MINTO WAREHOUSE AND LOGISTICS HUB

FLOODING & STORMWATER

27 APRIL 2016

Incorporating

Hyder

MINTO WAREHOUSE AND LOGISTICS HUB

Flooding & Stormwater

Author	Bruce Caldwell (flooding) David Stone (stormwater quality)	
Checker	David Stone	
Approver	Anna Zolotukhina	

Report No R-0003-AA9069-AAR-02

Date 27/04/2016

Revision Text 01

This report has been prepared for Qube in accordance with the terms and conditions of the appointment. Arcadis Australia Pacific Pty Limited (ABN 76 104 485 289) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

REVISIONS

Revision	Date	Description	Prepared by	Approved by
01	27/4/2016	SSDA Submission	BC/DS	AZ

F:\AA009069\R-Reports\Flooding & Stormwater\4. SSDA Submission\Minto Warehouse and Logistics Hub_Flooding Stormwater_27April2016.docx

CONTENTS

FIGURES

TABLES

APPENDICES

DRAWINGS

1 INTRODUCTION

1.1 BACKGROUND

Qube is preparing a State Significant Development Application (SSDA) in relation to the proposed development of 5 and 9 Culverston Road, Minto (refer **Figure 1**), being legally described as Lot 3 in DP 817793 and Lot 400 in DP 875711 (the Site) (refer **Figure 2**), for the purpose of a Warehouse and Logistics Hub (the Proposal).

Arcadis has been engaged by Qube to provide an initial flooding and stormwater assessment, and identify anticipated next steps with respect to future stormwater and flood analysis in support of a State Significant Development Application (SSDA) to be submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

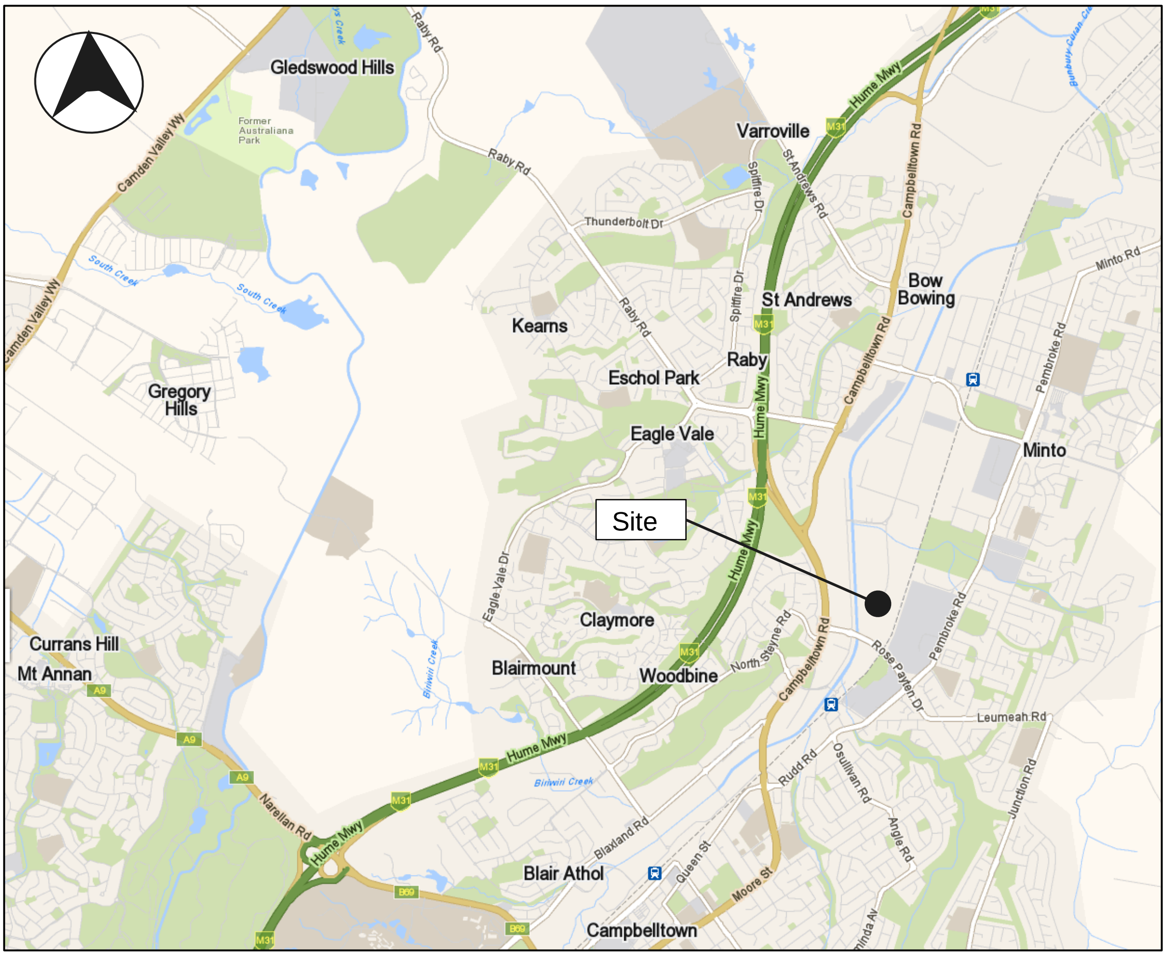


Figure 1: Location Area Plan

1.2 SITE AND WATERWAYS DESCRIPTION

The 29.6ha site is bound on all sides by open waterways (see **Figure 2** and **Figure 3**). Each of these waterways serve catchments external to the site. The most significant of these is Bow Bowing Creek which is a constructed channel along the west site boundary, however the open channels to the north (from Pembroke Park to Airds Road) and south (along Rose Payten Drive) of the site also have significant catchments that convey flows from east of the site to Bow Bowing Creek. The drainage system along the eastern site boundary is a smaller system, and serves some local eastern catchments as well as the railway.

Figure 3 outlines the existing site layout, indicating boundaries, areas, contouring, and easements.

Figure 2: Site Location Plan (Google maps)

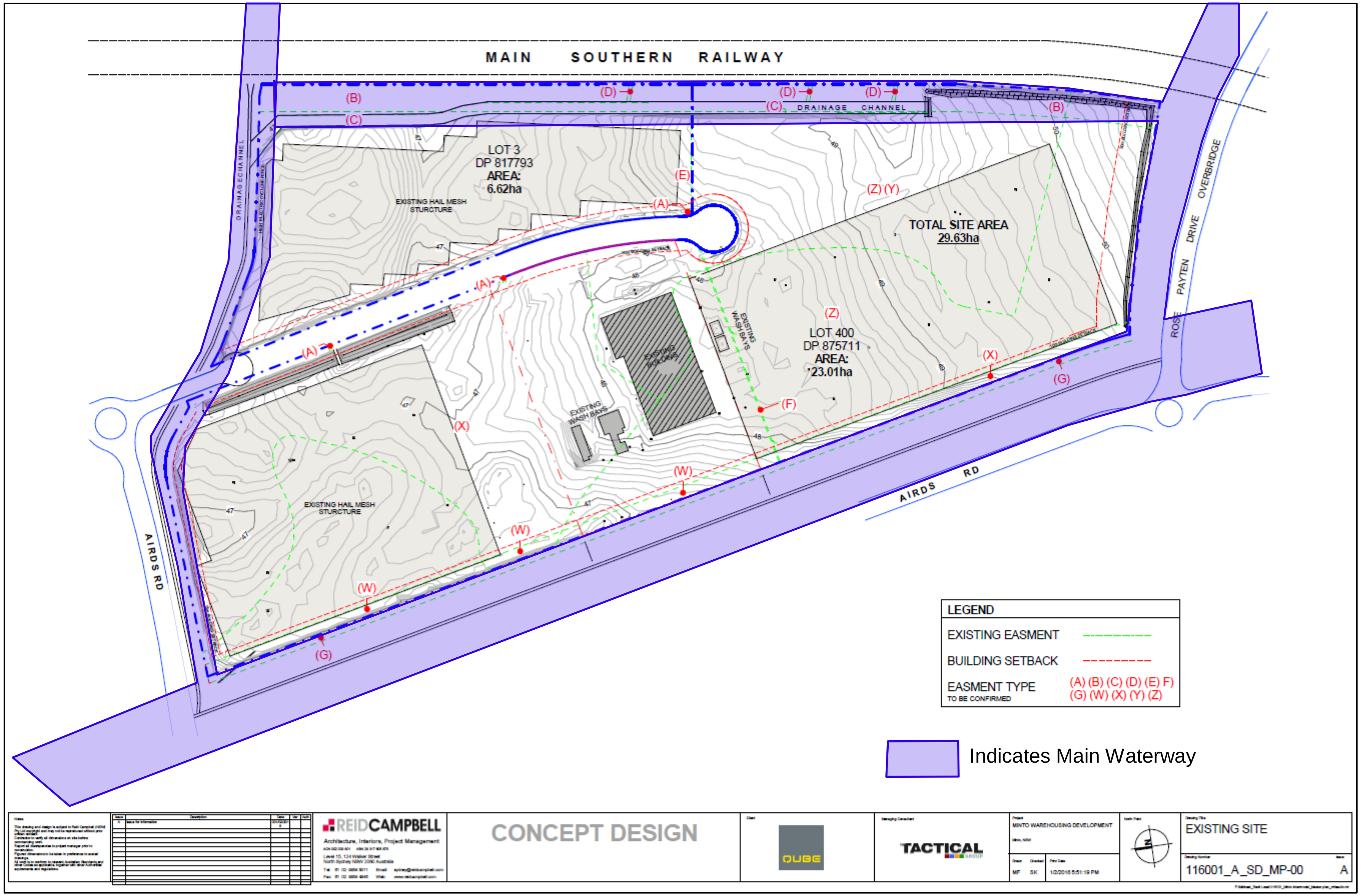


Figure 3: Existing Site Layout

1.3 PROPOSED DEVELOPMENT & APPROVAL CONDITIONS

The Proposal relates to a staged development application and seeks to establish an intermodal terminal comprising of warehousing, storage areas, loading areas and car parking as outlined in **Figure 4**.

The Department of Planning and Environment has provided the Secretary's Environmental Assessment Requirements (SEARs) to guide the preparation of an Environmental Impact Statement (EIS) for the proposed development. SEARs relevant to flooding and stormwater are outlined in **Table 1**.

Table 1: Secretary's Environmental Assessment Requirements

SEARs Reference	Key Assessment Requirement	Where Addressed
Soils and Water	A description of the water demands	Section 5
	A description of the measures to minimise water use	Section 5
	A detailed water balance	Section 5
	A description of waste water generated on-site	Section 5
	A description of the proposed erosion and sediment controls during construction and operation	Section 6
	A description of the surface and stormwater management system, including on-site detention, and measures to treat or re-use water	Sections 3 and 5
	An assessment of potential groundwater impacts associated with the development	Section 5
	An assessment of the impact of flooding on the development for the full range of flood events up to the probable maximum flood	Section 3
	An assessment of the impact of the proposed development on flood behaviour; and	Section 3
	Details of impact mitigation, management and monitoring measures.	Sections 3 to 5

In addition to the SEARs, the key issues raised by relevant government agencies are summarised in **Table 2**.

Table 2: Government Agency Key Issues

Agency	Issue
NSW Department of Primary Industries (DPI) - Attachment A 'Surface Water Assessment'	The predictive assessment of the impact of the proposed project on surface water sources should include the following:
	Identification of all surface water features including watercourses, wetlands and floodplains transected by or adjacent to the proposed project.
	Identification of all surface water sources as described by the relevant water sharing plan.
	Detailed description of dependent ecosystems and existing surface water users within the area, including basic landholder rights to water and adjacent/downstream licensed water users.
	Description of all works and surface infrastructure that will intercept, store, convey, or otherwise interact with surface water resources.
	Assessment of predicted impacts on the following:
	- flow of surface water, sediment movement, channel stability, and hydraulic regime,
	- water quality,
	- flood regime,
	- dependent ecosystems,

Agency	Issue
	- existing surface water users, and - planned environmental water and water sharing arrangements prescribed in the relevant water sharing plans.
DPI	Annual volumes of surface water and groundwater proposed to be taken by the activity (including through inflow and seepage) from each surface and groundwater source as defined by the relevant water sharing plan.
DPI	Assessment of any volumetric water licensing requirements (including those for ongoing water take following completion of the project).
DPI	The identification of an adequate and secure water supply for the life of the project. Confirmation that water can be sourced from an appropriately authorised and reliable supply. This is to include an assessment of the current market depth where water entitlement is required to be purchased.
DPI	A detailed and consolidated site water balance.
DPI	Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.
DPI	Full technical details and data of all surface and groundwater modelling.
DPI	Proposed surface and groundwater monitoring activities and methodologies.
DPI	Assessment of any potential cumulative impacts on water resources, and any proposed options to manage the cumulative impacts.
DPI	Consideration of relevant policies and guidelines.
Office of Environment & Heritage	Commentary on water quality and flooding – how this will be dealt with in the proposal
Sydney Water	Commentary on integrated water management strategy including alterative water supply, WSUD and proposed end uses

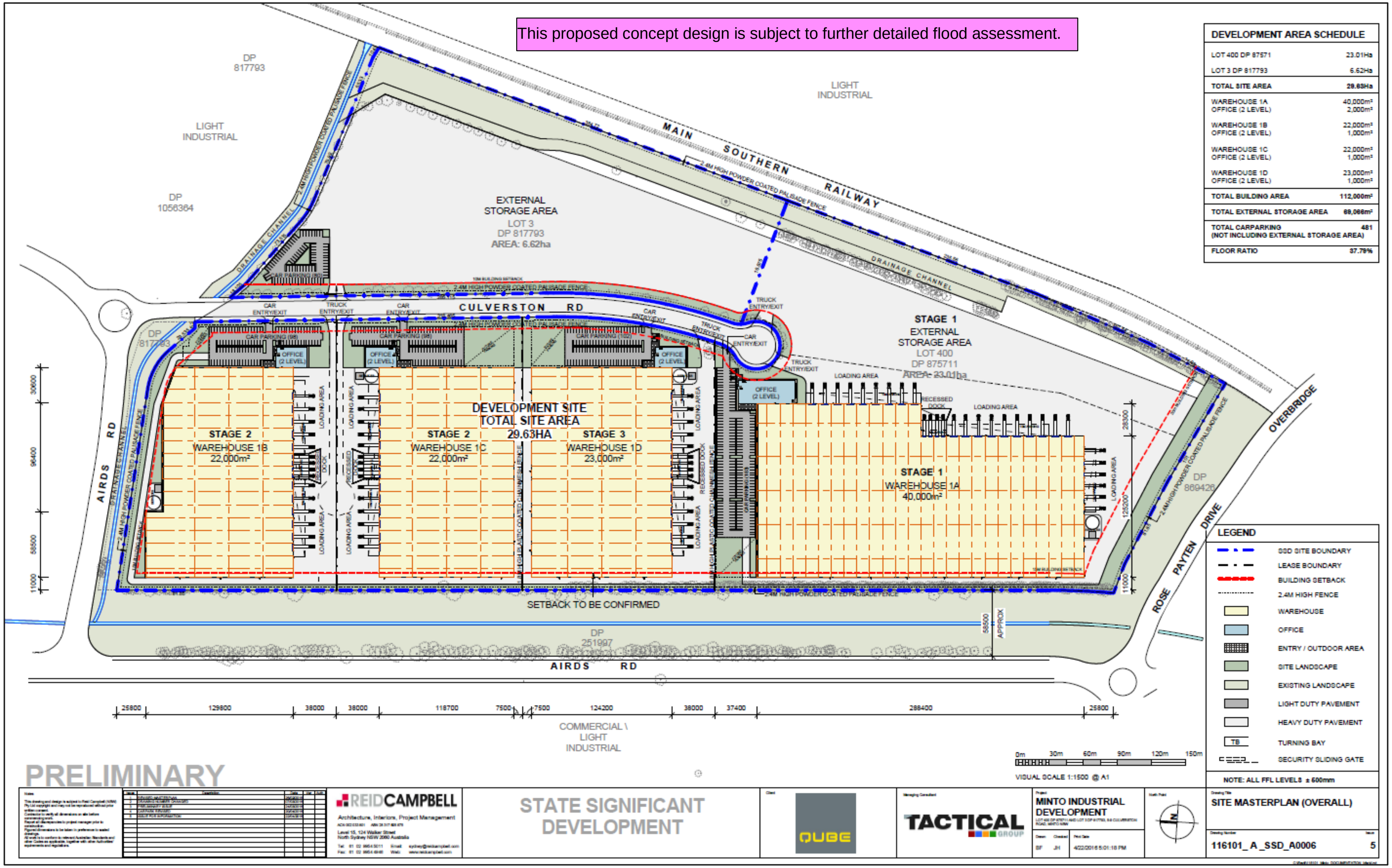


Figure 4: Concept Master Plan (refer to ***Appendix C*** *for A3 size figure)*

2 EXISTING FLOODING & STORMWATER DRAINAGE

CCC has recently completed a regional flood study for the Bow Bowing Bunbury Curran Creek catchment (outlined in **Figure 5**) which includes flood information of the main waterways.

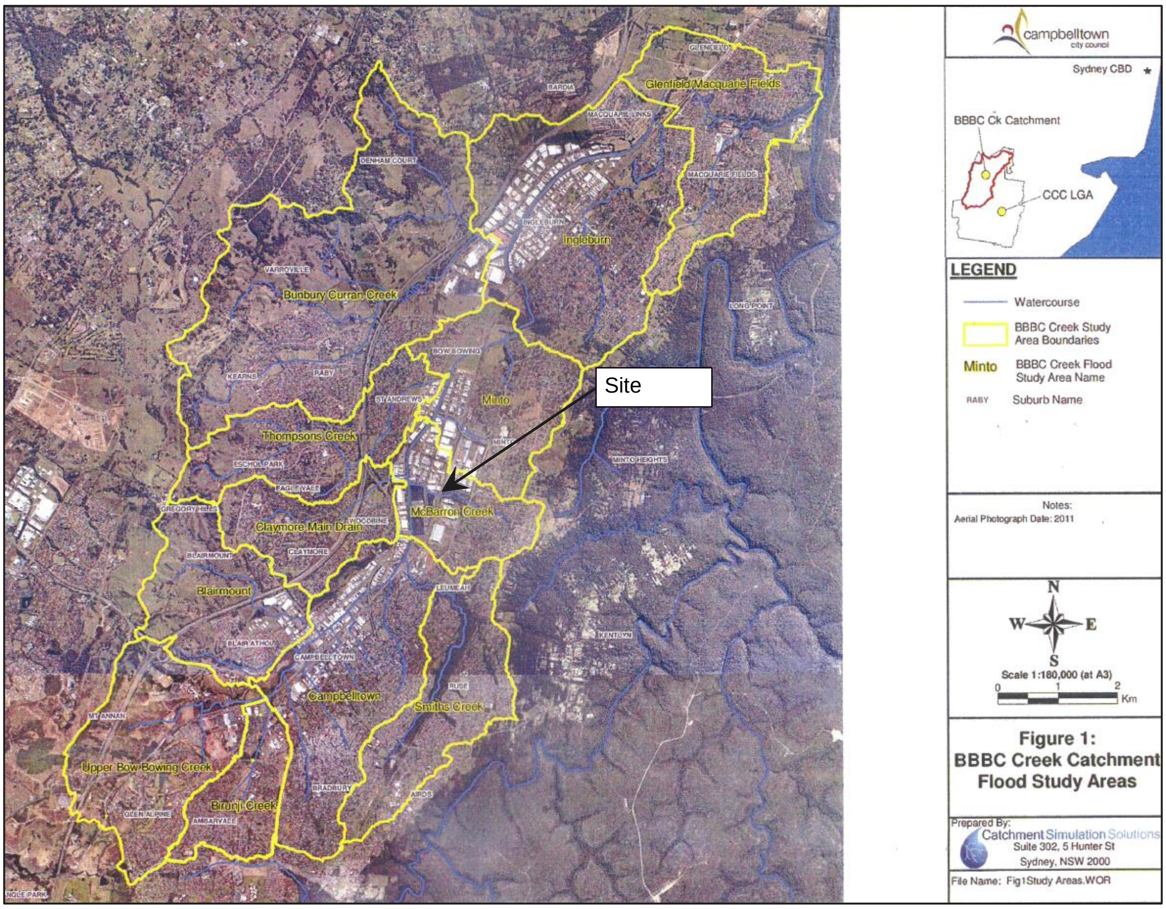


Figure 5: Bow Bowing Bunbury Curran Creek Flood Study Area

The Site is located within the Bow Bowing Bunbury Curran Creek catchment, downstream of significant urban catchment areas, and is adjacent to major waterways which surround the site and include a complex of waterway structures including bridges, culverts and drop structures (as indicated in Photos 1 to 3).

Photo 1: Culverston Road culvert viewing eastward (upstream) along northern site boundary.


Photo 2: Bow Bowing Creek, Airds Road bridge viewing northward (downstream) along the western site boundary.


Photo 3: Bow Bowing Creek, one of several drop structures viewing southward (upstream) along the western site boundary.

2.1 MAIN WATERWAY FLOOD LEVELS

CCC has advised that the influence of catchment development and associated waterway structures (including their potential hydraulic impacts under various blockage scenarios) have been taken into account in the CCC flood study. CCC flood information, providing flood levels for a range of design storm events, is included in **Appendix A**.

Figure 6 shows the 21 locations where flood levels have been defined within the main waterways (which surround the site) with **Table 3** summarising the 100 year ARI flood levels.

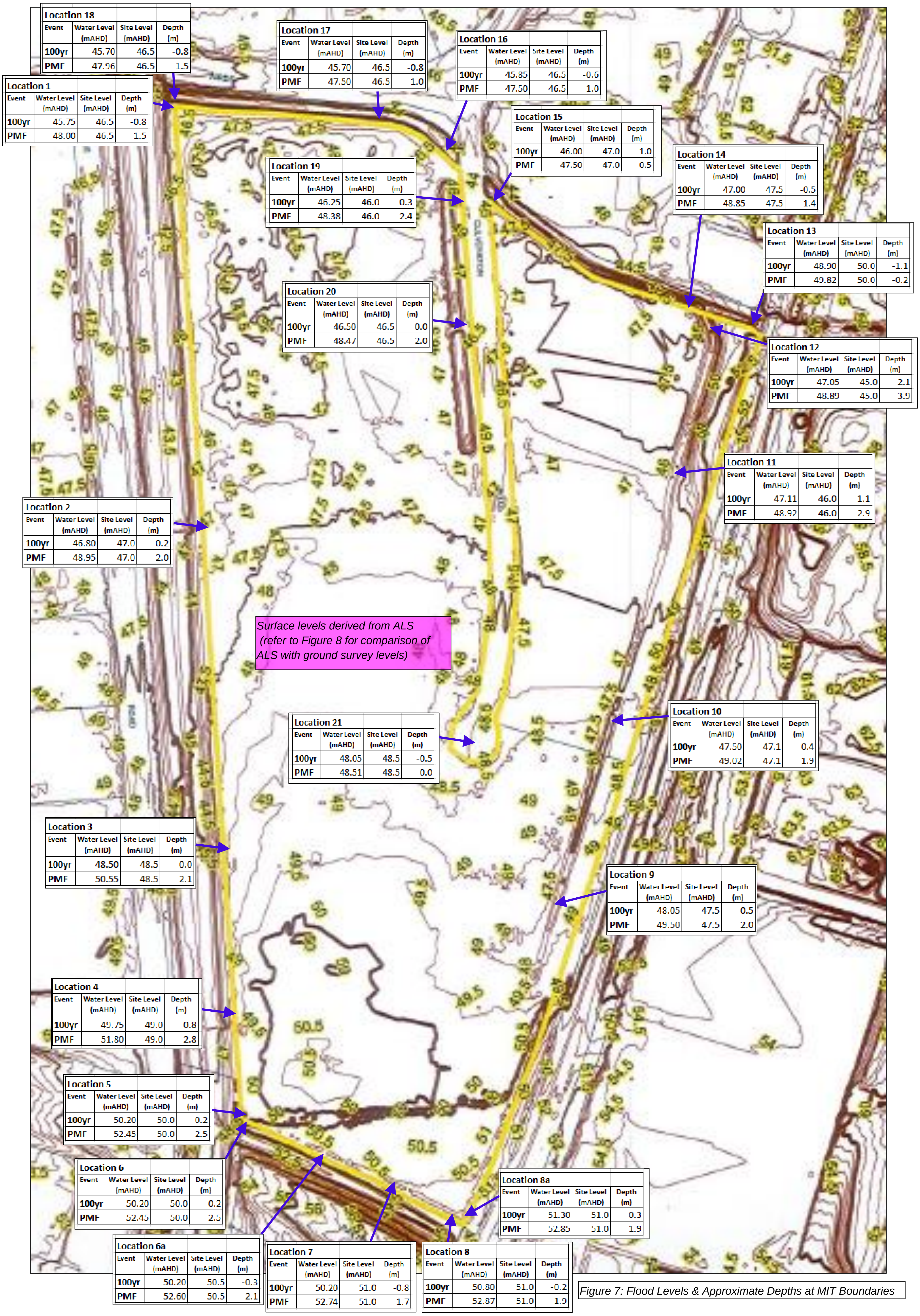
Figure 7 locates the provided 100 year and probable maximum flood (PMF) levels on a site base plan. The site base plan (indicating 0.5m contouring derived from aerial laser survey adopted for the CCC flood assessment) has been part of the flood model information provided by CCC.

Table 3: Main Waterways 100 year ARI Water Levels

Waterway	Location (see Figure 6)	Water Level* (mAHD)
Bow Bowing Channel	1	45.75
	2	46.80
	3	48.50
	4	49.75
	5	50.2
Formalised grass channel to the south (Rose Payten Drive side)	6	50.20
	6a	50.20
	7	50.20
	8	50.80
	8a	51.30
Formalised fabriform channel within the site	9	48.05
	10	47.50
	11	47.11
	12	47.05
Formalised fabriform channel to the north	13	48.90
	14	47.00
	15	46.00
	16	45.85
	17	45.70
	18	45.70
Culverston Road	19	46.25
	20	46.50
	21	48.05

* see **Appendix A** for full flood certificate figure. See **Appendix D** for flood frequency terminology.

Figure 6: Flood Level Locations



Location 18

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	45.70	46.5	-0.8
PMF	47.96	46.5	1.5

Location 17

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	45.70	46.5	-0.8
PMF	47.50	46.5	1.0

Location 16

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	45.85	46.5	-0.6
PMF	47.50	46.5	1.0

Location 1

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	45.75	46.5	-0.8
PMF	48.00	46.5	1.5

Location 15

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	46.00	47.0	-1.0
PMF	47.50	47.0	0.5

Location 14

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	47.00	47.5	-0.5
PMF	48.85	47.5	1.4

Location 19

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	46.25	46.0	0.3
PMF	48.38	46.0	2.4

Location 13

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	48.90	50.0	-1.1
PMF	49.82	50.0	-0.2

Location 20

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	46.50	46.5	0.0
PMF	48.47	46.5	2.0

Location 12

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	47.05	45.0	2.1
PMF	48.89	45.0	3.9

Location 11

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	47.11	46.0	1.1
PMF	48.92	46.0	2.9

Location 2

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	46.80	47.0	-0.2
PMF	48.95	47.0	2.0

Location 10

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	47.50	47.1	0.4
PMF	49.02	47.1	1.9

Location 21

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	48.05	48.5	-0.5
PMF	48.51	48.5	0.0

Location 3

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	48.50	48.5	0.0
PMF	50.55	48.5	2.1

Location 9

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	48.05	47.5	0.5
PMF	49.50	47.5	2.0

Location 4

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	49.75	49.0	0.8
PMF	51.80	49.0	2.8

Location 5

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	50.20	50.0	0.2
PMF	52.45	50.0	2.5

Location 6

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	50.20	50.0	0.2
PMF	52.45	50.0	2.5

Location 8a

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	51.30	51.0	0.3
PMF	52.85	51.0	1.9

Location 6a

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	50.20	50.5	-0.3
PMF	52.60	50.5	2.1

Location 7

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	50.20	51.0	-0.8
PMF	52.74	51.0	1.7

Location 8

Event	Water Level (mAHD)	Site Level (mAHD)	Depth (m)
100yr	50.80	51.0	-0.2
PMF	52.87	51.0	1.9

Figure 7: Flood Levels & Approximate Depths at MIT Boundaries

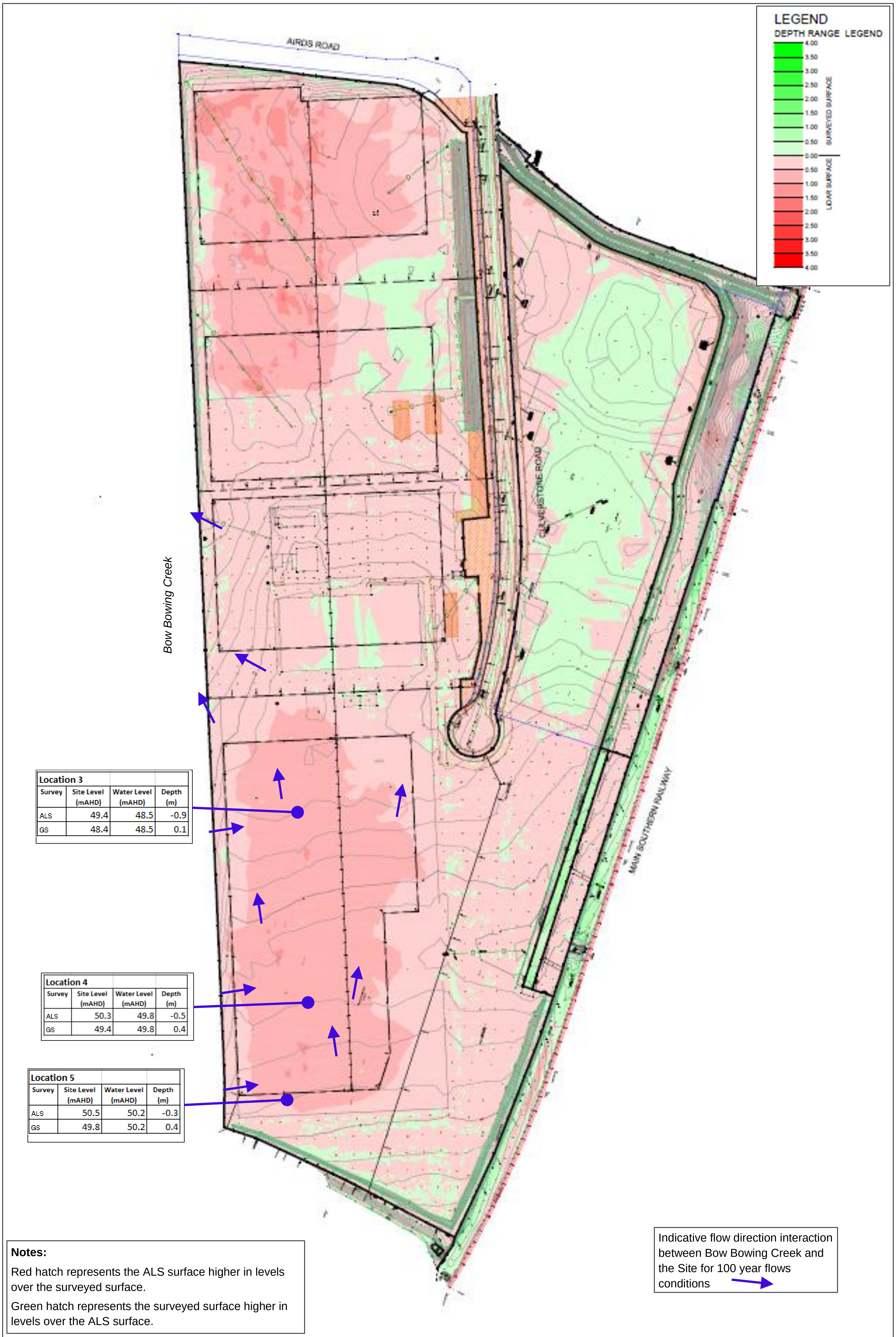
2.2 SITE INUNDATION

While **Figure 7** indicates that there would be very limited intrusion of 100 year flood levels into the site, a more accurate indication of flood intrusion into the site is based on traditional ground survey levels which has a nominal accuracy of ±0.01m, rather than aerial laser survey (ALS) which has a nominal accuracy of ±0.3m.

Figure 8 provides a comparison of the ALS and traditional ground survey (*Culverstone Road, Minto Dwg No. 1179345000, 'Plan Showing Levels, Details and Contours*' Dwgs 1 to 25 dated 12 February 2016 prepared by Cardo). In general, it is apparent that over the southern and north western portions of the site, traditional ground survey levels are significantly lower than the ALS levels (of the order of 0.5m to 1.0m), while in the north eastern site area the two sets of ground levels are similar. We note that it is an unusual situation where the ALS levels are well outside the nominal accuracy of ±0.3m.

With respect to site inundation, the 100 year flood intrusion into the site is now found to be significant. In particular, flood levels in the south western area of the site (at locations 3, 4 and 5) have been included in **Figure 8** as an indication that flood depths could be expected to extend across the site at a depth of approximately 0.4m at the southern end of the site, with water tending to flow northward (following ground surface flow paths, with varying depths).

The initial intent of the project investigations was to obtain and review Council's regional flood models. However, preliminary discussions with Council suggested that this was not necessary given that their information showed very limited flood intrusion into the site. As discussed above, due to discrepancies between the ALS and ground survey levels, this was subsequently found not to be the case. As such we are continuing dialogue with Council in order to determine an appropriate approach to address the differences in site levels in the regional flood modelling and intend, if permissible by Council, to obtain their models. With the Council models in hand, the approach would be to create an existing conditions model that more adequately represents flood levels in the main waterways (which surround the site). This would involve refining the site levels (replacing the ALS levels with the ground survey information) and, if necessary, additional adjustments that may more adequately represent the site specific representation within the broader CCC regional modelling.



Location 3			
Survey	Site Level (mAHD)	Water Level (mAHD)	Depth (m)
ALS	49.4	48.5	-0.9
GS	48.4	48.5	0.1

Location 4			
Survey	Site Level (mAHD)	Water Level (mAHD)	Depth (m)
ALS	50.3	49.8	-0.5
GS	49.4	49.8	0.4

Location 5			
Survey	Site Level (mAHD)	Water Level (mAHD)	Depth (m)
ALS	50.5	50.2	-0.3
GS	49.8	50.2	0.4

Notes:

Red hatch represents the ALS surface higher in levels over the surveyed surface.

Green hatch represents the surveyed surface higher in levels over the ALS surface.

Figure 8: Comparison of Aerial Laser Survey (ALS) and Traditional Ground Survey Levels

3 PROPOSED FLOODING & STORMWATER MANAGEMENT

3.1 SITE STORMWATER FLOOD LEVELS

While the main waterway flood levels define flood levels around the perimeter of the site, drainage analysis and design of the site stormwater systems is necessary to determine local flood levels across the site.

Section 3.2 discusses the site stormwater analysis and design requirements, in doing so, extracts from CCC's Development Control Plan 2014 (included in **Appendix B**) that are of particular relevance to the Proposal with respect to flooding and stormwater are highlighted.

3.2 SITE AND FLOOR LEVEL REQUIREMENTS

All development is to have a ground surface level at or above the 100 year average recurrence interval (ARI) flood level (CCC DCP 2014 Part 2.8.2c).

CCC DCP 2014 Part 2.8 Table 2.8.1 sets floor level requirements.

Table 2.8.1 Floor Level Requirements

Development Criteria	Where the depth of flow is:	Minimum Freeboard above the predicted 100yr ARI Flood level
Floor Level for any dwelling room# including all commercial or industrial areas	< 300mm	300mm
	> 300mm	500mm
Floor Level in relation to any creek or major stormwater line including detention basins for any dwelling room# including all commercial or industrial areas	Any depth	500mm
Garage or shed Floor Level**	<300mm	100mm
	>300mm	300mm
Underside of solid fencing in relation where overland flow is to be accommodated	Any depth	100mm (min)

 # For the purpose of Clause 2.8.2 b) 'a dwelling room' is any room within or attached to a dwelling excluding a garage or shed.

*** Garages and sheds with floor levels set to these standards will not be permitted to be converted to dwelling rooms at any time in the future.*

3.3 STORMWATER MAJOR AND MINOR SYSTEMS

Future design of the minor and major drainage systems is required to have the following capacities:

- Minor (pit and conduit) systems are to have minimum 10 year ARI capacity, with 20 year ARI capacity for major road crossings.
- Major (road/surface overland flow) systems are to be designed for 100 year ARI low hazard conditions.

Major and minor system performance is required to recognise the downstream (bounding waterway) flood levels (provided in this case in the CCC flood information, see **Appendix A**).

Future analysis is to include:

- Determination of sub-catchment areas and impervious percentages;
- Re-use of existing stormwater systems and discharge locations (based on available information). Typically re-use of the outlet structures shown in Photos 4 and 5 will be considered.

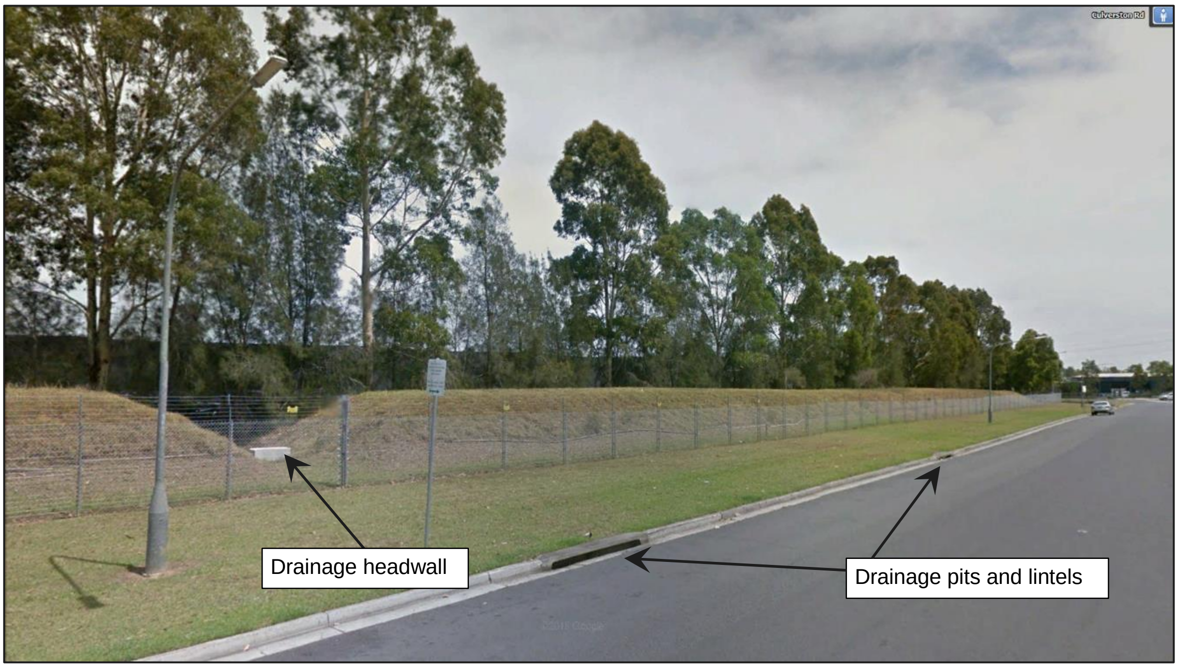


Photo 4: Existing drainage structures on Culverston Road (Google street view)

Photo 5: An existing drainage outlet structure on Bow Bowing Creek

3.4 PROBABLE MAXIMUM FLOOD (PMF)

The CCC requires that the PMF be checked with respect to the risk to property and/or life, all developments must consider the impact of storms greater than the 100 year ARI event in terms of evacuation routes. (DCP 2014 Part 4.13.1).

In addition to the 100 year ARI flood levels, it is necessary to understand flood regimes for the probable maximum flood (PMF) to inform on flood emergency and evacuation.

With respect to more extreme flood events, CCC has advised that in a PMF:

- the Site would be inundated by water depths of several metres over much of its area;

- there would be little warning (possibly of the order of only 10 minutes) due to the catchment urbanisation and short rainfall/runoff response times, yet inundation would be expected to subside quickly, between say 1.5 hours to 3 hours.

The implications with respect to evacuation planning are discussed below.

3.4.1 Evacuation Planning

As identified by CCC, the Site flooding would result from very short duration storms that potentially produce significant flows in this area. Such events, coming with little or no response time, means that the only realistic safe option in extreme flood events is for persons to seek on-site refuge in buildings with floor levels above defined probable maximum flood (PMF) levels.

With respect to evacuation, since hazardous flows would subside with the storm duration, evacuation would not be impeded by remnant flood waters on the catchment.

A Local Flood Plan is to be prepared for the Site development that includes:

- on-site refuge facilities, within buildings that are to be structurally stable during a PMF event.
- development of a means to inform all users of the site on how to respond and reach the refuge facilities in major flood events;
- collaboration with CCC and State Emergency Services in developing the Local Flood Plan. In particular, addressing evacuation and clean up procedures.

3.5 CLIMATE CHANGE

The CCC requires that the potential impacts of climate change be examined (DCP 2014 Part 4.25), however at a meeting with CCC (on 11 February 2016), Council advised that based on nearby catchment assessments, predicted climate change impacts with respect to rainfall runoff are expected to be minimal.

3.6 POTENTIAL FLOOD IMPACTS

As discussed in Section 2.2, it is proposed to obtain and refine CCC's regional flood models to better represent existing flood conditions on the Site. Once the existing conditions have been more adequately defined, we propose to re-configure the adjusted/refined existing condition modelling, to determine a potential re-development with flood mitigation measures that would satisfy development approval conditions.

3.7 CONCEPT DRAINAGE PLAN

The accompanying Concept Drainage Plan outlines preliminary flooding and stormwater management for the MIT, indicating:

- The potential re-use of existing drainage systems and connections where possible;
- Demolition of existing stormwater infrastructure and inclusion of new drainage systems to accommodate the proposed MIT;
- Where it is determined that new drainage systems are necessary, it is intended to maintain general sub-catchment flow distributions to the major waterways bounding the site, and discharge at existing discharge locations (avoiding additional and re-located discharge locations into the bounding waterways where feasible);
- Retention of existing neighbouring property stormwater connections, during construction and completion of the MIT.

Site fill is anticipated so as to comply with flood planning levels, and to achieve minimum gradings for site drainage including runoff and overland flowpaths in the storage areas, carparks and loading dock areas.

As such, the proposed concept design is subject to further assessment of the main waterway flood levels and extents, and determination of flood mitigation measures. Furthermore, site grading fill and minimum development levels are subject to within site stormwater analysis and design, which is to be carried out as part of future design.

4 STORMWATER QUALITY

4.1 OBJECTIVES

The key objectives for stormwater quality management for the Proposal include:

- Maintain or improve existing water quality
- Prevent bed and bank erosion and instability of waterways
- Incorporate a Water Sensitive Urban Design (WSUD) approach

4.2 METHODOLOGY

Assessment of the proposed development against the objectives above has been undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC V6.1). Modelling has been undertaken in accordance with the guideline Using MUSIC in Sydney's Drinking Water Catchment (Sydney Catchment Authority, 2012).

The land uses and imperviousness values for existing and proposed conditions are included in **Table 4**.

Table 4: Land Use Areas and Imperviousness

Land use	Existing		Proposed*	
	Area (ha)	Imperviousness (%)	Area (ha)	Imperviousness (%)
Roof	0.7	100	11.2	100
Road/Pavement**	26.8	100	16.3	100
Vegetated/ Landscaped	2.1	0	2.1	0

** Proposed conditions reflect the ultimate development of the MITD.*
*** Includes all impervious areas other than roofs (ie. roads, terminal pavements, building aprons etc),*

The MUSIC model layouts for existing and proposed conditions are included in **Figure 9**. A gross pollutant trap (GPT) is included in the proposed conditions which is considered standard practice for an industrial site. The GPT included in the model is representative of GPT's being placed on all stormwater lines that discharge from the site into the surrounding waterways. Given the significant volume of truck movements that will occur on the site it is also considered appropriate to select a GPT that will also be capable of capturing hydrocarbons or a separate oil/grit separator installed.

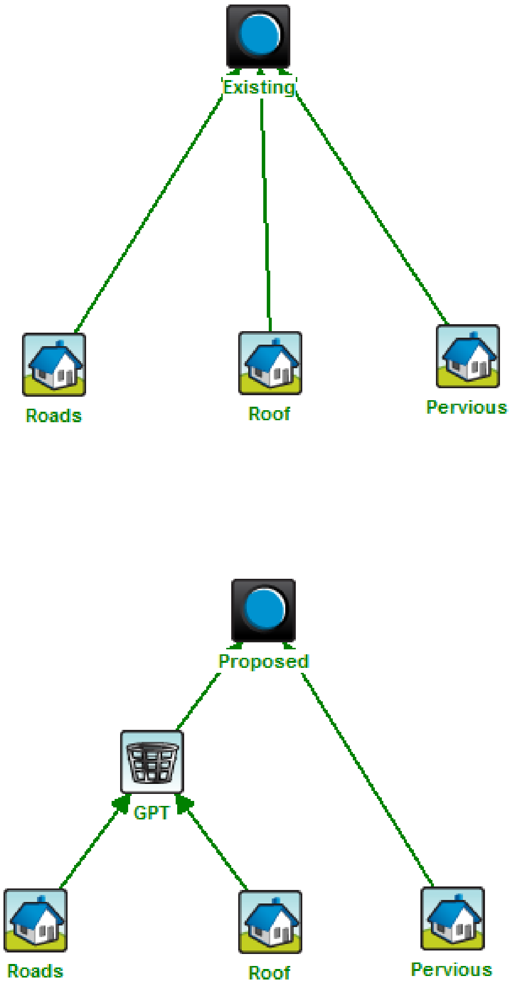


Figure 9: MUSIC Model Layouts for Existing and Proposed Conditions

4.3 RESULTS AND COMMENTS

The existing and proposed pollutant loads are presented in **Table 5.** There is clearly a significant reduction in pollutant loads. This reduction is largely is a result of:

1. Replacing significant roads/pavements areas, which have relatively high pollutant loads, with warehouse roofs which have relatively low pollutant loads.
2. Incorporating gross pollutant traps which are responsible for the significant reduction in gross pollutants and TSS.

Table 5: Existing and Proposed Average Annual Pollutant Loads

Scenario	Pollutant Loads (kg/year)			
	Gross pollutants	TSS	TP	TN
Existing	5,200	68,700	116	482
Proposed	560	24,000	81	432
% Change	-90%	-65%	-35%	-10%

** Model: AA009069_Minto_20160422.sqz*

5 SITE WATER BALANCE

5.1 OBJECTIVES

The objective of the site water balance is to identify any potential impacts on surface water and groundwater resources and assess management options where appropriate. This is in accordance with the SEARs (refer **Table 1**).

5.2 METHODOLOGY

Given that rainfall-runoff processes dominate the water balance for the site, a site water balance model was established using MUSIC (the same model used to assess water quality impacts, refer **Section 4**) for both existing and proposed conditions. MUSIC enables a continuous simulation of rainfall-runoff processes to be undertaken for a long time period. In this case, a 10 year period of rainfall was selected which includes a range of rainfall depths across both wet and dry years.

Other components of the site water balance include potable water supply from Sydney Water and wastewater discharge to sewer, although the volumes associated with these are relatively minor and have not been assessed in detail.

5.3 WATER DEMAND & WASTEWATER GENERATION

Preliminary annual water demands for the Proposal have been estimated based on 400 operational employees with an average demand of 150 L/day. This gives a water demand of approximately 20 ML/yr. No other significant water demands or industrial water usage are proposed.

No extraction from any surface water or groundwater resources is proposed. However, further consideration will be given to rainwater harvesting as a source of non-potable water as discussed further below.

Wastewater generation, allowing for an 80% sewer discharge factor relative to the water demands, is estimated to be approximately 16 ML/yr. This is proposed to be discharged to sewer.

The water demands and wastewater generation associated with the current land use for the site are unknown. However, the increase in warehouse area relative to existing suggests that demands for the proposed development will be higher than existing.

5.4 RAINFALL RUNOFF PROCESSES

Surface areas for the existing site land uses have been estimated from aerial photos. The existing site includes significant impervious areas (28 ha), consisting largely of roads/pavements (27 ha) and a small roof area (0.7 ha). The remaining area (2.1 ha) is pervious and is grassed or treed. Overall the existing site is approximately 95% impervious and 5% pervious.

The proposed conditions maintain the total imperviousness of the site at approximately 28 ha, however the roof area is proposed to increase to 11 ha and the road/pavement area reduced to 17 ha. The pervious area remains approximately the same.

5.5 RESULTS AND COMMENTS

The average annual water balance for the site is shown in **Figure 10.** This demonstrates that the existing and proposed water balances are almost identical and hence impacts as a result of the development are considered to be minimal and no additional mitigation measures required.

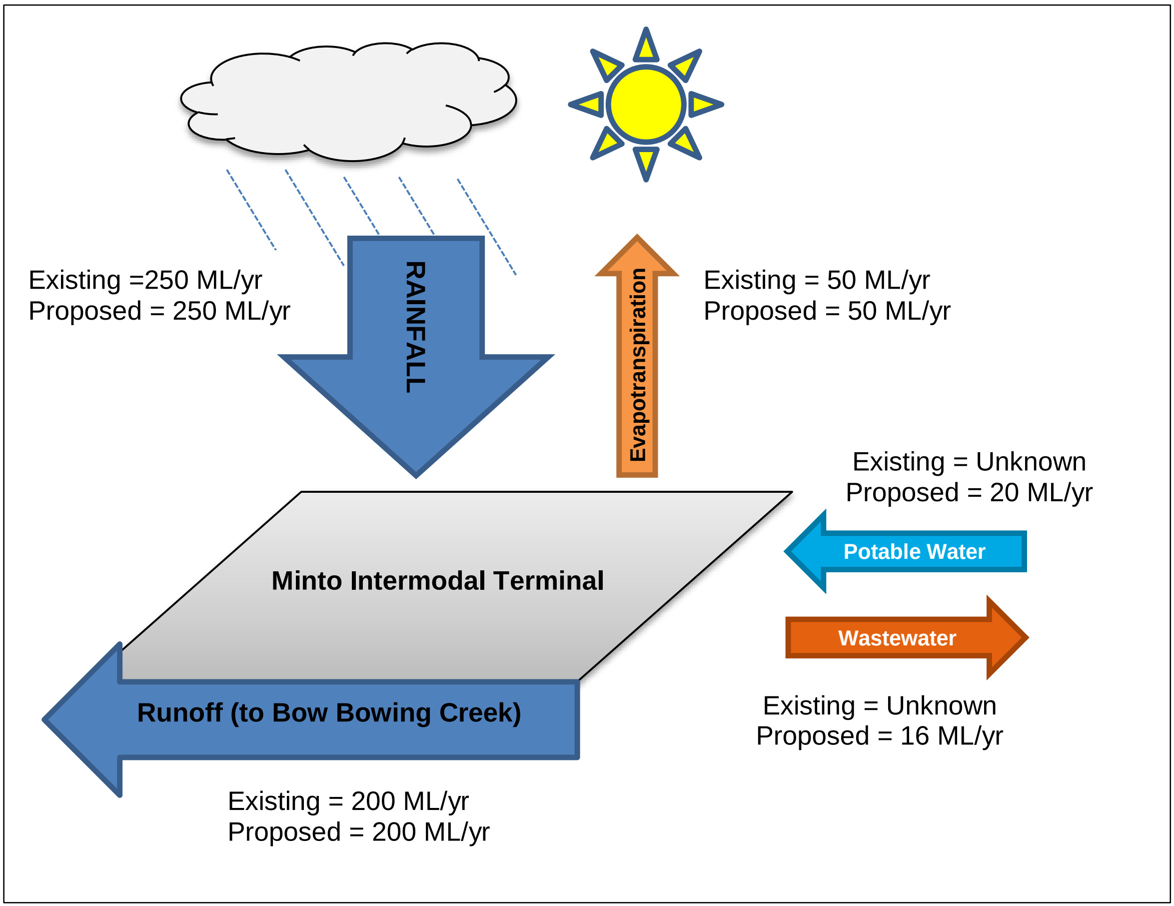


Figure 10: Site Water Balance for Existing and Proposed Conditions

6 CONSTRUCTION EROSION & SEDIMENT CONTROLS

An erosion and sediment control plan (refer to accompanying Drawings) has been prepared to assist the implementation of erosion and sedimentation control measures in accordance with 'Managing Urban Stormwater: Soils and Construction' Landcom 2004 publication. These measures include:

- Sediment Basins;
- Hay Bales;
- Silt Fences;
- Inlet filters;
- Diversion channels; and
- Stabilised site access and truck wash-down area.

7 CONCLUSION AND RECOMMENDATIONS

This Stormwater and Flooding Assessment has been prepared for approval of the Proposal. The following conclusions and recommendations have been made within this report:

- It is proposed to obtain and refine the CCC regional flood models of Bow Bowing Creek. With the models in hand, the approach would be to create an existing conditions model that more adequately represents flood levels in the main waterways (which surround the site). This would involve refining the site levels (replacing the ALS levels with the ground survey information) and, if necessary, additional adjustments that may more adequately represent the site specific representation within the broader CCC regional modelling.
- While the main waterway flood levels define flood levels around the perimeter of the site, drainage analysis and design of the site stormwater systems is necessary to determine local flood levels across the site.
- Site fill is anticipated so as to comply with flood planning levels, and to achieve minimum gradings for site drainage including runoff and overland flowpaths in the storage areas, carparks and loading dock areas. As such, the proposed concept design is subject to further assessment of the main waterway flood levels and extents, and determination of flood mitigation measures.
- Site grading fill and minimum development levels are subject to within site stormwater analysis and design, which is to be carried out as part of future design.
- Stormwater pollutant loads are expected to be reduced relative to existing conditions.
- The site water balance shows there will be minimal difference between existing and proposed conditions

APPENDIX A

Campbelltown City Council Flood Information

7 April 2016

Mr Bruce Caldwell
ARCADIS
Level 5/141 Walker Street
NORTH SYDNEY NSW 2060

bruce.caldwell@arcadis.com

Dear Mr Caldwell

Lot 3 DP 817793 (No. 5) and Lot 400 DP 875711 Culverston Road Minto- Flood information.

Council refers to your letter dated 15 February 2016 requesting flood information for the above properties.

I advise as follows:

1. The above properties are at risk of flooding from a 1% Annual Exceedance Probability (AEP) flood in the Bow Bowing creek to the west, fabriform channel to the north (by the side of Airds Road) and formalised channel to the south (by the side of Rose Payten Drive).

   The above properties are affected by flooding from a 1% Annual Exceedance Probability flood due to overland flow from the local catchment traversing lot in the formalised fabriform channel within the site.

2. The minimum fill (1% AEP flood level) and floor level requirement due to 1% AEP flooding in addition to the 20%, 5% and 2% AEP and PMF flood levels are given on the attached table (page 3) corresponding to the locations shown on the attached map (page 4). Please note that the 1% AEP flood levels have been provided for two scenarios. The first assumes that the site is in its current landform. The second assumes that the site has been (and all developable areas in the catchment are) filled to 10m above current levels. This forces all water into the roads, drains, creeks and open space areas and represents the "ideal" development scenario.

3. Please refer to Attachment No.1 for the details of the Culverston Road Box culvert.

4. Please refer to Attachment No. 2 for the contour plans on cadastral/aerial photo base and Council's stormwater network details as requested.

5. Your receipt for payment is enclosed (Attachment No.3).

6. With regard to the blockage factors used in Council Flood study please refer to the extract from the flood study report given below for your information.

5.2.5 Pit/Culvert Blockage

As shown in **Plate 7**, stormwater inlets and culverts may become blocked by debris during the course of a flood. As a result, most stormwater inlets and culverts will not operate at full efficiency during most floods. This can increase the severity of flooding across areas located adjacent to this drainage infrastructure.

In recognition of the potential for blockage to occur during a flood, blockage factors were applied to stormwater inlets and culverts. A blockage factor of 50% was applied to all minor (i.e., < 3 metre diameter) culvert crossings. A 50% blockage factor was also applied to all sag stormwater inlets and 20% blockage was applied to on-grade stormwater inlets in accordance with Council's *'Sustainable City Development Control Plan 2009, Volume 2: Engineering Design for Development'* (DCP) (Campbelltown City Council, 2009b).

7. Please refer to attachment No. 4 for the report by Council's consultant in response to point 3 of your above letter.

Council trusts the above information is of assistance. Should you have any further queries, please contact Cathy Kinsey on (02) 4645 4635.

Yours sincerely

Kevin Lynch
Manager Technical Services

Attachment 1 - Culverston Road culvert details
Attachment 2 - Contour & stormwater network detail plans
Attachment 3 - Receipt for payment
Attachment 4 - Report by Council's consultant

GH

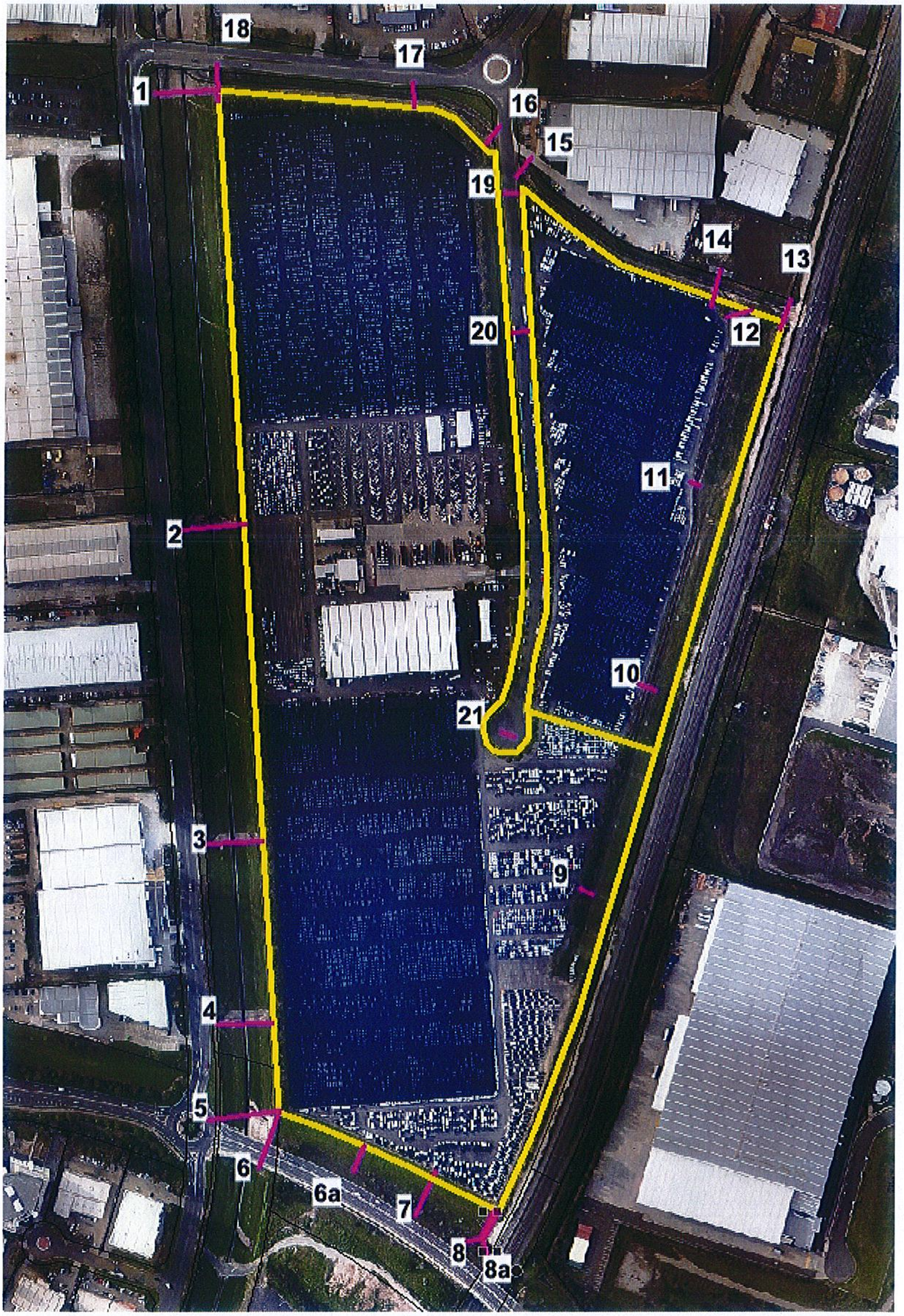
Table of flood levels at various locations.

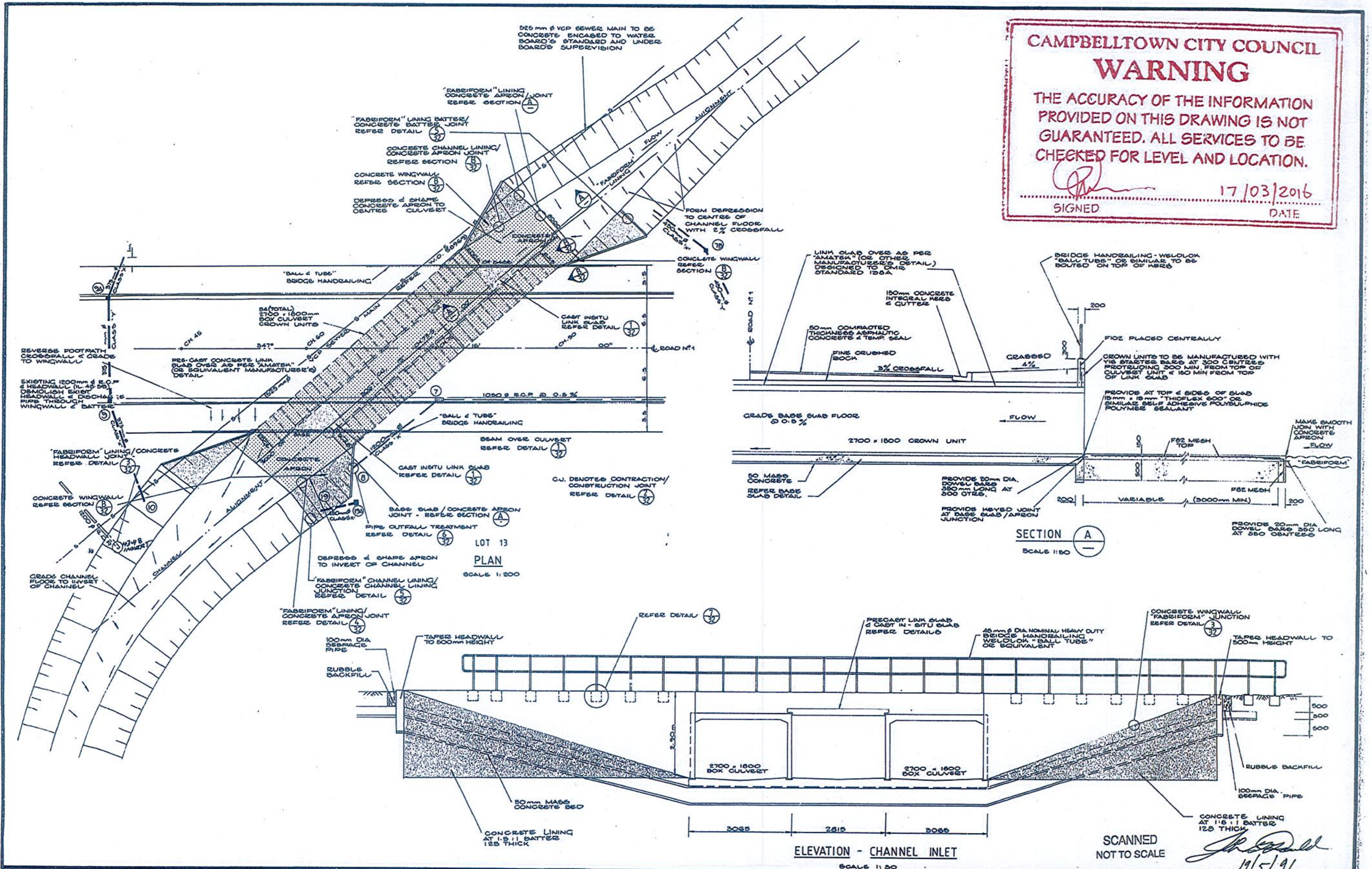
Detail of the flood way	Location	1% AEP flood level with current site ground levels [Min. Fill level] (m AHD)	Min. Floor level (m AHD)	1% AEP flood level with site filled to above flood levels * (m AHD)	20% AEP flood level (m AHD)	5% AEP flood level (m AHD)	2% AEP flood level (m AHD)	PMF (m AHD)
Bow Bowing Channel	1	45.75	46.25	45.88	44.50	44.80	45.25	48.00
	2	46.80	47.30	47.00	46.10	46.45	46.60	48.95
	3	48.50	49.00	48.73	47.80	48.15	48.33	50.55
	4	49.75	50.25	49.96	49.10	49.45	49.60	51.80
	5	50.20	50.70	50.47	49.50	49.85	50.05	52.45
Formalised grass channel to the south (Rose Payten Drive side)	6	50.20	50.70	50.54	49.50	49.85	50.05	52.45
	6a	50.20	50.70	50.62	49.70	49.75	49.79	52.60
	7	50.20	50.70	50.74	50.10	50.18	50.19	52.74
	8	50.80	51.30	51.04	50.70	50.76	50.78	52.87
	8a	51.30	51.30	51.22	N/A	51.10	51.21	52.85
Formalised fabriform channel within the site	9	48.05	48.55	48.54	48.00	48.00	48.00	49.50
	10	47.50	48.00	48.00	47.15	47.24	47.38	49.02
	11	47.11	47.61	47.75	46.80	46.86	46.99	48.92
	12	47.05	47.55	47.63	46.60	46.83	46.95	48.89
Fabriform channel to the north	13	48.90	49.40	48.90	48.65	48.75	48.82	49.82
	14	47.00	47.50	47.60	46.50	46.75	46.88	48.85
	15	46.00	46.50	46.46	45.45	45.72	45.89	47.50
	16	45.85	46.35	45.98	45.40	45.60	45.72	47.50
	17	45.70	46.20	45.88	45.30	45.50	45.61	47.50
	18	45.70	46.20	45.88	44.55	44.80	45.22	47.96
Culverston Road	19	46.25	46.55	46.47	46.10	46.21	46.25	48.38
	20	46.50	46.80	46.60	46.43	46.46	46.47	48.47
	21	48.05	48.35	48.20	47.93	48.02	48.04	48.51

Note: 1% AEP flood level at location 1 is due to back water from the downstream culvert.

** All areas within the flood study area, other than roads, drainage, and open space, have been raised 10m above the current levels.*

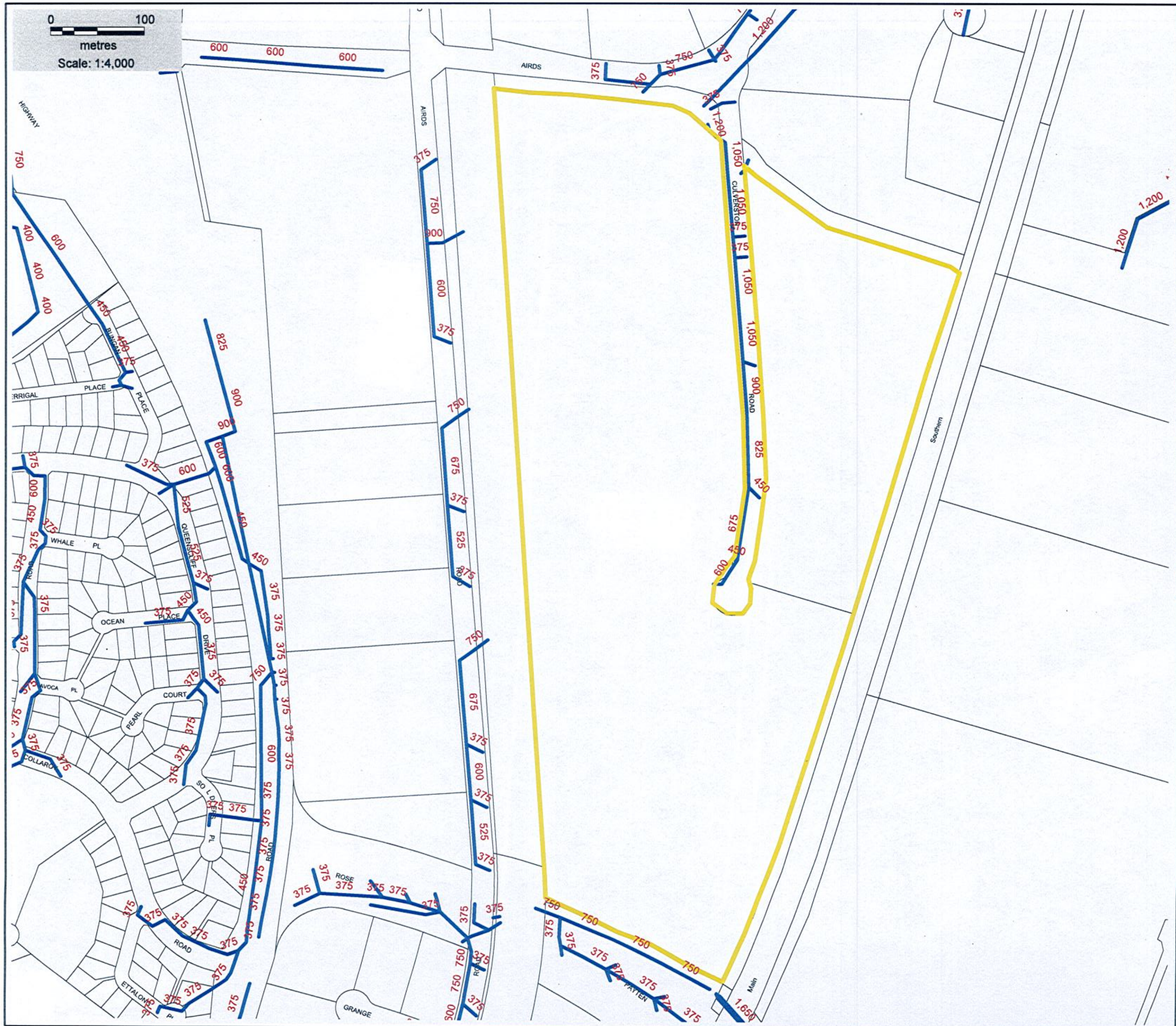
Flood level locations





EXISTING		PROPOSED		UTILITIES			No.	AMENDMENT	DATE	NOTES:
KERB & GUTTER		KERB & GUTTER		WATER MAIN	—W—	O W				
PIPE DRAINS		PIPE DRAINS		TELECOM CABLE	—T—	O T				
PITS		PITS		GAS MAIN	—G—	O G				
				SEWER MAIN	—S—	M.H.				
				COUNTY COUNCIL POLE						
				TELECOM POLE						

CONSULTING ENGINEER: LEAN LACKENBY & HAYWARD	MACARTHUR DEVELOPMENT CORPORATION	DESCRIPTION: PLAN OF BOX CULVERT AND ELEVATION	PLAN NUMBER: 88 / 92972
	M.Mathew — A/GENERAL MANAGER		No. of SHEETS: 32 — SHEET No: 31/A
	P.Witts — CHIEF PLANNER		
CONSULTING SURVEYORS:	A.Lolich — CHIEF ENGINEER		
	APPROVED: — DATE: FEB '89	PROJECT: KINTYRE INDUSTRIAL ESTATE	SCALE: 1:200, 1:50



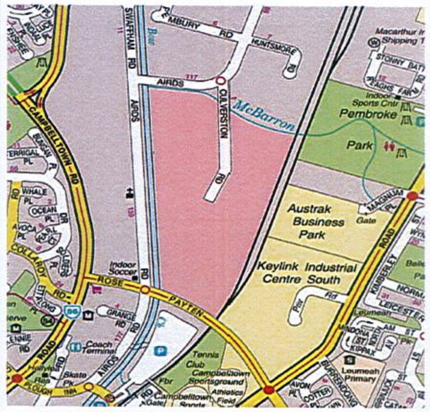
campbelltown
city council

city works
level 2, civic centre, queen street
PO Box 57 Campbelltown NSW 2560

Accuracy of the information shown on this plan is not guaranteed.

All service levels and locations should be confirmed on site.

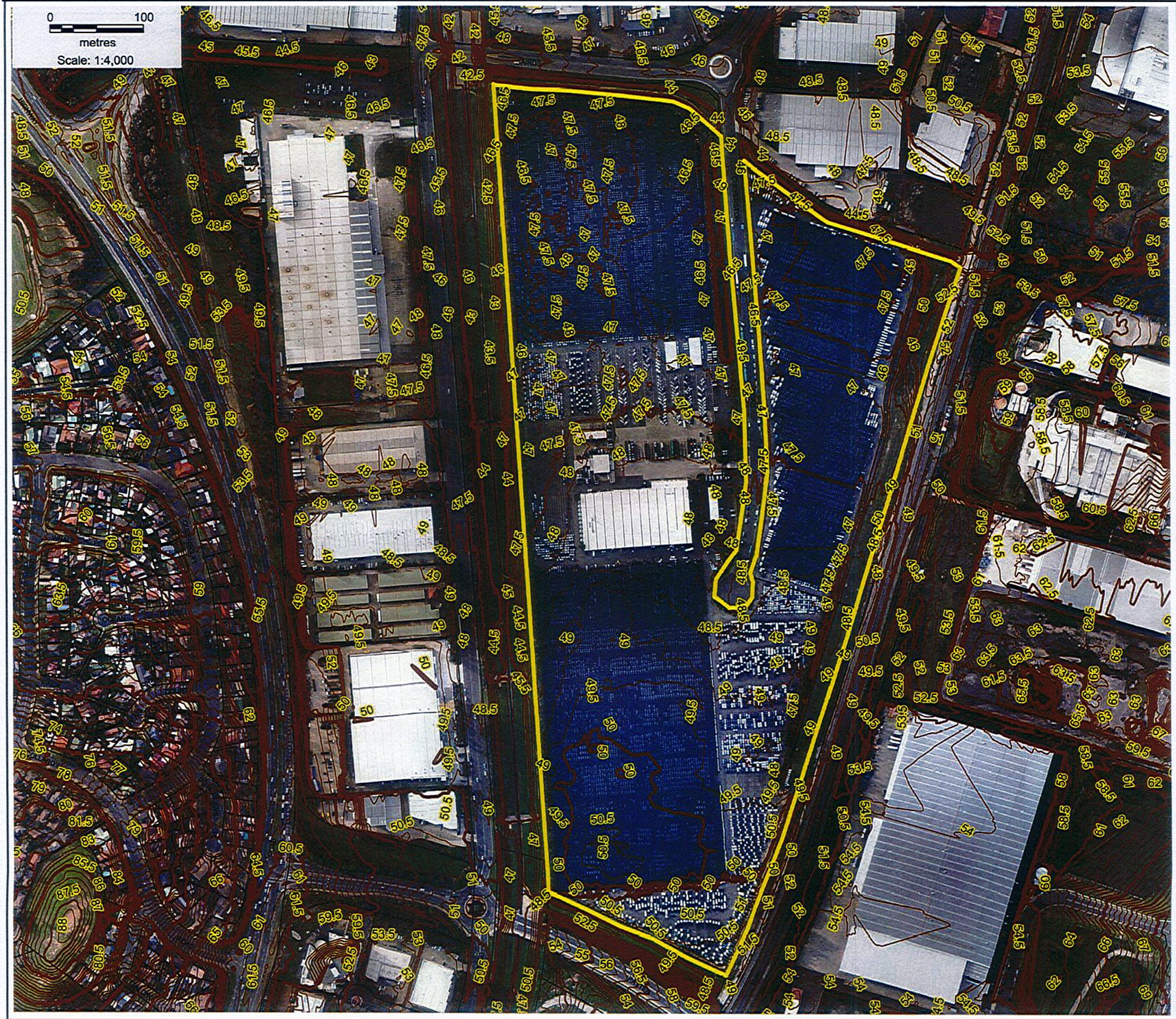
This information shall not be made public without the written permission of Council's Manager Technical Services.



N
W E
S

Lot 3 DP817793 and Lot 400 DP875711
Culverston Road Minto
14 March 2016

File :Stormwater_Advice_CulverstonMinto14March2016.wor



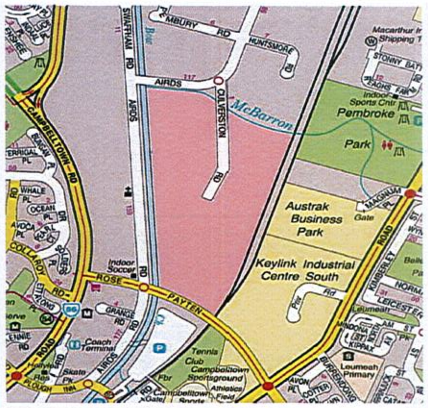
campbelltown
city council

city works
level 2, civic centre, queen street
PO Box 57 Campbelltown NSW 2560

Accuracy of the information shown on this plan is not guaranteed.

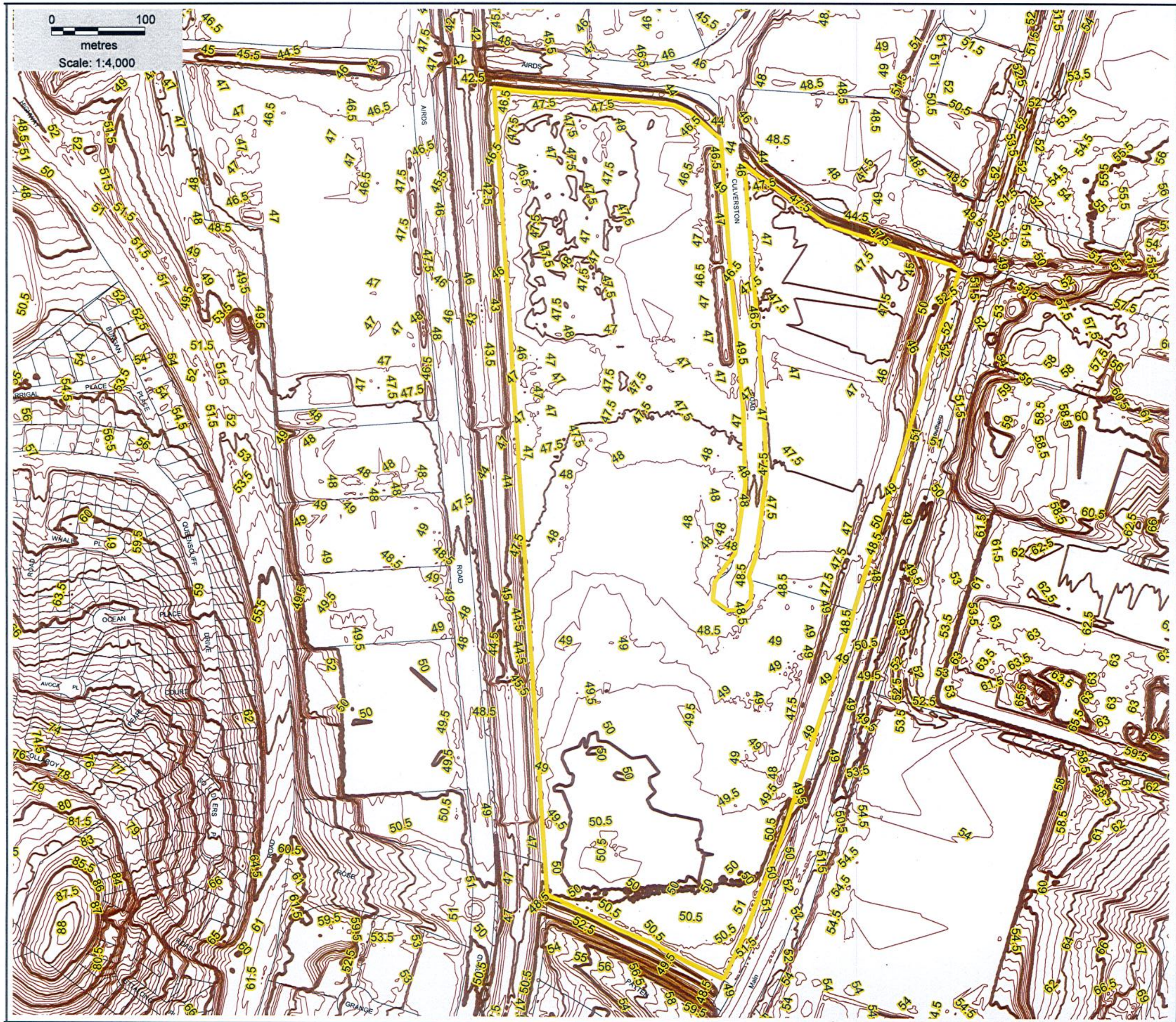
All service levels and locations should be confirmed on site.

This information shall not be made public without the written permission of Council's Manager Technical Services.



Lot 3 DP817793 and Lot 400 DP875711
Culverston Road Minto
14 March 2016

File :Stormwater_Advice_CulverstonMinto14March2016.wor



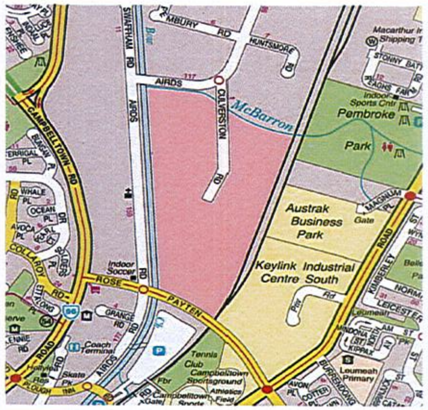
campbelltown
city council

city works
level 2, civic centre, queen street
PO Box 57 Campbelltown NSW 2560

Accuracy of the information shown on this plan is not guaranteed.

All service levels and locations should be confirmed on site.

This information shall not be made public without the written permission of Council's Manager Technical Services.



N
W E
S

Lot 3 DP817793 and Lot 400 DP875711
Culverston Road Minto
14 March 2016

File :Stormwater_Advice_CulverstonMinto14March2016.wor

Catchment Simulation Solutions
Canberra Office
13 Weatherburn Place
BRUCE ACT 2617
(02) 6251 0002
(02) 6251 8601
cryan@csse.com.au
Sydney Office
Suite 2.01
210 George Street
SYDNEY NSW 2000
(02) 8355 5500
(02) 8355 5505
dtetley@csse.com.au

Ms Gamini Hattotuwa
Campbelltown City Council
PO Box 57
CAMPELLTOWN NSW 2560

29th March, 2016

Dear Gamini,

Lot 3 DP 817793 & Lot 400 DP87511, Culverston Rd, Minto
Extreme Flood Assessment

I refer to recent correspondence regarding the proposed redevelopment of two lots adjoining Culverston Road at Minto (referred to as Lot 3 DP 817793 & Lot 400 DP87511). The location of the site is shown in **Figure 1**.

As you would be aware, the proposed development site is bordered by a number of open channels/waterways. Accordingly, there is potential for the site to be impacted by flooding during significant rainfall within the catchment. Therefore, we understand that ARCADIS has requested the provision of a range of "extreme flood" information to assist with the design of the proposed development. This includes:

- PMF warning times; and,
- Duration of PMF inundation across Culverston Road culvert, including duration of "high hazard" inundation.

Therefore, Catchment Simulation Solutions (CSS) has extracted Probable Maximum Flood (PMF) information from the results of TUFLOW modelling that was completed across the Minto/McBarron Creek catchment. The outcomes of this data extraction exercise is presented below.

PMF Assessment

To assess the potential flood warning times that may be available during a PMF, stage hydrographs were extracted from the results of the Minto/McBarron Creek TUFLOW modelling. The stage hydrographs describe the time variation in water level throughout the PMF at discreet locations. The location where stage hydrographs were extracted as part of the assessment is shown in **Figure 1** and includes:

- #1 - Swale near south-western corner of the site (i.e., downstream of railway);
- #2 - Bow Bowing Creek channel at south-western corner of site (i.e., downstream of Rose Payten Drive);
- #3 McBarron Creek near north-western corner of site (i.e., downstream of railway); and,
- #4 - Upstream of Culverston Road Culvert;

- #5 - Bow Bowing Creek channel at north-western corner of site (i.e., upstream of Airds Road)

A review of multiple PMF storm durations was completed to determine the storm durations that would provide the shortest flood warning times as well as the greatest durations of inundation. The stage hydrographs for the 15-minute and 2-hour PMF storm durations were selected for inclusion as:

- The 15-minute storm provides the least amount of warning time while still causing inundation across the site.
- The 2-hour storm duration produces the greatest duration of inundation across Culverston Road.

The stage hydrographs at locations #1 to #5 are provided in **Figures 1.1** to **1.5**.

Also included on a secondary axis in **Figures 1.1** to **1.5** are cross-sections that show the variation in ground surface in the vicinity of each stage hydrograph location. The alignment of each cross-section is shown on **Figure 1**. The cross-section information can be used to determine the elevation at which water would begin to "spill" from the waterways and start to enter the site or cross Culverston Road. This, in turn, can be correlated with the PMF stage hydrographs to determine the amount of warning time that would be available after the initial onset of rainfall before this threshold elevation is exceeded and inundation of the site/road would commence.

The time of first inundation after the initial onset of rainfall at each stage hydrograph location is also summarised in **Table 1**. It should be noted that the warning times are estimates only based upon interrogation of 5 locations around the perimeter of the site. There is potential for inundation of the site during the PMF at other locations at other times. Therefore, the calculated warning times should be considered estimates only.

Table 1 Inundation Times from Onset of Initial Rainfall

Location	Time from Onset of Rainfall (minutes)	
	15-minute PMF	2-hour PMF
1	8	16
2	31	44
3	9	22
4	8	21
5	29	41

Table 2 Duration of Inundation for Culverston Road

Location	Duration of Inundation (hours)		Duration of >H1 Inundation (hours)		Duration of >H3 Inundation (hours)	
	15-minute PMF	2-hour PMF	15-minute PMF	2-hour PMF	15-minute PMF	2-hour PMF
4	1.4	3.0	1.35	2.9	1.3	2.8

The information presented in **Figures 1.1** to **1.5** and **Table 1** shows that:

- Along the main Bow Bowing Creek channel, inundation of the site would occur around 30 minutes after the initial onset of rainfall during a 15-minute PMF. During the 2-hour PMF, inundation of the site would typically occur 40 minutes after the initial onset of rainfall.
- Along the tributaries bordering the northern and southern site boundaries, inundation of the site would commence less than 10 minutes after the initial onset of rainfall during the 15-minute PMF. Inundation of the site would generally occur 20 minutes after the initial onset of rainfall during a 2-hour PMF.

It is noted that an elevated embankment is provided around some sections of the site, which would afford some additional protection across the central sections of the site. However, in most cases, this will only afford an additional ~5 minutes of warning time.

The receding limb of the hydrograph was also interrogated at Culverston Road to determine how long the road would remain inundated. This information is presented in **Figure 1.4** and **Table 2** and shows:

- Inundation of Culverston Road will occur ~10 minutes after the initial onset of rainfall and will remain inundated for approximately 1.5 hours during the 15-minute PMF.
- Inundation of Culverston Road will occur ~20 minutes after the initial onset of rainfall during the 2-hour PMF and will remain inundated for approximately 3 hours.

The outputs from the TUFLOW model were also interrogated to determine the period that Culverston Road would be exposed to a high flood hazard (i.e., where evacuation from the site along Culverston Road would not be possible). For the purposes of this assessment, the duration of "high hazard" inundation was defined based upon hazard definitions presented in the Australian Government's *"Technical Flood Risk Management Guideline: Flood Hazard"* (2014). The hazard categories are reproduced in **Plate 1** and quantify the potential vulnerability of people, cars and structures based upon the depth and velocity of floodwaters at a particular location.

As shown in **Plate 1**, floodwater depths and velocities within the "H2" category (or higher) would mobilise small vehicles (i.e., evacuation by vehicles would not be possible) and the floodwater depths and velocities within the "H4" category (or higher) would be dangerous to able bodies adults (i.e., evacuation on foot would not be possible). Accordingly, the peak PMF velocities and depths were interrogated to determine the water level at which both of these hazard categories would be initiated, which is superimposed on **Figure 1.4**. This information, was then used to determine the duration that the roadway would be exposed to a hazard categorisation equal to or greater than the H2 and H4 designation. This information is summarised in **Table 2**.

As shown in **Table 2**, vehicular evacuation along Culverston Road unlikely to be possible for a period of between 1.35 and 2.9 and evacuation on foot is unlikely to be achievable for a period of between 1.3 and 2.8.

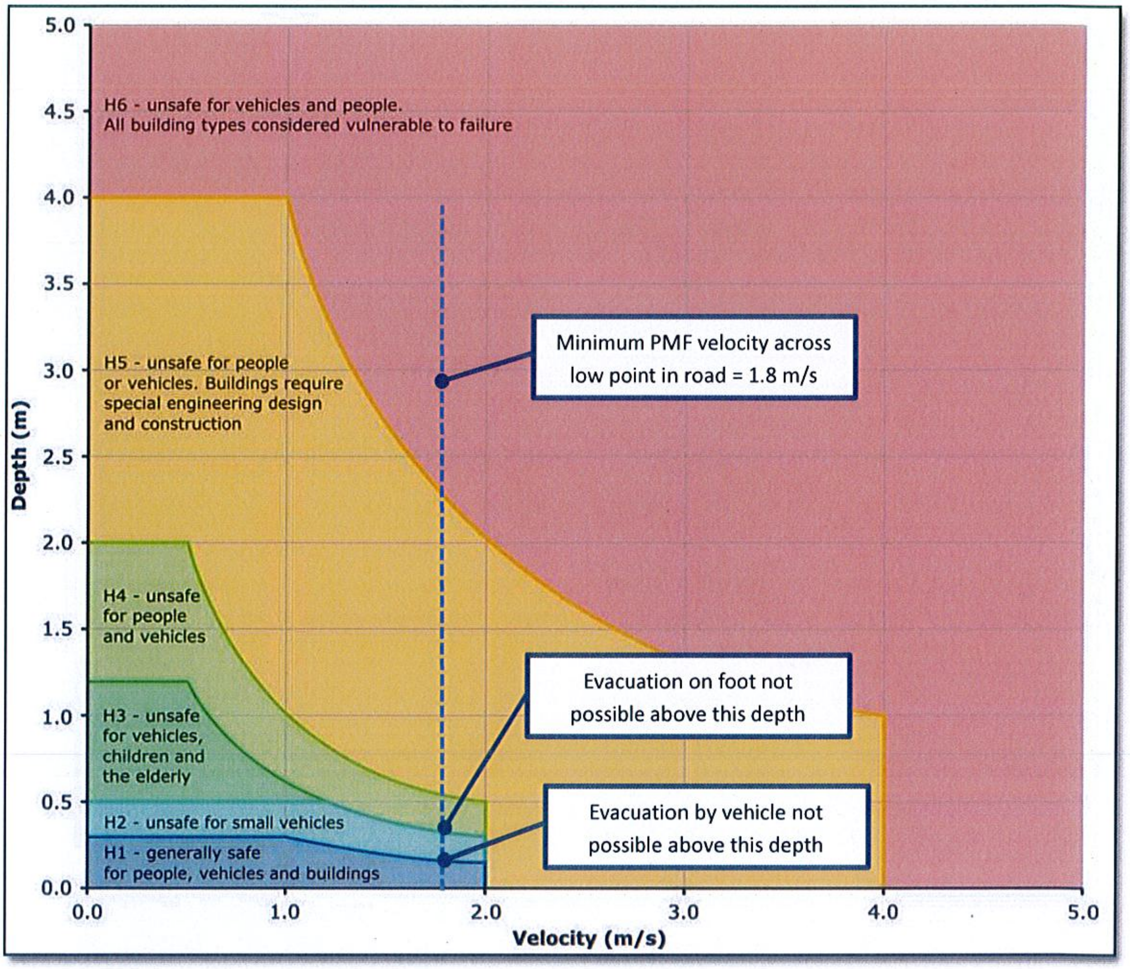


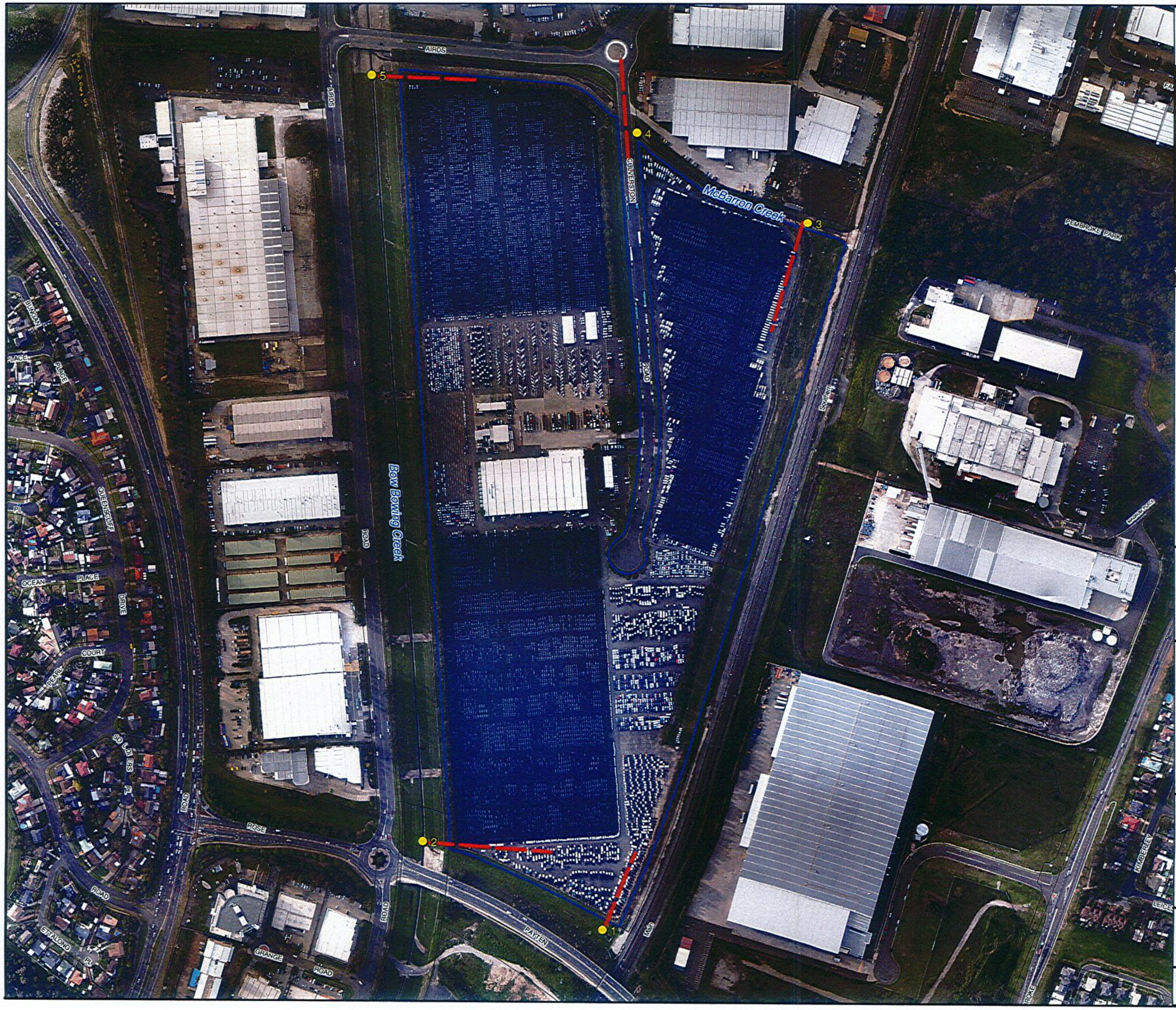
Plate 1 Flood hazard vulnerability curves (Australian Government, 2014)

We trust that the above report suitably summarises the outcomes of the extreme flood assessment. If you have any questions, please do not hesitate to contact the undersigned.

Kind Regards,

David Tetley
Catchment Simulation Solutions

Figures



LEGEND

- Site Boundary
- Stage Hydrograph Location
- Cross Section Alignment

Notes:
Aerial photo taken in 2014.

N W E S

Scale 1:4,000 (at A3)
0 100 200 m

Figure 1: Stage Hydrograph Locations

Prepared By:
Catchment Simulation Solutions
Suite 302, 5 Hunter St
Sydney, NSW 2000

File Name: Figure1 Stage hydrograph locations.wor

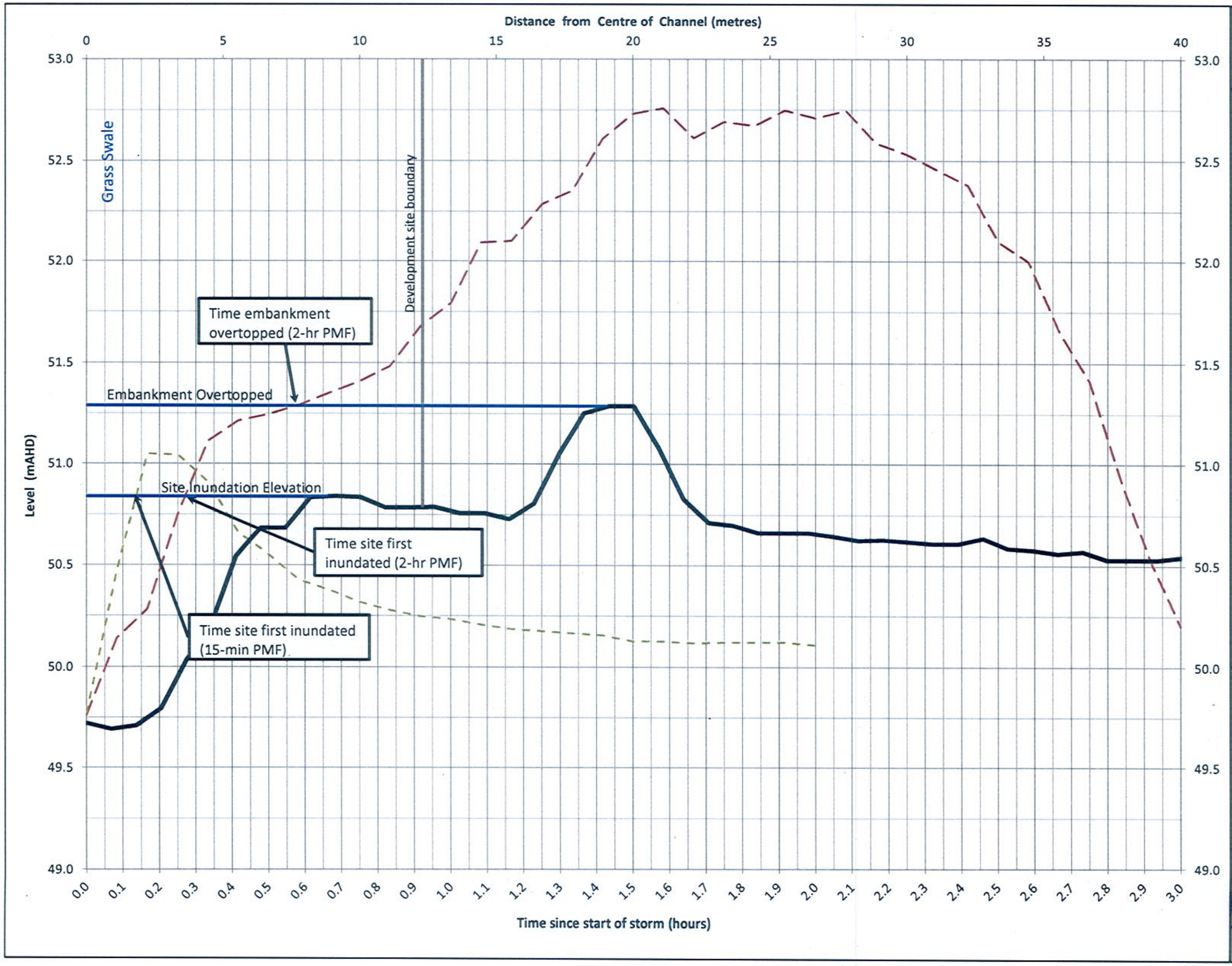


Figure 1.1: Location 1 PMF Stage Hydrographs

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Stage Hydrograph.xlsx

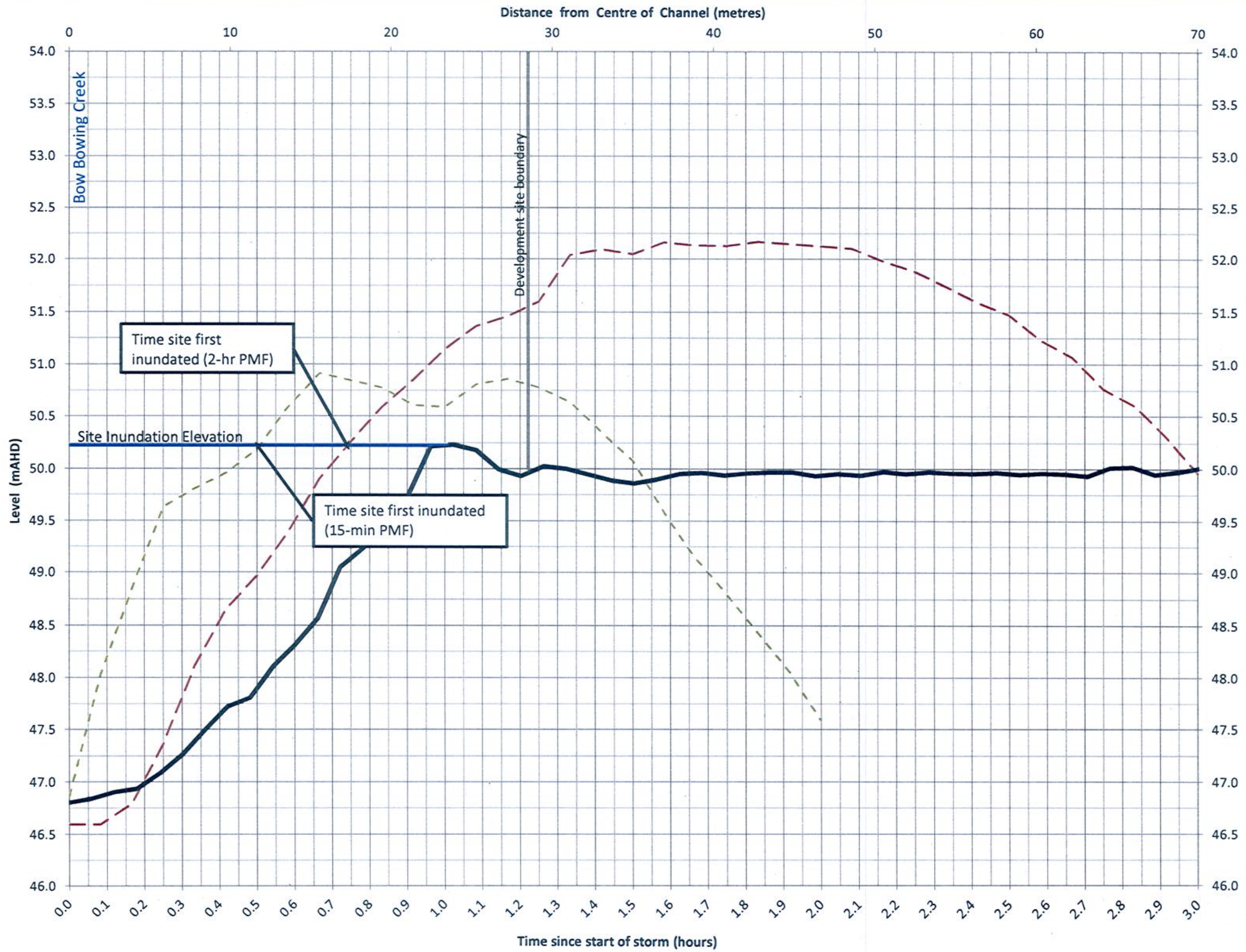


Figure 1.2: Location 2 PMF Stage Hydrographs

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Stage Hydrograph.xlsx

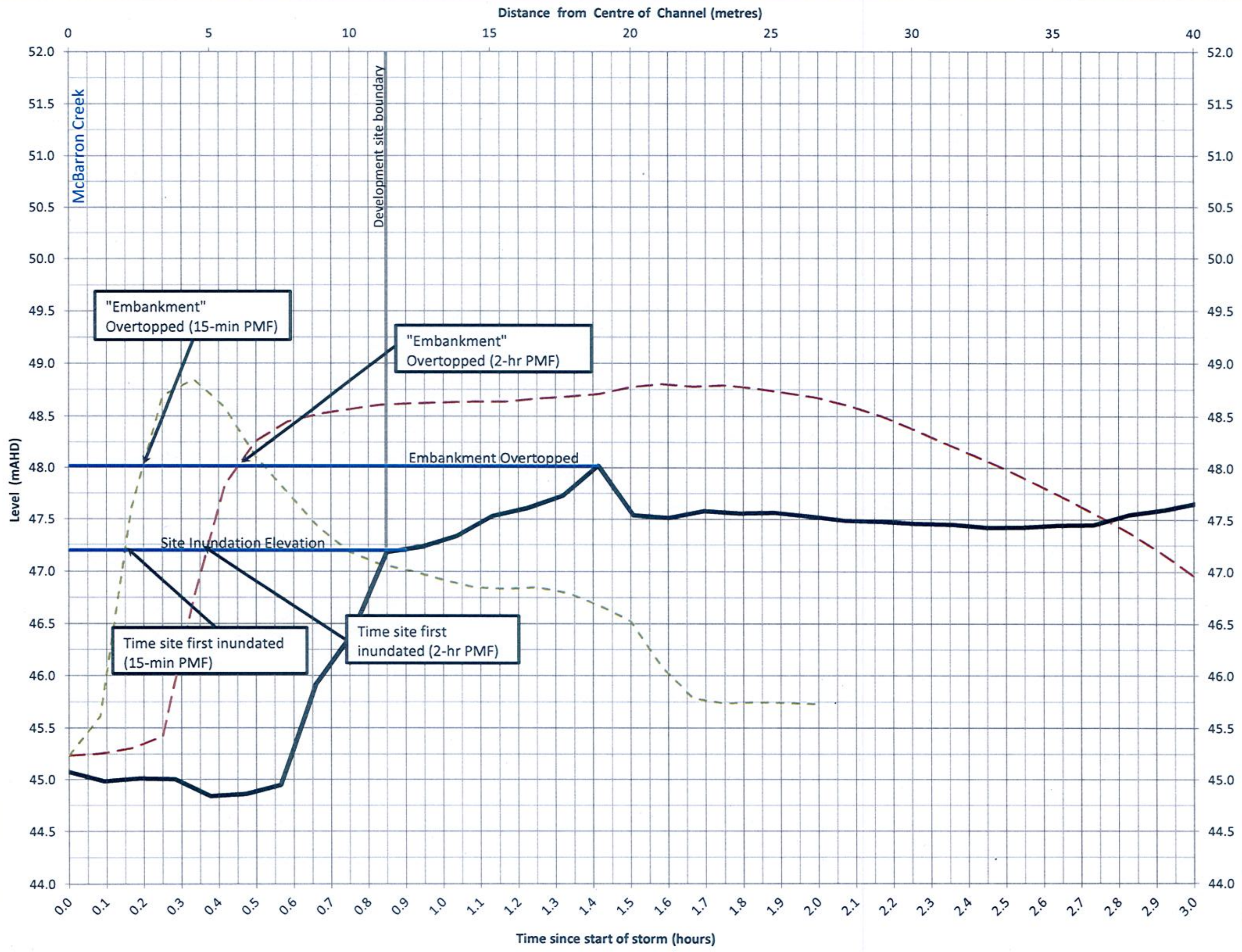
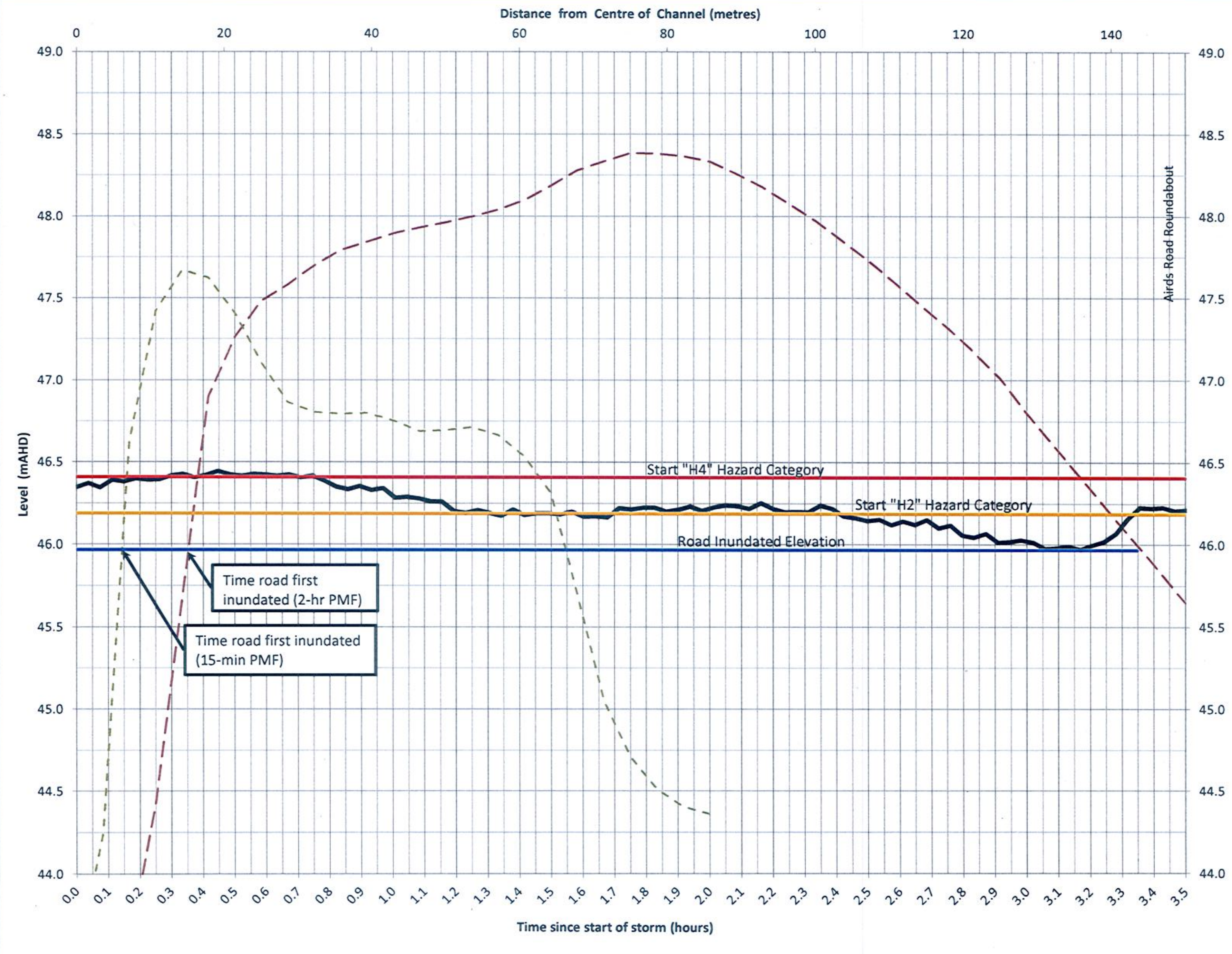


Figure 1.3: Location 3 PMF Stage Hydrographs

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Stage Hydrograph.xlsx



LEGEND

- PMF 2 hour stage hydrograph
- PMF 15-minute stage hydrograph
- Culvertston Road Centreline Profile

Figure 1.4: Location 4 PMF Stage Hydrographs

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Stage Hydrograph.xlsx

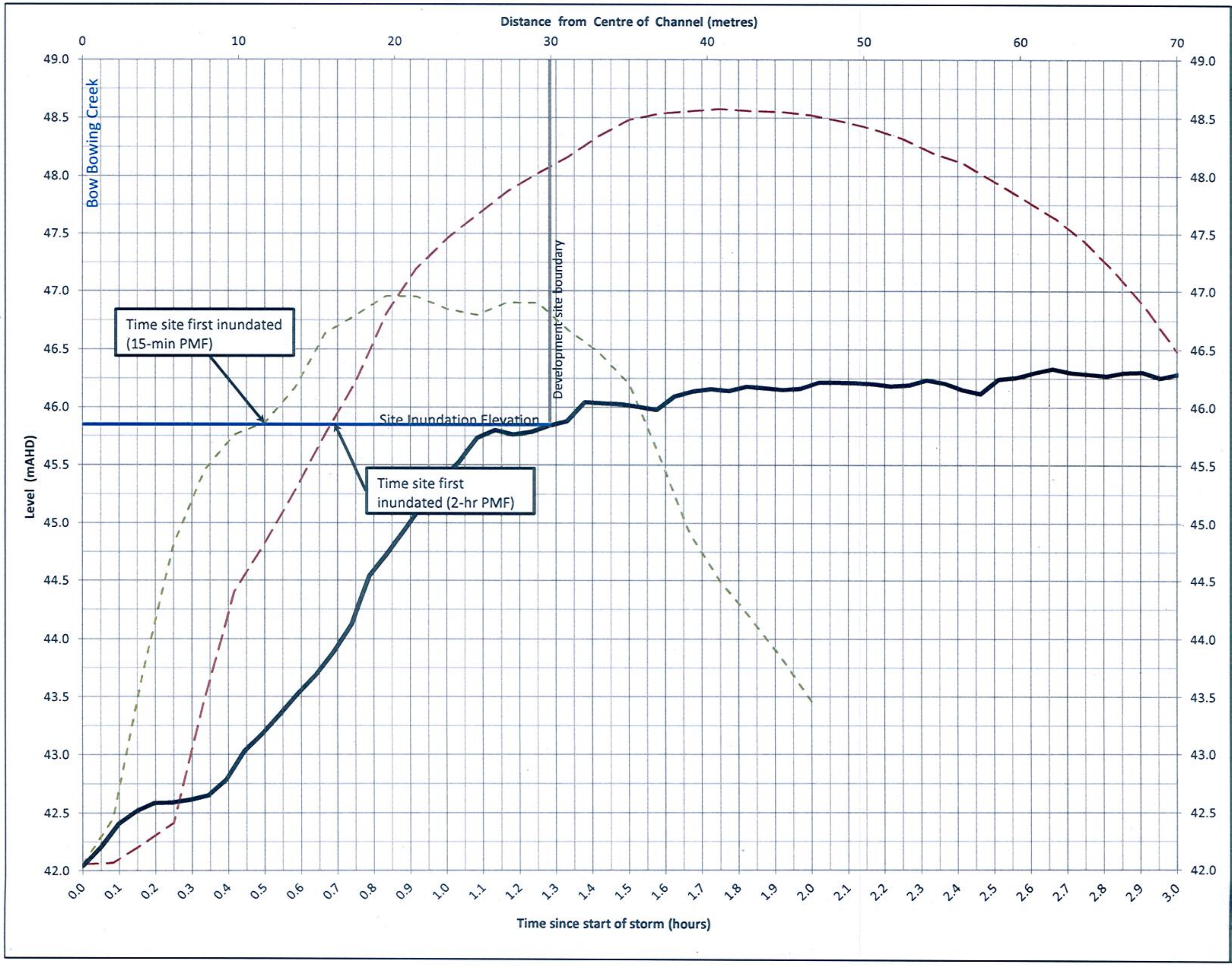


Figure 1.5: Location 5 PMF Stage Hydrographs

Prepared By:
Catchment Simulation Solutions
Suite 2.01, 210 George Street
Sydney, NSW, 2000

File Name: Stage Hydrograph.xlsx

APPENDIX B

Extracts from Campbelltown City Council's Development Controls

Part 2
Requirements Applying to all Types of Development

2.8 Cut, Fill and Floor Levels

term 'Vertical distance';

iii) batters to be no steeper than 6H:1V for public areas.

e) All fill shall be 'Virgin Excavated Natural Material' (VENM).

f) No fill shall be deposited in the vicinity of native vegetation.

Note: All filling works shall satisfy Council's Specification for Construction of Subdivision Roads and Drainage Works and AS 3798 Guidelines for Earthworks for Commercial and Residential Development (refer Volume 3).

Figure 2.8.2 - Proposed building platform.

2.8.2 Surface Water and Floor Levels

Design Requirements

a) Development shall not occur on land that is affected by the 100-year ARI event unless the development is consistent with the NSW Floodplain Development Manual.

b) All development on land affected by flow from main stream, local creek or over land flow shall satisfy the relevant fill and floor level requirements as specified in Table 2.8.1.

c) All development shall have a ground surface level, at or above a minimum, equal to the 100-year 'average recurrence interval' (ARI) flood level.

d) For development on land not affected by an overland flow path the minimum height of the slab above finished ground level shall be 150 mm, except in sandy, well-drained areas where the minimum height shall be 100 mm. These heights can be reduced locally to 50 mm near adjoining paved areas that slope away from the building in accordance with *AS 2870 (Residential Slabs and Footings Construction)*.

Note: These minimum heights are to the top of the finished ground level after completion of paving and similar.

Note: The development shall satisfy Sydney Water's requirements for 150mm clearance between finished floor level and the surface *of the sewered surcharge gully.*

e) Buildings involving basements, hospitals, seniors living dwellings and educational establishment with more than 50 students shall comply with the provisions of Volume 3.

f) Any solid fence constructed across an overland flow path shall be a minimum 100mm above the finished surface level of the overland flow path.

g) Where underground car parking is proposed, measures shall be taken in design and construction to ensure escape routes, pump out drainage systems (which include backup systems) and location of service utilities (including power, phone, lifts) are appropriately located in relation to the 100 year ARI event, in accordance with Section 4.13.8 of Volume 3.

Note: Any allotments located on land that has been filled, shall be burdened by an 88B restriction regarding that fill and shall be noted on the respective Section 149 certificate.

Table 2.8.1 Floor Level Requirements

Development Criteria	Where the depth of flow is:	Minimum Freeboard above the predicted 100yr ARI Flood level
Floor Level for any dwelling room# including all commercial or industrial areas	< 300mm	300mm
	> 300mm	500mm
Floor Level in relation to any creek or major stormwater line including detention basins for any dwelling room# including all commercial or industrial areas	Any depth	500mm
Garage or shed Floor Level**	<300mm	100mm
	>300mm	300mm
Underside of solid fencing in relation where overland flow is to be accommodated	Any depth	100mm (min)

 # For the purpose of Clause 2.8.2 b) 'a dwelling room' is any room within or attached to a dwelling excluding a garage or shed.

*** Garages and sheds with floor levels set to these standards will not be permitted to be converted to dwelling rooms at any time in the future.*

2.10 Water Cycle Management

2.10

Water Cycle Management

Objectives:

- Ensure that water cycle management appropriately responds to site and water catchment conditions.
- Ensure that Water Sensitive Urban Design (WSUD) principles are incorporated into development.
- Retain and reinstate (where appropriate) the natural water course into stormwater management measures.
- Ensure that the development is protected from mainstream, local catchment and overland flow aspects of flooding.

2.10.1 Water Cycle Management

Design Requirements

a) A comprehensive Water Cycle Management Plan (WCMP) shall be prepared and submitted as part of a development application.

Note: Refer to Table 2.1 Thresholds for when a WCMP is needed.

Note: For requirements relating to the preparation of a WCMP refer to Volume 3.

Figure 2.10.1 - Example of a WSUD approach to water quality.

2.10.2 Stormwater

Design Requirements

a) All stormwater systems shall be sized to accommodate the 100-year ARI event (refer to Section 4 of Volume 3).

b) The design and certification of any stormwater system shall be undertaken by a suitably qualified person.

c) Water quality control structures shall be located generally off line to creek paths or other watercourses. Major detention storages shall not be located on areas of native vegetation or within riparian areas.

d) Development shall not impact on adjoining sites by way of overland flow of stormwater unless an easement is provided. All overland flow shall be directed to designated overland flow paths such as roads.

e) Safe passage of the Probable Maximum Flood (PMF) shall be demonstrated for major systems.

f) A treatment train approach to water quality shall be incorporated into the design and construction of major systems.

g) A major/minor approach to drainage is to be taken for stormwater flows. Generally the piped drainage system shall be sized to accommodate the difference between the 100-year ARI flow and the maximum safe overland flow, with minimum requirements as set out in section 4 of Volume 3.

h) Stormwater collected on a development site shall be disposed of (under gravity) directly to the street or to another Council drainage system/device. Where stormwater cannot be discharged directly to a public drainage facility, a drainage easement of a suitable width shall be created over a downstream property(s) allowing for the provision of a drainage pipe of suitable size to adequately drain the proposed development to a public drainage facility.

Note: Rubble pits and charged lines are not generally considered a suitable drainage solution.

i) All proposed drainage structures incorporated within new development shall be designed to maintain public safety at all times.

j) Development shall not result in water run-off causing flooding or erosion on adjacent properties.

k) Stormwater run-off shall be appropriately channelled into a stormwater drain in accordance with Volume 3.

l) Where applicable, the development shall incorporate the creation of an appropriate easement to manage stormwater in accordance with Volume 3.

Figure 2.10.2 - Water quality devices can improve water quality and give an important visual enhancement to a development area.

2.10.3 Stormwater Drainage

a) A stormwater Drainage Concept Plan shall be prepared by a suitably qualified person, and submitted with all development applications, involving construction (except for internal alterations/fitouts), demonstrating to Council how the stormwater will be collected and discharged from the site.

b) The stormwater concept plan shall include the following information as a minimum:

  i) locations layouts and sizes of stormwater pipes and pits;

  ii) minimum grades and capacity of stormwater pipes; and

  iii) existing and proposed easements, site contours and overland flow path/s.

2.11 Heritage Conservation

CAMPBELLTOWN CITY COUNCIL

Campbelltown (Sustainable City) Development Control Plan 2014

Volume 3

Engineering Design for Development

Creating Campbelltown's Future 2025

Campbelltown (Sustainable City) Development Control Plan 2009 Volume 2 Engineering Design for Development - June 2009 -

Table of Contents

CONTENTS **PAGE NO.**

4.6 Tailwater

Water surface level calculations are required to recognise the effect of any downstream controls due to the location of structures or known water surface levels, whether on the development site or external to the site.

For bridges, other structures crossing stormwater systems, and adjoining development the peak level from a hydraulic jump is to be extended upstream until it meets the normal flow profile.

For development adjoining the main stormwater system (Bow Bowing main channel or local creeks and rivers) the tailwater level used is to be a tailwater in the downstream system generated by a storm of the same recurrence interval as the design ARI for the development. *e.g. an industrial development adjoining Bow Bowing Main is to use a 10-*

year ARI backwater control from the main channel in the design of the minor system for the site and 100 Year ARI backwater control for assessment of the major system.

The following provides minimum levels to use on minor systems:

- for free outfall, adopt the pipe obvert;
- for discharge into receiving waters, adopt a tailwater equivalent to the design ARI flood level;
- for discharge into existing systems where the hydraulic grade levels are unknown, adopt a tailwater 150mm below the natural surface/invert of gutter.
- for discharge into a point designed to surcharge, adopt a tailwater level equivalent to the height of surcharge; and
- the tailwater level is not to be below pipe obvert.

Consideration will be given to accepting a lower starting level where this is supported by appropriate calculations demonstrating that this is suitable.

4.12 Minor System

The minor stormwater system is to be designed to accommodate the nominal flows identified in Table 4.5 below. The system may be required to accommodate higher flows if the major system cannot safely carry the difference between the 100 year ARI flows and the capacity of the minor system.

Table 4.5 Nominal Design ARI for the Minor System

{PRIVATE }LAND USE	A.R.I. (years)
Rural Residential	5
Urban Residential	5
Neighbourhood shopping centres	10
Industrial areas	10
Service trades areas	10
Low lying and flat residential areas	10
Town centres (Macarthur, Campbelltown & Ingleburn)	20
Major Shopping Centres	20
Major road crossings	20
Arterial Road crossings	100
Access to emergency facilities	100
Trunk stormwater facilities located in open space and drainage reserves ##	¼ to 5

the return period adopted will depend on adjoining land use, scour potential, public nuisance, safety and environmental considerations

4.13.1 PMF Requirements

The Probable Maximum Flood (PMF) is defined as the peak flood derived from routing the Probable Maximum Precipitation (PMP) through the stormwater system.

Safe passage of the PMF must be demonstrated on major systems.

Where there is risk to property and/or life it will be necessary to check the results for the Probable Maximum Flood (PMF). Where the PMF results in catastrophic failure or considerable damage then the design criteria is to take account of the risk and implement measures to eliminate or limit that risk. Such additional investigation is required in the following situations:

- Design of dam spillways;
- Design of detention basins;
- Adequacy of existing dam spillways;
- Major bridge design;
- Major release areas; and
- Major public infrastructure such as hospitals.

All developments must consider the impact of storms greater than the 100 year ARI event in terms of evacuation routes. No properties should be isolated or become islands in events greater than the 100 year ARI event. Flooding risks should increase incrementally, i.e. no small increase in runoff should generate major increases in affectation.

The methods set out in "The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method" published by the Commonwealth Bureau of Meteorology (June 2003, as amended) are to be used in the estimation of the PMP.

http://www.bom.gov.au/hydro/has/gsdm_document.shtml

4.13.4 Major Flows in Roadways

Major flows in the roadway are not to exceed the difference between the 100-year ARI flow and the capacity of the piped drainage system. Where safety criteria set out in Section 4.18 cannot be met the piped minor drainage system must be increased in size until such criteria are met.

e.g. The 100 year ARI flow at a specific location is 5 m^3/s. The development is in a residential area and the nominal capacity of the minor system as set out in Table 4.6 is 5 years. The peak 5-year ARI flow is 3 m^3/s. If the 2 m^3/s (5 m^3/s minus 3 m^3/s) are modelled down the roadway, a velocity depth product (VD) of 0.6 m^2/s is predicted. This is in excess of the limiting value set in Figure 4.12. If flows in the roadway are reduced to 1 m^3/s the value of VD becomes 0.4 m^2/s. The minor system must therefore be designed to accommodate 4 m^3/s.

Where roadways are used to convey major flows guidance given in Australian Rainfall and Runoff, Austroads and RTA publications are to be used where applicable in the design of these systems. Where major roadways are located upstream of urban areas with a lower standard of stormwater provision, special consideration must be given to the interface of these areas to ensure the objectives of each are met. This may result in an area being provided with a larger minor stormwater system than would otherwise be required.

Materials used in the construction of medians, paths, nature strips and the like should be able to withstand inundation at the anticipated velocities and recurrence intervals.

The need to provide ready discharge from road floodways at the low point or other relief points to remove water quickly and avoid ponding and the deposition of gravel and silt on the roadway, must be considered in the design.

Gutter flows on bus routes and distributor roads are to be limited to a maximum width of 2.0m and depth of 125mm.

Where other criteria regarding safety and velocity can be satisfied, the criteria given in Table 4.14 are to be used to determine the allowable flow in roads.

Table 4.14 Surface flow criteria for roads

Road	Criteria
Collector and arterial roads	One full lane in each direction clear
All locations	Depth < 50 mm above top of kerb

Cross Drainage

No water is to run off adjacent land (other than sheet flow) or adjoining roads onto major roads in floods of up to the 20-year ARI. Main stormwater facilities crossing the road alignment and serving catchments outside the road reservation are to be designed to take runoff of at least 20-year return frequency.

Bridges and other major drainage structures are to be designed to take flows of 100 years ARI with freeboard of 600mm. Afflux and hydraulic gradelines are to be determined in all cases. Consideration to the requirements of DIPNR and NSW Fisheries regarding these crossings are to be incorporated into the design.

Where surface flow crosses a major traffic route the flow is to be limited to a depth of 150mm and a length of 10m in floods of 100 year ARI.

Longitudinal Drainage

The design of longitudinal drainage within road reservations is to be adequate to maintain, in the 100-year ARI event, an unrestricted service on one lane of moving traffic (3.5m wide) in each direction on all roads with 2 or more lanes in each direction.

4.25 Climate Change

Climate change is occurring. Current predictions indicate that NSW will experience more intense rainfall with greater periods of dry weather between events. As such Council is requiring climate change to be considered for developments meeting any of the criteria below:

- Any industrial development ≥ 2500 m^2;
- Any commercial development ≥ 2500 m^2; and
- Residential development ≥ 10 lots.

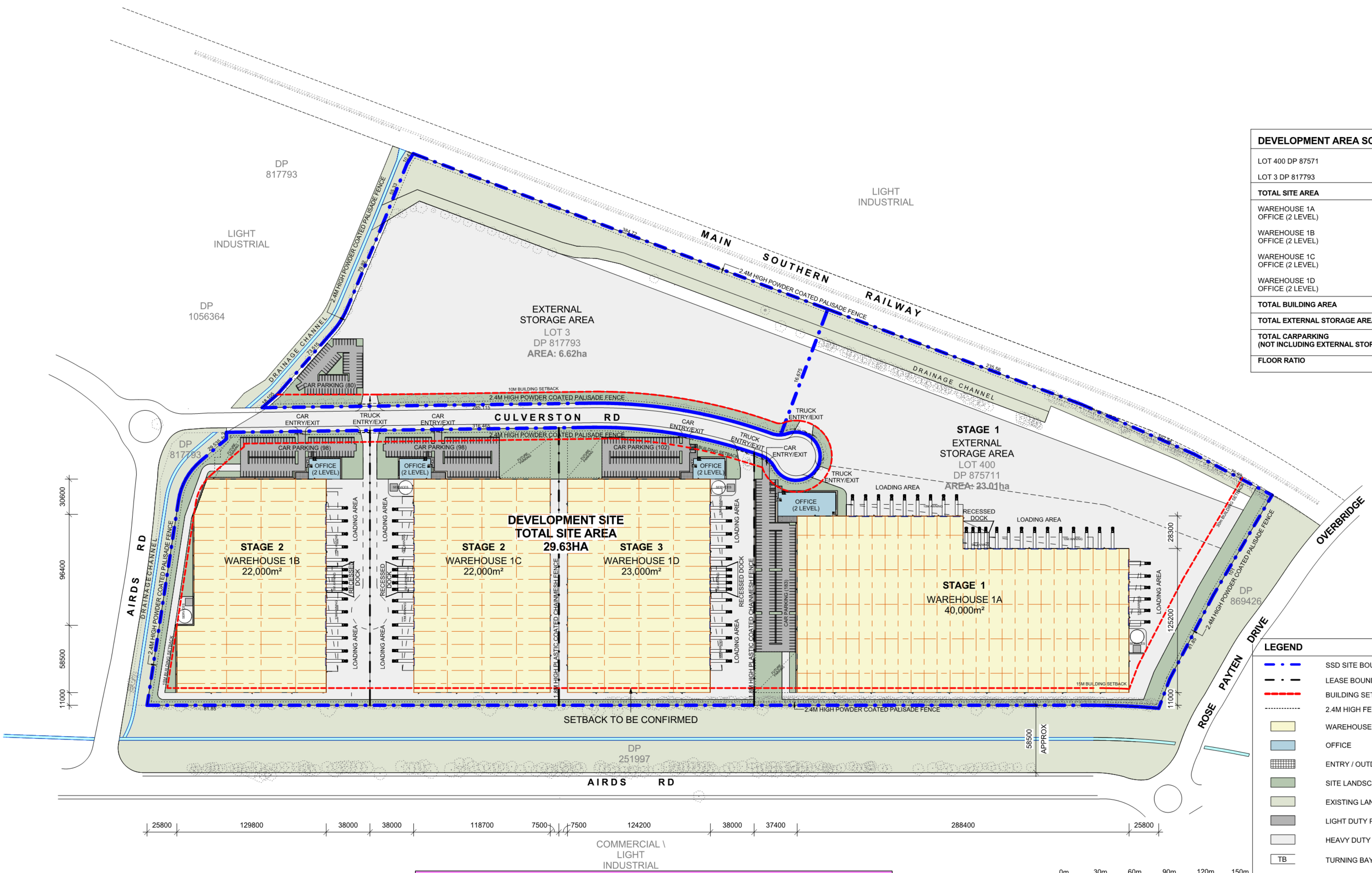
There are currently a range of possible climate change scenarios being proposed. Council requires assessment of the impacts on proposed and existing downstream development where the application meets the above criteria. The applicant is to examine the impacts of a 10% increase in all rainfall values in the rainfall hyetograph determined either from Australian Rainfall and Runoff or using the values in Appendix B of this DCP. This analysis is in addition to the analysis required using the standard values.

Council is not requiring that stormwater systems be designed to accommodate these increased flows unless the analysis shows a significant deficit in the stormwater system without augmentation to address climate change flows. Each application will be dealt with on a case by case basis.

APPENDIX C

Minto Warehouse and Logistics Hub Master Plan

(‘Minto Industrial Development’ Site Master Plan (Overall), Dwg No. 116001_A_SSD_A0006, Issue 5 22/04/16, prepared by Reid Campbell)



PRELIMINARY

This proposed concept design is subject to further detailed flood assessment.

DEVELOPMENT AREA SCHEDULE

LOT 400 DP 87571	23.01Ha
LOT 3 DP 817793	6.62Ha
TOTAL SITE AREA	**29.63Ha**
WAREHOUSE 1A OFFICE (2 LEVEL)	40,000m² 2,000m²
WAREHOUSE 1B OFFICE (2 LEVEL)	22,000m² 1,000m²
WAREHOUSE 1C OFFICE (2 LEVEL)	22,000m² 1,000m²
WAREHOUSE 1D OFFICE (2 LEVEL)	23,000m² 1,000m²
TOTAL BUILDING AREA	**112,000m²**
TOTAL EXTERNAL STORAGE AREA	**69,066m²**
TOTAL CARPARKING (NOT INCLUDING EXTERNAL STORAGE AREA)	**481**
FLOOR RATIO	**37.79%**

LEGEND

- SSD SITE BOUNDARY
- LEASE BOUNDARY
- BUILDING SETBACK
- 2.4M HIGH FENCE
- WAREHOUSE
- OFFICE
- ENTRY / OUTDOOR AREA
- SITE LANDSCAPE
- EXISTING LANDSCAPE
- LIGHT DUTY PAVEMENT
- HEAVY DUTY PAVEMENT
- TB TURNING BAY
- SECURITY SLIDING GATE

0m 30m 60m 90m 120m 150m

VISUAL SCALE 1:1500 @ A1

NOTE: ALL FFL LEVELS ± 500mm

Issue	Description	Date
1	REVISED MASTERPLAN	26/02/2016
2	DRAWING NUMBER CHANGED	07/03/2016
3	PRELIMINARY ISSUE	24/03/2016
4	CARPARK REVISED	20/04/2016
5	ISSUE FOR INFORMATION	22/04/2016

REIDCAMPBELL
Architecture, Interiors, Project Management
Level 15, 124 Walker Street
North Sydney NSW 2060 Australia
Tel: 61 02 9954 5011 Email: sydney@reidcampbell.com
Fax: 61 02 9954 4946 Web: www.reidcampbell.com

STATE SIGNIFICANT DEVELOPMENT

Client: QUBE

Managing Consultant: TACTICAL GROUP

Project: MINTO INDUSTRIAL DEVELOPMENT
LOT 400 DP 875711 AND LOT 3 DP 817793, 5-8 CULVERSTON ROAD, MINTO NSW

Drawn: BF Checked: JH Print Date: 4/22/2016 5:01:18 PM

Drawing Title: SITE MASTERPLAN (OVERALL)

Drawing Number: 116101_ A _SSD_A0006 Issue: 5

APPENDIX D

Flood Estimation Terminology

(Extract from Australian Rainfall and Runoff ‘Terminology Draft Discussion Paper’ ARR Website 18/06/2015)

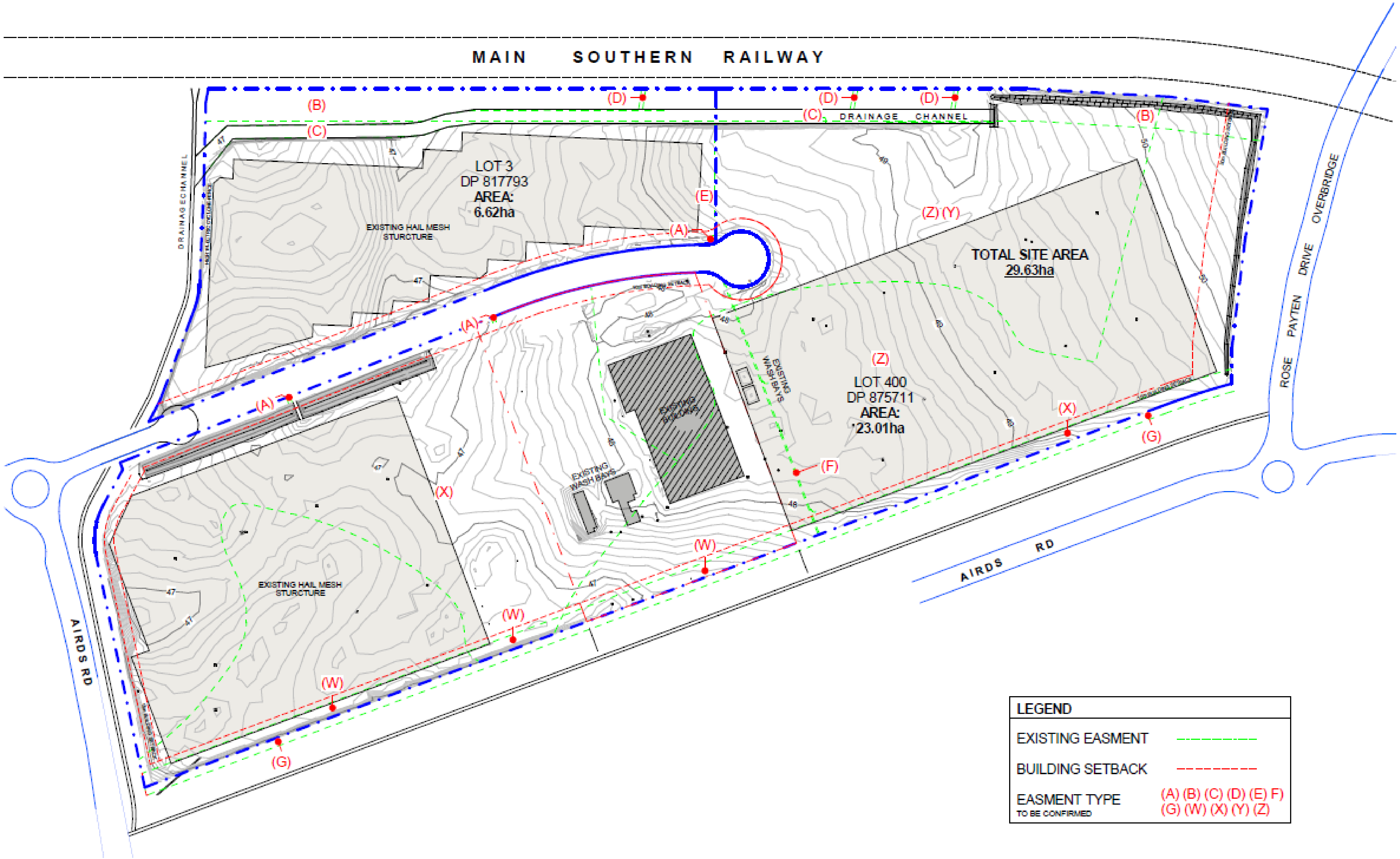
Table 1.1 Australian Rainfall and Runoff Preferred Terminology

EY	AEP (%)	AEP (1 in x)	ARI	Use
6	99.75	1.002	0.17	WSUD
4	98.17	1.02	0.25	
3	95.02	1.05	0.33	
2	86.47	1.16	0.50	
1	63.21	1.58	1.00	
0.69	50.00	2	1.44	Stormwater/pit and pipe design
0.5	39.35	2.54	2.00	
0.22	20.00	5	4.48	
0.2	18.13	5.52	5.00	
0.11	10.00	10	9.49	
0.05	5.00	20	20	Flooding
0.02	2.00	50	50	
0.01	1.00	100	100	
0.005	0.50	200	200	
0.002	0.20	500	500	
0.001	0.10	1000	1000	
0.0005	0.05	2000	2000	Limit CRC FORGE
0.0002	0.02	5000	5000	Extreme risk /Dams

DRAWINGS

(and aerial photo)

Aerial photo of Site (Google maps)



REIDCAMPBELL
Architecture, Interiors, Project Management
Level 15, 124 Walker Street
North Sydney NSW 2060 Australia

CONCEPT DESIGN

QUBE

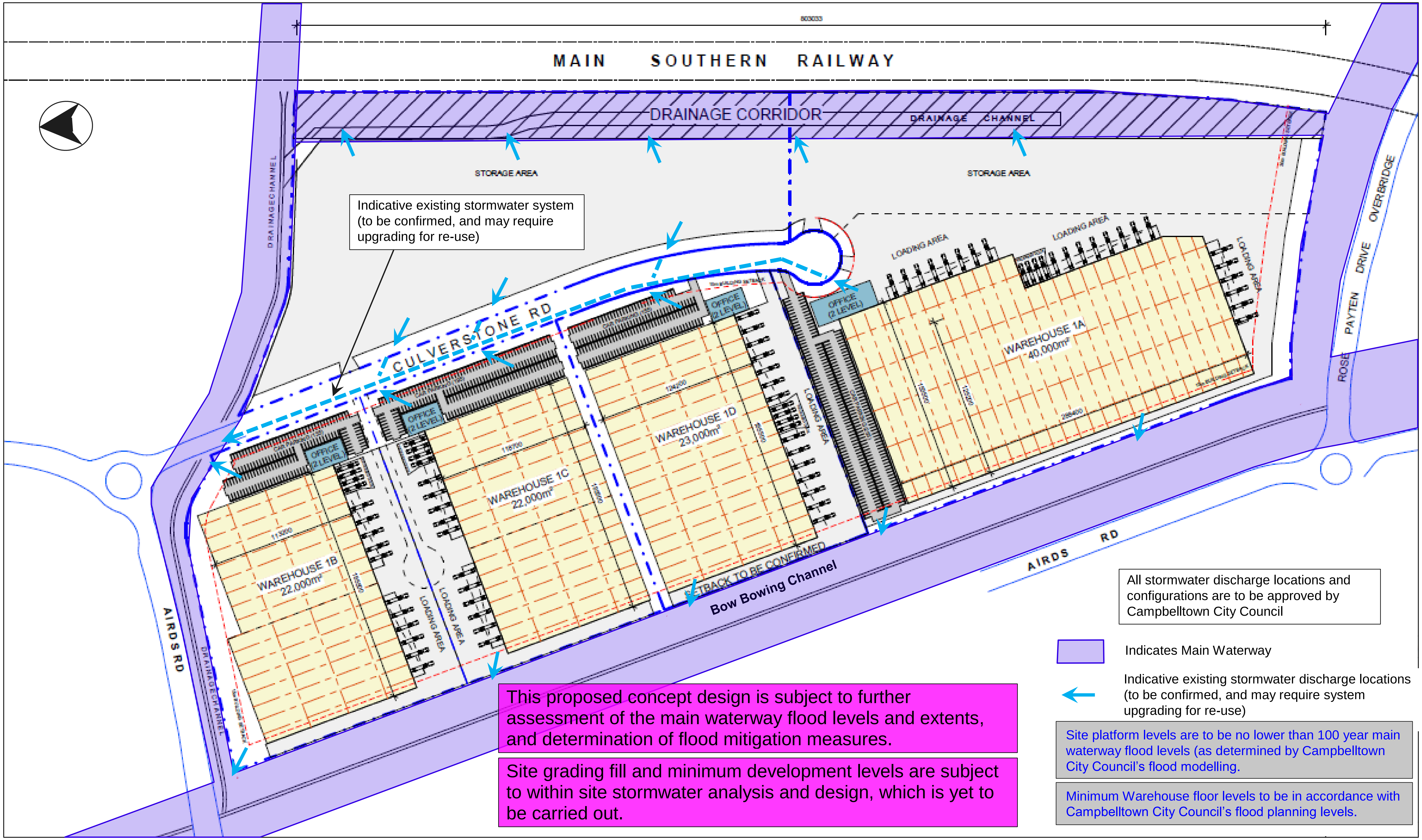
TACTICAL GROUP

MINTO WAREHOUSING DEVELOPMENT

Drawn	Checked	Print Date
MF	SK	1/2/2016 5:51:19 PM

EXISTING SITE

116001_A_SD_MP-00 A



Drainage Concept Plan