 0 2000 4000 6000 8000mm
1:400 (A3) 1 :200 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

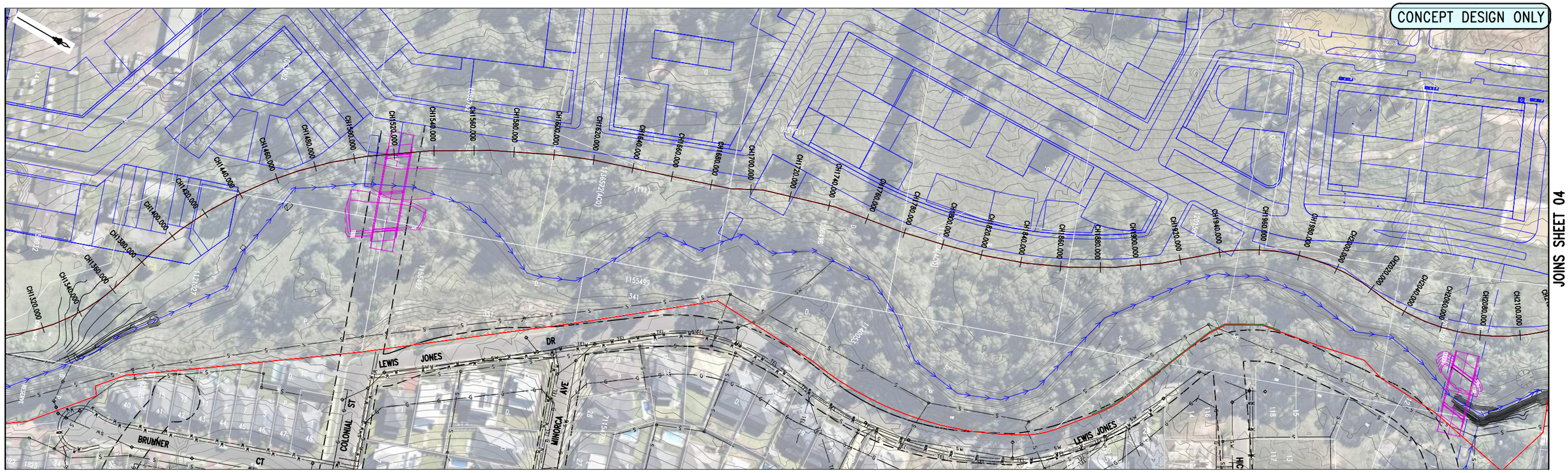
ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
DESIGN FLOOD PROFILE - WEST BOUNDARY

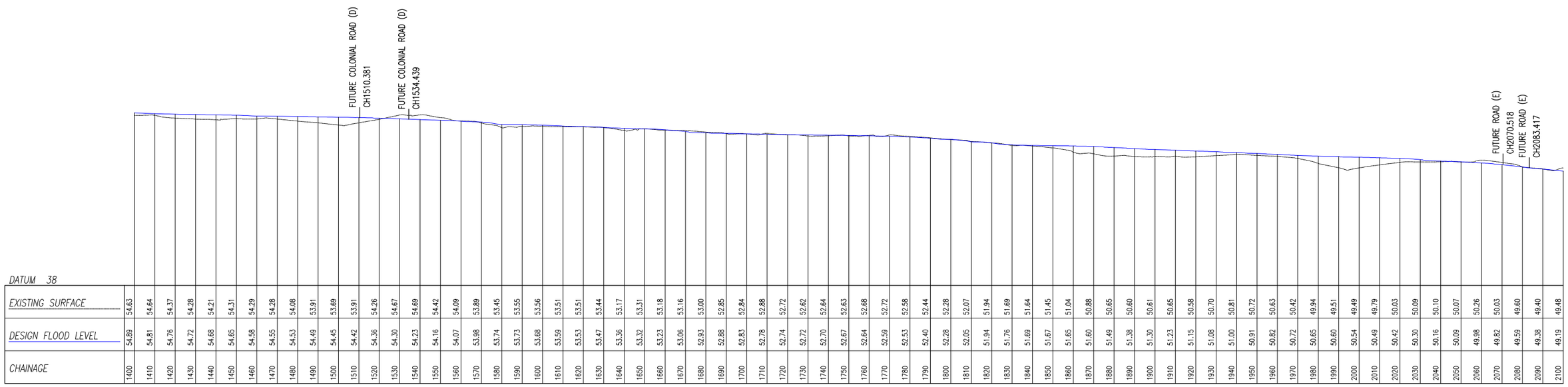
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 065
ISSUE A | SHEET No. 2 OF 4

SWATI.EXT AUG 2014



PLAN
SCALE: 1:1000



DATUM 38

CHAINAGE	EXISTING SURFACE	DESIGN FLOOD LEVEL
1400	54.63	54.89
1410	54.64	54.81
1420	54.37	54.76
1430	54.28	54.72
1440	54.21	54.68
1450	54.31	54.65
1460	54.29	54.58
1470	54.28	54.55
1480	54.08	54.53
1490	53.91	54.49
1500	53.69	54.45
1510	53.91	54.42
1520	54.26	54.36
1530	54.67	54.30
1540	54.69	54.23
1550	54.42	54.16
1560	54.09	54.07
1570	53.89	53.98
1580	53.45	53.74
1590	53.55	53.73
1600	53.56	53.68
1610	53.51	53.59
1620	53.51	53.53
1630	53.44	53.47
1640	53.17	53.36
1650	53.31	53.32
1660	53.18	53.23
1670	53.16	53.06
1680	53.00	52.93
1690	52.85	52.88
1700	52.84	52.83
1710	52.88	52.78
1720	52.72	52.74
1730	52.62	52.72
1740	52.64	52.70
1750	52.63	52.67
1760	52.68	52.64
1770	52.72	52.59
1780	52.58	52.53
1790	52.44	52.40
1800	52.28	52.28
1810	52.07	52.05
1820	51.94	51.94
1830	51.69	51.76
1840	51.64	51.69
1850	51.45	51.67
1860	51.04	51.65
1870	50.88	51.60
1880	50.65	51.49
1890	50.60	51.38
1900	50.61	51.30
1910	50.65	51.23
1920	50.58	51.15
1930	50.70	51.08
1940	50.81	51.00
1950	50.72	50.91
1960	50.63	50.82
1970	50.42	50.72
1980	49.94	50.65
1990	49.51	50.60
2000	49.49	50.54
2010	49.79	50.49
2020	50.03	50.42
2030	50.09	50.30
2040	50.10	50.16
2050	50.07	50.09
2060	50.26	49.98
2070	50.03	49.82
2080	49.60	49.59
2090	49.40	49.38
2100	49.48	49.19

LONGITUDINAL SECTION – 0CH–FLOOD–BDY–WEST
A1 HORIZONTAL SCALE 1:1000
A1 VERTICAL SCALE 1:200

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234–EMC–003.
2. FOR COMPLETE LANDFILL EXTENTS REFER TO SUPPLEMENTARY GENERAL ARRANGEMENT DRAWINGS No's 0234–EMC–121 TO 0234–EMC–127.

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234–EMC–003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

10000 0 10000 20000 30000 40000mm
1 : 2000 (A3) 1 :1000 (A1)

2000 0 2000 4000 6000 8000mm
1 :400 (A3) 1 :200 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
DESIGN FLOOD PROFILE - WEST BOUNDARY

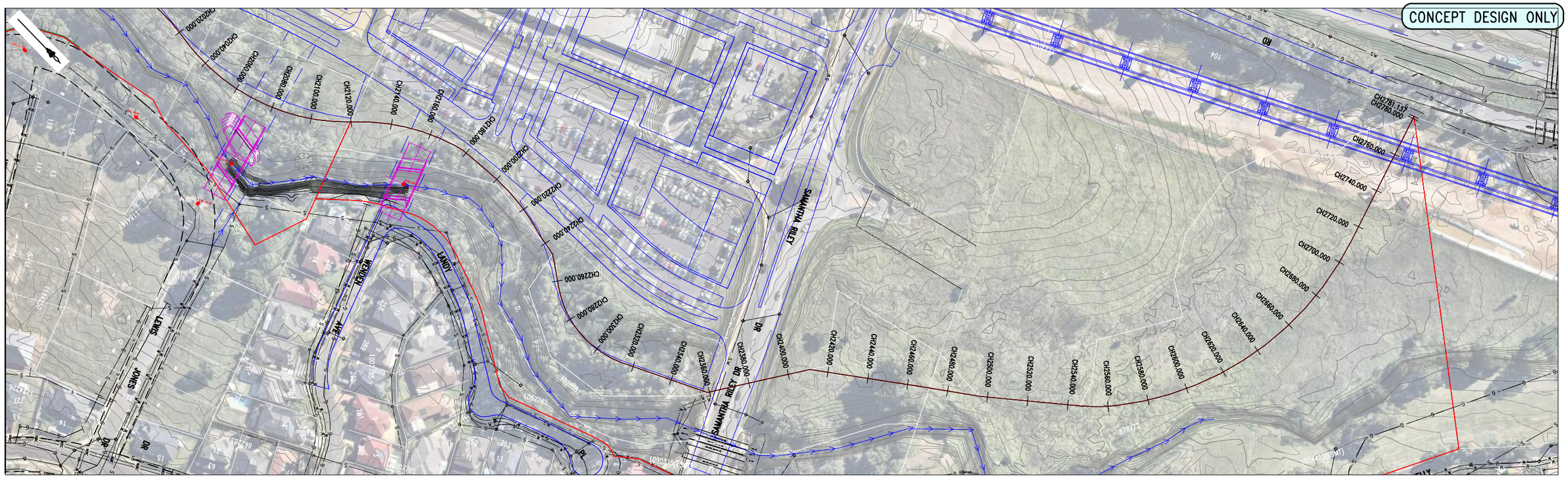
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 066
ISSUE A | SHEET No. 3 OF 4

SWATI-EXT AUG 2014

CONCEPT DESIGN ONLY

JOINS SHEET 03



PLAN
SCALE: 1:1000

DATUM 33

CHAINAGE	EXISTING SURFACE	DESIGN FLOOD LEVEL
2100	49.48	49.19
2110	49.56	49.02
2120	49.56	48.94
2130	49.47	48.84
2140	49.49	48.73
2150	49.39	48.64
2160	49.24	48.51
2170	48.89	48.37
2180	48.93	48.31
2190	48.67	48.29
2200	48.55	48.29
2210	48.57	48.25
2220	48.71	48.24
2230	48.57	48.24
2240	48.39	48.24
2250	48.33	48.24
2260	48.13	48.23
2270	47.92	48.02
2280	48.13	47.97
2290	48.89	47.95
2300	48.16	47.87
2310	47.81	47.80
2320	47.66	47.74
2330	47.62	47.66
2340	47.50	47.66
2350	47.64	47.66
2360	48.62	47.61
2370	47.89	47.47
2380	47.89	47.33
2390	48.44	47.19
2400	47.34	47.06
2410	47.35	46.92
2420	47.24	46.85
2430	47.12	46.78
2440	46.86	46.75
2450	46.90	46.75
2460	46.83	46.74
2470	46.75	46.72
2480	46.62	46.65
2490	46.52	46.62
2500	46.48	46.57
2510	46.62	46.32
2520	46.58	46.22
2530	46.45	46.15
2540	46.46	46.08
2550	46.43	46.00
2560	45.98	45.95
2570	45.84	45.91
2580	45.81	45.85
2590	45.87	45.81
2600	45.91	45.75
2610	45.80	45.66
2620	45.84	45.58
2630	45.56	45.50
2640	45.66	45.42
2650	45.53	45.33
2660	45.43	45.25
2670	45.43	45.17
2680	45.34	45.09
2690	45.23	45.00
2700	44.93	44.93
2710	45.23	44.85
2720	45.18	44.77
2730	45.27	44.69
2740	45.15	44.62
2750	45.28	44.54
2760	44.75	44.46
2770	44.88	44.39
2780	45.00	44.31
2781.14	45.00	44.30

LONGITUDINAL SECTION – OCH-FLOOD-BDY-WEST
A1 HORIZONTAL SCALE 1:1000
A1 VERTICAL SCALE 1:200

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

10000 0 10000 20000 30000 40000mm
1 : 2000 (A3) 1 :1000 (A1)

2000 0 2000 4000 6000 8000mm
1 :400 (A3) 1 :200 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

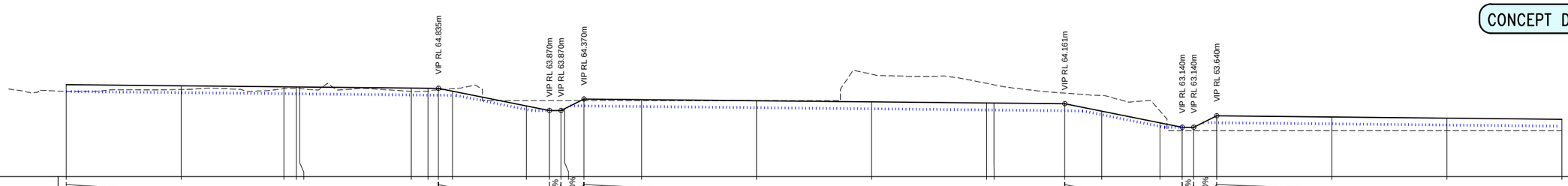
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
DESIGN FLOOD PROFILE - WEST BOUNDARY

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 067
ISSUE A | SHEET No. 4 OF 4

SWAL-EXT AUG 2016

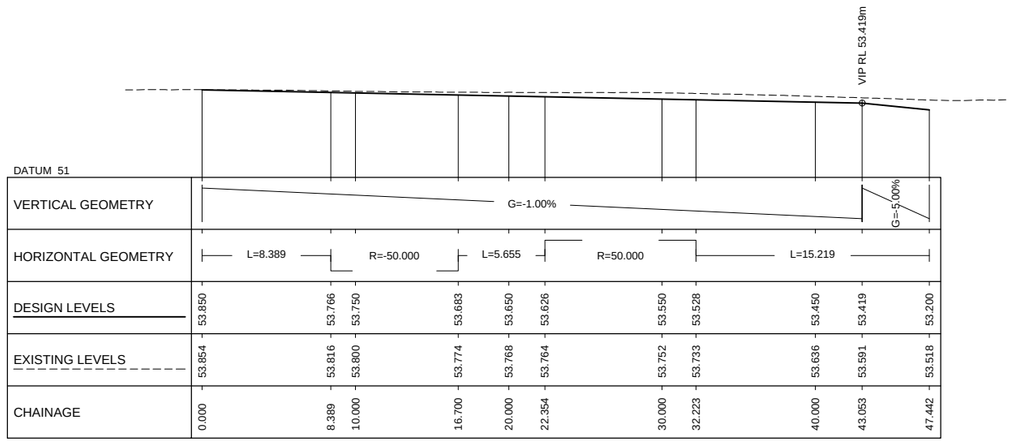
CONCEPT DESIGN ONLY



DATUM 61

| | | |

CONCEPT DESIGN ONLY



LONGITUDINAL SECTION - MD03

A1 HORIZONTAL SCALE 1:200
A1 VERTICAL SCALE 1:100

——— DESIGN LEVEL CORRESPONDS TO LOW FLOW CHANNEL INVERT (REFER TO REFERENCE LEVEL FOR 0234-EMC-036 DETAIL 2)

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT

THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

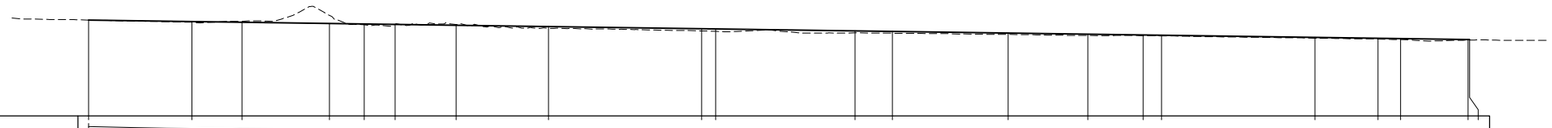
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
CREEK LONGITUDINAL SECTIONS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 071
ISSUE A | SHEET No. 2 OF 3

SWAT-EXT AUG 2014

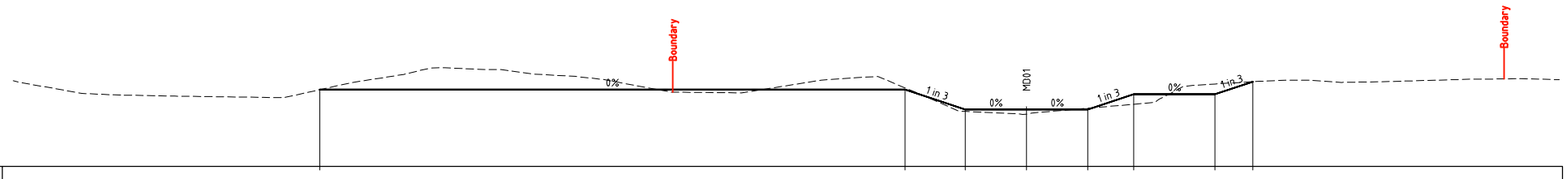
CONCEPT DESIGN ONLY



DATUM 44

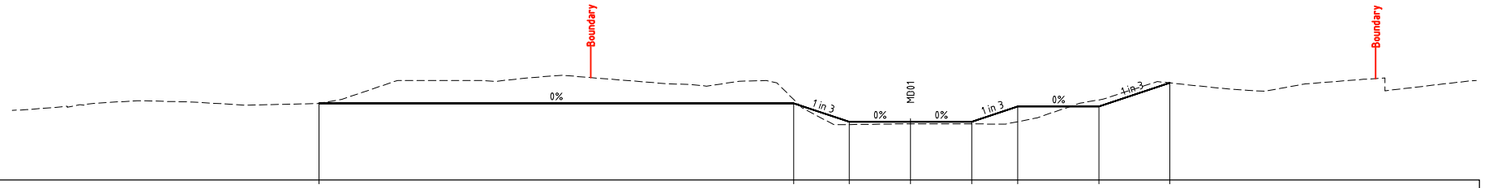
| | | |

CONCEPT DESIGN ONLY



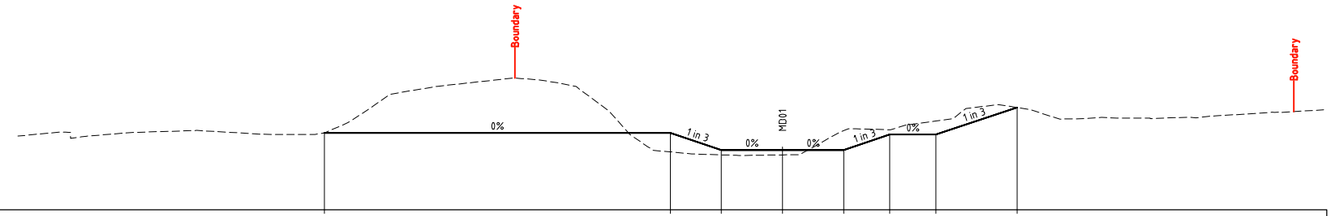
DATUM 63.000										
DESIGN LEVELS	65.500	65.500	64.847	64.847	64.847	65.347	65.347	65.758		
EXISTING LEVELS	65.497	65.557	64.789	64.697	64.894	65.023	65.683	65.758		
DESIGN OFFSETS	-23.055	-3.960	-2.000	0.000	2.000	3.500	6.150	7.383		

CH 30.000



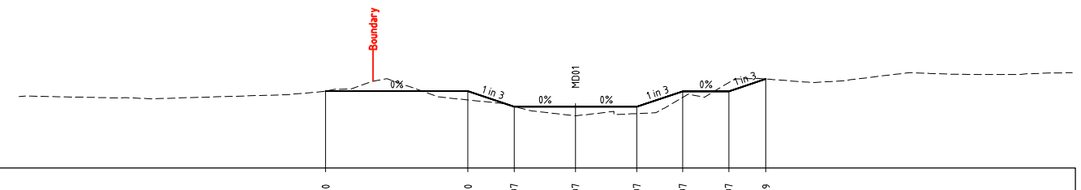
DATUM 63.000										
DESIGN LEVELS	65.500	65.500	64.897	64.897	64.897	65.397	65.397	66.166		
EXISTING LEVELS	65.500	65.625	64.808	64.830	64.827	64.902	65.613	66.166		
DESIGN OFFSETS	-19.299	-3.810	-2.000	0.000	2.000	3.500	6.150	8.459		

CH 20.000



DATUM 63.000										
DESIGN LEVELS	65.500	65.500	64.947	64.947	64.947	65.447	65.447	66.330		
EXISTING LEVELS	65.500	64.886	64.786	64.785	65.578	65.603	65.890	66.330		
DESIGN OFFSETS	-14.946	-3.660	-2.000	0.000	2.000	3.500	5.000	7.650		

CH 10.000



DATUM 63.000										
DESIGN LEVELS	65.500	65.500	64.997	64.997	64.997	65.497	65.497	65.899		
EXISTING LEVELS	65.500	65.217	65.002	64.697	64.770	65.298	65.782	65.899		
DESIGN OFFSETS	-8.153	-3.510	-2.000	0.000	2.000	3.500	5.000	6.207		

CH 0.000

CROSS SECTIONS - MD01

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:100

NOTES:
1. EPHEMERAL BENCH AND FLOODPLAIN AREAS (SHOWN FLAT) MUST STILL BE GRADED TOWARDS CENTRE OF CHANNEL (NOMINAL 1% GRADE) TO PROMOTE DRAINAGE AND INHIBIT PONDING.
2. MEANDERING LOW FLOW CHANNEL NOT SHOWN ON MD01. REFER TO DRG 0234-EMC-012, 0234-EMC-013 AND 0234-EMC-037 FOR DETAILS.
3. FUTURE LANDFILL AND ASSOCIATED EDGE TREATMENTS NOT SHOWN ON CROSS SECTIONS.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

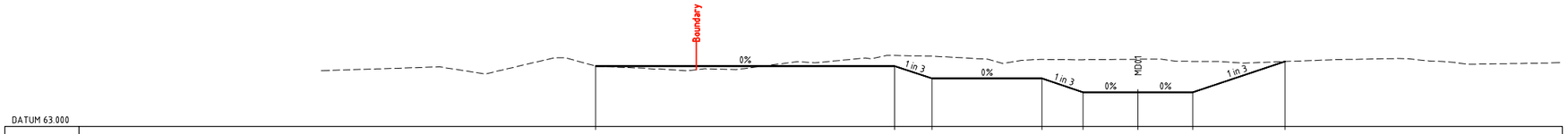
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
CREEK CROSS SECTIONS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 085
ISSUE A | SHEET No. 1 OF 10

SWA1-EXT AUG 2014

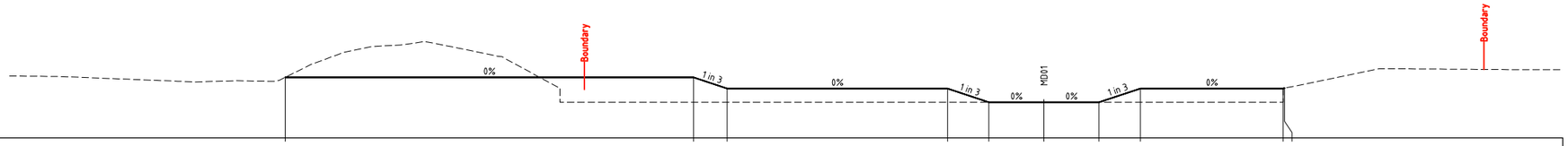
CONCEPT DESIGN ONLY



DATUM 63.000

DESIGN LEVELS	65.200	65.200	64.745	64.745	64.245	64.245	64.245	65.365		
EXISTING LEVELS	65.200	65.584	65.559	65.440	65.430	65.447	65.369	65.365		
DESIGN OFFSETS	-19.756	-8.866	-7.500	-3.500	-2.000	0.000	2.000	5.361		

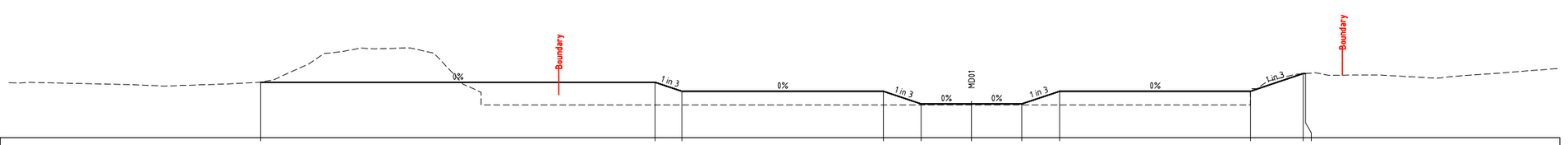
CH 70.000



DATUM 63.000

DESIGN LEVELS	65.200	65.200	64.795	64.795	64.295	64.295	64.795	64.795	64.811	
EXISTING LEVELS	65.201	64.300	64.300	64.300	64.300	64.300	64.300	64.803	64.811	
DESIGN OFFSETS	-27.547	-12.716	-11.500	-3.500	-2.000	0.000	2.000	3.500	8.685	8.735

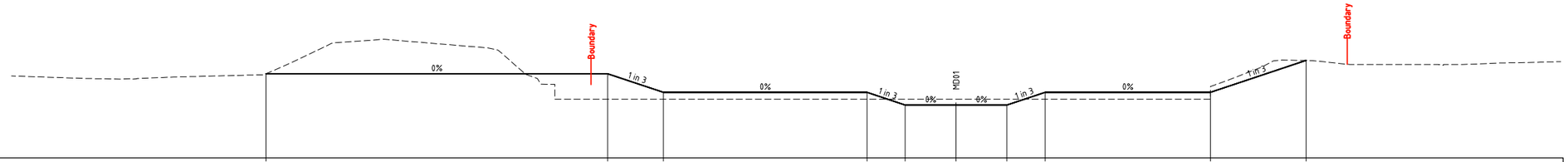
CH 60.000



DATUM 63.000

DESIGN LEVELS	65.200	65.200	64.845	64.845	64.345	64.345	64.345	64.845	64.845	65.541
EXISTING LEVELS	65.200	64.300	64.300	64.300	64.300	64.300	64.300	64.300	64.944	65.536
DESIGN OFFSETS	-28.229	-12.566	-11.500	-3.500	-2.000	0.000	2.000	3.500	11.081	13.170

CH 50.000



DATUM 62.000

DESIGN LEVELS	65.300	65.300	64.570	64.570	64.070	64.070	64.070	64.570	64.570	65.823
EXISTING LEVELS	65.300	64.300	64.300	64.300	64.300	64.300	64.300	64.300	64.805	65.823
DESIGN OFFSETS	-27.120	-13.691	-11.500	-3.500	-2.000	0.000	2.000	3.500	10.000	13.759

CH 40.000

CROSS SECTIONS - MD01

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:100

NOTES:
1. EPHEMERAL BENCH AND FLOODPLAIN AREAS (SHOWN FLAT) MUST STILL BE GRADED TOWARDS CENTRE OF CHANNEL (NOMINAL 1% GRADE) TO PROMOTE DRAINAGE AND INHIBIT PONDING.
2. MEANDERING LOW FLOW CHANNEL NOT SHOWN ON MD01. REFER TO DRG 0234-EMC-012, 0234-EMC-013 AND 0234-EMC-037 FOR DETAILS.
3. FUTURE LANDFILL AND ASSOCIATED EDGE TREATMENTS NOT SHOWN ON CROSS SECTIONS.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16	
DRAWN	C.RUSINGAH AAJV	15.04.16	
VERIFIED	B. WITHNALL AAJV	24.01.17	
APPROVED	N.BARTHO AAJV	24.01.17	

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

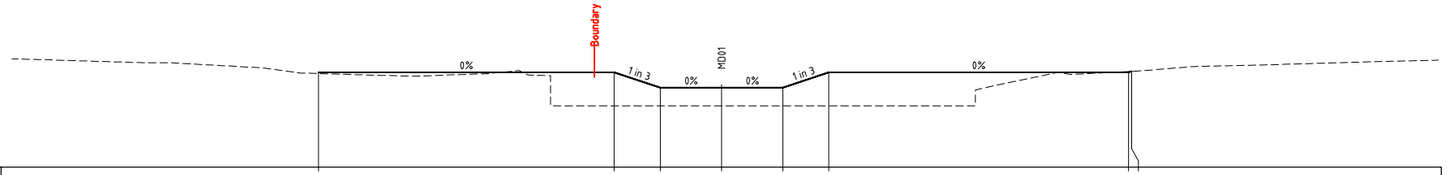
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
CREEK CROSS SECTIONS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 086
ISSUE A | SHEET No. 2 OF 10

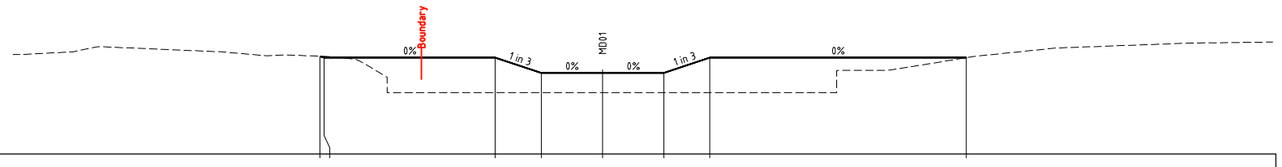
SWATH EXT AUG 2014
554
801

CONCEPT DESIGN ONLY



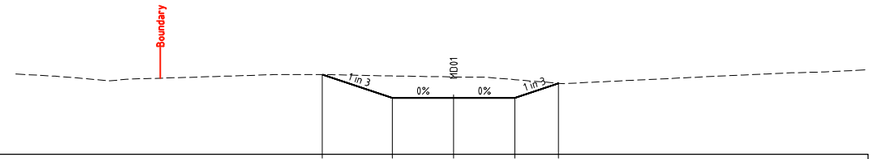
DATUM 61.000								
DESIGN LEVELS	64.090	64.090	63.590	63.590	63.590	64.090	64.090	64.123
EXISTING LEVELS	64.050	63.000	63.000	63.000	63.000	63.000	64.117	64.123
DESIGN OFFSETS	-13.149	-3.500	-2.000	0.000	2.000	3.500	13.276	13.375

CH 110.000



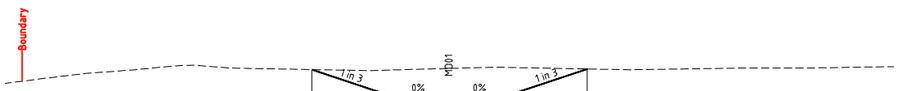
DATUM 61.000								
DESIGN LEVELS	64.187	64.140	64.140	63.640	63.640	63.640	64.140	64.140
EXISTING LEVELS	64.187	64.102	63.000	63.000	63.000	63.000	63.000	64.140
DESIGN OFFSETS	-9.222	-9.080	-3.500	-2.000	0.000	2.000	3.500	11.864

CH 100.000



DATUM 62.000						
DESIGN LEVELS	64.599	63.840	63.840	63.840	64.314	
EXISTING LEVELS	64.599	64.553	64.522	64.433	64.314	
DESIGN OFFSETS	-4.279	-2.000	0.000	2.000	3.424	

CH 90.000



DATUM 63.000						
DESIGN LEVELS	65.016	64.195	64.195	64.195	65.036	
EXISTING LEVELS	65.016	64.998	65.051	65.085	65.036	
DESIGN OFFSETS	-4.463	-2.000	0.000	2.000	4.524	

CH 80.000

CROSS SECTIONS - MD01

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:100

NOTES:
1. EPHEMERAL BENCH AND FLOODPLAIN AREAS (SHOWN FLAT) MUST STILL BE GRADED TOWARDS CENTRE OF CHANNEL (NOMINAL 1% GRADE) TO PROMOTE DRAINAGE AND INHIBIT PONDING.
2. MEANDERING LOW FLOW CHANNEL NOT SHOWN ON MD01. REFER TO DRG 0234-EMC-012, 0234-EMC-013 AND 0234-EMC-037 FOR DETAILS.
3. FUTURE LANDFILL AND ASSOCIATED EDGE TREATMENTS NOT SHOWN ON CROSS SECTIONS.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
CREEK CROSS SECTIONS

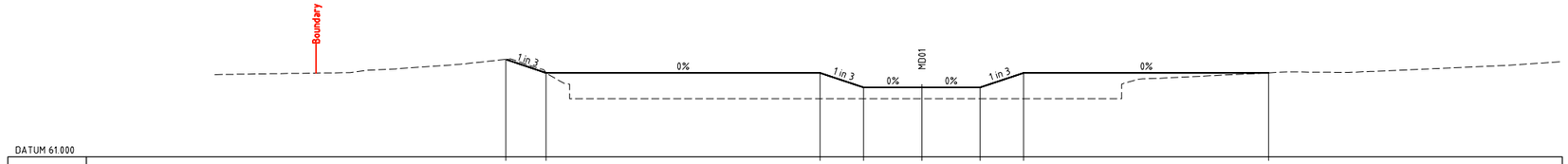
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 087

ISSUE A | SHEET No. 3 OF 10

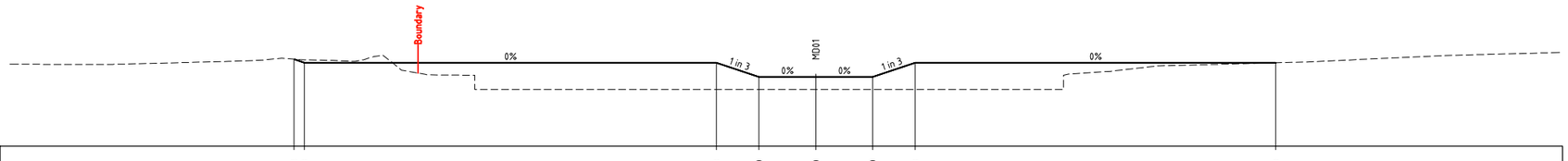
SWAL-EXT AUG 2016

CONCEPT DESIGN ONLY



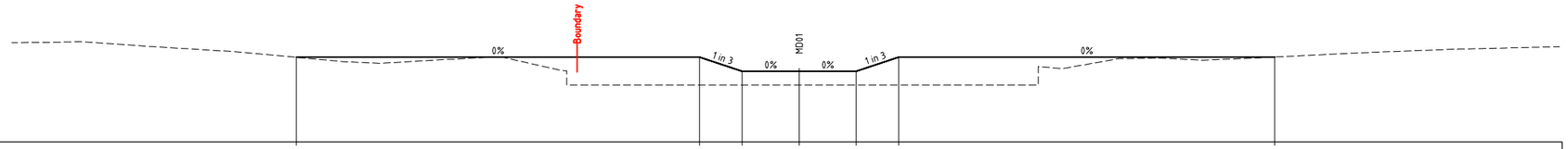
	DATUM 61.000							
DESIGN LEVELS	64.351	63.890	63.890	63.390	63.390	63.390	63.890	63.890
EXISTING LEVELS	64.351	63.890	63.000	63.000	63.000	63.000	63.000	63.890
DESIGN OFFSETS	-14.309	-12.926	-3.500	-2.000	0.000	2.000	3.500	11.927

CH 150.000



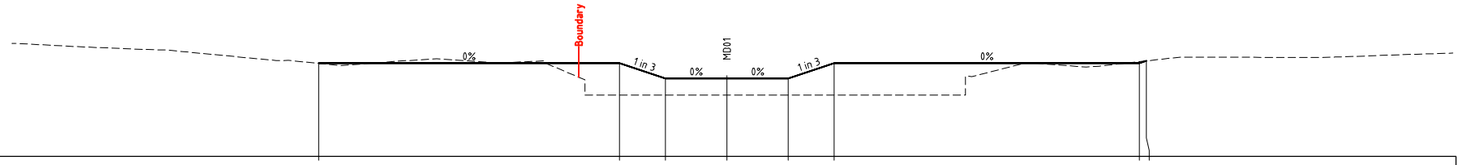
	DATUM 61.000						
DESIGN LEVELS	64.063	63.940	63.940	63.440	63.440	63.440	63.940	63.940
EXISTING LEVELS	64.063	64.045	63.000	63.000	63.000	63.000	63.000	63.940
DESIGN OFFSETS	-18.382	-18.011	-3.500	-2.000	0.000	2.000	3.500	16.200

CH 140.000



	DATUM 61.000						
DESIGN LEVELS	63.990	63.990	63.490	63.490	63.490	63.990	63.990
EXISTING LEVELS	63.979	63.000	63.000	63.000	63.000	63.000	63.990
DESIGN OFFSETS	-17.667	-3.500	-2.000	0.000	2.000	3.500	16.711

CH 130.000



	DATUM 61.000							
DESIGN LEVELS	64.040	64.040	63.540	63.540	63.540	64.040	64.040	64.116
EXISTING LEVELS	64.036	63.000	63.000	63.000	63.000	63.000	64.090	64.116
DESIGN OFFSETS	-13.318	-3.500	-2.000	0.000	2.000	3.500	13.455	13.684

CH 120.000

CROSS SECTIONS - MD01

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:100

NOTES:
1. EPHEMERAL BENCH AND FLOODPLAIN AREAS (SHOWN FLAT) MUST STILL BE GRADED TOWARDS CENTRE OF CHANNEL (NOMINAL 1% GRADE) TO PROMOTE DRAINAGE AND INHIBIT PONDING.
2. MEANDERING LOW FLOW CHANNEL NOT SHOWN ON MD01. REFER TO DRG 0234-EMC-012, 0234-EMC-013 AND 0234-EMC-037 FOR DETAILS.
3. FUTURE LANDFILL AND ASSOCIATED EDGE TREATMENTS NOT SHOWN ON CROSS SECTIONS.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED	R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER	15.02.17
ACCEPTED	R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER	15.02.17

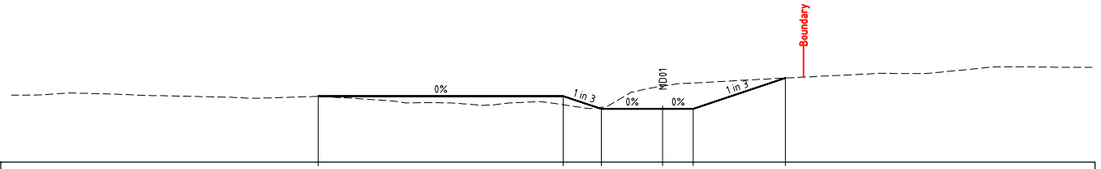
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
CREEK CROSS SECTIONS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 088
ISSUE A | SHEET No. 4 OF 10

SWA1-EXT AUG 2014

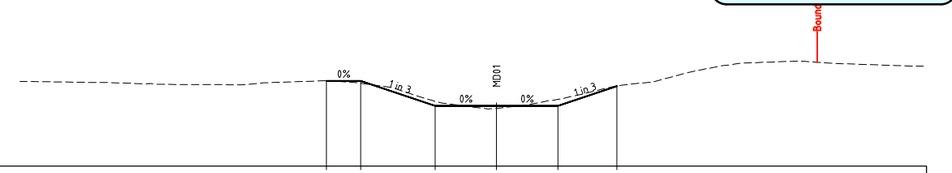
CONCEPT DESIGN ONLY



DATUM 61.000

DESIGN LEVELS	63.149	63.149	62.735	62.735	62.735	63.737
EXISTING LEVELS	63.140	62.868	62.784	63.472	63.575	63.737
DESIGN OFFSETS	-11.239	-3.242	-2.000	0.000	1.000	4.006

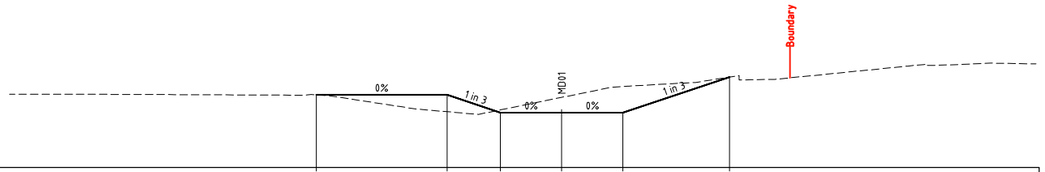
CH 190.000



DATUM 60.000

DESIGN LEVELS	62.775	62.775	61.965	61.965	61.965	62.606
EXISTING LEVELS	62.780	62.697	62.104	61.879	62.168	62.606
DESIGN OFFSETS	-5.546	-4.431	-2.000	0.000	2.000	3.925

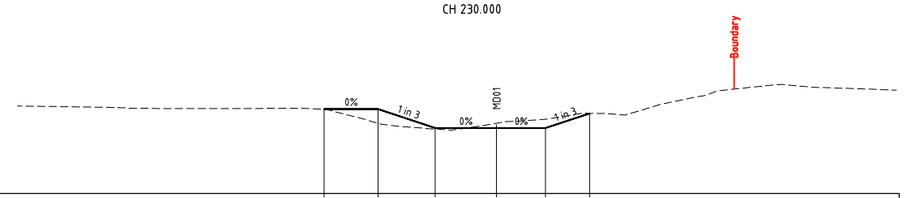
CH 230.000



DATUM 61.000

DESIGN LEVELS	63.364	63.364	62.785	62.785	62.785	63.944
EXISTING LEVELS	63.363	62.816	62.874	63.282	63.636	63.944
DESIGN OFFSETS	-8.006	-3.740	-2.000	0.000	2.000	5.479

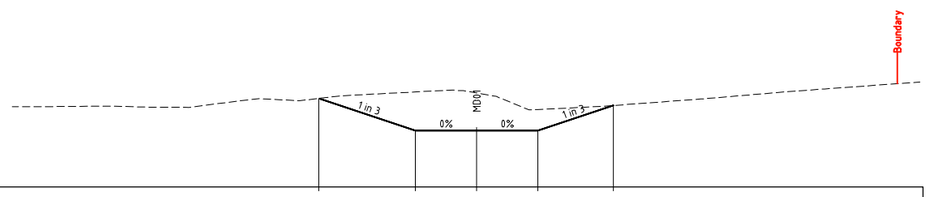
CH 180.000



DATUM 60.000

DESIGN LEVELS	62.751	62.751	62.130	62.130	62.130	62.609
EXISTING LEVELS	62.750	62.285	62.097	62.285	62.420	62.609
DESIGN OFFSETS	-5.624	-3.863	-2.000	0.000	1.600	3.039

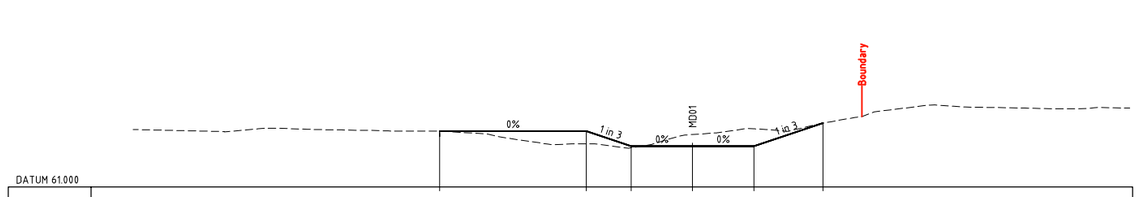
CH 220.000



DATUM 61.000

DESIGN LEVELS	63.884	62.835	62.835	62.835	63.655
EXISTING LEVELS	63.884	64.097	64.065	63.524	63.655
DESIGN OFFSETS	-5.150	-2.000	0.000	2.000	4.460

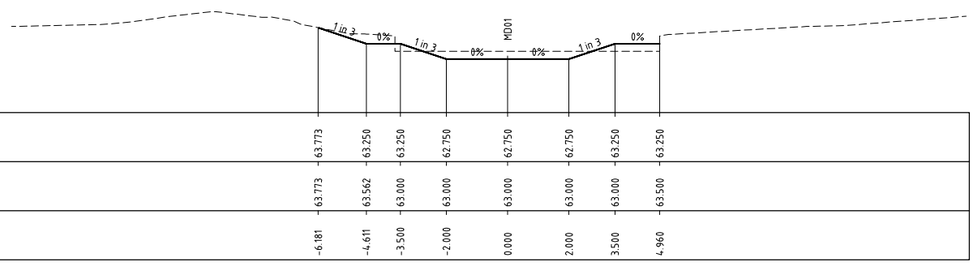
CH 170.000



DATUM 61.000

DESIGN LEVELS	62.820	62.820	62.330	62.330	63.082
EXISTING LEVELS	62.819	62.407	62.280	62.709	62.895	63.082
DESIGN OFFSETS	-8.250	-3.471	-2.000	0.000	2.000	4.258

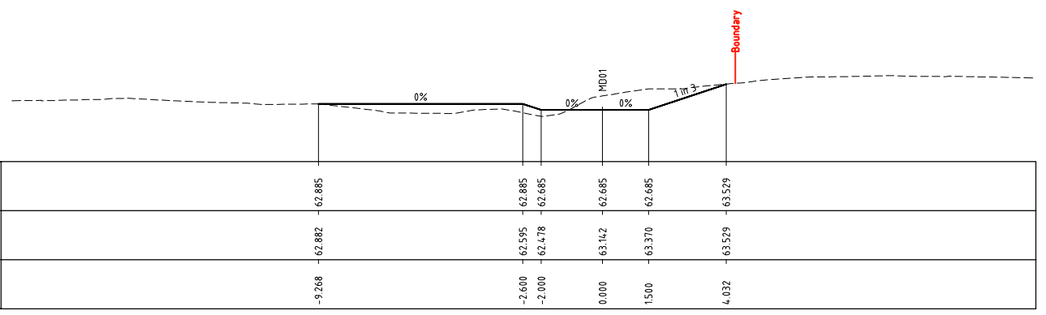
CH 210.000



DATUM 61.000

DESIGN LEVELS	63.773	63.250	63.250	62.750	62.750	62.750	63.250	63.250
EXISTING LEVELS	63.773	63.562	63.000	63.000	63.000	63.000	63.000	63.500
DESIGN OFFSETS	-6.181	-4.611	-3.500	-2.000	0.000	2.000	3.500	4.960

CH 160.000



DATUM 61.000

DESIGN LEVELS	62.885	62.885	62.685	62.685	63.529
EXISTING LEVELS	62.882	62.595	62.478	63.142	63.370	63.529
DESIGN OFFSETS	-9.268	-2.600	-2.000	0.000	1.500	4.032

CH 200.000

CROSS SECTIONS - MD01

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:100

NOTES:
1. EPHEMERAL BENCH AND FLOODPLAIN AREAS (SHOWN FLAT) MUST STILL BE GRADED TOWARDS CENTRE OF CHANNEL (NOMINAL 1% GRADE) TO PROMOTE DRAINAGE AND INHIBIT PONDING.
2. MEANDERING LOW FLOW CHANNEL NOT SHOWN ON MD01. REFER TO DRG 0234-EMC-012, 0234-EMC-013 AND 0234-EMC-037 FOR DETAILS.
3. FUTURE LANDFILL AND ASSOCIATED EDGE TREATMENTS NOT SHOWN ON CROSS SECTIONS.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

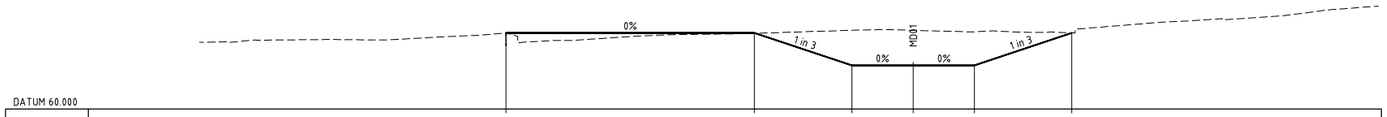
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
CREEK CROSS SECTIONS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 089
ISSUE A | SHEET No. 5 OF 10

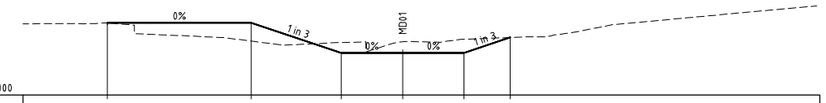
SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



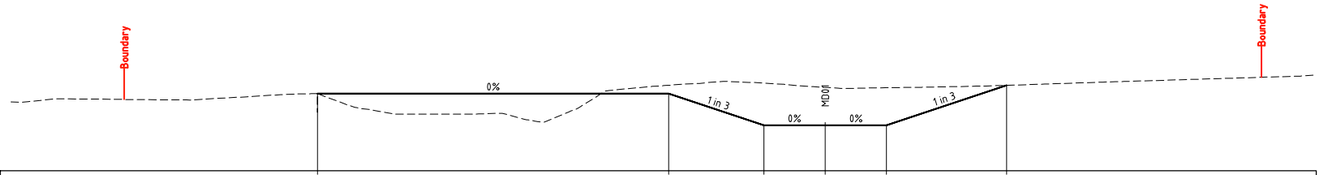
DATUM 60.000							
DESIGN LEVELS	62.485	62.485	61.425	61.425	61.425	62.484	
EXISTING LEVELS	62.485	62.470	62.570	62.568	62.521	62.484	
DESIGN OFFSETS	-13.283	-5.181	-2.000	0.000	2.000	5.177	

CH 270.000



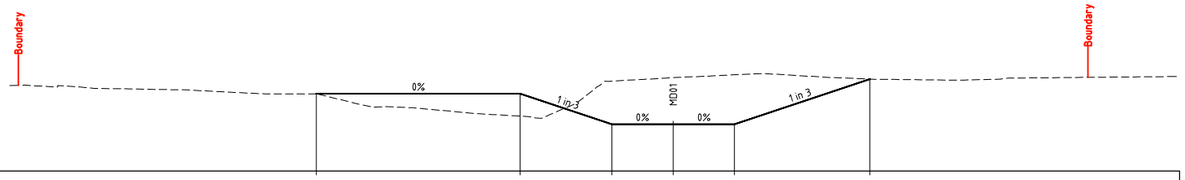
DATUM 60.000							
DESIGN LEVELS	62.355	62.355	61.375	61.375	61.375	61.878	
EXISTING LEVELS	62.355	61.761	61.714	61.740	61.820	61.878	
DESIGN OFFSETS	-9.631	-4.940	-2.000	0.000	2.000	3.510	

CH 280.000



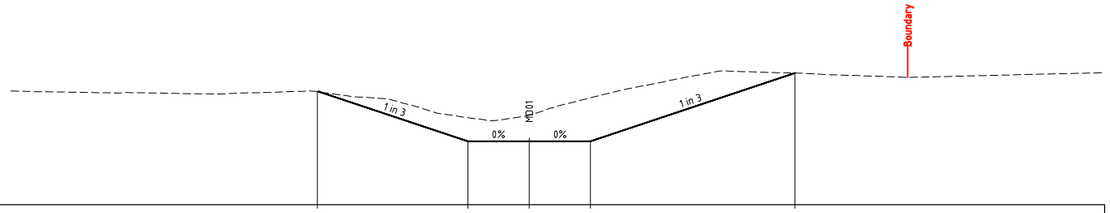
DATUM 60.000							
DESIGN LEVELS	62.509	62.509	61.475	61.475	61.475	62.781	
EXISTING LEVELS	62.509	62.782	62.857	62.713	62.702	62.781	
DESIGN OFFSETS	-16.557	-5.103	-2.000	0.000	2.000	5.918	

CH 260.000



DATUM 60.000							
DESIGN LEVELS	62.521	62.521	61.525	61.525	61.525	62.998	
EXISTING LEVELS	62.515	61.792	62.933	63.045	63.138	62.998	
DESIGN OFFSETS	-11.639	-4.990	-2.000	0.000	2.000	6.419	

CH 250.000



DATUM 59.000							
DESIGN LEVELS	62.699	61.065	61.065	61.065	63.288		
EXISTING LEVELS	62.679	61.832	61.935	62.480	63.288		
DESIGN OFFSETS	-6.905	-2.000	0.000	2.000	8.669		

CH 240.000

CROSS SECTIONS - MD01

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:100

NOTES:
1. EPHEMERAL BENCH AND FLOODPLAIN AREAS (SHOWN FLAT) MUST STILL BE GRADED TOWARDS CENTRE OF CHANNEL (NOMINAL 1% GRADE) TO PROMOTE DRAINAGE AND INHIBIT PONDING.
2. MEANDERING LOW FLOW CHANNEL NOT SHOWN ON MD01. REFER TO DRG 0234-EMC-012, 0234-EMC-013 AND 0234-EMC-037 FOR DETAILS.
3. FUTURE LANDFILL AND ASSOCIATED EDGE TREATMENTS NOT SHOWN ON CROSS SECTIONS.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16	
DRAWN	C.RUSINGAH AAJV	15.04.16	
VERIFIED	B. WITHNALL AAJV	24.01.17	
APPROVED	N.BARTHO AAJV	24.01.17	

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

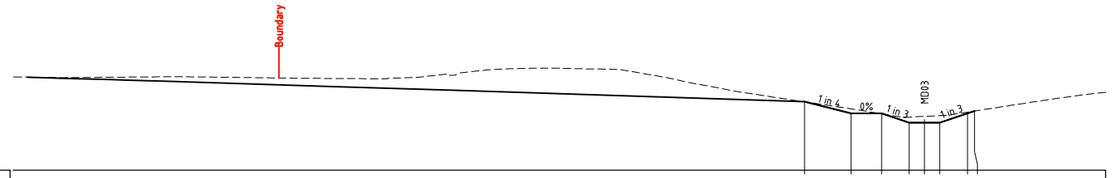
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
CREEK CROSS SECTIONS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 090
ISSUE A | SHEET No. 6 OF 10

SWA1-EXT AUG 2014

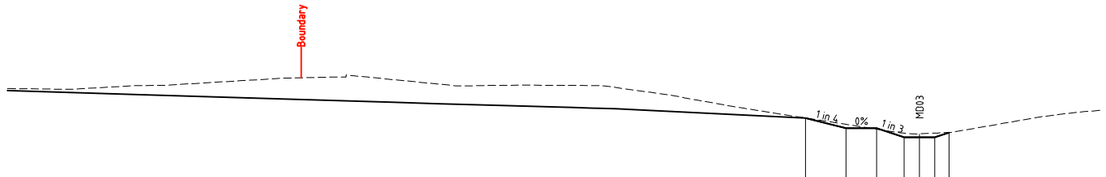
CONCEPT DESIGN ONLY



DATUM 52.000

DESIGN LEVELS	54.229	53.850	53.850	53.550	53.550	53.550	53.850	53.928
EXISTING LEVELS	54.229	54.000	53.835	53.727	53.752	53.778	53.890	53.928
DESIGN OFFSETS	-3.916	-2.400	-1.400	-0.500	0.000	0.500	1.400	1.635

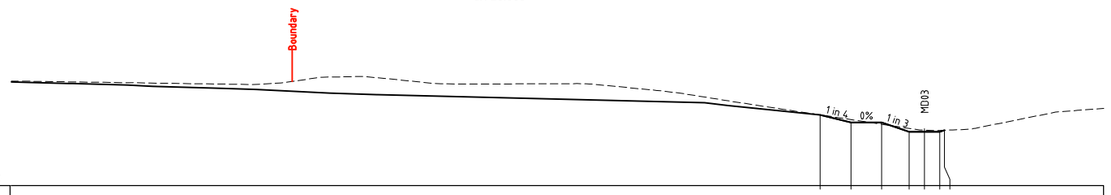
CH 30.000



DATUM 52.000

DESIGN LEVELS	54.280	53.950	53.950	53.650	53.650	53.650	53.803
EXISTING LEVELS	54.280	54.074	53.917	53.784	53.768	53.787	53.803
DESIGN OFFSETS	-3.720	-2.400	-1.400	-0.500	0.000	0.500	0.960

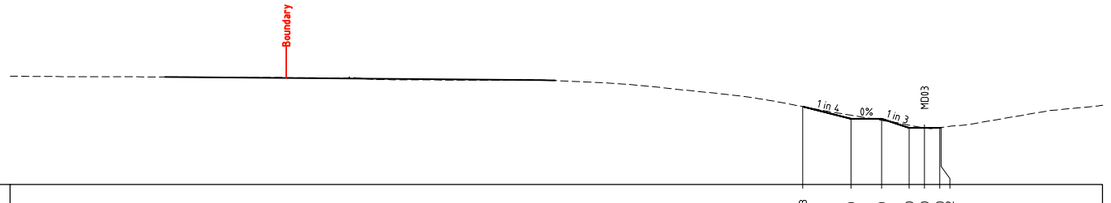
CH 20.000



DATUM 52.000

DESIGN LEVELS	54.301	54.050	54.050	53.750	53.750	53.750	53.801
EXISTING LEVELS	54.301	54.149	53.998	53.859	53.800	53.794	53.801
DESIGN OFFSETS	-3.403	-2.400	-1.400	-0.500	0.000	0.500	0.652

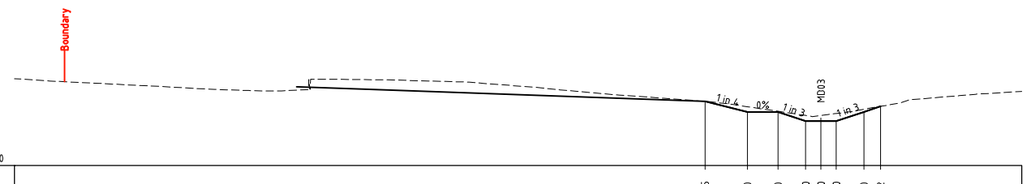
CH 10.000



DATUM 52.000

DESIGN LEVELS	54.543	54.150	54.150	53.850	53.850	53.850	53.862	
EXISTING LEVELS	54.543	54.262	54.093	53.936	53.854	53.857	53.862	
DESIGN OFFSETS	-3.970	-2.400	-1.400	-0.500	0.000	0.500	0.535	

CH 0.000



DATUM 52.000

DESIGN LEVELS	54.095	53.750	53.750	53.450	53.450	53.450	53.750	53.932
EXISTING LEVELS	54.095	53.921	53.770	53.635	53.636	53.701	53.836	53.932
DESIGN OFFSETS	-3.780	-2.400	-1.400	-0.500	0.000	0.500	1.400	1.947

CH 40.000

CROSS SECTIONS - MD03

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:100

NOTES:
1. EPHEMERAL BENCH AND FLOODPLAIN AREAS (SHOWN FLAT) MUST STILL BE GRADED TOWARDS CENTRE OF CHANNEL (NOMINAL 1% GRADE) TO PROMOTE DRAINAGE AND INHIBIT PONDING.
2. MEANDERING LOW FLOW CHANNEL NOT SHOWN ON MD03. REFER TO DRG 0234-EMC-012, 0234-EMC-013 AND 0234-EMC-037 FOR DETAILS.
3. FUTURE LANDFILL AND ASSOCIATED EDGE TREATMENTS NOT SHOWN ON CROSS SECTIONS.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B.WHITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT

THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

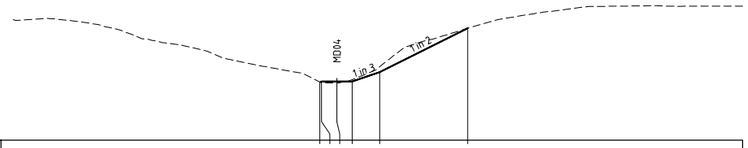
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
CREEK CROSS SECTIONS

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 091
ISSUE A
SHEET No. 7 OF 10

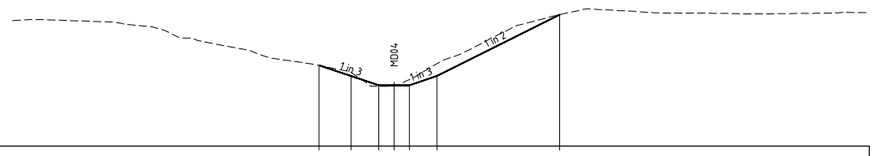
SWA1-EXT AUG 2014
554
801
RL1

CONCEPT DESIGN ONLY



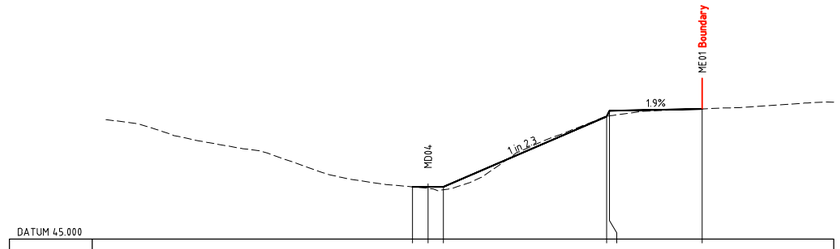
DATUM 45.000									
DESIGN LEVELS	46.893	46.912	46.912	46.912	47.212			48.645	
EXISTING LEVELS	46.893	46.875	46.969	46.969	47.391			48.645	
DESIGN OFFSETS	-0.557	-0.500	0.000	0.500	1.400			4.266	

CH 30.000



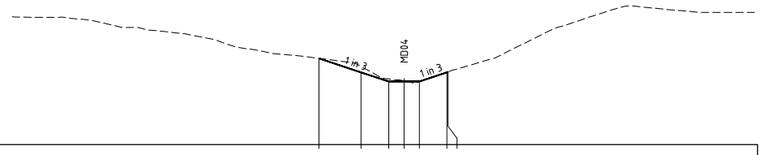
DATUM 45.000									
DESIGN LEVELS	47.630	47.282	46.982	46.982	47.282			49.282	
EXISTING LEVELS	47.630	47.409	46.951	46.988	47.172	47.685		49.282	
DESIGN OFFSETS	-2.444	-1.400	-0.500	0.000	0.500	1.400		5.400	

CH 20.000



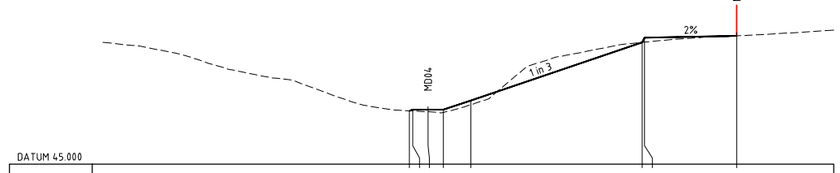
DATUM 45.000									
DESIGN LEVELS	46.701	46.702	46.702			49.000	49.084	49.242	
EXISTING LEVELS	46.701	46.654	46.605			49.000	49.017	49.244	
DESIGN OFFSETS	-0.503	0.000	0.500			5.829	5.923	8.947	

CH 60.000



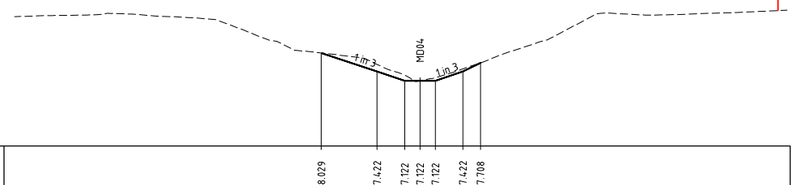
DATUM 45.000									
DESIGN LEVELS	47.810	47.352	47.052	47.052	47.352	47.367			
EXISTING LEVELS	47.810	47.543	47.136	47.081	47.051	47.356	47.367		
DESIGN OFFSETS	-2.773	-1.400	-0.500	0.000	0.500	1.400	1.430		

CH 10.000



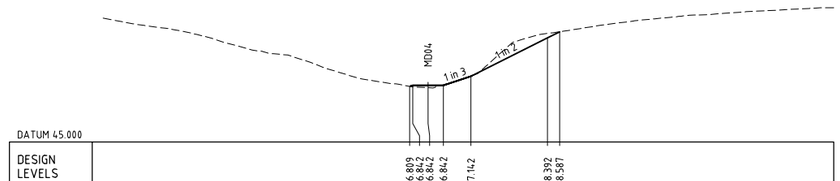
DATUM 45.000									
DESIGN LEVELS	46.736	46.772	46.772	46.772	47.072			48.966	49.178
EXISTING LEVELS	46.736	46.631	46.705	46.683	46.934			48.966	48.973	49.175
DESIGN OFFSETS	-0.606	-0.500	0.000	0.500	1.400			6.989	7.066	10.071

CH 50.000



DATUM 45.000									
DESIGN LEVELS	48.029	47.422	47.122	47.122	47.122	47.422	47.708		
EXISTING LEVELS	48.029	47.655	47.308	47.122	47.220	47.510	47.708		
DESIGN OFFSETS	-3.221	-1.400	-0.500	0.000	0.500	1.400	1.973		

CH 0.000



DATUM 45.000									
DESIGN LEVELS	46.809	46.842	46.842	46.842	47.142			48.392	48.587
EXISTING LEVELS	46.809	46.789	46.769	46.862	47.148			48.533	48.587
DESIGN OFFSETS	-0.598	-0.500	0.000	0.500	1.400			3.900	4.292

CH 40.000

CROSS SECTIONS - MD04

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:100

NOTES:
1. EPHEMERAL BENCH AND FLOODPLAIN AREAS (SHOWN FLAT) MUST STILL BE GRADED TOWARDS CENTRE OF CHANNEL (NOMINAL 1% GRADE) TO PROMOTE DRAINAGE AND INHIBIT PONDING.
2. LOW FLOW CHANNEL NOT SHOWN ON MD04. REFER TO DRG 0234-EMC-039 FOR DETAILS.
3. FUTURE LANDFILL AND ASSOCIATED EDGE TREATMENTS NOT SHOWN ON CROSS SECTIONS.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16	
DRAWN	C.RUSINGAH AAJV	15.04.16	
VERIFIED	B.WHITHNALL AAJV	24.01.17	
APPROVED	N.BARTHO AAJV	24.01.17	

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
CREEK CROSS SECTIONS

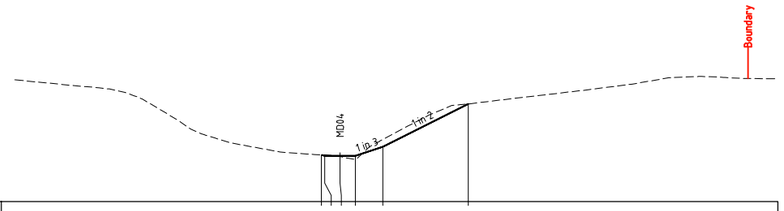
DRAWING No. 0234-EMC 092

ISSUE A | SHEET No. 8 OF 10

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

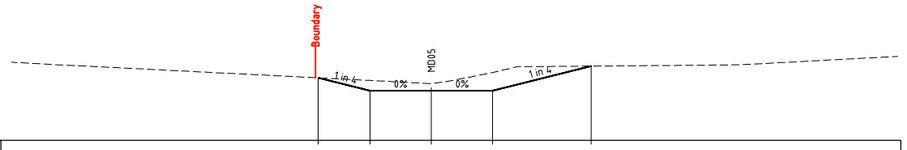
SWAN-EXT AUG 2014

CONCEPT DESIGN ONLY



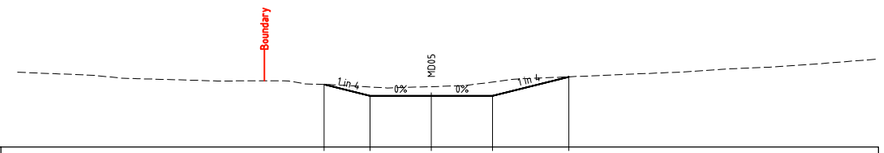
| | | |

CONCEPT DESIGN ONLY



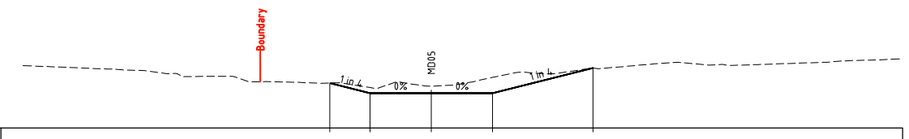
DATUM 65.000					
DESIGN LEVELS	67.036	66.614	66.614	66.614	67.418
EXISTING LEVELS	67.036	66.950	66.847	67.211	67.418
DESIGN OFFSETS	-3.689	-2.000	0.000	2.000	5.219

CH 30.000



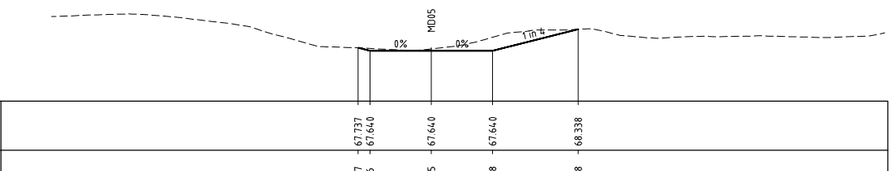
DATUM 65.000					
DESIGN LEVELS	67.038	66.664	66.664	66.664	67.285
EXISTING LEVELS	67.038	66.956	66.965	67.115	67.285
DESIGN OFFSETS	-3.497	-2.000	0.000	2.000	4.486

CH 20.000



DATUM 66.000					
DESIGN LEVELS	67.468	67.140	67.140	67.140	67.958
EXISTING LEVELS	67.468	67.320	67.367	67.650	67.958
DESIGN OFFSETS	-3.313	-2.000	0.000	2.000	5.273

CH 10.000

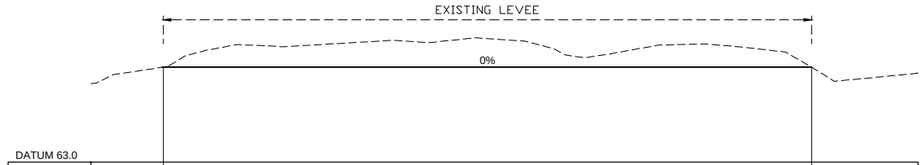


DATUM 66.000					
DESIGN LEVELS	67.737	67.640	67.640	67.640	68.338
EXISTING LEVELS	67.737	67.716	67.695	68.078	68.338
DESIGN OFFSETS	-2.388	-2.000	0.000	2.000	4.792

CH 0.000

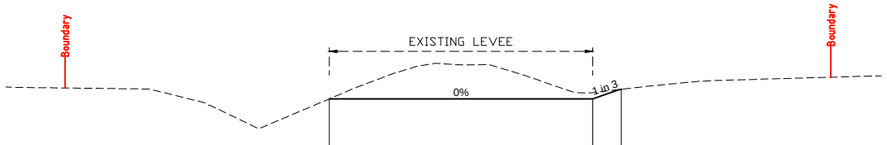
CROSS SECTIONS - MD05

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:100



DATUM 63.0		
EXISTING LEVELS	66.100	66.100
DESIGN LEVELS	66.100	66.100
DESIGN OFFSETS	3.142	24.289

SECTION 2



DATUM 64.0			
EXISTING LEVELS	66.100	66.304	66.411
DESIGN LEVELS	66.100	66.100	66.411
DESIGN OFFSETS	4.063	12.656	13.588

SECTION 1

CROSS SECTIONS - LEVEE

A1 HORIZONTAL SCALE 1:100
A1 VERTICAL SCALE 1:100

NOTES:
1. EPHEMERAL BENCH AND FLOODPLAIN AREAS (SHOWN FLAT) MUST STILL BE GRADED TOWARDS CENTRE OF CHANNEL (NOMINAL 1% GRADE) TO PROMOTE DRAINAGE AND INHIBIT PONDING.
2. LOW FLOW CHANNEL NOT SHOWN ON MD05. REFER TO DRG 0234-EMC-039 FOR DETAILS.
3. FUTURE LANDFILL AND ASSOCIATED EDGE TREATMENTS NOT SHOWN ON CROSS SECTIONS.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

DESIGNED	G.KIRBY AAJV	15.04.16	
DRAWN	C.RUSINGAH AAJV	15.04.16	
VERIFIED	B.WHITHNALL AAJV	24.01.17	
APPROVED	N.BARTHO AAJV	24.01.17	

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER
ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

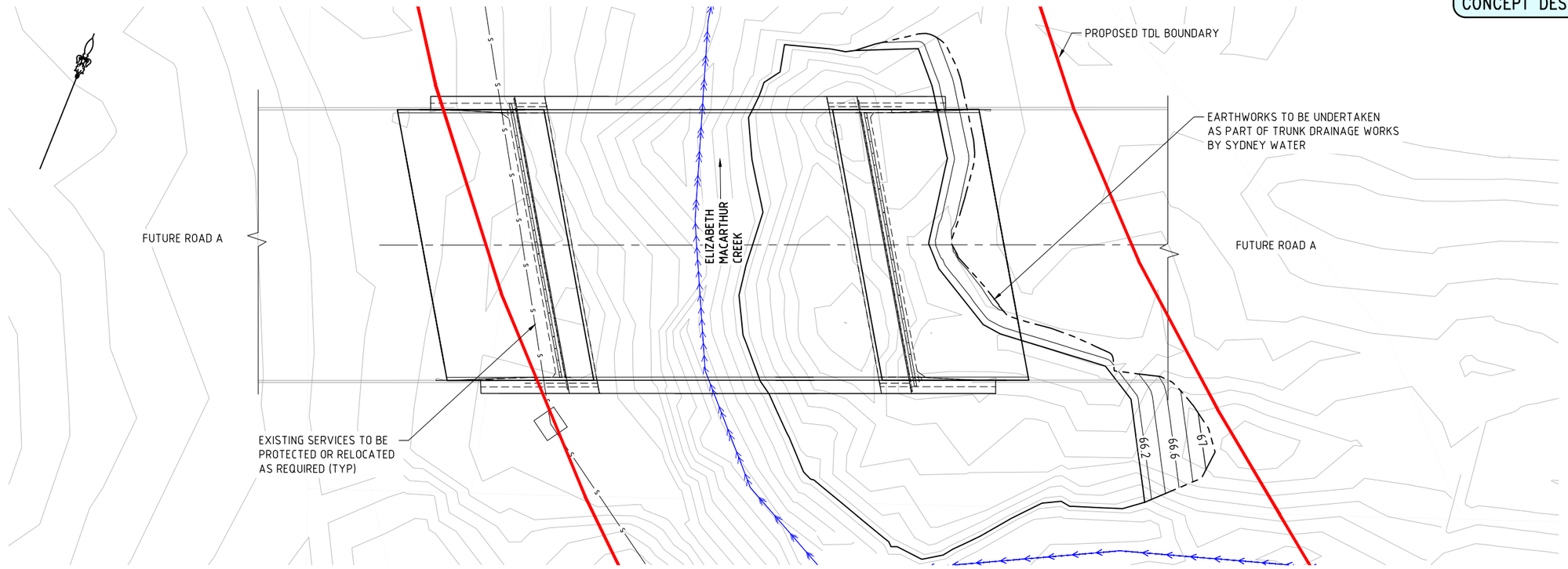
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
CREEK CROSS SECTIONS

A1	PROJ No. 20029728	DRAWING STATUS: FINAL CONCEPT

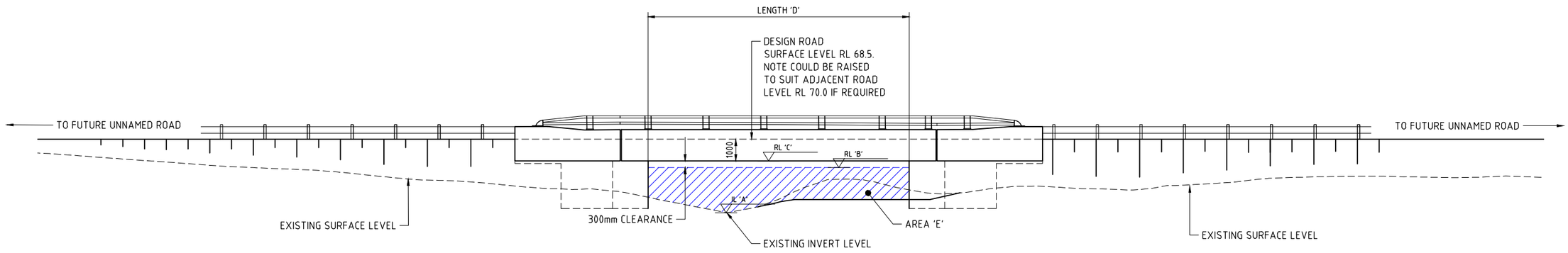
DRAWING No. 0234-EMC 094
ISSUE A
SHEET No. 10 OF 10

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:100



ELEVATION
SCALE: 1:100

PARAMETER	DIMENSION	VALUE
EXISTING CREEK INVERT LEVEL (m AHD)	A	65.4
100 YEAR ARI DESIGN FLOOD LEVEL (m AHD)	B	67.2
MINIMUM BRIDGE SOFFIT LEVEL (m AHD)	C	67.5
MINIMUM BRIDGE SPAN LENGTH (m)	D	12.0
MINIMUM BRIDGE WATERWAY AREA (m2)	E	10.7
100 YEAR ARI DESIGN PEAK FLOW (m3/s)	-	16.0

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 1 2 3 4 5m
1 : 200 (A3) 1 : 100 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

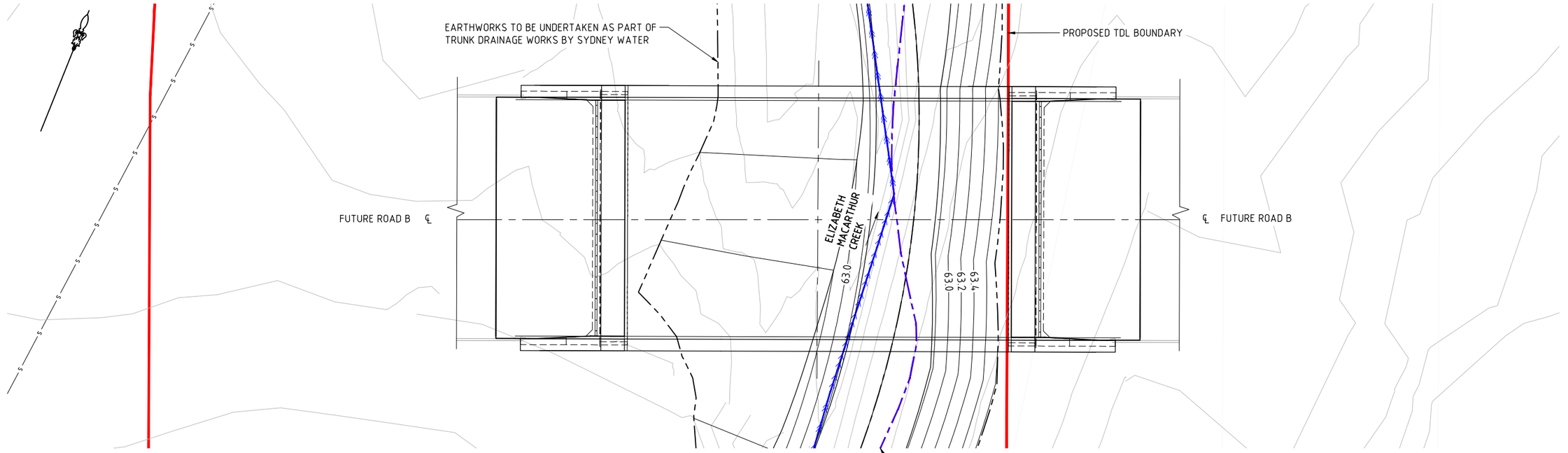
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
FUTURE BRIDGE CROSSING-FUTURE ROAD A

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

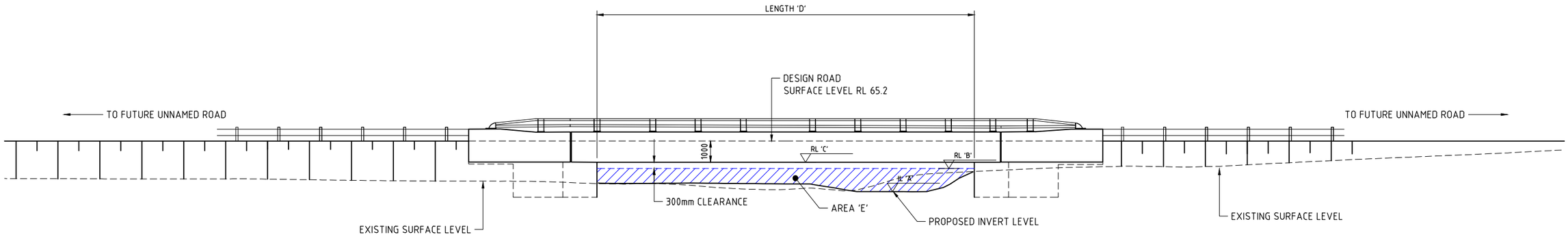
DRAWING No. 0234-EMC 110
ISSUE A | SHEET No. 1 OF 8

SWATI-EXT AUG 2014
554
801
841
37m

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:100



ELEVATION
SCALE: 1:100

PARAMETER	DIMENSION	VALUE
PROPOSED CREEK INVERT LEVEL (m AHD)	A	62.8
100 YEAR ARI DESIGN FLOOD LEVEL (m AHD)	B	63.9
MINIMUM BRIDGE SOFFIT LEVEL (m AHD)	C	64.2
MINIMUM BRIDGE SPAN LENGTH (m)	D	18.0
MINIMUM BRIDGE WATERWAY AREA (m2)	E	12.5
100 YEAR ARI DESIGN PEAK FLOW (m3/s)	-	17.4

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 1 2 3 4 5m
1 : 200 (A3) 1 : 100 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16	
DRAWN	C.RUSINGAH AAJV	15.04.16	
VERIFIED	B. WITHNALL AAJV	24.01.17	
APPROVED	N.BARTHO AAJV	24.01.17	

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER
ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
FUTURE BRIDGE CROSSING-FUTURE ROAD B

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 111
ISSUE A | SHEET No. 2 OF 8

SWAT-EXT AUG 2014
554
801

CONCEPT DESIGN ONLY

FUTURE ROAD PAVEMENT LEVELS ON UPGRADED APPROACH NO LOWER THAN RL 61.3

1
0234-EMC-113

INDICATIVE EXTENT OF REQUIRED CREEK REINSTATEMENT WORKS TO BE UNDERTAKEN AS PART OF FUTURE BRIDGE WORKS. MAKE SMOOTH TRANSITIONS TO EXISTING CREEK AT UPSTREAM AND DOWNSTREAM TIE INS.

EXISTING SERVICES TO BE PROTECTED OR RELOCATED AS REQUIRED (TYP)

EXISTING HEADWALL TO BE DEMOLISHED AND REMOVED

DESIGN CONTOURS DEVELOPED TO TIE INTO CREEK PROFILE WITH APPROXIMATE INVERT LEVEL IL 59.6mAHD AS PER SUPPLEMENTARY SURVEY DATA. LEVELS TO BE CONFIRMED AS PART OF FUTURE DETAILED DESIGN. WORKS TO PROVIDE SMOOTH TRANSITION TO EXISTING CHANNEL

CREEK INVERT AT UPSTREAM TIE IN 60.0m AHD (APPROX)

ELIZABETH MACARTHUR CREEK

BASE WIDTH 2.0m (TYP.)

PROPOSED TDL BOUNDARY

℄ BALMORAL ROAD

EXISTING CULVERTS TO BE DEMOLISHED AND REMOVED

FREE SETTLERS DRIVE

EXISTING HEADWALL TO BE DEMOLISHED AND REMOVED

ADJUST EXISTING STORMWATER OUTLETS TO SUIT CREEK REINSTATEMENT WORKS. NEW OUTLETS TO BE CONSTRUCTED IN ACCORDANCE WITH SYDNEY WATER REQUIREMENTS.

CURRENT APPROVED SUBDIVISION PLANS SHOW FUTURE ROUNDABOUT AT RL 61.75. IT IS RECOMMENDED THAT THE INTERSECTION AND ROAD APPROACHES ARE LIFTED TO SUIT FUTURE BRIDGE DECK LEVEL OF RL 62.6. SUITABLE ROAD PROFILE ADJUSTMENTS TO BE DEVELOPED AS PART OF FUTURE DETAILED DESIGN OF ROAD WORKS

PLAN
SCALE: 1:200

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 2 4 6 8 10m
1 : 400 (A3) 1 : 200 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

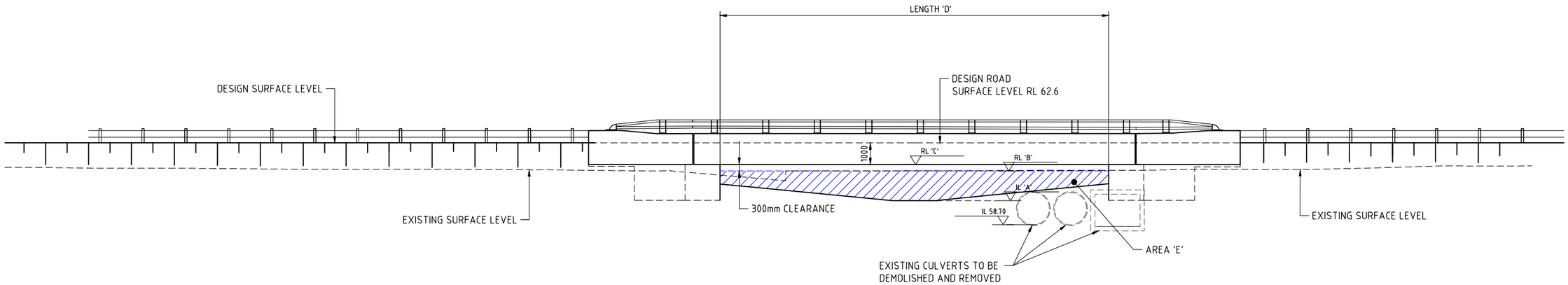
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
FUTURE BRIDGE CROSSING-BALMORAL ROAD

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 112
ISSUE A | SHEET No. 3 OF 8

SWA1-EXT AUG 2014
554
801
RL1

CONCEPT DESIGN ONLY



SECTION 1 (0234-EMC-112)
1:100

PARAMETER	DIMENSION	VALUE
PROPOSED CREEK INVERT LEVEL (m AHD)	A	59.9
100 YEAR ARI DESIGN FLOOD LEVEL (m AHD)	B	61.3
MINIMUM BRIDGE SOFFIT LEVEL (m AHD)	C	61.6
MINIMUM BRIDGE SPAN LENGTH (m)	D	18.0
MINIMUM BRIDGE WATERWAY AREA (m2)	E	15.8
100 YEAR ARI DESIGN PEAK FLOW (m3/s)	-	20.5

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 1 2 3 4 5m
1 : 200 (A3) 1 : 100 (A1)

DESIGNED G.KIRBY AAJV 15.04.16
DRAWN C.RUSINGAH AAJV 15.04.16
VERIFIED B. WITHNALL AAJV 24.01.17
APPROVED N.BARTHO AAJV 24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

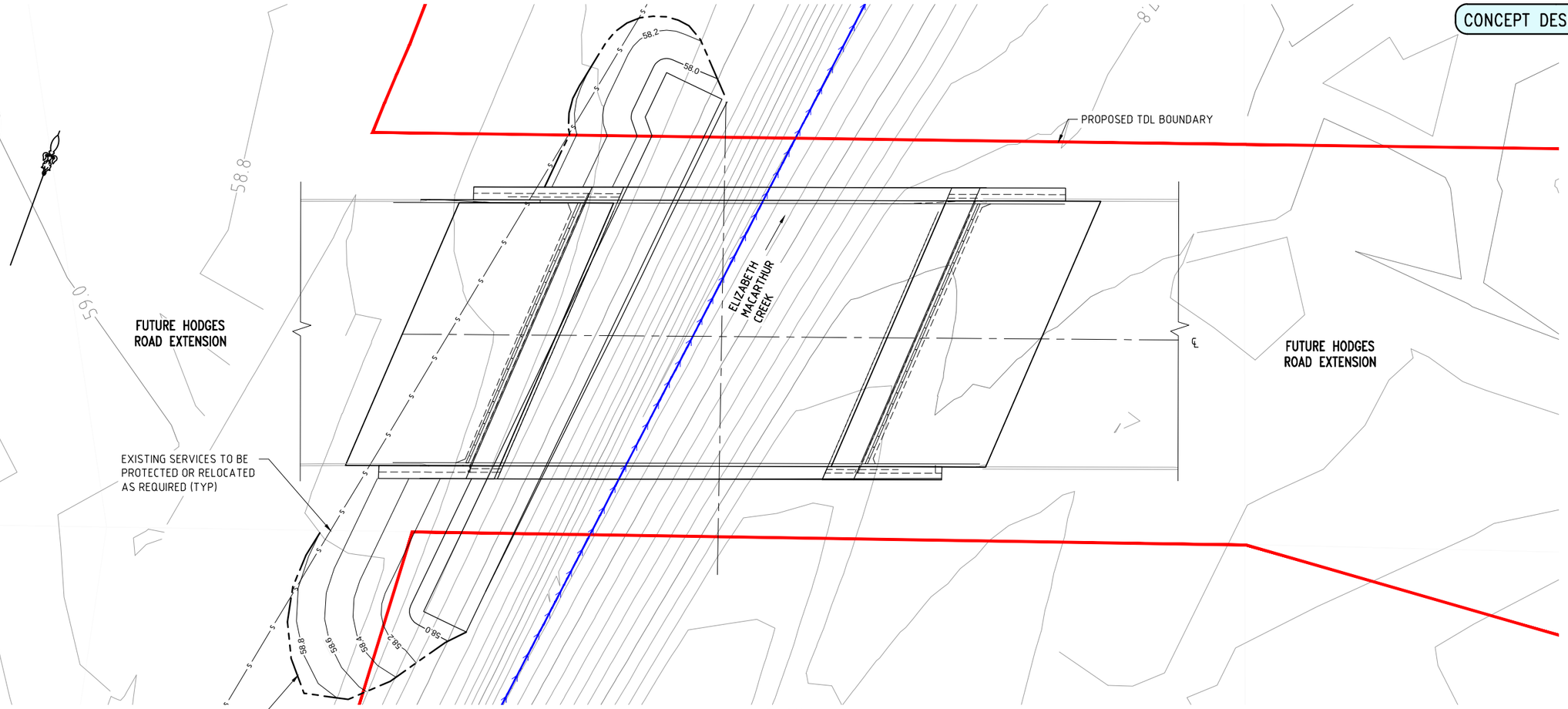
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
FUTURE BRIDGE CROSSING-BALMORAL ROAD

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

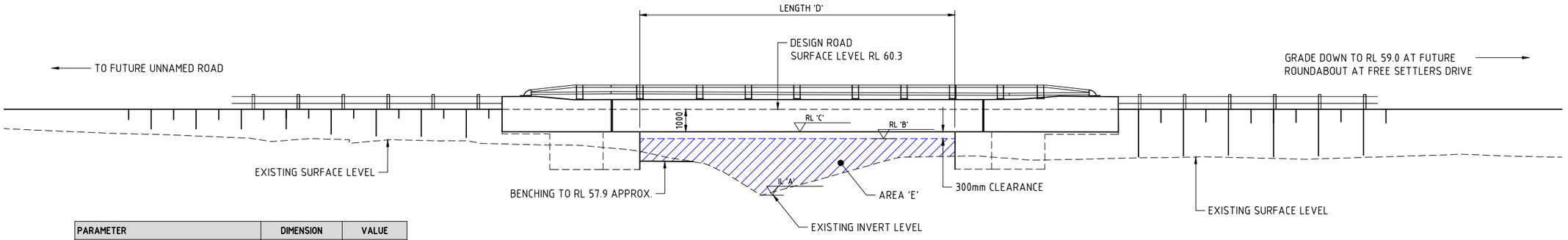
DRAWING No. 0234-EMC 113
ISSUE A | SHEET No. 4 OF 8

SWA1-EXT AUG 2014
554
801

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:100



ELEVATION
SCALE: 1:100

PARAMETER	DIMENSION	VALUE
EXISTING CREEK INVERT LEVEL (m AHD)	A	56.4
100 YEAR ARI DESIGN FLOOD LEVEL (m AHD)	B	59.0
MINIMUM BRIDGE SOFFIT LEVEL (m AHD)	C	59.3
MINIMUM BRIDGE SPAN LENGTH (m)	D	14.0
MINIMUM BRIDGE WATERWAY AREA (m2)	E	14.3
100 YEAR ARI DESIGN PEAK FLOW (m3/s)		22.8

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 1 2 3 4 5m
1 : 200 (A3) 1 : 100 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

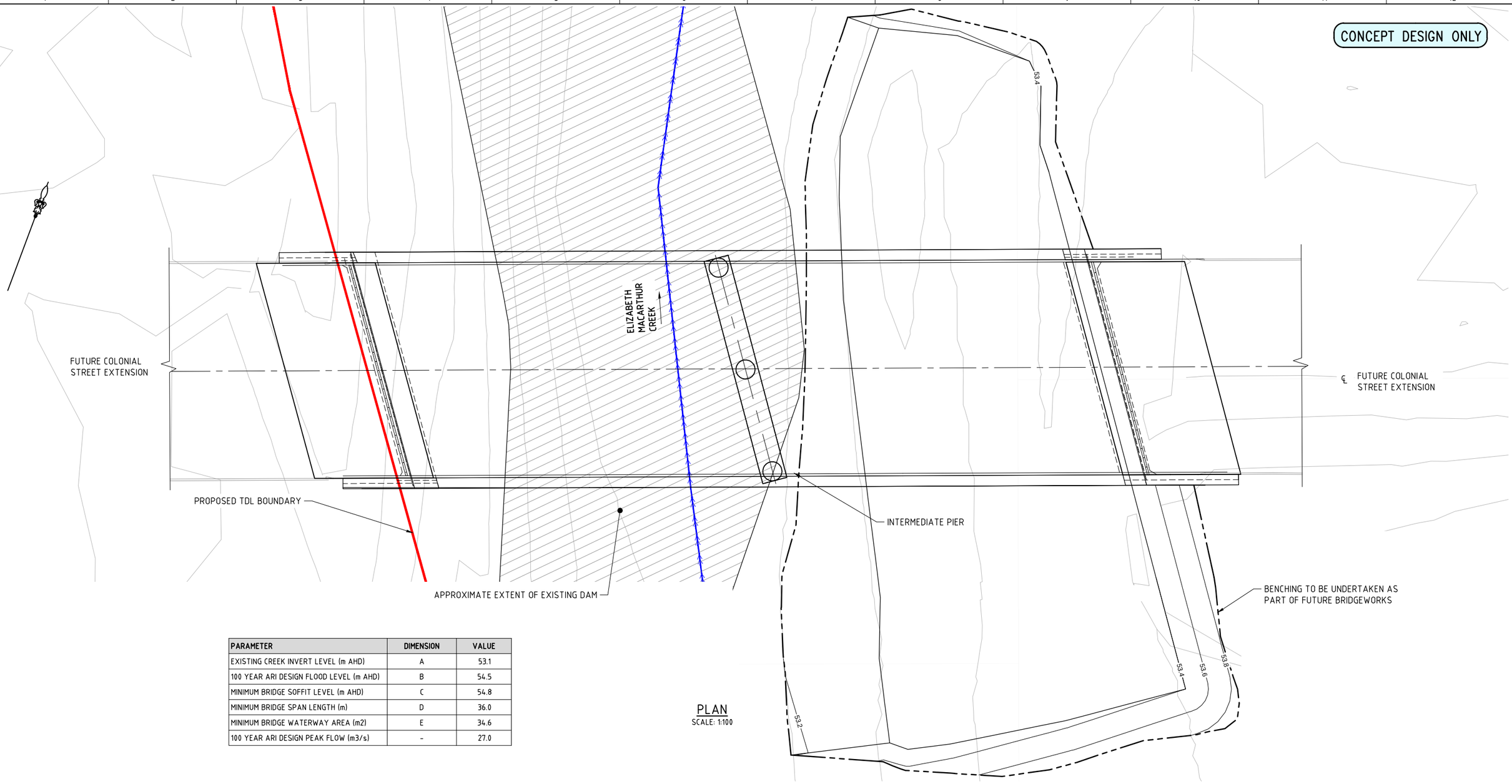
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
FUTURE BRIDGE CROSSING-HODGES ROAD

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 114
ISSUE A | SHEET No. 5 OF 8

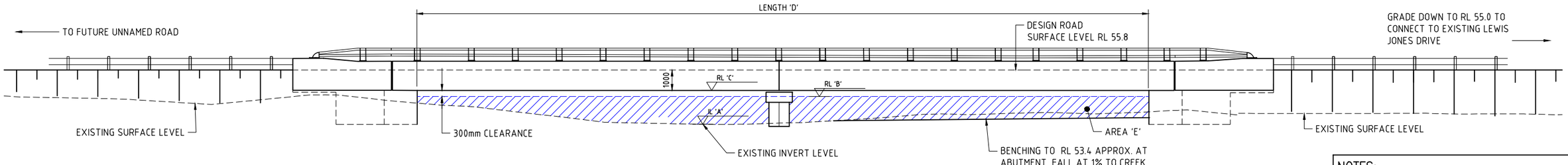
SWAI-EXT AUG 2014
554
801
R41

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:100

PARAMETER	DIMENSION	VALUE
EXISTING CREEK INVERT LEVEL (m AHD)	A	53.1
100 YEAR ARI DESIGN FLOOD LEVEL (m AHD)	B	54.5
MINIMUM BRIDGE SOFFIT LEVEL (m AHD)	C	54.8
MINIMUM BRIDGE SPAN LENGTH (m)	D	36.0
MINIMUM BRIDGE WATERWAY AREA (m2)	E	34.6
100 YEAR ARI DESIGN PEAK FLOW (m3/s)	-	27.0



ELEVATION
SCALE: 1:100

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

1 : 200 (A3) 1 : 100 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16	
DRAWN	C.RUSINGAH AAJV	15.04.16	
VERIFIED	B. WITHNALL AAJV	24.01.17	
APPROVED	N.BARTHO AAJV	24.01.17	

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17 R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER

ACCEPTED 15.02.17 R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER

ELIZABETH MACARTHUR CREEK ROUSE HILL DEVELOPMENT AREA TRUNK DRAINAGE CONCEPT DESIGN FUTURE BRIDGE CROSSING-COLONIAL STREET

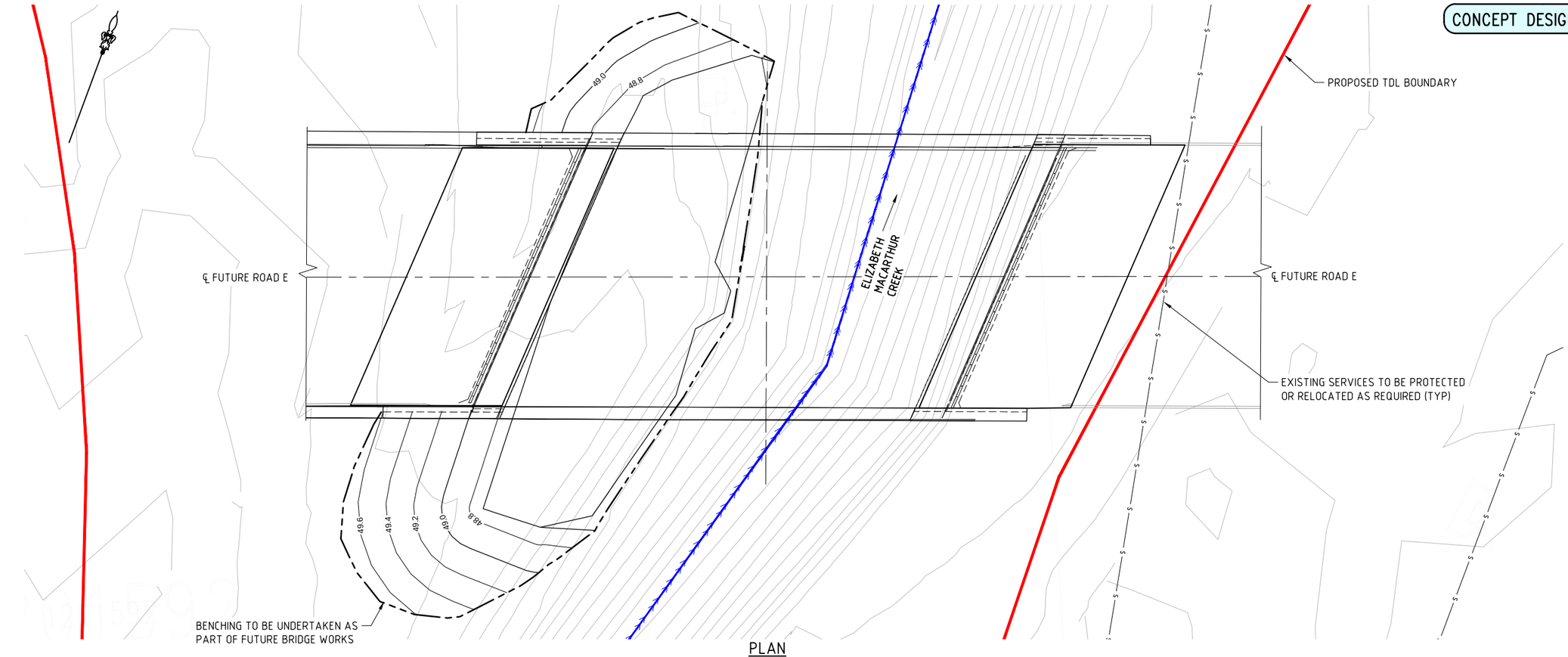
A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 115

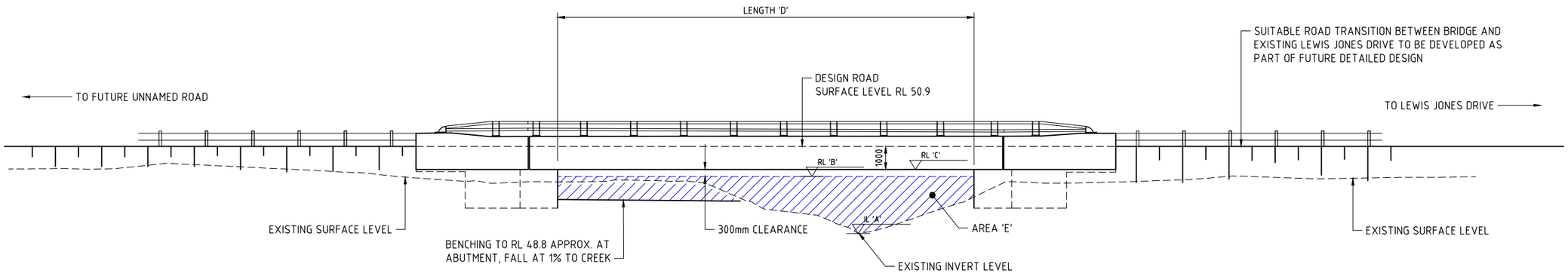
ISSUE A | SHEET No. 6 OF 8

SWAT-EXT AUG 2016

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:100



ELEVATION
SCALE: 1:100

PARAMETER	DIMENSION	VALUE
EXISTING CREEK INVERT LEVEL (m AHD)	A	47.2
100 YEAR ARI DESIGN FLOOD LEVEL (m AHD)	B	49.6
MINIMUM BRIDGE SOFFIT LEVEL (m AHD)	C	49.9
MINIMUM BRIDGE SPAN LENGTH (m)	D	18.0
MINIMUM BRIDGE WATERWAY AREA (m2)	E	22.4
100 YEAR ARI DESIGN PEAK FLOW (m3/s)	-	31.6

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 1 2 3 4 5m
1 : 200 (A3) 1 : 100 (A1)

DESIGNED G.KIRBY AAJV 15.04.16
DRAWN C.RUSINGAH AAJV 15.04.16
VERIFIED B. WITHNALL AAJV 24.01.17
APPROVED N.BARTHO AAJV 24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER 15.02.17
ACCEPTED R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER 15.02.17

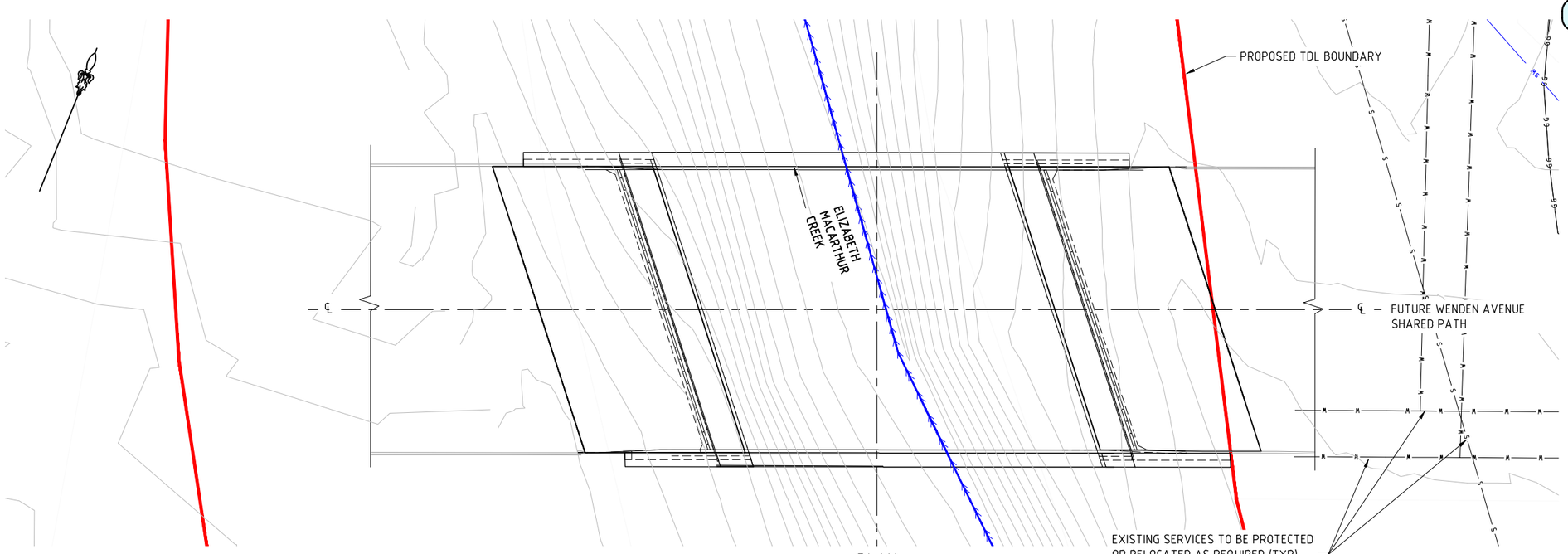
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
FUTURE BRIDGE CROSSING-FUTURE ROAD E

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

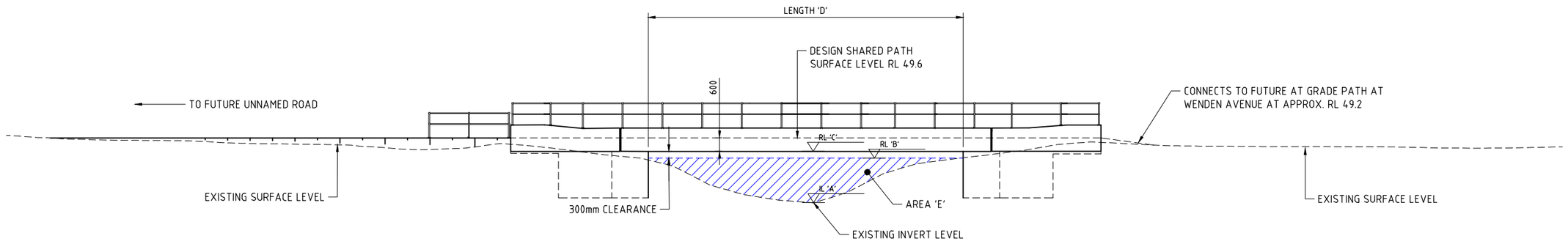
DRAWING No. 0234-EMC 116
ISSUE A | SHEET No. 7 OF 8

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:100



ELEVATION
SCALE: 1:100

PARAMETER	DIMENSION	VALUE
EXISTING CREEK INVERT LEVEL (m AHD)	A	46.4
100 YEAR ARI DESIGN FLOOD LEVEL (m AHD)	B	48.7
MINIMUM BRIDGE SOFFIT LEVEL (m AHD)	C	49.0
MINIMUM BRIDGE SPAN LENGTH (m)	D	14.0
MINIMUM BRIDGE WATERWAY AREA (m2)	E	16.6
100 YEAR ARI DESIGN PEAK FLOW (m3/s)	-	33.4

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 1 2 3 4 5m
1 : 200 (A3) 1 : 100 (A1)

DESIGNED	G.KIRBY AAJV	15.04.16
DRAWN	C.RUSINGAH AAJV	15.04.16
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

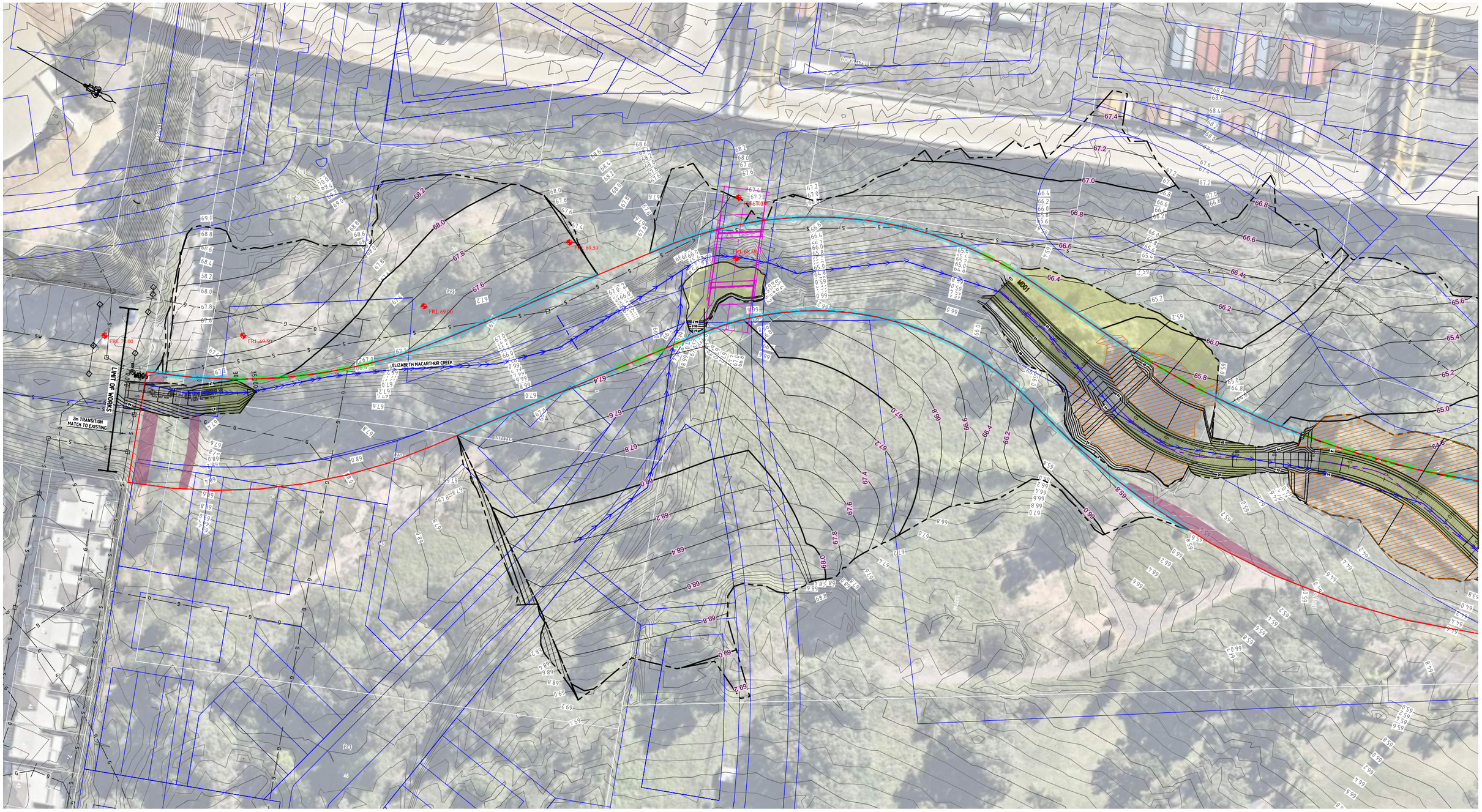
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
FUTURE BRIDGE CROSSING-WENDEN AV PATH

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 117
ISSUE A | SHEET No. 8 OF 8

SWA1-EXT AUG 2014
554
801

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:500

JOINS SHEET 02

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 10 20 25m
1 : 1000 (A3) 1 : 500 (A1)

DESIGNED	G.KIRBY AAJV	09.01.17
DRAWN	C.RUSINGAH AAJV	09.01.17
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

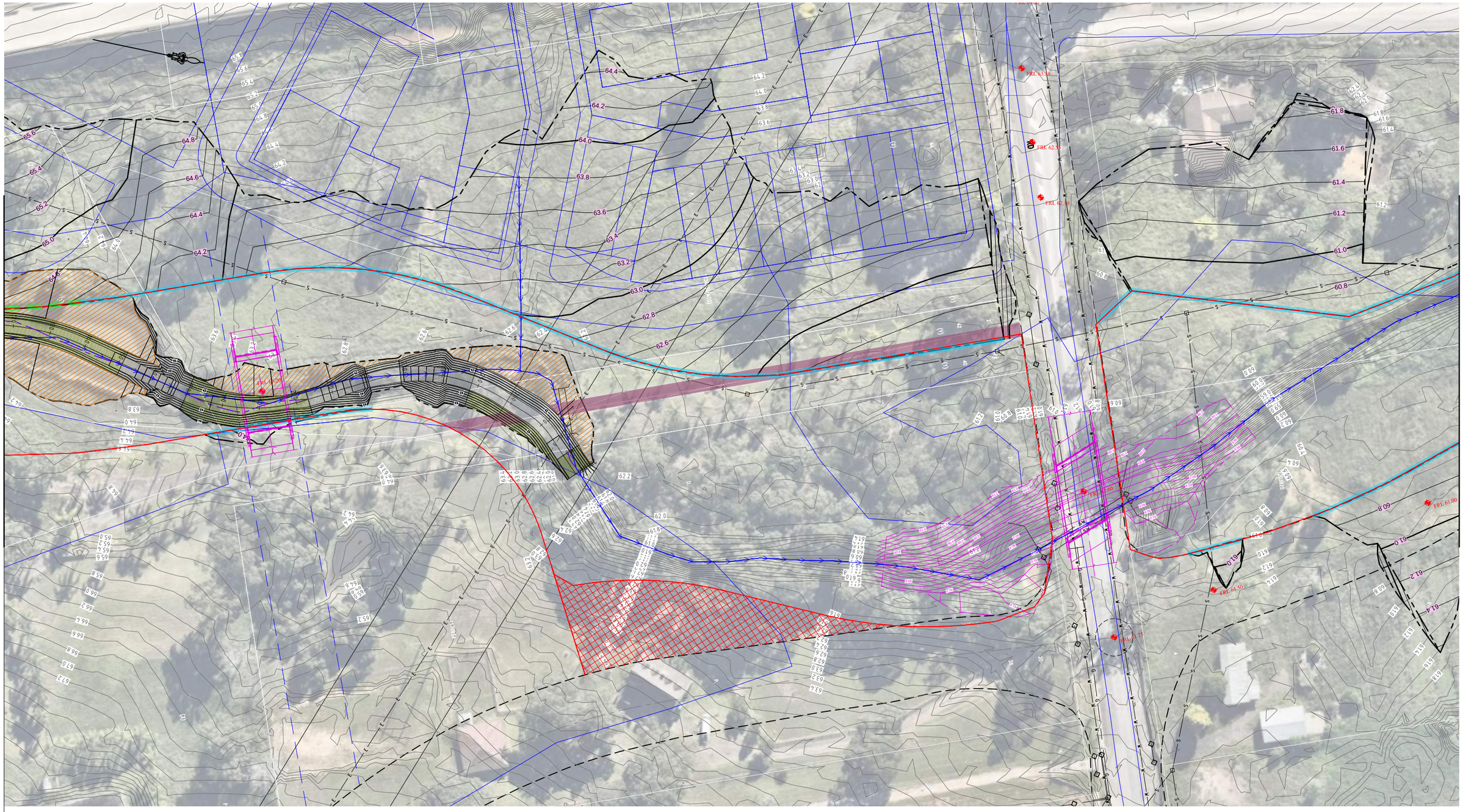
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
LANDFILL EXTENTS GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 121
ISSUE A | SHEET No. 1 OF 07

SWATH EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:500

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 10 20 25m
1 : 1000 (A3) 1 : 500 (A1)

DESIGNED	G.KIRBY AAJV	09.01.17
DRAWN	C.RUSINGAH AAJV	09.01.17
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

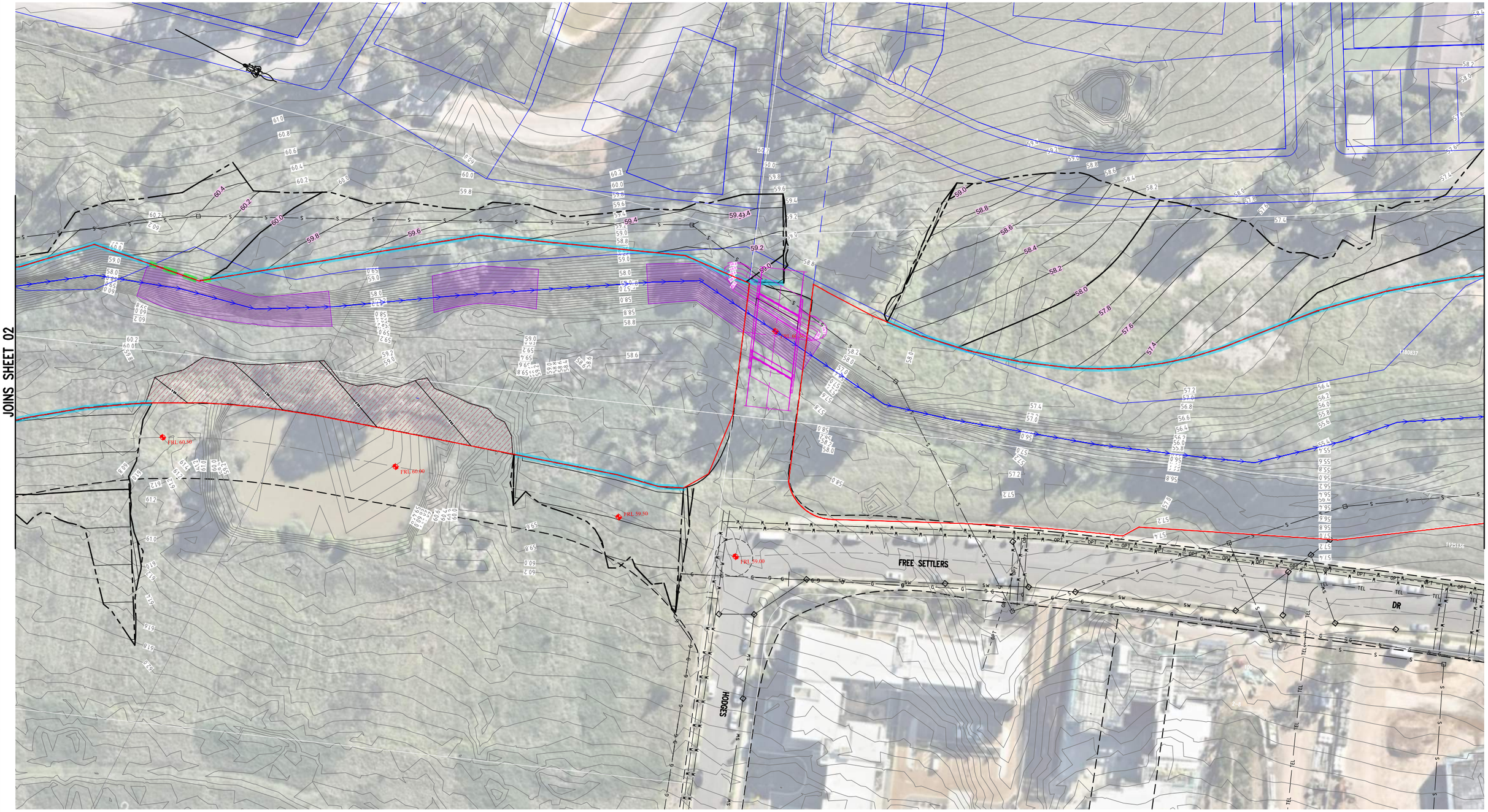
ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
LANDFILL EXTENTS GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 122
ISSUE A | SHEET No. 2 OF 07

SWAT-EXT AUG 2014

CONCEPT DESIGN ONLY



PLAN
SCALE: 1:500

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 10 20 25m
1 : 1000 (A3) 1 : 500 (A1)

DESIGNED	G.KIRBY AAJV	09.01.17
DRAWN	C.RUSINGAH AAJV	09.01.17
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
LANDFILL EXTENTS GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 123
ISSUE A | SHEET No. 3 OF 07

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY

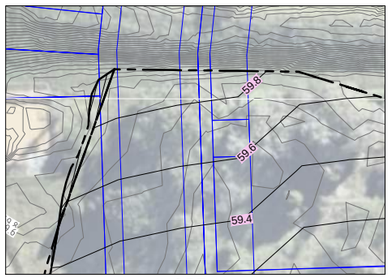
SEE INSET 'A'

LANDFILL TO TRANSITION INTO UPGRADE ROAD FORMATION

PROPOSED MEMORIAL AVENUE ROAD UPGRADE BY RMS

JOINS SHEET 03

JOINS SHEET 05



INSET 'A'

PLAN
SCALE: 1:500

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 10 20 25m
1 : 1000 (A3) 1 : 500 (A1)

DESIGNED	G.KIRBY AAJV	09.01.17
DRAWN	C.RUSINGAH AAJV	09.01.17
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED	R.PARSELL TECHNICAL ADVISOR/ENGINEER SYDNEY WATER	15.02.17
ACCEPTED	R.RAHIMULLAH PROJECT MANAGER SYDNEY WATER	15.02.17

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
LANDFILL EXTENTS GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 124
ISSUE A | SHEET No. 4 OF 07

SWAT-EXT AUG 2014

CONCEPT DESIGN ONLY

PLAN
SCALE: 1:500

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 10 20 25m
1 : 1000 (A3) 1 : 500 (A1)

DESIGNED	G.KIRBY AAJV	09.01.17
DRAWN	C.RUSINGAH AAJV	09.01.17
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
LANDFILL EXTENTS GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 125
ISSUE A | SHEET No. 5 OF 07

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY

PLAN
SCALE: 1:500

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 10 20 25m
1 : 1000 (A3) 1 : 500 (A1)

DESIGNED	G.KIRBY AAJV	09.01.17
DRAWN	C.RUSINGAH AAJV	09.01.17
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
LANDFILL EXTENTS GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 126
ISSUE A | SHEET No. 6 OF 07

SWA1-EXT AUG 2014

CONCEPT DESIGN ONLY

PLAN
SCALE: 1:500

NOTES:
1. FOR NOTES & LEGEND REFER TO DRAWING 0234-EMC-003.

AAJV
2 Palmer Street
North Parramatta NSW 2151Australia
Ph: +61 2 8896 4100 | Fax: +61 2 9890 3558 |
ABN 14 821 636 099

0 10 20 25m
1 : 1000 (A3) 1 : 500 (A1)

DESIGNED	G.KIRBY AAJV	09.01.17
DRAWN	C.RUSINGAH AAJV	09.01.17
VERIFIED	B. WITHNALL AAJV	24.01.17
APPROVED	N.BARTHO AAJV	24.01.17

LETTER	DETAILS OF AMENDMENT	APP'D	DATE

COPYRIGHT
THIS DESIGN IS NOT TO BE COPIED OR AMENDED WITHOUT WRITTEN PERMISSION FROM SYDNEY WATER

Sydney WATER

RECOMMENDED 15.02.17
R.PARSELL
TECHNICAL ADVISOR/ENGINEER
SYDNEY WATER

ACCEPTED 15.02.17
R.RAHIMULLAH
PROJECT MANAGER
SYDNEY WATER

ELIZABETH MACARTHUR CREEK
ROUSE HILL DEVELOPMENT AREA
TRUNK DRAINAGE CONCEPT DESIGN
LANDFILL EXTENTS GENERAL ARRANGEMENT

A1 | PROJ No. 20029728 | DRAWING STATUS: FINAL CONCEPT

DRAWING No. 0234-EMC 127
ISSUE A | SHEET No. 7 OF 07

SWAI-EXT AUG 2014

Appendix E - Sydney Water Response to Feasibility Application

Case Number: 175809

14 May 2019

LANDCOM
c/- Rose Atkins Rimmer

FEASIBILITY LETTER

ROUSE HILL DEVELOPMENT AREA - Stage 3 Service Area

Developer:	**LANDCOM**
Your reference:	**4/25564**
Development:	**27 Old Windsor Rd, Kellyville**
Development Description:	**Mixed residential and commercial development being delivered as part of the Kellyville and Bella Vista Station Precinct project.**
Your application date:	**16 January 2019**

Dear Applicant

This Feasibility Letter (Letter) is a guide only. It provides general information about what Sydney Water's requirements could be if you applied to us for a Section 73 Certificate (Certificate) for your proposed development. **The information is accurate at today's date only.**

If you obtain development consent for that development from your consent authority (this is usually your local Council) they will require you to apply to us for a Section 73 Certificate. You will need to submit a new application (and pay another application fee) to us for that Certificate by using your current or another Water Servicing Coordinator (Coordinator).

Sydney Water will then send you either a:

- Notice of Requirements (Notice) and Developer Works Deed (Deed); or
- Certificate.

These documents will be the definitive statement of Sydney Water's requirements.

There may be changes in Sydney Water's requirements between the issue dates of this Letter and the Notice or Certificate. The changes may be:

1. Developer Charges

(a) Adjustment of charges due to the Consumer Price Index (CPI);
(b) Adjustment of charges because of a scheduled review by the Independent Pricing and Review Tribunal (IPART). After that review and registration of the new charges, Sydney Water has to apply those charges; or
(c) If there is rezoning of any land within the development proposal, then new charges will apply.

2. **Changing the Proposed Development**

- If you change your proposed development, e.g. the development description or the plan/ site layout, after today, the requirements in this Letter could change when you submit your new application; and

- if you decide to do your development in stages then you must submit a new application (and pay another application fee) for each stage.

No warranties or assurances can be given about the suitability of this document or any of its provisions for any specific transaction. It does not constitute an approval from Sydney Water and to the extent that it is able, Sydney Water limits its liability to the reissue of this Letter or the return of your application fee. You should rely on your own independent professional advice.

What You Must Do To Get A Section 73 Certificate in the Future

To get a Section 73 Certificate in the future you must do the following things. You can also find out about this process by visiting www.sydneywater.com.au > Plumbing, building & developing > Developing > Land Development.

1. **Obtain Development Consent from the consent authority for your development proposal.**

2. **Engage a Water Servicing Coordinator (Coordinator).**

   You must engage your current or another authorised Coordinator to manage the design and construction of works that you must provide, at your cost, to service your development. If you wish to engage another Coordinator (at any point in this process) you must write and tell Sydney Water.

   For a list of authorised Coordinators, either visit www.sydneywater.com.au > Plumbing, building & developing > Developing > Providers > Lists or call **13 20 92.**

   The Coordinator will be your point of contact with Sydney Water. They can answer most questions that you might have about the process and developer charges and can give you a quote or information about costs for services/works (including Sydney Water costs).

3. **Developer Works Deed**

   After the Coordinator has submitted your new application, they will receive the Sydney Water Notice and Developer Works Deed. You and your accredited Developer Infrastructure Providers (Providers) will need to sign and lodge both copies of the Deed with your nominated Coordinator. After Sydney Water has signed the documents, one copy will be returned to the Coordinator.

   The Deed sets out for this project:

   - your responsibilities;
   - Sydney Water's responsibilities; and
   - the Provider's responsibilities.

   You must do all the things that we ask you to do in that Deed. This is because your development does not have water, recycled water, sewer and storm water services and you must construct and pay for the following works extensions under this Deed to provide these services.

   Note: The Coordinator must be fully authorised by us for the whole time of the agreement.

4. **Drinking Water, Recycled Water, Sewer and Stormwater Works**

   - Information supplied with your application is very similar to that which was used to create the scheme plans and we will need to confirm in more detail, when known, building heights, densities etc in the proposed precincts to ensure the scheme plans are still

appropriate.

- Based our understanding of information supplied, it appears that these precincts will have customised servicing arrangements with unique demand and discharge levels and patterns. A refresh of our existing scheme plans may be required once further details are known.
- Zoning, FSR and building heights are consistent with the current zoning on the Planning website. And scheme plans have been developed in conjunction with this information https://www.planningportal.nsw.gov.au/find-a-property/4053327__101__DP1084481

4.1 Drinking Water

Your development must have a frontage to a water main that is the right size and can be used for connection.

Sydney Water has assessed your application and found that:
The proposed development is within a known high growth area along the North West Metro line.

- Drinking water and recycled water scheme plans have been created based on predicted development types, at the time the Metro rail project was instigated circa 2015.

- You must construct drinking water main extensions to serve your development. They must comply with the standards for Dual Water Reticulation Systems talked about in section 4.2.1 below.

- A service connection and property service must be provided for your development off the drinking water mains to be constructed.
  They must comply with the standards for Dual Water Reticulation Systems talked about in section 4.2.1 below.

4.2 Recycled Water

Your development must have a frontage to a recycled water main that is the right size and can be used for connection.

Sydney Water has assessed your application and found that:
The proposed development is within a known high growth area along the North West Metro line.

- Drinking water and recycled water scheme plans have been created based on predicted development types, at the time the Metro rail project was instigated circa 2015.

- You must construct recycled water main extensions to serve your development. They must comply with the standards for Dual Water Reticulation Systems talked about in section 4.2.1 below.

- A service connection and property service must be provided for your development off the recycled water mains to be constructed.

They must comply with the standards for Dual Water Reticulation Systems talked about in section 4.2.1 below.

4.2.1 Sydney Water's Standards for Dual Water Reticulation

Your development is in an area where both drinking and recycled water systems are available. The drinking and recycled water works required above must comply with the standards for Dual Water Reticulation Systems that are set down in the Water Supply Code of Australia (Sydney Water Edition) (the Code).

These standards require that service connections and property services be provided for both drinking and recycled water for your development. The installation of these services must either be carried out or supervised by a licensed plumber. It must meet the:

(a) Administrative requirements of the Plumbing Code of Australia; and Technical requirements of the Dual Water Drawings Set within the Code.

4.3 Sewer

Your development must have a sewer main that is the right size and can be used for connection. That sewer must also have a connection point within your development's boundaries.

Sydney Water has assessed your application and found that:
The proposed development is within a known high growth area along the North West Metro line.

- A wastewater scheme plan has not been created but an assessment of the Carrier has been undertaken. Lead-ins will need to be sized from the Carrier for each sub-catchment.

- **You must construct waste water main extensions to serve your development**. The terms of the Deed define this extension as 'Major Works'.

4.4 Stormwater Connection

Any stormwater design is to be carried out according to the current guidelines title "Stormwater connections to natural waterways in the Rouse Hill Development Area" dated 31 July 2014. Copies of the stormwater plans are to be attached in the eDeveloper system.

Stormwater drawings below 1 in 100-year flood limit are to be drawn in AutoCad format and given to the Water Servicing Coordinator. Water Servicing Coordinator is required to transfer these drawings on to the Sydney Water template, prior to submit as design drawings. No works within the 100-year flood level are to be carried out without Sydney Water approval and the payment of the appropriate bond money.

Landscaping / Road Work

Any filling carried out as part of the development will need to be contained wholly within the boundaries of the proposed lots and roads, and not encroach onto the 100-year flood boundary or Sydney Water land. Also, any fill will need to be stabilised in such a way so as to prevent any collapse or intrusion onto the trunk drainage lands over time. Details of the work adjacent to the Creek are to be submitted to ensure that these requirements are met.

- Minor batter spill into the trunk drainage corridor is acceptable
    - desirable maximum spill 1.5 metres @ 3H:1V
    - absolute maximum spill 2.0 metres @ 3H:1V for short occasional isolated sections

Vegetation Management Plan

All the disturbed area below the 100-year flood limits and within Sydney Water land are to be revegetated according to the current guidelines. A site-specific Vegetation Management Plan is to be prepared according to the guidelines in the “Stormwater connections to waterways in the Rouse Hill Development Area” and submitted to Sydney Water for approval. Toe, Middle and Upper zones are to be identified within the disturbed area and the specific plants that are proposed on each zone and its density are to be tabulated in the Vegetation Management Plan.

The restoration work is to be according to the approved Vegetation Management Plan and need to maintain for a minimum period of 12 months. Bond money is required for connection, revegetation and maintenance.

Bond Money

Bond money is required for revegetation of the disturb land and maintaining this revegetation for a period of 12 months. Proponent is required to identify the extent of the land to be disturbed within Sydney Water land or within 100-year flood limit to carry out any stormwater connection or sewer work. Estimated cost for the revegetation and 12 months period of maintenance are to be provided in the Vegetation Management Plan in order to determine the required bond money.

Bond money also would be required for the stormwater connection if the application is not associated with Section 73 application or Section 73 Certificate is required prior to submit the Work As Constructed drawings.

The bond money would be refunded to the proponent only after the satisfactory completion of maintaining the revegetated plants for a period of 12 months.

If the proposed development requires enter into the trunk drainage land for sewer works then this Vegetation Management Plan should cover both the stormwater and sewer work.

Water Sensitive Urban Design

Stormwater discharge form the site is to be treated to meet the target as specified in the “Stormwater connections to waterways in the Rouse Hill Development Area”.

Funding of works

Under Sydney Water's 'Funding of infrastructure to service growth' policy we may agree to contribute towards a portion of the cost of the works you are required to build. This is done either by Sydney Waters Schedule of Rates or via the Procurement process. Your Water Service Coordinator can advise you in relation to this policy, the likelihood of Sydney Water sharing a portion of the cost and the process you need to satisfy Sydney Water's probity requirements.

If you do choose to request a quote through the Schedule of Rates for Sydney Water's contribution you will avoid going through the full procurement process. Your WSC can advise you of this option.

The funding assessment will be made at the detailed design stage, prior to any construction works commencing. A firm commitment would not be made by Sydney Water until we:

- Have reviewed the detailed design and;
- Have reviewed the detailed construction quotations needed to meet our probity requirements and;
- Come to an agreement on the amount.

5. Ancillary Matters

5.1 Asset adjustments

If any Sydney Water drinking water main, recycled water main, sewer or stormwater asset constructed or under construction is found, after the issue of this Notice, to require adjustment or deviation as a result of your development; then this work must be undertaken in conjunction with the abovementioned water, recycled water, sewer and storm water extension. If this happens, you will need to do this work as well as the extension we have detailed above at your cost. The work must meet the conditions of this Notice and you will need to complete it **before we can issue the Certificate**. Sydney Water will need to see the completed designs for the work and we will require you to lodge a security. The security will be refunded once the work is completed.

5.2 Entry onto neighbouring property

If you need to enter a neighbouring property, you must have the written permission of the relevant property owners and tenants. You must use Sydney Water's **Permission to Enter** form(s) for this. You can get copies of these forms from your Coordinator or the Sydney Water website. Your Coordinator can also negotiate on your behalf. Please make sure that you address all the items on the form(s) including payment of compensation and whether there are other ways of designing and constructing that could avoid or reduce their impacts. You will be responsible for all costs of mediation involved in resolving any disputes. Please allow enough time for entry issues to be resolved.

5.3 Costs

Construction of these **future** works will require you to pay project management, survey, design and construction costs **directly to your suppliers**. Additional costs payable to Sydney Water may include:

- water main shutdown and disinfection;
- connection of new water mains to Sydney Water system(s);
- design and construction audit fees;
- contract administration, Operations Area Charge & Customer Redress prior to project finalisation;
- creation or alteration of easements etc; and
- water usage charges where water has been supplied for building activity purposes prior to disinfection of a newly constructed water main.

Note: Payment for any Goods and Services (including Customer Redress) provided by Sydney Water will be required prior to the issue of the Section 73 Certificate or release of the Bank Guarantee or Cash Bond.

Your Coordinator can tell you about these costs.

6. **Developer Charges**

Development Servicing Plan (DSP)	**Basis of Calculation**	**Charge ($) for Applicable Period** **(14/05/19-30/06/19)**
Rouse Hill Recycled	Residential Development Density > 156 lots/dwellings per ha band 8402 lots/dwellings @ $951 = $7990302 less Credit of $0 for previous use	$7,990,302.00
Rouse Hill Recycled	Commercial Area 295250 sqm @ $71695 per ha = $2116794 less Credit of $0 for previous payment/use	$2,116,794.00
DEVELOPER CHARGES TOTAL:		**$10,107,096.00**

DSP charges are a contribution towards the cost of systems (e.g. pipelines and treatment plants) which will serve your development. Sydney Water has no power to change these costs because they are decided by IPART. If you want more information visit the IPART website www.IPART.nsw.gov.au. If there is a dispute, the cost of arbitration will be shared

equally by you and Sydney Water (see *IPART Act 1992, Section 31*).

The amounts shown above are an estimate of charges that would be applicable, as of today's date, to your development had you obtained Development Approval for your proposal. **No Payments can be accepted for these estimates.** Should you obtain Development Approval for this proposal and apply for a Section 73 Certificate in the future, then Sydney Water will advise you of the DSP charges applicable to your Development.

6. **Approval of your Building Plans**

You must have your building plans approved **before the Certificate can be issued. Building construction work MUST NOT commence until Sydney Water has granted approval.** Approval is needed because construction/building works may affect Sydney Water's assets (e.g. water and sewer mains).

Your Coordinator can tell you about the approval process including:

- Your provision, if required, of a "Services Protection Report" (also known as a "pegout"). This is needed to check whether the building and engineering plans show accurately where Sydney Water's assets are located in relation to your proposed building work. Your Coordinator will then either approve the plans or make requirements to protect those assets before approving the plans;
- Possible requirements;
- Costs; and
- Timeframes.

You can also find information about this process (including technical specifications) if you either:

- Visit www.sydneywater.com.au > Plumbing, building & developing > Building > Building over or next to assets. Here you can find Sydney Water's *Technical guidelines - Building over and adjacent to pipe assets;* or
- Call 13 20 92.

Notes:

- **The Certificate will not be issued until the plans have been approved and, if required, Sydney Water's assets are altered or deviated;**
- **You can only remove, deviate or replace any of Sydney Water's pipes using temporary pipework if you have written approval from Sydney Water's Urban Growth Business. You must engage your Coordinator to arrange this approval; and**
- **You must obtain our written approval before you do any work on Sydney Water's systems. Sydney Water will take action to have work stopped on the site if you do not have that approval. We will apply Section 44 of the *Sydney Water Act 1994.***

7. **Special Requirements**

Multi-level individual metering requirements

Your development must either allow for or provide individual metering. This means that you must:

1. comply at all times and in all respects with the requirements of Sydney Water's "*Multi-level Individual Metering Guide*" (version 6 dated 1 July 2015);

2. provide and install plumbing and space for individual metering in accordance with Sydney Water's "*Multi-level Individual Metering Guide*";

3. if and when you implement a strata/ stratum plan (or strata/ stratum subdivide) you must:

    a. engage an Accredited Metering Supplier ("**AMS**") to provide individual metering in accordance with the "*Multi-level Individual Metering Guide"* and meet the cost of the meters and metering system;

    b. transfer the meters and metering system to Sydney Water once the Testing Certificate has been issued by Sydney Water to the AMS and the AMS has confirmed that payment for the meters and metering system has been paid in full.

Before the Section 73 Certificate can be issued, you will be required to sign an undertaking to show that you understand and accept these metering requirements and associated costs.

Visit www.sydneywater.com.au > Plumbing, Building & Developing > Plumbing > Meters & metered standpipes to see the *Multi-level individual metering guide* and find out more.

OTHER THINGS YOU NEED TO DO:

Shown below are other things you need to do that are NOT a requirement for the Certificate. They may well be a requirement of Sydney Water in the future because of the impact of your development on our assets. You must read them before you go any further.

Disused Sewerage Service Sealing

Please do not forget that you must pay to disconnect all disused private sewerage services and seal them at the point of connection to a Sydney Water sewer main. This work must meet Sydney Water's standards in the Plumbing Code of Australia (the Code) and be done by a licensed drainer. The licensed drainer must arrange for an inspection of the work by a NSW Fair Trading Plumbing Inspection Assurance Services (PIAS) officer. After that officer has looked at the work, the drainer can issue the Certificate of Compliance. The Code requires this.

Soffit Requirements

Please be aware that floor levels must be able to meet Sydney Water's soffit requirements for property connection and drainage.

Requirements for Business Customers for Commercial and Industrial Property Developments

If this property is to be developed for Industrial or Commercial operations, it may need to meet the following requirements:

Trade Wastewater Requirements

If this development is going to generate trade wastewater, the property owner must submit an application requesting permission to discharge trade wastewater to Sydney Water's sewerage system. You must wait for approval of this permit before any business activities can commence.

The permit application should be emailed to Sydney Water's Business Customer Services at businesscustomers@sydneywater.com.au

It is illegal to discharge Trade Wastewater into the Sydney Water sewerage system without permission.

A **Boundary Trap** is required for all developments that discharge trade wastewater where arrestors and special units are installed for trade wastewater pre-treatment.

If the property development is for Industrial operations, the wastewater may discharge into a sewerage area that is subject to wastewater reuse. Find out from Business Customer Services if this is applicable to your development.

Backflow Prevention Requirements

Backflow is when there is unintentional flow of water in the wrong direction from a potentially polluted source into the drinking water supply.

All properties connected to Sydney Water's supply must install a testable **Backflow Prevention Containment Device** appropriate to the property's hazard rating. Property with a high or medium hazard rating must have the backflow prevention containment device tested annually. Properties identified as having a low hazard rating must install a non-testable device, as a minimum.

Separate hydrant and sprinkler fire services on non-residential properties, require the installation of a testable double check detector assembly. The device is to be located at the boundary of the property.

Before you install a backflow prevention device:

1. Get your hydraulic consultant or plumber to check the available water pressure versus the property's required pressure and flow requirements.
2. Conduct a site assessment to confirm the hazard rating of the property and its services. Contact PIAS at NSW Fair Trading on **1300 889 099**.

For installation you will need to engage a licensed plumber with backflow accreditation who can be found on the Sydney Water website:
http://www.sydneywater.com.au/Plumbing/BackflowPrevention/

Water Efficiency Recommendations

Water is our most precious resource and every customer can play a role in its conservation. By working together with Sydney Water, business customers are able to reduce their water consumption. This will help your business save money, improve productivity and protect the environment.

Some water efficiency measures that can be easily implemented in your business are:

- Install water efficiency fixtures to help increase your water efficiency, refer to WELS (Water Efficiency Labelling and Standards (WELS) Scheme, http:// www.waterrating.gov.au/
- Consider installing rainwater tanks to capture rainwater runoff, and reusing it, where cost effective. Refer to http://www.sydneywater.com.au/Water4Life/InYourBusiness/ RWTCalculator.cfm
- Install water-monitoring devices on your meter to identify water usage patterns and leaks.
- Develop a water efficiency plan for your business.

It is cheaper to install water efficiency appliances while you are developing than retrofitting them later.

Contingency Plan Recommendations

Under Sydney Water's customer contract Sydney Water aims to provide Business Customers with a continuous supply of clean water at a minimum pressure of 15meters head at the main tap. This is equivalent to 146.8kpa or 21.29psi to meet reasonable business usage needs.

Sometimes Sydney Water may need to interrupt, postpone or limit the supply of water services to your property for maintenance or other reasons. These interruptions can be planned or unplanned.

Water supply is critical to some businesses and Sydney Water will treat vulnerable customers, such as hospitals, as a high priority.

Have you thought about a **contingency plan** for your business? Your Business Customer Representative will help you to develop a plan that is tailored to your business and minimises productivity losses in the event of a water service disruption.

For further information please visit the Sydney Water website at: http:// www.sydneywater.com.au/OurSystemsandOperations/TradeWaste/ or contact Business Customer Services on **1300 985 227** or businesscustomers@sydneywater.com.au

Fire Fighting

Your firefighting service must be drawn from the recycled water system.
Definition of fire fighting systems is the responsibility of the developer and is not part of the Section 73 process. It is recommended that a consultant should advise the developer regarding the fire fighting flow of the development and the ability of Sydney Water's system to provide that flow in an emergency. Sydney Water's Operating Licence directs that Sydney Water's mains are only required to provide domestic supply at a minimum pressure of 15 m head.

A report supplying modelled pressures called the Statement of Available pressure can be purchased on-line through Sydney Water Tap in™ and may be of some assistance when defining the fire fighting system. The Statement of Available pressure, may advise flow limits that relate to system capacity or diameter of the main and pressure limits according to pressure management initiatives. If mains are required for fire fighting purposes, the mains shall be arranged through the water main extension process and not the Section 73 process.

Large Water Service Connections (Dual Water)

A drinking water main and a recycled water main will be available, once you have completed your drinking and recycled water main construction to serve your development. The size of your development means that you will need dual water connections larger than the standard domestic 20 mm size.

To get approval for your connection, you will need to lodge an application with Sydney Water Tap in™. You, or your hydraulic consultant, may need to supply the following:

- A plan of the hydraulic layout;
- A list of all the fixtures/fittings within the property;
- A copy of the fireflow pressure inquiry issued by Sydney Water;
- A pump application form (if a pump is required);
- All pump details (if a pump is required).

You will have to pay an application fee.

The service connection will need to meet with:

Administrative requirements of the Plumbing Code of Australia; and
Technical requirements of the Dual Water Drawings Set within the Code.

Sydney Water does not consider whether a water main is adequate for fire fighting purposes for your development. We cannot guarantee that this water supply will meet your Council's fire fighting requirements. The Council and your hydraulic consultant can help.

Disused Water Service Sealing

You must pay to disconnect all disused private water services and seal them at the point of connection to a Sydney Water water main. This work must meet Sydney Water's standards in the Plumbing Code of Australia (the Code) and be done by a licensed plumber. The licensed plumber must arrange for an inspection of the work by a NSW Fair Trading Plumbing Inspection Assurance Services (PIAS) officer. After that officer has looked at the work, the drainer can issue the Certificate of Compliance. The Code requires this.

Other fees and requirements
The requirements in this Advice Letter relate to your future Certificate application only. Sydney Water may be involved with other aspects of your development and there may be other fees or requirements. These include:

- construction/building plan approval fees;
- plumbing and drainage inspection costs;
- the installation of backflow prevention devices;
- trade waste requirements;
- large water connections and
- council fire fighting requirements. (It will help you to know what the fire fighting requirements are for your development as soon as possible. Your hydraulic consultant can help you here.)

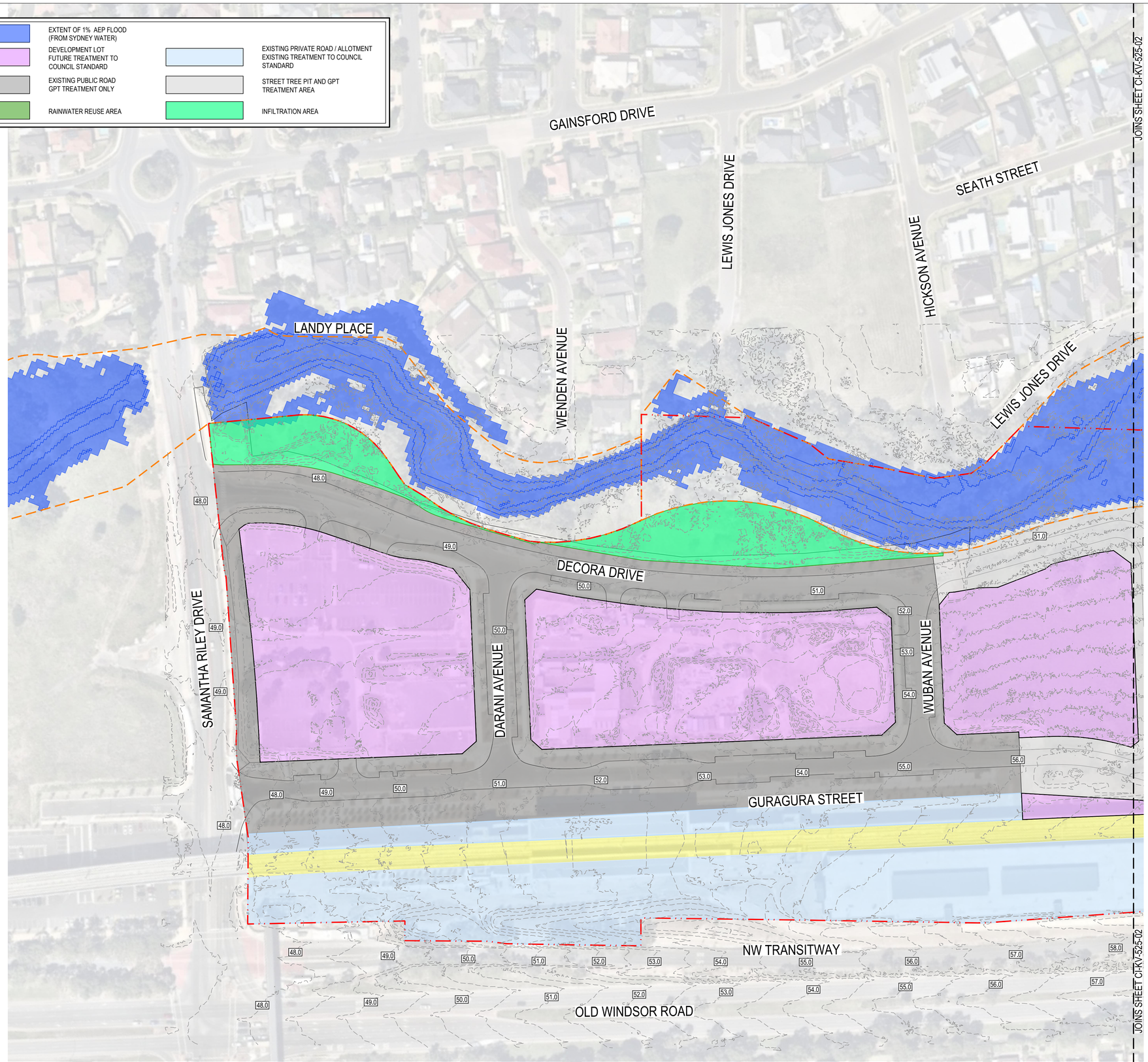
No warranties or assurances can be given about the suitability of this document or any of its provisions for any specific transaction. It does not constitute an approval from Sydney Water and to the extent that it is able, Sydney Water limits its liability to the reissue of this Letter or the return of your application fee. You should rely on your own independent professional advice.

END

Appendix F – Concept Stormwater Management Plans

LEGEND

- SSDA BOUNDARY
- SP2 ZONE BOUNDARY
- EXISTING CONTOURS (0.5M INTERVALS) — 49.5
- EXISTING RAIL
- EXTENT OF 1% AEP FLOOD (FROM SYDNEY WATER)
- DEVELOPMENT LOT FUTURE TREATMENT TO COUNCIL STANDARD
- EXISTING PUBLIC ROAD GPT TREATMENT ONLY
- RAINWATER REUSE AREA
- EXISTING PRIVATE ROAD / ALLOTMENT EXISTING TREATMENT TO COUNCIL STANDARD
- STREET TREE PIT AND GPT TREATMENT AREA
- INFILTRATION AREA



1:1000 10 0 10 20 30 40 50 A1
1:2000 A3

REV	DESCRIPTION	DRAWN	APP'D	DATE
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
B	SSDA ISSUE	JDU	OKW	21.04.20
A	SSDA ISSUE	CPO	OKW	12.08.19

DRAWN:	CPO
DESIGNED:	OKW
VERIFIED:	... ../../..
APPROVED FOR TENDER:	... ../../..
APPROVED FOR CONSTRUCTION:	... ../../..

LANDCOM
ARCHITECT/CLIENT

KELLYVILLE AND BELLA VISTA
PROJECT

KELLYVILLE WSUD CATCHMENT PLAN - SHEET 1 OF 2
TITLE

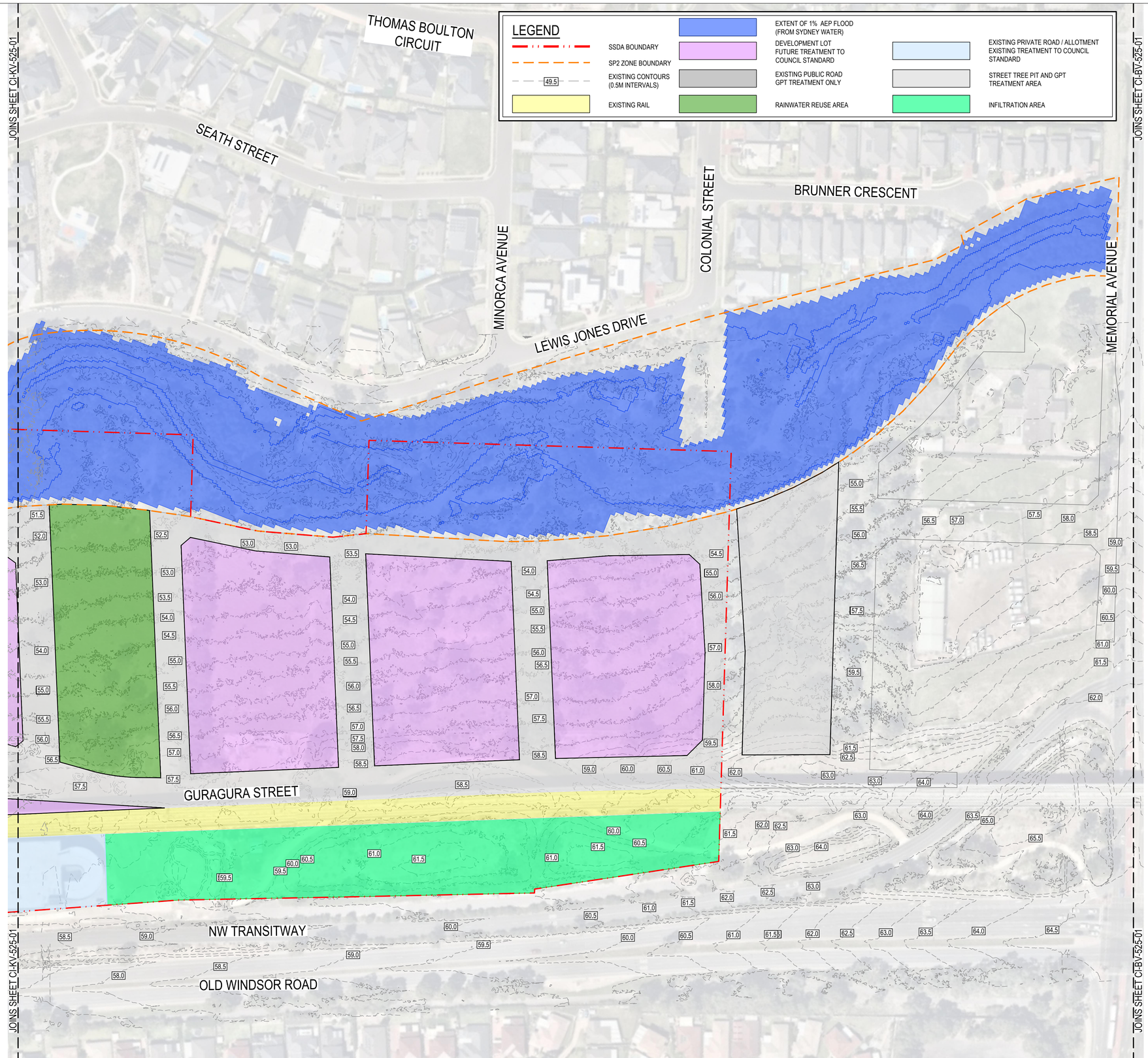
40416-CI-KV-500-01.dwg

Stantec

CONCEPT
NOT FOR CONSTRUCTION

1:1000	40416	CI-KV-500-01	B
SCALE @ A1	PROJECT No	DRAWING No	REV

21/04/2020 5:15:47 PM



1:1000 10 0 10 20 30 40 50 A1
1:2000 A3

REV	DESCRIPTION	DRAWN	APP'D	DATE
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
B	SSDA ISSUE	JDU	OKW	21.04.20
A	SSDA ISSUE	CPO	OKW	12.08.19

DRAWN:	CPO
DESIGNED:	OKW
VERIFIED:	... ../../..
APPROVED FOR TENDER:	... ../../..
APPROVED FOR CONSTRUCTION:	... ../../..

LANDCOM
ARCHITECT/CLIENT

KELLYVILLE AND BELLA VISTA
PROJECT

KELLYVILLE WSUD CATCHMENT PLAN - SHEET 2 OF 2
TITLE

Stantec

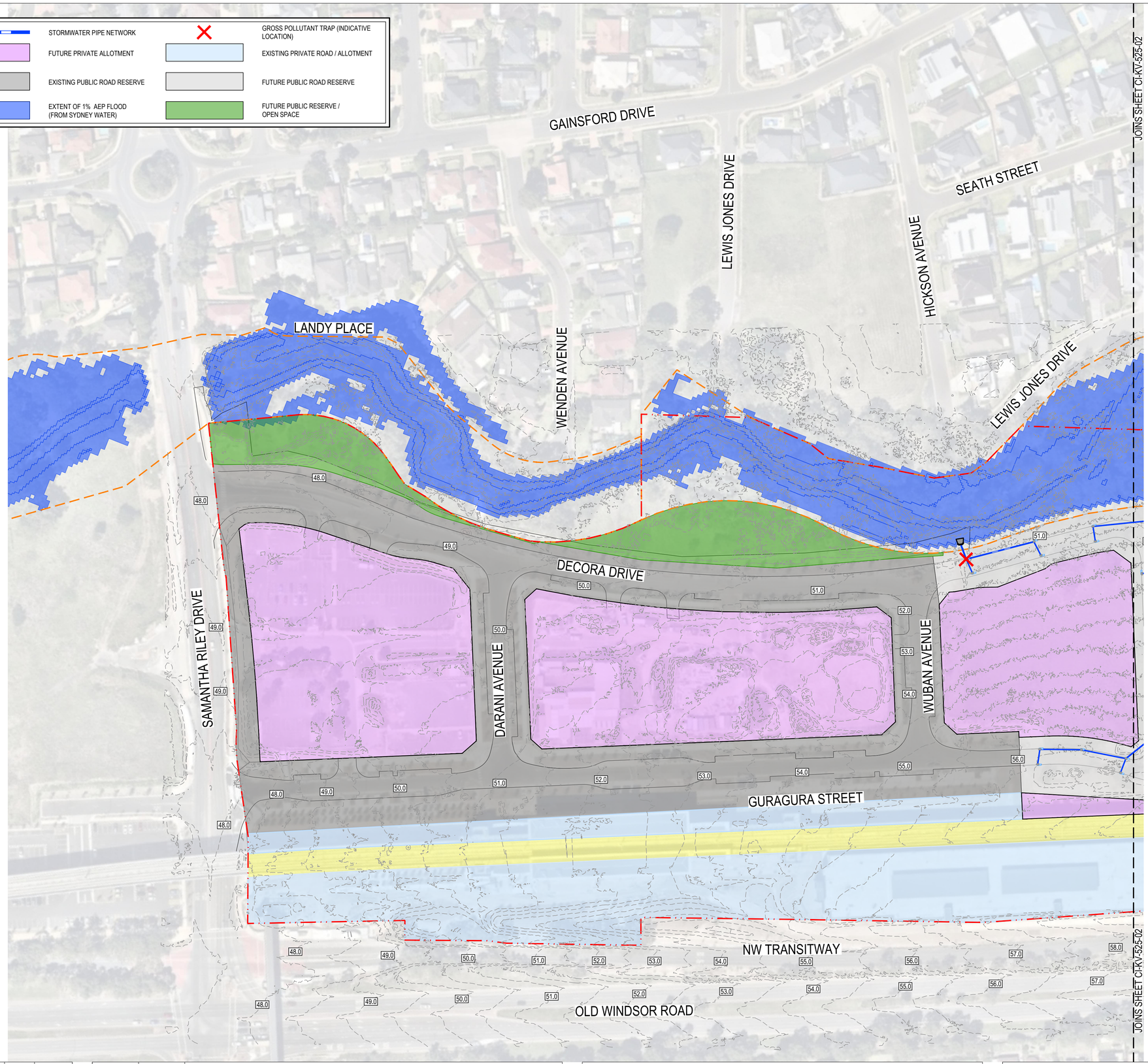
CONCEPT
NOT FOR CONSTRUCTION

1:1000	40416	CI-KV-500-02	B
SCALE @ A1	PROJECT No	DRAWING No	REV

40416-CI-KV-500-02.dwg
22/04/2020 3:13:42 PM

LEGEND

- SSDA BOUNDARY
- SP2 ZONE BOUNDARY
- EXISTING CONTOURS (0.5M INTERVALS) — 49.5
- EXISTING RAIL
- STORMWATER PIPE NETWORK
- FUTURE PRIVATE ALLOTMENT
- EXISTING PUBLIC ROAD RESERVE
- EXTENT OF 1% AEP FLOOD (FROM SYDNEY WATER)
- GROSS POLLUTANT TRAP (INDICATIVE LOCATION)
- EXISTING PRIVATE ROAD / ALLOTMENT
- FUTURE PUBLIC ROAD RESERVE
- FUTURE PUBLIC RESERVE / OPEN SPACE



1:1000 10 0 10 20 30 40 50 A1
1:2000 A3

REV	DESCRIPTION	DRAWN	APP'D	DATE
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
B	SSDA ISSUE	JDU	OKW	21.04.20
A	SSDA ISSUE	CPO	OKW	12.08.19

DRAWN:	CPO
DESIGNED:	OKW
VERIFIED:	... ../../..
APPROVED FOR TENDER:	... ../../..
APPROVED FOR CONSTRUCTION:	... ../../..

LANDCOM
ARCHITECT/CLIENT

KELLYVILLE AND BELLA VISTA
PROJECT

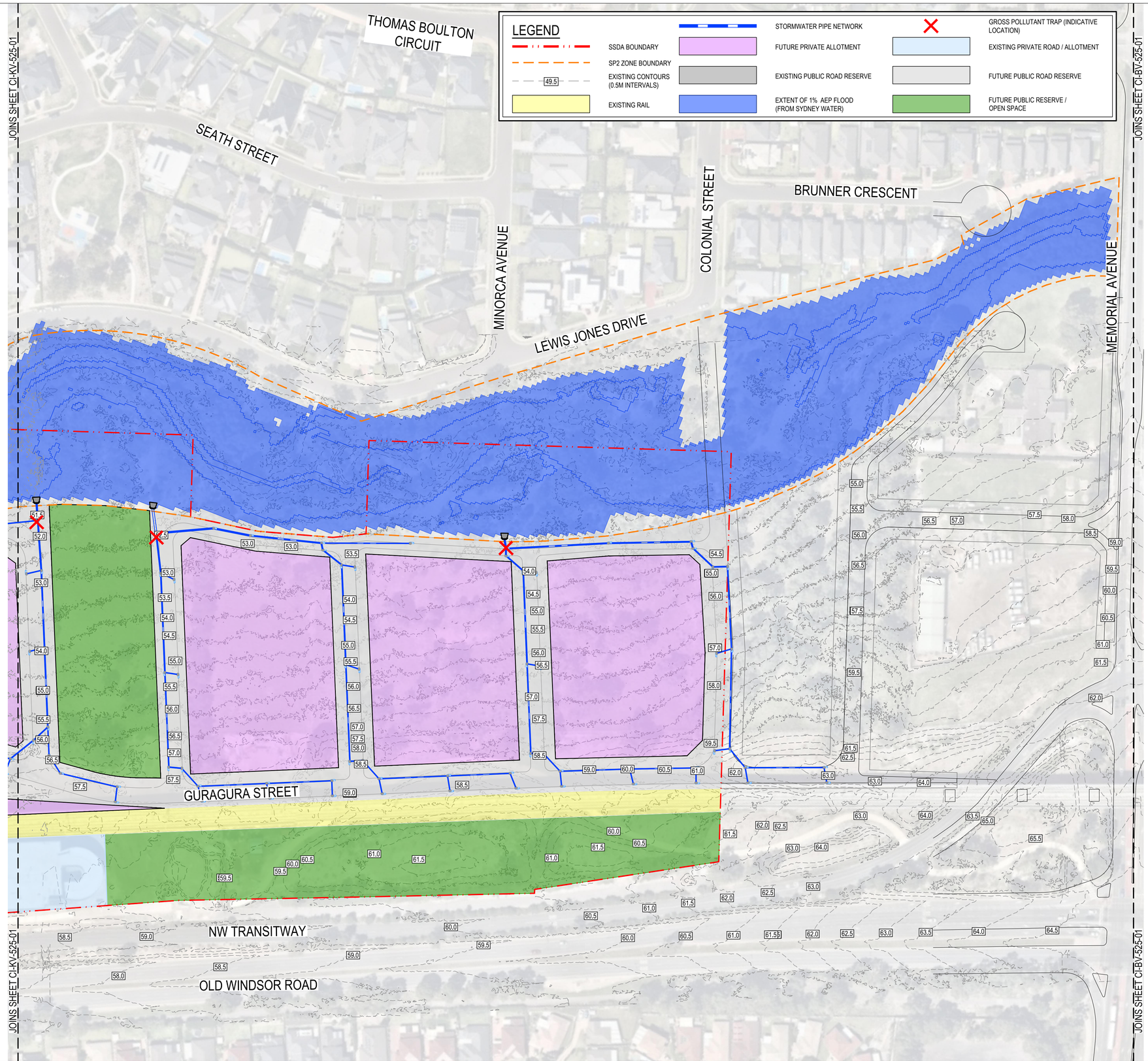
KELLYVILLE CONCEPT WATER CYCLE MANAGEMENT PLAN - SHEET 1 OF 2
TITLE

40416-CI-KV-525-01.dwg
22/04/2020 3:22:22 PM

Stantec

CONCEPT
NOT FOR CONSTRUCTION

SCALE @ A1	PROJECT No	DRAWING No	REV
1:1000	40416	CI-KV-525-01	B



1:1000 10 0 10 20 30 40 50 A1
1:2000 A3

REV	DESCRIPTION	DRAWN	APP'D	DATE
C	SSDA ISSUE	JDU	OKW	21.04.20
B	SSDA ISSUE	CPO	OKW	19.08.19
A	SSDA ISSUE	CPO	OKW	12.08.19

DRAWN:	CPO
DESIGNED:	OKW
VERIFIED:	... ../../..
APPROVED FOR TENDER:	... ../../..
APPROVED FOR CONSTRUCTION:	... ../../..

LANDCOM
ARCHITECT/CLIENT

KELLYVILLE AND BELLA VISTA
PROJECT

KELLYVILLE CONCEPT WATER CYCLE MANAGEMENT PLAN - SHEET 2 OF 2
TITLE

Stantec

CONCEPT
NOT FOR CONSTRUCTION

1:1000	40416	CI-KV-525-02	C
SCALE @ A1	PROJECT No	DRAWING No	REV

40416-CI-KV-525-02.dwg
22/04/2020 4:39:28 PM

Appendix G - MUSIC Modelling Results

Source nodes
Location,Blocks A & B,Existing Carpark and Station Area,75% Proposed Road Areas (Public),Block C,Public Reserves 1 & 2,Regional Park,Blocks D_ E & F,75% Proposed Road Areas (Public),25% Proposed Road Areas (Public),25% Proposed Road Areas (Public)
ID,1,3,6,7,16,23,26,28,30,31
Node
Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Zoning Surface
Type,Commercial,Sealedroad,Sealedroad,Commercial,Revegetatedland,Revegetatedland,Commercial,Sealedroad,Sealedroad,Sealedroad
Total Area (ha),2.49,2.92,0.55,0.81,0.58,0.668,2.32,1.23,0.18,0.42
Area Impervious (ha),2.2460171641791,2.77694179104478,0.523054104477612,0.730632089552239,0.0262298507462688,0.0302095522388061,2.09267462686567,1.16973917910448,0.171181343283582,0.399423134328358
Area Pervious (ha),0.243982835820896,0.143058208955224,0.0269458955223881,0.0793679104477611,0.553770149253731,0.637790447761194,0.227325373134328,0.0602608208955224,0.00881865671641793,0.0205768656716418
Field Capacity (mm),70,70,70,70,70,70,70,70,70,70
Pervious Area Infiltration Capacity coefficient - a,210,210,210,210,210,210,210,210,210,210
Pervious Area Infiltration Capacity exponent - b,4.7,4.7,4.7,4.7,4.7,4.7,4.7,4.7,4.7,4.7
Impervious Area Rainfall Threshold (mm/day),1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4
Pervious Area Soil Storage Capacity (mm),170,170,170,170,170,170,170,170,170,170
Pervious Area Soil Initial Storage (% of Capacity),30,30,30,30,30,30,30,30,30,30
Groundwater Initial Depth (mm),10,10,10,10,10,10,10,10,10,10
Groundwater Daily Recharge Rate (%),50,50,50,50,50,50,50,50,50,50
Groundwater Daily Baseflow Rate (%),4,4,4,4,4,4,4,4,4,4
Groundwater Daily Deep Seepage Rate (%),0,0,0,0,0,0,0,0,0,0
Stormflow Total Suspended Solids Mean (log mg/L),2.15,2.43,2.43,2.15,1.6,1.6,2.15,2.43,2.43,2.43
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32,0.32
Stormflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0
Stormflow Total Phosphorus Mean (log mg/L),-0.6,-0.3,-0.3,-0.6,-1.1,-1.1,-0.6,-0.3,-0.3,-0.3
Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25,0.25
Stormflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0
Stormflow Total Nitrogen Mean (log mg/L),0.3,0.34,0.34,0.3,-0.05,-0.05,0.3,0.34,0.34,0.34
Stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0
Baseflow Total Suspended Solids Mean (log mg/L),1.2,1.2,1.2,1.2,0.78,0.78,1.2,1.2,1.2,1.2
Baseflow Total Suspended Solids Standard Deviation (log mg/L),0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0
Baseflow Total Phosphorus Mean (log mg/L),-0.85,-0.85,-0.85,-0.85,-1.52,-1.52,-0.85,-0.85,-0.85,-0.85
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0
Baseflow Total Nitrogen Mean (log mg/L),0.11,0.11,0.11,0.11,-0.52,-0.52,0.11,0.11,0.11,0.11
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0
Flow based constituent generation - enabled,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off
Flow based constituent generation - flow file, , , , , , , , , ,

Flow based constituent generation - base flow column, , , , , , , , , ,
Flow based constituent generation - pervious flow column, , , , , , , , , ,
Flow based constituent generation - impervious flow column, , , , , , , , , ,
Flow based constituent generation - unit, , , , , , , , , ,
OUT - Mean Annual Flow (ML/yr),17.0,20.7,3.89,5.53,1.46,1.68,15.8,8.71,1.27,2.97
OUT - TSS Mean Annual Load (kg/yr),3.12E3,7.18E3,1.36E3,1.00E3,42.5,49.7,2.88E3,3.05E3,448,1.04E3
OUT - TP Mean Annual Load (kg/yr),4.99,12.1,2.29,1.63,95.8E-3,0.109,4.61,5.12,0.742,1.75
OUT - TN Mean Annual Load (kg/yr),37.1,49.5,9.28,12.0,0.954,1.11,34.6,20.8,3.07,7.15
OUT - Gross Pollutant Mean Annual Load (kg/yr),454,547,103,148,8.34,9.61,423,231,33.7,78.7
Rain In (ML/yr),21.2982,24.9764,4.70443,6.92834,4.96106,5.71375,19.8442,10.5208,1.53963,3.5925
ET Loss (ML/yr),4.30506,4.30502,0.810874,1.40043,3.51298,4.04596,4.01109,1.81343,0.265382,0.619215
Deep Seepage Loss (ML/yr),0,0,0,0,0,0,0,0,0,0
Baseflow Out
(ML/yr),0.323772,0.189842,0.0357579,0.105323,0.716458,0.825163,0.301668,0.0799678,0.0117026,0.0273061
Imp. Stormflow Out (ML/yr),16.435,20.3439,3.8319,5.34634,0.21268,0.244948,15.313,8.56953,1.25408,2.92618
Perv. Stormflow Out
(ML/yr),0.24057,0.141057,0.0265689,0.0782576,0.532345,0.613115,0.224145,0.0594178,0.0086953,0.020289
Total Stormflow Out (ML/yr),16.6756,20.485,3.85847,5.42459,0.745025,0.858063,15.5371,8.62895,1.26277,2.94647
Total Outflow (ML/yr),16.9994,20.6748,3.89423,5.52992,1.46148,1.68323,15.8388,8.70891,1.27448,2.97377
Change in Soil Storage (ML/yr),-0.00608202,-0.00356614,-0.000671691,-0.00197847,-0.0134586,-0.0155006,-0.00566677,-0.00150219,-0.000219834,-0.000512959
TSS Baseflow Out (kg/yr),5.5399,3.24669,0.612812,1.80206,4.66226,5.36848,5.16331,1.3672,0.200177,0.466763
TSS Total Stormflow Out (kg/yr),3118.27,7179.25,1358.47,1002.92,37.8263,44.328,2879.2,3046.98,447.808,1036.98
TSS Total Outflow (kg/yr),3123.81,7182.5,1359.08,1004.72,42.4886,49.6965,2884.36,3048.34,448.008,1037.45
TP Baseflow Out
(kg/yr),0.0503789,0.029493,0.00555939,0.0163771,0.0238051,0.0274313,0.0468694,0.0124305,0.00181848,0.00424467
TP Total Stormflow Out
(kg/yr),4.94295,12.0937,2.28023,1.61324,0.0720432,0.0812299,4.55986,5.10436,0.740238,1.74206
TP Total Outflow (kg/yr),4.99333,12.1232,2.28579,1.62961,0.0958482,0.108661,4.60673,5.11679,0.742057,1.7463
TN Baseflow Out
(kg/yr),0.433216,0.254142,0.0478504,0.14093,0.224846,0.258866,0.403784,0.107062,0.0156599,0.0365567
TN Total Stormflow Out (kg/yr),36.6619,49.2275,9.23403,11.8718,0.728761,0.850971,34.152,20.7193,3.05617,7.10974
TN Total Outflow (kg/yr),37.0951,49.4816,9.28188,12.0127,0.953607,1.10984,34.5558,20.8263,3.07183,7.14629
GP Total Outflow (kg/yr),455.249,547.73,103.169,148.093,9.03279,10.4033,424.168,230.722,33.7642,78.7832

No Imported Data Source nodes

USTM treatment nodes
Location,'Dummy' Future Treatment,'Dummy' Existing Treatment,'Dummy' Future Treatment,Media Filtration,Rainwater Tank,2x Rainwater tanks,Media Filtration,Media Filtration,'Dummy' Future Treatment,3x Rainwater tanks,Media Filtration,Rainwater Harvesting
ID,2,4,8,13,14,15,17,24,25,27,29,32
Node
Type,BioRetentionNodeV4,BioRetentionNodeV4,BioRetentionNodeV4,MediaFiltrationNode,RainWaterTankNode,RainWaterTankNode,MediaFiltrationNode,MediaFiltrationNode,BioRetentionNodeV4,RainWaterTankNode,MediaFiltrationNode,RainWaterTankNode
Lo-flow bypass rate (cum/sec),0,0,0,0,0,0,0,0,0,0,0,0
Hi-flow bypass rate (cum/sec),100,100,100,100,100,100,100,100,100,100,100,100
Inlet pond volume, , , , ,0,0, , , ,0, ,0
Area (sqm),250,320,80,115,50,120,5781,6678,220,120,315,550
Initial Volume (m^3), , , , ,100,240, , , ,240, ,0
Extended detention depth (m),0.3,0.3,0.3,0.05,0.2,0.2,0.03,0.03,0.3,0.2,0.05,0.2
Number of Rainwater tanks, , , , ,1,2, , , ,3, ,1
Permanent Pool Volume (cubic metres), , , , ,100,240, , , ,240, ,650
Proportion vegetated, , , , ,0,0, , , ,0, ,0
Equivalent Pipe Diameter (mm), , , , ,300,424, , , ,520, ,50
Overflow weir width (m),2,2,2,100,10,10,100,100,2,10,100,10
Notional Detention Time (hrs), , , , ,29.6E-3,35.6E-3, , , ,23.7E-3, ,11.7
Orifice Discharge Coefficient, , , , ,0.6,0.6, , , ,0.6, ,0.6
Weir Coefficient,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7
Number of CSTR Cells,3,3,3,3,2,2,3,3,3,2,3,2
Total Suspended Solids - k (m/yr),8000,8000,8000,8000,400,400,8000,8000,8000,400,8000,400
Total Suspended Solids - C* (mg/L),20,20,20,20,12,12,20,20,20,12,20,12
Total Suspended Solids - C** (mg/L), , , , ,12,12, , , ,12, ,12

Total Phosphorus - k (m/yr),6000,6000,6000,6000,300,300,6000,6000,6000,300,6000,300
Total Phosphorus - C* (mg/L),0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13
Total Phosphorus - C** (mg/L), , , , ,0.13,0.13, , , ,0.13, ,0.13
Total Nitrogen - k (m/yr),500,500,500,500,40,40,500,500,500,40,500,40
Total Nitrogen - C* (mg/L),1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4,1.4
Total Nitrogen - C** (mg/L), , , , ,1.4,1.4, , , ,1.4, ,1.4
Threshold Hydraulic Loading for C** (m/yr), , , , ,0,0, , , ,0, ,0
Horizontal Flow Coefficient,3,3,3, , , , , ,3, , ,
Reuse Enabled,Off,Off,Off,Off,On,On,Off,Off,Off,On,Off,On
Max drawdown height (m), , , , ,2,2, , , ,2, ,1.18181818181818
Annual Demand Enabled,Off,Off,Off,Off,On,On,Off,Off,Off,On,Off,On
Annual Demand Value (ML/year), , , , ,0.323,1.001, , , ,0.921, ,2.6712
Annual Demand Distribution, , , , ,PET,PET, , , ,PET, ,PET
Annual Demand Monthly Distribution: Jan, , , , , , , , , , , ,
Annual Demand Monthly Distribution: Feb, , , , , , , , , , , ,
Annual Demand Monthly Distribution: Mar, , , , , , , , , , , ,
Annual Demand Monthly Distribution: Apr, , , , , , , , , , , ,
Annual Demand Monthly Distribution: May, , , , , , , , , , , ,
Annual Demand Monthly Distribution: Jun, , , , , , , , , , , ,
Annual Demand Monthly Distribution: Jul, , , , , , , , , , , ,
Annual Demand Monthly Distribution: Aug, , , , , , , , , , , ,
Annual Demand Monthly Distribution: Sep, , , , , , , , , , , ,
Annual Demand Monthly Distribution: Oct, , , , , , , , , , , ,
Annual Demand Monthly Distribution: Nov, , , , , , , , , , , ,
Annual Demand Monthly Distribution: Dec, , , , , , , , , , , ,
Daily Demand Enabled,Off,Off,Off,Off,On,On,Off,Off,Off,On,Off,Off
Daily Demand Value (ML/day), , , , ,0.00432,0.01079, , , ,0.01036, ,
Custom Demand Enabled,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off
Custom Demand Time Series File, , , , , , , , , , , ,
Custom Demand Time Series Units, , , , , , , , , , , ,
Filter area (sqm),250,320,80,115, , ,5781,6678,220, ,315,
Filter perimeter (m),0.1,0.1,0.1, , , , , ,0.1, , ,
Filter depth (m),0.5,0.5,0.5,0.8, , ,0.3,0.3,0.5, ,0.8,
Filter Median Particle Diameter (mm), , , ,0.45, , ,0.45,0.45, , ,0.45,
Saturated Hydraulic Conductivity (mm/hr),100,100,100,125, , ,100,100,100, ,125,
Infiltration Media Porosity,0.35,0.35,0.35,0.3, , ,0.3,0.3,0.35, ,0.3,
Length (m), , , , , , , , , , , ,
Bed slope, , , , , , , , , , , ,
Base Width (m), , , , , , , , , , , ,
Top width (m), , , , , , , , , , , ,
Vegetation height (m), , , , , , , , , , , ,
Vegetation Type,Vegetated with Effective Nutrient Removal Plants,Vegetated with Effective Nutrient Removal Plants,Vegetated with Effective Nutrient Removal Plants, , , , , ,Vegetated with Effective Nutrient Removal Plants, , ,
Total Nitrogen Content in Filter (mg/kg),800,800,800, , , , ,800, , ,
Orthophosphate Content in Filter (mg/kg),40,40,40, , , , ,40, , ,
Is Base Lined?,Yes,Yes,Yes, , , , ,Yes, , ,
Is Underdrain Present?,Yes,Yes,Yes, , , , ,Yes, , ,
Is Submerged Zone Present?,No,No,No, , , , ,No, , ,
Submerged Zone Depth (m), , , , , , , , , , , ,
B for Media Soil Texture,13,13,13,-9999,-9999,-9999,-9999,-9999,13,-9999,-9999,-9999
Proportion of upstream impervious area treated, , , , , , , , , , , ,
Exfiltration Rate (mm/hr),0,0,0,0,0,0,0,0,0,0,0,0
Evaporative Loss as % of PET,100,100,100, ,0,0, , ,100,0, ,0
Depth in metres below the drain pipe, , , ,0, , ,0,0, , ,0,
TSS A Coefficient, , , ,0.52, , ,0.52,0.52, , ,0.52,
TSS B Coefficient, , , ,-0.39, , ,-0.39,-0.39, , ,-0.39,
TP A Coefficient, , , ,1.28, , ,1.28,1.28, , ,1.28,
TP B Coefficient, , , ,-0.19, , ,-0.19,-0.19, , ,-0.19,
TN A Coefficient, , , ,1.67, , ,1.67,1.67, , ,1.67,
TN B Coefficient, , , ,-0.09, , ,-0.09,-0.09, , ,-0.09,
Sfc,0.61,0.61,0.61, , , , , ,0.61, , ,
S*,0.37,0.37,0.37, , , , , ,0.37, , ,
Sw,0.11,0.11,0.11, , , , , ,0.11, , ,
Sh,0.05,0.05,0.05, , , , , ,0.05, , ,

Emax (m/day),0.008,0.008,0.008, , , , , ,0.008, , ,
Ew (m/day),0.001,0.001,0.001, , , , , ,0.001, , ,
IN - Mean Annual Flow (ML/yr),13.0,20.7,4.01,3.89,5.53,17.0,1.46,1.68,12.0,15.8,8.71,1.71
IN - TSS Mean Annual Load (kg/yr),1.88E3,7.18E3,544,1.36E3,1.00E3,3.12E3,42.5,49.7,1.68E3,2.88E3,3.05E3,3.81
IN - TP Mean Annual Load (kg/yr),3.40,12.1,1.03,2.29,1.63,4.99,95.8E-3,0.109,3.08,4.61,5.12,30.9E-3
IN - TN Mean Annual Load (kg/yr),27.8,49.5,8.48,9.28,12.0,37.1,0.954,1.11,25.7,34.6,20.8,0.600
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00,547,0.00,103,148,454,8.34,9.61,0.00,423,231,0.00
OUT - Mean Annual Flow (ML/yr),12.7,20.0,3.91,3.89,4.01,13.0,1.48,1.71,11.7,12.0,8.71,0.380
OUT - TSS Mean Annual Load (kg/yr),454,1.14E3,140,156,544,1.88E3,3.32,3.81,424,1.68E3,296,3.55
OUT - TP Mean Annual Load (kg/yr),1.60,3.30,0.501,0.596,1.03,3.40,27.1E-3,30.9E-3,1.49,3.08,1.27,34.5E-3
OUT - TN Mean Annual Load (kg/yr),17.9,25.5,5.61,5.41,8.48,27.8,0.518,0.600,16.9,25.7,11.8,0.315
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Flow In (ML/yr),13.0396,20.5795,4.01043,3.87713,5.50332,16.9031,1.45605,1.67645,12.029,15.7502,8.67002,1.69861
ET Loss (ML/yr),0.355235,0.686164,0.103457,0,0,0,0,0.30417,0,0,0
Infiltration Loss (ML/yr),0,0,0,0,0,0,0,0,0,0,0,0
Low Flow Bypass Out (ML/yr),0,0,0,0,0,0,0,0,0,0,0,0
High Flow Bypass Out (ML/yr),0,0,0,0,0,0,0,0,0,0,0,0
Orifice / Filter Out
(ML/yr),7.24272,12.7597,2.14485,2.92178,3.87468,12.2402,1.47492,1.69861,6.46136,11.6821,6.94874,0.20745
Weir Out (ML/yr),5.42945,7.1827,1.75867,0.959393,0.135748,0.79938,0,0,5.25156,0.346942,1.73087,0.173039
Transfer Function Out (ML/yr),0,0,0,0,0,0,0,0,0,0,0,0
Reuse Supplied (ML/yr),0,0,0,0,1.52241,3.91922,0,0,0,3.79744,0,1.32364
Reuse Requested (ML/yr),0,0,0,0,1.92226,4.85546,0,0,0,4.68489,0,2.6868
% Reuse Demand Met,0,0,0,0,79.199,80.7178,0,0,0,81.0572,0,49.2646
% Load Reduction,2.81804,3.09604,2.66598,-0.104292,27.1271,22.8569,-1.29618,-1.32167,2.62783,23.6262,-
0.110701,77.6
TSS Flow In
(kg/yr),1881.04,7179.6,543.919,1358.55,1004.72,3123.81,42.2864,49.4301,1684.45,2884.36,3047.13,3.80933
TSS ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TSS Infiltration Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TSS Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TSS High Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TSS Orifice / Filter Out
(kg/yr),22.3544,32.6125,6.73106,38.5471,523.147,1756.84,3.29917,3.79133,19.9772,1636.68,96.9281,2.18699
TSS Weir Out (kg/yr),431.65,1103.12,132.785,117.428,20.7747,124.206,0,0,404.485,47.7548,198.678,1.36633
TSS Transfer Function Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TSS Reuse Supplied (kg/yr),0,0,0,0,49.109,139.109,0,0,0,129.749,0,15.8816
TSS Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TSS % Reuse Demand Met,0,0,0,0,0,0,0,0,0,0,0,0
TSS % Load
Reduction,75.8642,84.1811,74.3498,88.5189,45.8632,39.7837,92.198,92.3299,74.801,41.6011,90.2989,6.72055
TP Flow In
(kg/yr),3.40459,12.1015,1.02981,2.28165,1.62961,4.99331,0.0953967,0.108146,3.0791,4.60672,5.1076,0.0308753
TP ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TP Infiltration Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TP Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TP High Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TP Orifice / Filter Out
(kg/yr),0.497648,0.78702,0.148799,0.301188,0.99243,3.18628,0.0269446,0.0307403,0.444342,2.99104,0.746626,0.0223
484
TP Weir Out (kg/yr),1.09833,2.50597,0.352177,0.293799,0.0373737,0.218299,0,0,1.04363,0.0880858,0.51824,0.0121557
TP Transfer Function Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TP Reuse Supplied (kg/yr),0,0,0,0,0.23538,0.624807,0,0,0,0.595899,0,0.171747
TP Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TP % Reuse Demand Met,0,0,0,0,0,0,0,0,0,0,0,0
TP % Load Reduction,53.1229,72.7887,51.3527,73.923,36.8066,31.8173,71.7552,71.5752,51.6751,33.1603,75.2356,-
11.7531
TN Flow In
(kg/yr),27.8257,49.3279,8.48343,9.25298,12.0127,37.0951,0.949239,1.10484,25.6982,34.5558,20.7618,0.600346
TN ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TN Infiltration Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TN Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TN High Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0

TN Orifice / Filter Out (kg/yr),6.62673,8.97284,1.98498,3.24936,8.19453,26.1025,0.516102,0.597836,5.92045,24.916,7.84453,0.198137
TN Weir Out (kg/yr),11.2842,16.5355,3.61975,2.14826,0.288832,1.72321,0,0,10.9788,0.78232,3.91805,0.116955
TN Transfer Function Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TN Reuse Supplied (kg/yr),0,0,0,0,2.78851,7.3676,0,0,0,7.01424,0,1.76977
TN Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
TN % Reuse Demand Met,0,0,0,0,0,0,0,0,0,0,0,0
TN % Load Reduction,35.6315,48.2882,33.9332,41.6662,29.3799,24.988,45.6299,45.8896,34.2398,25.6324,43.3451,47.5149
GP Flow In (kg/yr),0,547.3,0,103.083,147.845,454.484,8.34337,9.60923,0,423.457,230.534,0
GP ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
GP Infiltration Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
GP Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
GP High Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
GP Orifice / Filter Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
GP Weir Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
GP Transfer Function Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
GP Reuse Supplied (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
GP Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0
GP % Reuse Demand Met,0,0,0,0,0,0,0,0,0,0,0,0
GP % Load Reduction,100,100,100,100,100,100,100,100,100,100,100,100
PET Scaling Factor,2.1,2.1,2.1, , , , ,2.1, , ,

Generic treatment nodes
Location,Generic GPT (Rocla),Generic GPT (Rocla),Generic GPT (Rocla)
ID,11,19,21
Node Type,GPTNode,GPTNode,GPTNode
Lo-flow bypass rate (cum/sec),0,0,0
Hi-flow bypass rate (cum/sec),10,10,10
Flow Transfer Function
Input (cum/sec),0,0,0
Output (cum/sec),0,0,0
Input (cum/sec),10,10,10
Output (cum/sec),10,10,10
Input (cum/sec), , ,
Output (cum/sec), , ,
Input (cum/sec), , ,
Output (cum/sec), , ,
Input (cum/sec), , ,
Output (cum/sec), , ,
Input (cum/sec), , ,
Output (cum/sec), , ,
Input (cum/sec), , ,
Output (cum/sec), , ,
Input (cum/sec), , ,
Output (cum/sec), , ,
Input (cum/sec), , ,
Output (cum/sec), , ,
Input (cum/sec), , ,
Output (cum/sec), , ,
Gross Pollutant Transfer Function
Enabled,True,True,True
Input (kg/ML),0,0,0
Output (kg/ML),0,0,0
Input (kg/ML),100,100,100
Output (kg/ML),2,2,2
Input (kg/ML), , ,
Output (kg/ML), , ,
Input (kg/ML), , ,
Output (kg/ML), , ,
Input (kg/ML), , ,
Output (kg/ML), , ,
Input (kg/ML), , ,
Output (kg/ML), , ,

Input (kg/ML), , ,
Output (kg/ML), , ,
Input (kg/ML), , ,
Output (kg/ML), , ,
Input (kg/ML), , ,
Output (kg/ML), , ,
Input (kg/ML), , ,
Output (kg/ML), , ,
Total Nitrogen Transfer Function
Enabled,True,True,True
Input (mg/L),0,0,0
Output (mg/L),0,0,0
Input (mg/L),50,50,50
Output (mg/L),50,50,50
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Total Phosphorus Transfer Function
Enabled,True,True,True
Input (mg/L),0,0,0
Output (mg/L),0,0,0
Input (mg/L),0.5,0.5,0.5
Output (mg/L),0.5,0.5,0.5
Input (mg/L),10,10,10
Output (mg/L),7,7,7
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Total Suspended Solids Transfer Function
Enabled,True,True,True
Input (mg/L),0,0,0
Output (mg/L),0,0,0
Input (mg/L),75,75,75
Output (mg/L),75,75,75
Input (mg/L),1000,1000,1000
Output (mg/L),300,300,300
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,

Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
Input (mg/L), , ,
Output (mg/L), , ,
TSS Flow based Efficiency Enabled,Off,Off,Off
TSS Flow based Efficiency, , ,
TP Flow based Efficiency Enabled,Off,Off,Off
TP Flow based Efficiency, , ,
TN Flow based Efficiency Enabled,Off,Off,Off
TN Flow based Efficiency, , ,
GP Flow based Efficiency Enabled,Off,Off,Off
GP Flow based Efficiency, , ,
IN - Mean Annual Flow (ML/yr),9.08,32.7,23.8
IN - TSS Mean Annual Load (kg/yr),744,1.59E3,1.76E3
IN - TP Mean Annual Load (kg/yr),1.84,4.89,4.54
IN - TN Mean Annual Load (kg/yr),14.1,43.5,36.2
IN - Gross Pollutant Mean Annual Load (kg/yr),33.7,0.00,78.7
OUT - Mean Annual Flow (ML/yr),9.08,32.7,23.8
OUT - TSS Mean Annual Load (kg/yr),517,1.17E3,1.28E3
OUT - TP Mean Annual Load (kg/yr),1.82,4.88,4.50
OUT - TN Mean Annual Load (kg/yr),14.1,43.5,36.2
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.675,0.00,1.57
Flow In (ML/yr),9.04123,32.5655,23.7034
ET Loss (ML/yr),0,0,0
Infiltration Loss (ML/yr),0,0,0
Low Flow Bypass Out (ML/yr),0,0,0
High Flow Bypass Out (ML/yr),0,0,0
Orifice / Filter Out (ML/yr),0,0,0
Weir Out (ML/yr),0,0,0
Transfer Function Out (ML/yr),9.04123,32.5655,23.7034
Reuse Supplied (ML/yr),0,0,0
Reuse Requested (ML/yr),0,0,0
% Reuse Demand Met,0,0,0
% Load Reduction,0,0,0
TSS Flow In (kg/yr),742.988,1587.96,1759.64
TSS ET Loss (kg/yr),0,0,0
TSS Infiltration Loss (kg/yr),0,0,0
TSS Low Flow Bypass Out (kg/yr),0,0,0
TSS High Flow Bypass Out (kg/yr),0,0,0
TSS Orifice / Filter Out (kg/yr),0,0,0
TSS Weir Out (kg/yr),0,0,0
TSS Transfer Function Out (kg/yr),516.502,1166.36,1275.19
TSS Reuse Supplied (kg/yr),0,0,0
TSS Reuse Requested (kg/yr),0,0,0
TSS % Reuse Demand Met,0,0,0
TSS % Load Reduction,30.4831,26.5494,27.5313
TP Flow In (kg/yr),1.83502,4.8806,4.52658
TP ET Loss (kg/yr),0,0,0
TP Infiltration Loss (kg/yr),0,0,0
TP Low Flow Bypass Out (kg/yr),0,0,0
TP High Flow Bypass Out (kg/yr),0,0,0
TP Orifice / Filter Out (kg/yr),0,0,0
TP Weir Out (kg/yr),0,0,0
TP Transfer Function Out (kg/yr),1.81881,4.87314,4.49051
TP Reuse Supplied (kg/yr),0,0,0
TP Reuse Requested (kg/yr),0,0,0
TP % Reuse Demand Met,0,0,0
TP % Load Reduction,0.883492,0.152701,0.796879

TN Flow In (kg/yr),14.05,43.3472,36.069
TN ET Loss (kg/yr),0,0,0
TN Infiltration Loss (kg/yr),0,0,0
TN Low Flow Bypass Out (kg/yr),0,0,0
TN High Flow Bypass Out (kg/yr),0,0,0
TN Orifice / Filter Out (kg/yr),0,0,0
TN Weir Out (kg/yr),0,0,0
TN Transfer Function Out (kg/yr),14.05,43.3472,36.069
TN Reuse Supplied (kg/yr),0,0,0
TN Reuse Requested (kg/yr),0,0,0
TN % Reuse Demand Met,0,0,0
TN % Load Reduction,0,0,0
GP Flow In (kg/yr),33.7373,0,78.7192
GP ET Loss (kg/yr),0,0,0
GP Infiltration Loss (kg/yr),0,0,0
GP Low Flow Bypass Out (kg/yr),0,0,0
GP High Flow Bypass Out (kg/yr),0,0,0
GP Orifice / Filter Out (kg/yr),0,0,0
GP Weir Out (kg/yr),0,0,0
GP Transfer Function Out (kg/yr),0.674736,0,1.57439
GP Reuse Supplied (kg/yr),0,0,0
GP Reuse Requested (kg/yr),0,0,0
GP % Reuse Demand Met,0,0,0
GP % Load Reduction,100,100,100

Other nodes
Location,North 2 Catchment,North 1 Catchment,Junction,Post-Development Node,Junction,South 1 Catchment,Junction
ID,5,9,10,12,18,20,22
Node Type,JunctionNode,JunctionNode,JunctionNode,PostDevelopmentNode,JunctionNode,JunctionNode,JunctionNode
IN - Mean Annual Flow (ML/yr),9.08,34.1,9.08,67.0,32.7,23.8,23.8
IN - TSS Mean Annual Load (kg/yr),517,1.17E3,744,2.96E3,1.59E3,1.28E3,1.76E3
IN - TP Mean Annual Load (kg/yr),1.82,4.91,1.84,11.2,4.89,4.50,4.54
IN - TN Mean Annual Load (kg/yr),14.1,44.0,14.1,94.2,43.5,36.2,36.2
IN - Gross Pollutant Mean Annual Load (kg/yr),0.675,0.00,33.7,2.25,0.00,1.57,78.7
OUT - Mean Annual Flow (ML/yr),9.08,34.1,9.08,67.0,32.7,23.8,23.8
OUT - TSS Mean Annual Load (kg/yr),517,1.17E3,744,2.96E3,1.59E3,1.28E3,1.76E3
OUT - TP Mean Annual Load (kg/yr),1.82,4.91,1.84,11.2,4.89,4.50,4.54
OUT - TN Mean Annual Load (kg/yr),14.1,44.0,14.1,94.2,43.5,36.2,36.2
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.675,0.00,33.7,2.25,0.00,1.57,78.7
% Load Reduction,15.2,12.7,15.2,15.2,13.3,18.5,18.5
TSS % Load Reduction,81.6,88.7,73.6,85.3,84.6,81.8,74.9
TN % Load Reduction,42.2,49.8,42.2,46.3,49.8,43.2,43.2
TP % Load Reduction,60.9,71.5,60.5,66.4,71.4,61.1,60.8
GP % Load Reduction,99.8,100,88.1,99.9,100,99.8,89.4

Links
Location,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage
Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage
Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage
Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,3,8,10,11,5,6,13,7,14,1,15,16,17,4,2,18,19,21,20,22,23,25,26,27,28,29,9,30,31,24,32
Target node ID,4,10,11,5,12,13,10,14,8,15,2,17,9,18,18,19,9,20,12,21,24,22,27,25,29,22,12,10,22,32,22
Muskingum-Cunge Routing,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not
Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not
Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not Routed,Not
Routed,Not Routed,Not Routed,Not Routed,Not Routed
Muskingum K, , , ,

IN - TP Mean Annual Load (kg/yr),12.1,0.501,1.84,1.82,1.82,2.29,0.596,1.63,1.03,4.99,3.40,95.8E-3,27.1E-3,3.30,1.60,4.89,4.88,4.50,4.50,4.54,0.109,1.49,4.61,3.08,5.12,1.27,4.91,0.742,1.75,30.9E-3,34.5E-3
IN - TN Mean Annual Load (kg/yr),49.5,5.61,14.1,14.1,14.1,9.28,5.41,12.0,8.48,37.1,27.8,0.954,0.518,25.5,17.9,43.5,43.5,36.2,36.2,36.2,1.11,16.9,34.6,25.7,20.8,11.8,44.0,3.07,7.15,0.600,0.315
IN - Gross Pollutant Mean Annual Load (kg/yr),547,0.00,33.7,0.675,0.675,103,0.00,148,0.00,454,0.00,8.34,0.00,0.00,0.00,0.00,0.00,1.57,1.57,78.7,9.61,0.00,423,0.00,231,0.00,0.00,33.7,78.7,0.00,0.00
OUT - Mean Annual Flow (ML/yr),20.7,3.91,9.08,9.08,9.08,3.89,3.89,5.53,4.01,17.0,13.0,1.46,1.48,20.0,12.7,32.7,32.7,23.8,23.8,23.8,1.68,11.7,15.8,12.0,8.71,8.71,34.1,1.27,2.97,1.71,0.380
OUT - TSS Mean Annual Load (kg/yr),7.18E3,140,744,517,517,1.36E3,156,1.00E3,544,3.12E3,1.88E3,42.5,3.32,1.14E3,454,1.59E3,1.17E3,1.28E3,1.28E3,1.76E3,49.7,424,2.88E3,1.68E3,3.05E3,296,1.17E3,448,1.04E3,3.81,3.55
OUT - TP Mean Annual Load (kg/yr),12.1,0.501,1.84,1.82,1.82,2.29,0.596,1.63,1.03,4.99,3.40,95.8E-3,27.1E-3,3.30,1.60,4.89,4.88,4.50,4.50,4.54,0.109,1.49,4.61,3.08,5.12,1.27,4.91,0.742,1.75,30.9E-3,34.5E-3
OUT - TN Mean Annual Load (kg/yr),49.5,5.61,14.1,14.1,14.1,9.28,5.41,12.0,8.48,37.1,27.8,0.954,0.518,25.5,17.9,43.5,43.5,36.2,36.2,36.2,1.11,16.9,34.6,25.7,20.8,11.8,44.0,3.07,7.15,0.600,0.315
OUT - Gross Pollutant Mean Annual Load (kg/yr),547,0.00,33.7,0.675,0.675,103,0.00,148,0.00,454,0.00,8.34,0.00,0.00,0.00,0.00,0.00,1.57,1.57,78.7,9.61,0.00,423,0.00,231,0.00,0.00,33.7,78.7,0.00,0.00

Catchment Details
Catchment Name,CI-CA-Kellyville (Exc Exist) (GPT+Trees)_20.04.22
Timestep,6 Minutes
Start Date,25/12/1984
End Date,31/05/2010 11:54:00 PM
Rainfall Station, 66124 PARRAMATTA
ET Station,User-defined monthly PET
Mean Annual Rainfall (mm), 856
Mean Annual ET (mm), 1201

Design with
community in mind

Level 6, Building B
207 Pacific Highway
St Leonards NSW 2065
Tel +61 +61 2 8484 7000
E enquiries.ap@stantec.com

For more information please visit www.stantec.com

Stantec