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FLOOD INVESTIGATION REPORT

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

Queensland Government

Approval no: DEV2018/987

Date: 12 November 2024

AURA BROOK

Prepared for **Stockland Development Pty Ltd**



Document information

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TABLE OF CONTENTS

EXECUTIVE SUMMARY 5

1 INTRODUCTION 6

1.1 Scope of this Report 6

2 BACKGROUND 7

2.1 Location 7

2.2 Previous/Ongoing Investigations 7

2.3 Report Reviews and Revisions 8

3 HYDROLOGICAL ANALYSIS 12

3.1 Land Use Assumptions 12

3.2 Catchment Delineation 12

3.3 Model Parameter Verification 13

3.4 XP-SWMM Design Model 17

4 HYDRAULIC ANALYSIS 21

4.1 Strategy 21

4.2 Hydraulic Objectives 21

4.3 Model Configuration 22

4.4 Model Scenarios 29

4.5 Sensitivity Events 30

4.6 Minimum Allotment Levels – WSL Results 31

4.7 1D Hydraulic Analysis 33

5 CONCLUSION 36

6 RECOMMENDATIONS 36

7 REFERENCES 37

8 DISCLAIMER 37

APPENDIX A: SITE LAYOUT 38

APPENDIX B: RATIONAL METHOD CALCULATIONS 39

APPENDIX C: TUFLOW MODEL CONFIGUARTIONS 40

APPENDIX D: CONCEPT DRAWINGS 41

APPENDIX E: FLOOD PLANS – DESIGN EVENTS 42

APPENDIX F: FLOOD PLANS – SENSITIVITY EVENTS 43

APPENDIX G: WATER SURFACE LEVEL RESULTS..... 44

APPENDIX H: 1D STRUCTURE RESULTS..... 45

TABLE OF FIGURES

Figure 1 - Site Location and Surrounding Area.....7
Figure 2 - Design Rainfall Depth by IFD.....17
Figure 3 - Analysis Locations for Critical Storms.....20
Figure 4 - TUFLOW Model Area.....23
Figure 5 – Major Hydrograph inflow locations.....24
Figure 6 - Simplified 1D Link Layout (Selected Locations).....34

EXECUTIVE SUMMARY

Egis Consulting Pty Ltd (previously Calibre Professional Services Pty Ltd) has been commissioned by Stockland Development Pty Ltd to prepare a Flood Investigation Report for part of Precincts 11, 12 and 14 of the Aura Development. The assessment has been focused on the design of the Aura Brook, major stormwater drainage throughout the Brook and determining adjacent minimum allotment levels.

The intent of the Aura Brook is to provide a channel for stormwater conveyance and provide a joint recreational space of benefit to the surrounding community with integrated water sensitive urban design devices. A system of water bodies are proposed to be located within the base of the channel. Paired with bioretention basins and wetlands, the lakes will provide community benefit through generating recreational interest around the water bodies and also work towards improving downstream water quality.

The aim of this report is to investigate flooding capacity of the Aura Brook and determine the minimum allotment levels of the surrounding lots. Through the use of a two-dimensional (2D) flood model using TUFLOW, this investigation has concluded the following:

- Water surface levels (WSL) throughout the Brook were determined for a range of design and sensitivity scenarios to determine capacity of the low flow channel and major stormwater infrastructure within the Brook
- As shown in **Section 4.6**, minimum allotment levels and minimum habitable floor levels were determined;
- A number of sensitivity scenarios have been addressed investigating the effects of increased vegetation and potential blockage of the culvert structures;
- The channel downstream of the CAMCOS rail line has capacity to convey up to and including the 1% AEP climate change storm event flows from the Brook to Bells Creek (South); and
- The low flow channel proposed along the extent of the Brook has sufficient capacity to convey the minor flows whilst maintaining 39% AEP flood immunity for the bioretention basin.

Further details in relation to the above outcomes are provided within the following report.

1 INTRODUCTION

Egis Consulting Pty Ltd (previously Calibre Professional Service Pty Ltd) has been commissioned by Stockland Development Pty Ltd to prepare a Flood Investigation Report for part of Precincts 11, 12 and 14 within the Aura development Priority Development Area (PDA). This document has been prepared to support the Reconfiguration of Lot (ROL) Development Approval (DA) for the aforementioned precincts.

The investigation presented in this report is focused on determining minimum allotment levels for Precincts 11, 12 and 14. Through the use of hydrological and 2D hydraulic modelling of a range of sensitivity and design scenarios to optimise the capacity and flow conveyance of the Brook and to set minimum allotment levels.

The major channel traversing Aura Precincts 11, 12 and 14 will herein referred to as the "Brook". Refer to **Appendix A** for the layout of the site.

1.1 Scope of this Report

The scope of this investigation includes the following:

- *Hydrological Modelling*: prepare and calibrate a hydrological model within XPSWMM to generate inflows for the hydraulic modelling. Undertake a comparison between different rainfall intensities and temporal patterns.
- *Hydraulic Investigation*: hydraulic analysis of the Brook was undertaken using the TUFLOW modelling software with the aim of detailing the following:
  - Determine the conveyance capacity and characteristics of the model;
  - Optimise the major culvert structures located throughout the channel;
  - Model water surface levels (WSL's) within the Brook for a range of design and sensitivity scenarios; and
  - Set minimum allotment levels.

The scope of this report is to focus on the trunk conveyance of flow through the Brook itself, modelling of detailed drainage networks feeding into the Brook will be completed during the respective detailed design phase for that network.

2 BACKGROUND

2.1 Location

The site is located within the Sunshine Coast Council (SCC) Local Government Area and the Caloundra South Priority Development Area (PDA).

The site is located approximately 8km south west of Caloundra's Main Street and is bounded by the Bruce Highway to the west, Bells Creek (North) to the north and Bells Creek (South) to the south.

An extract from Drawing No**. 18-000340-SK3100** attached in **Appendix A** is shown below identifying the extent of the Aura Brook.

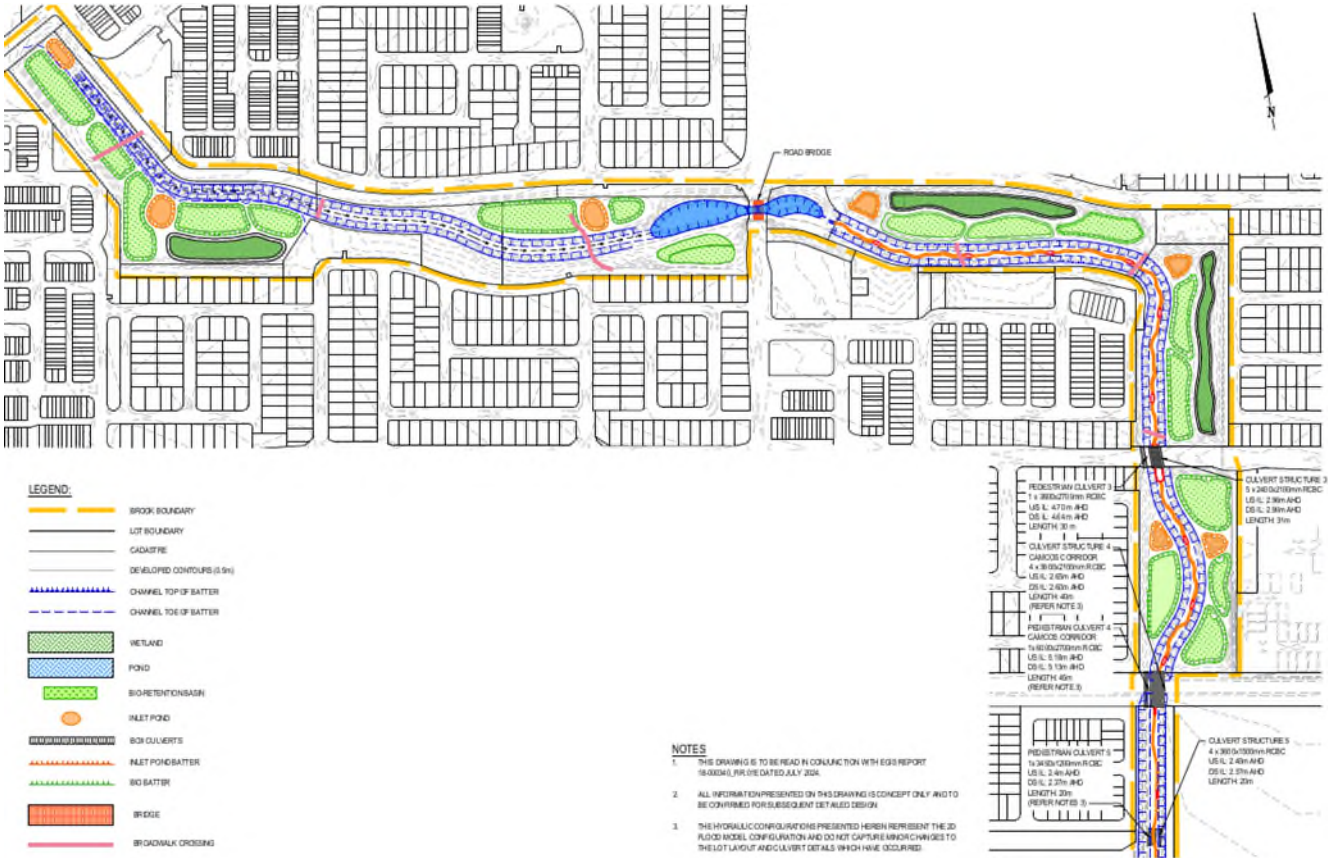


FIGURE 1 - SITE LOCATION AND SURROUNDING AREA

2.2 Previous/Ongoing Investigations

2.2.1 Aura Regional Flood Model – 2017 Revision – Addendum Report (BMT WBM 2017)

Regional flood modelling has been undertaken by BMT WBM to investigate the regional effects of the proposed development on regional flooding and to provide detention basin sizing for the development. This 2017 investigation was completed as an update to their previous investigation Caloundra South Development: Flood Risk Management Strategy (August 2015).

2.2.2 Ongoing Regional Flood Modelling being completed by BMT

BMT has undertaken and continues to undertake a number of flooding investigations as part of the broader Aura Flood Modelling Strategies to keep current and inform design. As part of this investigation, Egis was provided with maximum water height rasters for the regional flood model detailed in the BMT WBM 2017 report, which included both ARR2019 hydrology and a 50m span Road bridge. These results were provided to be consistent with the ARR2019 methodology adopted for the Brook and were subsequently used to derive model tailwater conditions as described in Section 4.3.6.

2.2.3 Aura Flood Risk Management Report 2020 (BMT 2020)

BMT has undertaken numerous flooding assessments over the past 10 years to support the proposed mixed-use development for the development site (Aura site) and its Priority Development Area (PDA). The previous assessments were undertaken to support EPBC Act, Material Change of Use (MCU) and previous Reconfiguration of Lot (RoL) approvals elsewhere in the PDA, as well as to inform the design of the proposed development. The work documented in the BMT 2020 report builds on the previous work in support of a RoL application for precincts 11,12 and 14.

The Caloundra South: Updated Flood Risk Management Strategy 2018 Final Report (BMT, 2018) is the latest approved report, and the BMT 2020 report constitutes an updated version which includes additional proposed design across the Aura site.

2.3 Report Reviews and Revisions

2.3.1 Revision B – 9 August 2019

Revision B of this report dated 9 August 2019 was prepared in support of a Priority Development Area (PDA) development application (ref: DEV2018/987) submitted by Stockland Development Pty Ltd to Economic Development Queensland (EDQ) for a preliminary review by the Minister for EDQ. Subsequent to this preliminary review, the Minister identified further issues which are detailed in two 'Further Issues' letters prepared by EDQ to Stockland dated 10 December 2019 and 23 December 2019.

Further to the Minister's preliminary review, EDQ commissioned Jacobs Group (Australia) Pty Ltd to undertake a peer review Calibre's revision B of this report. Jacobs' peer review is detailed in their report Aura Stormwater Investigations for Precincts 11, 12 and 14 – Peer Review (ref: IH169500-101-CH-001), dated 10 September 2019.

As mentioned in EDQ's Further Issues letter on 23 December 2019, there has been correspondence between Jacobs and Calibre regarding the Stormwater documentation that was submitted as part of the PDA development application. A number of matters were resolved; however, there were a number of outstanding 'Further Issue' items outstanding.

2.3.2 Revision C – 30 June 2020

In order to address the conditions of the Preliminary approval and Part Approval for Operational work for Waterway barrier works decided by the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP), dated 28 February 2019 (ref: 1710-2004 SDA), special consideration for fish passage is required in the design and modelling methodology for the proposed culvert structures. Provisions such as internal baffles, embedment depth, culvert length and gradient have been incorporated into the TUFLOW model for 1D elements.

Revision C of this report dated 30 June 2020 was prepared to address the following:

- 'Further Issues' items raised by EDQ pertaining to the Aura Brook Flood Investigation in their 10 December 2019 letter to Stockland;
- Peer review items raised by Jacobs' August 2019 report, and subsequently tabled in EDQ's 23 December 2019 letter to Stockland; and
- Conditions of Preliminary Approval and part approval pertaining to fish passage requirements for the proposed culvert structures, which are deemed Waterway barrier works by DSDMIP.

As such, the structure and methodology of the earlier revisions of this report were generally maintained, but sections were added or amended to comply with the latest subdivision layout, bulk earthworks and the aforementioned approval items by various statutory authorities and peer reviewers.

2.3.3 Revision D – 09 March 2021

2.3.3.1 Condition 33 of PDA Decision Notice dated 9 February 2021

Subsequent to Stockland's submission of Revision C of this report to EDQ for review, the Minister for EDQ granted development approval subject to development conditions set out in the PDA decision notice dated 9 February 2021 (ref: DEV2018/987). This Revision D report has been prepared to address Conditions 33 of that PDA decision notice. For ease of reference, Condition 33 is reproduced in indented italicised text below, followed by Calibre's response with references to the Sections of this report that have been updated to address them.

33. Aura Brook Flood investigation Report – Compliance Assessment
Submit to EDQ TS for compliance assessment, an addendum to the Aura Brook Flood Investigation Report dated 30 June 2020 and prepared by Calibre to reflect the changes made by the letter report prepared by Calibre 17 000934.3015RFI01.LM.rl dated 23 July 2020, the Technical Memorandum 17-000934.3015TM03.AM.rl dated 10 December 2020 prepared by Calibre, and any other approved changes.

The changes described in Calibre's letter report 17 000934.3015RFI01.LM.rl dated 23 July 2020 were captured in the previous Revision C of this report. As such, no further changes to this Revision D report are required to accord with 17 000934.3015RFI01.LM.rl dated 23 July 2020.

Calibre's Technical Memorandum *17-000934.3015TM03.AM.rl* dated 10 December 2020 was undertaken to provide additional information following the EDQ Further Issues letter dated 3 December 2020 and Lot Layout Changes Request dated 30 November 2020. This Revision D report contains amendments to **Section 4.6** and the addition of **Section 4.7** to capture the further analysis that was detailed to address Items 90, 91, 92 and 93 of the Technical Memorandum *17-000934.3015TM03.AM.rl* pertaining to flood hazard, 1d modelling results and the DFE.

2.3.3.2 Review of Tailwater Conditions derived from BMT Regional Flood Model

Revision D report included a review of the BMT 2020 report (described in **Section 2.2**) and the resultant maximum water height rasters from BMTs 2020 regional flood model received by Calibre on 3 February 2021. A comparison of these 2020 model rasters against previously provided 2017 model rasters and a discussion of adopted tailwater conditions for this investigation are provided in **Section 4.3.6.1**.

2.3.3.3 Aura Brook and Banya Avenue Pedestrian Connections

During discussions with EDQ Officers, details were requested concerning pedestrian connections between Aura Brook and Banya Avenue. In response to these requests in formal EDQ Engineering Comments dated October 2020 and a subsequent layout change, Calibre provided Technical Memorandum *17-000934.3015TM02.AM.rl* dated 11 November 2020. Calibre subsequently prepared more detailed plans indicating the concept design of pedestrian paths along the lower portion of Aura Brook. These concept designs were provided in Technical Memorandum *17-000934.3015TM02.AM.rl* which included pedestrian culvert configurations at Baya Avenue (designated Culvert Structure Group 3 in this report) and the CAMCOS crossing (designated Culvert Structure Group 4 in this report) detailed on Calibre Drawings 17-000934.3015-SK2001 and SK2014, with reference to 17-000934.3015-SK123.

The hydraulic modelling of 1d culvert structure groups is detailed in **Section 4.3.7**. The invert levels for the pedestrian culverts modelled for this investigation are not consistent with the pedestrian culvert invert levels detailed for Banya Avenue on Calibre Drawing 17-000934.3015-SK2014 and for the Ultimate CAMCOS crossing on Calibre Drawing 17-000934.3015-SK123. A comparison of the pedestrian crossings represented as 1D model elements and the updated design presented on the Calibre Drawings is provided in **Table 1** below.

TABLE 1 - UPDATED DESIGN OF PEDESTRIAN CROSSING INVERTS				
1D MODEL ELEMENT ID	CROSSING NAME	MODELLED HYDRAULIC INVERTS (US/DS)	AS DESIGNED INVERTS (US/DS)	EGIS DRAWING REFERENCE
Culv3_PED	Banya Avenue Pedestrian Crossing	5.39 / 5.33 (mAHD)	4.75 / 4.65 (mAHD)	17-000934.3015-SK2014
Culv4_PED	Ultimate CAMCOS Pedestrian Crossing	5.18 / 5.13 (mAHD)	3.68 / 3.63 (mAHD)	17-000934.3015-SK123

The design iterations that have occurred subsequent to the hydraulic modelling undertaken in this flood investigation have resulted in lower 'as designed' Pedestrian Crossings along the Brook that what has been modelled. It is expected that the higher modelled culvert inverts will result in conservatively higher flood depths through the Brook than the 'as designed' configuration. As such, the flood modelling presented in this investigation is considered appropriate for the application in the context of this report. Further modelling and analysis will be undertaken during future Compliance Assessment to ensure flooding conditions represented through modelling align with the 'as designed' conditions.

2.3.3.4 Updated Lot Layout

A minor change to the overall lot layout was made after the modelling presented in this Revision D report was completed. As such, Drawings 18-000340-SK3100, SK3101 and SK3102 presented in figures and appendices within this report have not been updated to reflect the latest lot layout at the date of issuing this report. The updated lot layout will not materially change the outcome of this flooding investigation and therefore no update to the flood model has been undertaken. Any minor discrepancies in catchment parameterisation associated with the minor lot layout changes will be updated as part of future modelling to address Compliance Assessment as per the development conditions set out in the PDA decision notice dated 9 February 2021 (ref: DEV2018/987).

2.3.4 Revision E – July 2024

Revision E of this report dated July 2024 was prepared to document all changes to the XP-SWMM and TUFLOW flood model undertaken to align the flood model with the current design iteration of civil design for Aura Development Precincts 11, 12 and 14.

This report incorporates the updates detailed within the Calibre Addendum to Aura Brook Flood Investigation Report, Revision D (18-000340-TM06A dated 25 November 2021). These updates included modifications to Culvert Structure Group 3 invert levels and the layered flow constrictions for the boardwalk structures. This report also includes model updates detailed within the Egis P15 East Stormwater Management Plan, Revision C (17-000934-3058-SWMP01C dated 16 June 2024). This plan addressed the inclusion of Culvert Structure Group 5 which facilitates a second emergency evacuation route.

Additional changes to the 1d XP-SWMM model and 2d TUFLOW flood model have been undertaken to further align the models with ongoing civil designs and are as follows:

- Through discussions with Stockland and iterative testing, the channel design was modified to remove portions of the lake design along the channel. The lake underneath the road bridge has remained within the design and the overall channel upstream of the bridge being lifted. Thus, the design DEM modelled has been updated to align with the latest channel design.

- Progressive civil design of Precincts 11, 12 and 14 including lot layout changes, resulted in catchment updates and respective land use amendments. In correspondence, updates were required to the hydrology of the Aura Brook, thus amendments were made to the 1d hydrological model and respective inputs for the 2d hydraulic model.
- Egis have undertaken a review of the updated approved BMT 2024 maximum water height rasters from BMTs regional flood model, received by Egis on 6 February 2024. The previously adopted tailwater levels derived from the BMT 2017 report were compared with the 2024 regional flood modelling received from BMT on 6 February 2024 with the 2d model boundary conditions updated accordingly. This is detailed further in **Section 4.3.6.**

As such, the structure and methodology of analysis and reporting remained consistent with previous iterations of this investigation, with results and sections amended as necessary.

3 HYDROLOGICAL ANALYSIS

Hydrological analysis of the developed catchments discharging to the Aura Brook has been undertaken to generate inflow hydrographs for the hydraulic model. The hydrological analysis was undertaken using XPSWMM modelling software. Catchments were delineated to ensure accurate water surface levels and flows at the key infrastructure and channel elements.

As identified by BMT, the Bells Creek Catchment does not contain sufficient gauge data for calibration. Therefore, the XPSWMM hydrological model has been calibrated against peak flow results calculated through the Rational Method. The Rational Method is no longer supported in the Australian Rainfall and Runoff guideline 2019 (ARR 2019). However, its use is still supported in Queensland Urban Drainage Manual 2017 (QUDM 2017) and is a requirement of the SCC Planning Scheme (SC6.14.3.9 (21)). This is also a common undertaking within the Sunshine Coast Area.

It is noted that the requirements for peak flow mitigation has been addressed by BMT within their regional flood modelling.

3.1 Land Use Assumptions

Fraction impervious values have been determined based on the lot density for each catchment and the expected land use breakdown as per Calibre **Drawing No. 18-000340-SK3102 in Appendix D**. To ensure consistency with the previous analysis undertaken for the Aura Master Plan development and regional flooding analysis, land use fraction impervious values have been adopted in accordance with Calibre's Concept Stormwater Management Plan (Internal Conveyance) Report and BMT WBM's Aura Regional Flood Model – 2017 Revision Addendum Report. Refer to **Table 2** for the land use fraction impervious values adopted and **Table 3** for the catchment parameters for fraction impervious.

TABLE 2 - LAND USE FRACTION IMPERVIOUS

LAND USE	PERCENTAGE IMPERVIOUS (%)
Commercial/Industrial	90
Urban/Retirement Living	90
Emerging Community	90
Schools	80
Community Facilities	70
Low and Medium Density Residential	80
High Density	90
Parks	5
Open Space & Sports Fields	0

3.2 Catchment Delineation

Catchments were delineated based upon the site layout, preliminary bulk earthworks design, concept drainage and discharge locations to the Brook as at the time of preparing Revision E of this report (refer to **Section 2.3.4** and the Site Layout plan presented in **Appendix A**). The catchment delineation adopted in the XPSWMM model is detailed on Drawing No. **18-000340-SK3101** in **Appendix D** and summarised in **Table 3** below.

TABLE 3 - CATCHMENT PARAMETERS		
CATCHMENT LABEL	AREA (HA)	FRACTION IMPERVIOUS (%)
B1	28.71	47%
B2A	6.13	83%
B2B	0.85	70%
B2C	3.42	85%
B3	6.66	78%
B4	17.95	78%
B5A	6.90	80%
B5B	4.10	80%
B6A	18.78	78%
B6B	15.32	62%
B7	10.68	78%
B8A	12.51	77%
B8B	14.01	53%
B8C	6.45	72%
B9A	4.35	80%
B9B	4.83	84%
B10	12.28	75%
B11	9.90	1%
B13	7.39	9%
B15	2.92	4%
B16	3.46	12%
B17	8.57	13%
B18	1.94	0%

3.3 Model Parameter Verification

A XPSWMM 1D model was configured to simulate the hydrology for the site under developed conditions. To confirm the hydrology model's suitability for purpose it was compared to the Rational Method. This verification has been updated to align with the latest catchment updates and updated ARR 2019 rainfall data. Refer to **Appendix B** for Rational Method calculations.

3.3.1 Verification Model Rainfall

The calibration originally undertaken to develop the Rational Method itself was undertaken using hydrologic modelling which was set up using (now superseded) ARR 1987 rainfall intensities. For this reason, the rainfall adopted within the XPSWMM verification model has been updated to adopt the current ARR 2019 rainfall intensities and ensemble temporal patterns aligning with the critical storm analysis undertaken in **Section 3.4**.

3.3.2 Rational Method Peak Flow Estimation

To verify the XPSWMM model configuration, Rational Method calculations have been undertaken for three (3) catchments identified as Catchment B4, B5A and B7, as shown on Drawing No. **18-000340-SK3101** in **Appendix D**. The catchments chosen to verify the hydrological model were chosen for their large size and flow path length, furthermore they provide a good representative sample of the overall investigation area.

For the detailed Time of Concentration and peak flow calculation, refer to the Rational Method calculations provided in **Appendix B**. A summary of the peak flows determined for the verification are summarised in **Table 4.**

TABLE 4 - RATIONAL METHOD PEAK FLOWS

AEP	CATCHMENT B4 (M^3/S)	CATCHMENT B5A (M^3/S)	CATCHMENT B7 (M^3/S)
63%	2.26	1.14	1.62
39%	2.98	1.50	2.13
18%	4.06	2.05	2.90
10%	4.89	2.46	3.50
5%	5.88	2.94	4.17
2%	7.50	3.73	5.32
1%	8.43	4.17	5.95

3.3.3 Infiltration Losses and Lag Parameter Value

In order to achieve an acceptable correlation between the XPSWMM model (Laurenson's Method) to the Rational Method, differing parameters were adopted for the major and minor exceedance probabilities. A range of Initial and Continuing Loss values were trialled to achieve a close correlation of the XPSWMM model against the Rational Method calculation presented in **Section 3.3.2**. The verified XPSWMM parameters which achieve the closest correlation are presented in **Table 5** below.

TABLE 5 - XPSWMM VERIFIED PARAMETERS

XPSWMM MODEL PARAMETER	MINOR (63%-5% AEP)	MAJOR (2%-0.05% AEP)
Pervious Area – Initial Loss (mm/hr)	35	35
Pervious Area – Continuing Loss (mm/hr)	5	5
Impervious Area – Initial Loss (mm/hr)	1	1
Impervious Area – Continuing Loss (mm/hr)	0	0
BX Factor	1.5	1.5

The configuration was verified by comparing peak flows generated by the XPSWMM model and the Rational Method calculations for sub-catchments B4, B5A and B7. Catchments B4, B5A and B7 are proposed as primarily residential land use and are typical of other sub-catchment areas surrounding The Brook. The verification was conducted for the 63% AEP to 1% AEP storm events using ARR 2016 Bureau of Meteorology (BOM) IFD data for the site location.

It is noted that a comparison of the results of the Regional Flood Frequency Method (RFFE) analysis was considered unsuitable for application to the highly urbanised catchment proposed for the Developed Scenario. Furthermore, the ARR Data Hub (*https://data.arr-software.org/*) identifies a rural initial loss of 27mm with a continuing loss of 2.7mm/hr for the site. A comparison of the results of a hydrological analysis in XPSWMM adopting the ARR Data Hub values found peak runoff to be lower when adopting the ARR Data Hub values. Therefore, since the infiltration parameters presented in **Table 5** provide a higher minimum lot level, these values were considered to be more justifiable for the application.

3.3.4 Verification Result Comparison

Adopting the above verification parameters, the peak flow relationships from the XPSWMM model was amended to more closely represent the peak flow characteristics estimated using the Rational Method. The XPSWMM peak flows are representative of the critical duration and temporal pattern for each storm event as derived by the critical storm analysis methodology outlined in **Section 3.4.2**. The resulting verification results are provided below in **Table 6, Table 7** and **Table 8.**

TABLE 6 - CATCHMENT B4 CALIBRATION VERIFICATION

MODEL CONFIGURATION	AEP	RATIONAL METHOD	XPSWMM	DIFFERENCE	AVERAGE
Minor Storm Events	63	2.26	3.379	49%	Excluded
	39	2.98	4.209	41%	24%
	18	4.06	5.116	26%	
	10	4.89	5.879	20%	
	5	5.88	6.705	14%	
Major Storm Events	2	7.50	7.827	4%	4%
	1	8.43	8.695	3%	

TABLE 7 - CATCHMENT B5A CALIBRATION VERIFICATION					
MODEL CONFIGURATION	AEP	RATIONAL METHOD	XPSWMM	DIFFERENCE	AVERAGE
Minor Storm Events	63	1.14	1.587	40%	Excluded
	39	1.50	1.976	32%	18%
	18	2.05	2.402	17%	
	10	2.46	2.791	13%	
	5	2.94	3.183	8%	
Major Storm Events	2	3.73	3.693	-1%	-1%
	1	4.17	4.098	-2%	

TABLE 8 - CATCHMENT B7 CALIBRATION VERIFICATION					
MODEL CONFIGURATION	AEP	RATIONAL METHOD	XPSWMM	DIFFERENCE	AVERAGE
Minor Storm Events	63	1.62	2.302	42%	Excluded
	39	2.13	2.868	35%	20%
	18	2.90	3.486	20%	
	10	3.50	4.055	16%	
	5	4.17	4.625	11%	
Major Storm Events	2	5.32	5.409	2%	1%
	1	5.95	6.013	1%	

Due to the hydrological models tendency to overestimate flows for the 63% AEP event it has been excluded from the verification process.

The results presented above show a tight calibration for the major design events. Due to the differences between the two runoff estimation approaches a calibration within 5% for all catchments were unable to be achieved for the minor events with such large catchments. However, the above calibration is considered to be acceptable for the following reasons:

- The purpose of this investigation is to detail the flows through the channel and the major infrastructure to set allotment levels. These outputs are dependent on the major design events which are achieving a close calibration.
- The minor events will be modelled in a conservative manner and will not affect how the minimum lot levels are set.

3.4 XP-SWMM Design Model

3.4.1 Design Rainfall Depths

Design rainfall Intensity-Frequency-Duration (IFD) data and temporal pattern ensembles were obtained via the ARR Data Hub for the study area. The design rainfall depths for each standard storm duration and AEP are presented in **Figure 2**.

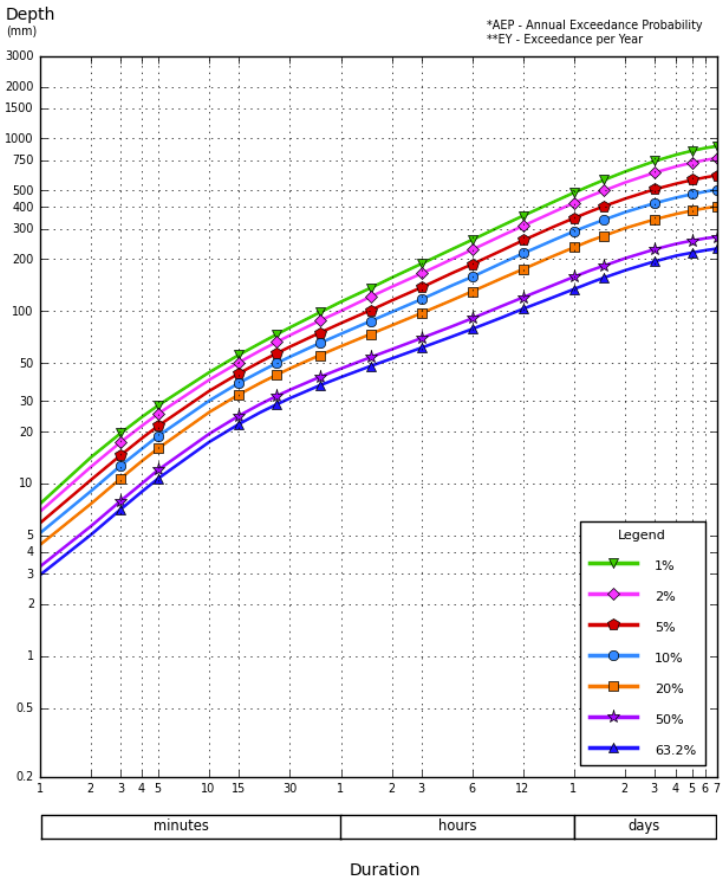


FIGURE 2 - DESIGN RAINFALL DEPTH BY IFD

3.4.2 Critical Duration and Temporal Patterns

Ensembles containing ten different storm temporal patterns were obtained from the AR&R Data Hub. Temporal patterns define the time-varying distribution of rainfall for the storm duration, which varies depending on the duration and AEP of the design storm event. Temporal pattern ensembles were loaded into the XP-SWMM model for each design AEP event for the following standard storm durations:

- 10 minute
- 15 minute
- 20 minute
- 25 minute
- 30 minute
- 45 minute
- 1 hour
- 1.5 hour
- 2 hour
- 3 hour

In order to reduce the number of 2D simulation undertaken in TUFLOW a 1D fast model was first constructed within XPSWMM. Through the benefit of reduced run times in the 1D model all model simulations were able to be first run and identify which critical durations and temporal patterns were necessary to progress through to 2D modelling in TUFLOW.

The following methodology was applied in accordance with AR&R 2019 to ascertain the design flow hydrograph to be adopted in the hydraulic modelling;

- For each 1D link, take the average of 10 peak flow rates corresponding to each temporal pattern (TP);
- Select the storm duration that produces the maximum average peak flow and adopt as the critical duration for each link;
- For each link select the temporal pattern that produces the median peak flow rate as the critical temporal pattern for that link;
- Tabulate the selected critical storms for each link by critical duration and temporal pattern for each AEP event (refer); and
- Use best engineering judgement (as detailed below) to select which critical storms hydrographs to simulate in the hydraulic model.

For the purposes of this assessment, each of the critical storms were selected for input into the hydraulic model for each AEP (48 simulations total). The critical storms adopted for the hydraulic analysis are summarised in **Table 9** and **Table 10**, below.

TABLE 9 - CRITICAL STORMS BY ANALYSIS LOCATION FOR 39% AND 18% AEP STORMS

ANALYSIS LOCATION	39% AEP		18% AEP		RATIONALE FOR SELECTED LOCATION
	CRITICAL STORM	PEAK FLOW	CRITICAL STORM	PEAK FLOW	
Link 20	10 min TP 1	2.641	15 min TP 6	3.253	Uppermost reach of Brook
Link 21	30 min TP 9	6.065	30 min TP 5	7.395	Pinch point along upper reach
Link 22	30 min TP 9	10.057	15 min TP 1	11.914	Immediately upstream of road bridge
Link 24	30 min TP 7	13.637	30 min TP 9	17.165	90 degree bend in Brook causing super-elevated flow
Link 44	30 min TP 5	15.015	1 hr TP 9	20.881	Immediately upstream of Culvert 3
Link 26	1 hr TP 4	14.081	1 hr TP 7	18.946	Immediately upstream of Culvert 4 (CAMCOS)

TABLE 10 - CRITICAL STORMS BY ANALYSIS LOCATION FOR 1% AND 1% CLIMATE CHANGE AEP STORMS

ANALYSIS LOCATION	1% AEP		1% AEP CC*		RATIONALE FOR SELECTED LOCATION
	CRITICAL STORM	PEAK FLOW	CRITICAL STORM	PEAK FLOW	
Link 20	10 min TP 6	4.731	15 min TP9	6.034	Uppermost reach of Brook
Link 21	25 min TP 9	12.340	25 min TP 4	14.862	Pinch point along upper reach
Link 22	25 min TP 4	20.612	25 min TP 4	24.488	Immediately upstream of road bridge
Link 24	45 min TP 6	30.725	45 min TP 2	34.550	90 degree bend in Brook causing super-elevated flow
Link 44	45 min TP 2	36.365	30 min TP 8	42.273	Immediately upstream of Culvert 3
Link 26	1.5 hr TP 5	32.819	1.5 hr TP 5	37.753	Immediately upstream of Culvert 4 (CAMCOS)

*Climate change scenario for a year 2100 climate

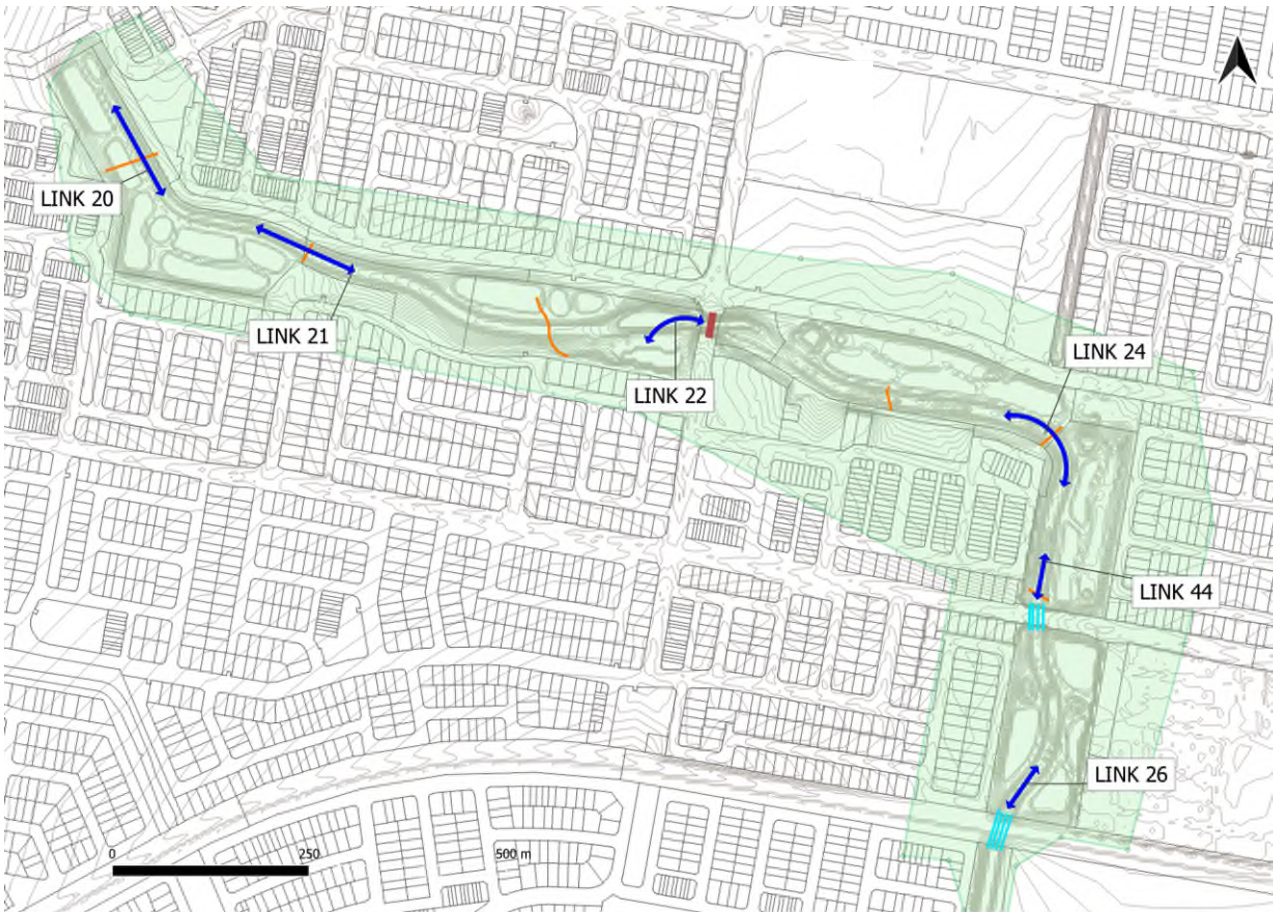


FIGURE 3 - ANALYSIS LOCATIONS FOR CRITICAL STORMS

3.4.3 DIS Rainfall Scenarios

The above ARR 2019 methodology is the adopted method for all design elements including identifying minimum lot levels. As a sensitivity however a duration independent storm (DIS) rainfall methodology was modelled.

DIS events were run for the following AEP events:

- 1% AEP + Climate Change; and
- 0.05% AEP + Climate Change.

4 HYDRAULIC ANALYSIS

4.1 Strategy

The aim of this investigation is to analyse the concept channel design, determine the conveyance capacity of the channel/major stormwater infrastructure and to set minimum allotment levels. This analysis has been undertaken using the TUFLOW modelling software to provide accurate results through the Brook while incorporating the relevant aspects of the regional flood analysis.

The Brook has been designed to serve a variety of different purposes for the development with approximately eighteen (18) bioretention basins to mitigate the increase in pollutants generated from the site, (3) online wetland and recreational spaces. A minor flow channel runs along the full length of the Brook connecting one (1) proposed lakes. The minor flow channel has been designed to ensure the bioretention basins have 39% AEP flood immunity.

The Brook is traversed by two (2) road crossings and the Caboolture to Maroochydore Corridor Study (CAMCOS) railway line. In addition to this, six (6) pedestrian boardwalks have been modelled within the Brook. To ensure stormwater remains unimpeded by these crossings, three (3) major culvert structures and one vehicle bridge are proposed to convey flows. During the construction phase, the CAMCOS railway corridor is likely to be used as a haul road which will traverse the Aura Brook channel via a bed level crossing (or similar, to be confirmed). As such, the channel only will be built through to Bells Creek (South) during this interim phase of works.

The proposed culvert structure at the CAMCOS corridor (designated Culvert Structure 4) represents the possible configuration of the Brook in the 'ultimate design' scenario, which will result in a constriction to flows through the Brook. The losses through this proposed culvert structure will result in headwater that will raise the upstream water surface levels through the Brook, and therefore the minimum allotment levels. As such, this preliminary crossing has been included within this analysis to present a possible ultimate design scenario and future-proof the analysis to demonstrate that future railway works will not be critically restricted by the proposed allotment levels. Importantly, the final sizing of these culverts (or bridge) is the responsibility of the future railway designer and will require additional flood modelling by them to ensure they're not reducing freeboards to the surrounding properties.

During the interim phase, while the CAMCOS corridor facilitates a haul road, unimpeded flow across the haul road will result in lower WSLs through the upstream development. Analysis of this interim scenario has therefore been omitted from this analysis. Further analysis to ensure flooding conditions are not exacerbated by the proposed haul road configuration will be undertaken with future design works. The ultimate and interim phase configurations at the CAMCOS corridor are depicted on Drawing Numbers 17-000934-3015-SK123 and 17-000934-3015-SK123B, included as part of the DA submission.

For the purpose of detailing the minor flow conveyance through the Brook and setting minimum allotment levels, the following analysis has been undertaken for the 39% AEP and 1% AEP Climate Change storm events and the sensitivity scenarios documented in **Section 4.5** below. All remaining storm events are not considered to be relevant to achieve the outcomes of this investigation.

4.2 Hydraulic Objectives

The following hydraulic objectives have been the focus of design for the following TUFLOW model.

4.2.1 Residential Lots Adjacent to Open Channels

In order to maintain consistency with the design standards of the wider regional flood modelling undertaken by BMT in *Aura Regional Flood Model – 2017 Revision – Addendum Report* (2017) a freeboard of 350mm from the defined flood event (DFE) to the lot has been adopted. Given the Brook acts to provide local drainage for the adjacent areas a freeboard of 300mm would generally only be required in accordance with QUDM. Therefore, the adoption of 350mm freeboard to lots is considered conservative.

Also, in accordance with the design standards set out by BMT, the adopted freeboard to the minimum habitable floor level is to be set 500mm above the DFE.

4.2.2 Culvert Design

Sunshine Coast Regional Council Stormwater Guidelines (Schedule 6 2014, p SC6-200) identifies the design immunity for urban drainage to be in accordance with QUDM.

QUDM (2017) Table 7.3.1 identifies the following design criteria for cross drainage (culverts) based upon the Average Annual Daily Traffic (AADT):

- Major Road (>3,000 AADT) – 2% AEP (50yr ARI); and
- Minor Road (<3,000 AADT) – 10% AEP (10yr ARI).

Based on the expected AADT's all culverts modelled within this assessment have been assumed to be major culverts.

In addition to the above conveyance requirements, trafficability requirements require maximum flow depths of 200mm and a depth x velocity product not exceeding 0.3m^2/s.

Railway crossings have been provided with 1% AEP overtopping immunity.

Conditions of Preliminary Approval pertaining to fish passage requirements for the proposed culvert structures within the proposed fish habitat areas, which are deemed Waterway barrier works by DSDMIP. Further details are provided in **Section 4.3.7.**

4.3 Model Configuration

4.3.1 Topographical Data and Projection

The Digital Terrain Model's (DTM) used in this analysis consisted of a 1km by 1km LIDAR tile at the outlet of the Brook to Bells Creek (South) and a bulk earthworks TIN over the extent of the Master Plan site. The model was projected to the GDA94 / MGA Zone 56 coordinate system.

The design tin adopted for this modelling is depicted on Sketch Plans SK3100, SK101 and SK3102 provided in **Appendix A** and **Appendix D**.

4.3.2 2D Model Area

The 2D model extent for this analysis focuses on the Brook with the boundary extending over the surrounding residential lots to capture any potential flows overtopping the Brook. Refer to **Figure 4** below for the 2D model extent (39% AEP results shown on figure). A 2D grid cell size of 3m combined with a starting time step of 1 second was used for this analysis.

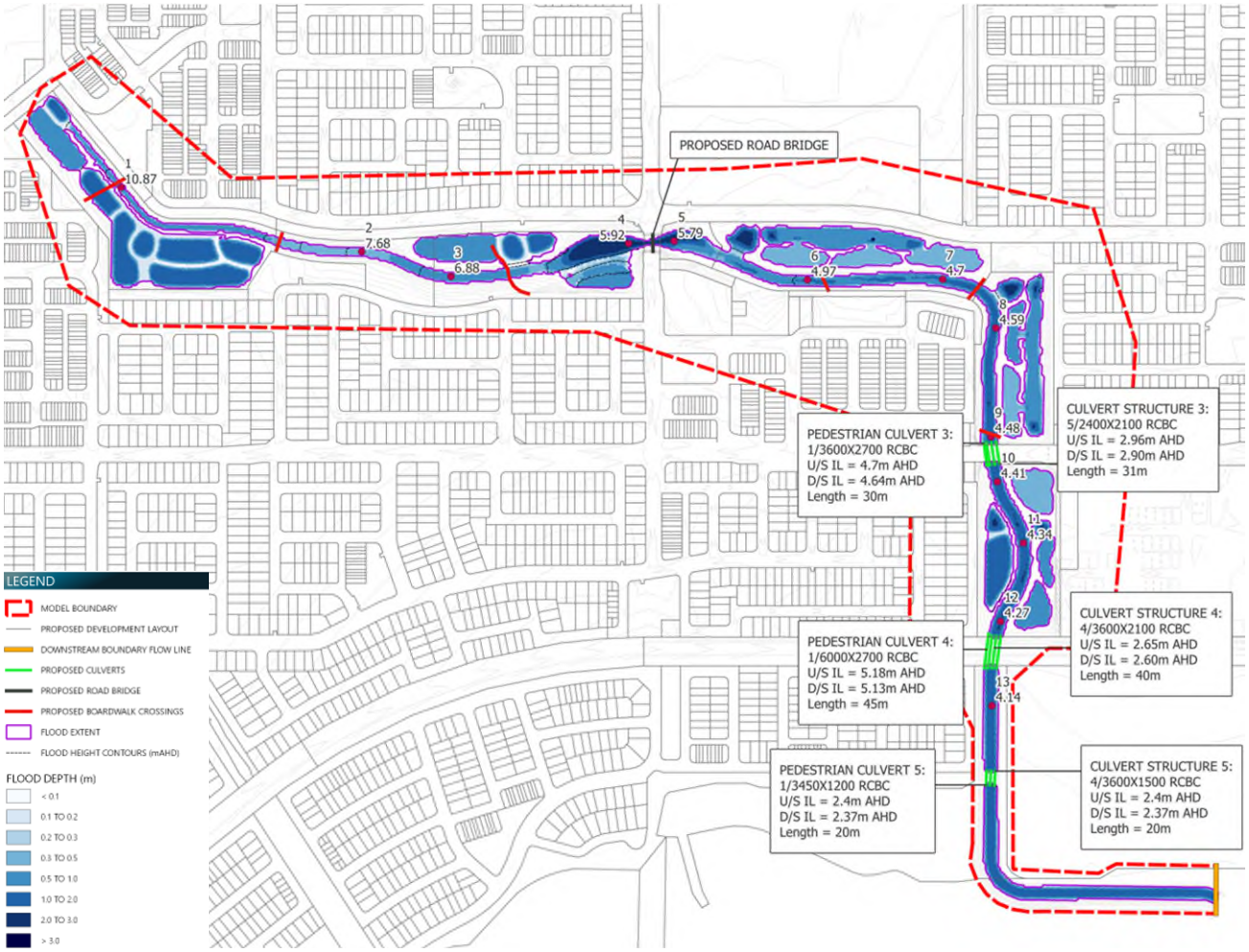


FIGURE 4 - TUFLOW MODEL AREA

4.3.3 Manning's n Value

Various Manning's n roughness values have been utilised to represent the 2D topographical areas within the flood. Mannings values within the drain have generally been adopted as Manning's Roughness of 0.12, a sensitivity scenario whereby the roughness was increased to 0.15 was completed and is discussed further in **Section 4.5**. Mannings roughness's external to the Brook were assumed to be 0.15 to simulate a lumped roughness for the developed landuses.

These values are consistent with hydraulic roughness recommended in the SSC Planning Scheme, however, it should be noted that the use if this high roughness is likely to yield conservatively high water levels and flow velocities are likely to be under predicted. Egis's understanding is that SCC prefer developed allotment levels to be set off the assumption that the channels may not be maintained and will therefore have increased hydraulic roughness. **Section 4.7** provides further details of analysis with lower Manning's n roughness values.

A hydraulic roughness of 0.014 was adopted for the concrete culverts (slightly rougher than the standard 0.013) to reflect the roughening required at the bottom of the culverts to meet fish passage requirements. The outermost culvert cell on both channel banks incorporate rigid baffles on the bankside internal sidewalls with 150mm horizontal protrusion (width) into the flow. The resultant increase in culvert roughness has been modelled with Manning's n=0.028 in accordance with AR&R (Book 6, Chapter 2, Equation 6.2.33).

4.3.4 Inflow Locations

The inflow hydrographs (time vs flow) for each of the storm durations outlined in **Section 3.4.2** were input into the model using SA Polygons. Inflow location assumptions were adopted as follows:

- Piped Flows (63% & 39% AEP) – The upstream stormwater drainage network for each catchment will be conveyed to the appropriate outlet location. This was generally assumed to be the inlet pond where one was present or directly into the Brook low flow where no inlet pond was provided.
- Overland Flows (5% to 0.05% AEP) – Runoff from all remaining storm events are to be conveyed to the Brook overland flow via the internal road network. As such inflow polygons have been provided within the Brook along the extent of each catchment frontage.

The inflow locations (TUFLOW SA polygons) for the overland flows for each catchment in addition to three differing piped outlets are presented in blue in **Figure 5** (pipe outlet locations may differ and are subject to future detailed design).



FIGURE 5 – MAJOR HYDROGRAPH INFLOW LOCATIONS

4.3.5 Initial Water Levels

Initial water levels were provided within the bioretention basins and wetlands as part of the 2D modelling to represent possible pre-burst rainfall filling the extended detention depths of the WSUD elements. Initial water levels were adopted as follows:

- Bioretention Basins – Top of filter media level plus 300mm extended detention.
- Wetlands – Standing water surface levels plus 500mm extended detention.

4.3.6 Tailwater Conditions

The proposed Brook is situated between Bells Creek (North) and Bells Creek (South) with the Brook itself discharging to the south. The hydraulic model was analysed for a number of storm durations to determine the critical durations as discussed in **Section 3.4.2**, above, with the longest critical duration being the 3 hour event at the lower reaches of the Brook. Importantly, it was identified that the Brook with a total catchment area of approximately 200 ha has a significantly faster rainfall/runoff response than the larger regional catchment draining to Bells Creek South. Accordingly, the peak maximum water surface level (WSL) rasters for the regional flood model detailed in the BMT WBM 2017 report (referred to herein as the 2017 BMT flood rasters) occur significantly after the peak discharge from the Brook (non-coincidental flooding). To account for the effect of non-coincidental flooding, guidance from Table B-1 of the *Maroochy Shire Council IWM Guidelines*, 2006 were adopted. This approach is used to identify the appropriate AEP regional flood level to use for the tailwater condition within the local model.

Based upon the ratio of the local catchment area to the regional catchment area the 2.5% AEP regional storm was identified. As such, the maximum WSL corresponding to the regional 2% AEP was adopted for the downstream tailwater for the 1% AEP storms (both present and future climate) for the purpose of the major infrastructure drainage optimisation, flow conveyance and setting minimum allotment levels. This constitutes a conservative approach for the selection of downstream boundary conditions.

For each design AEP, a WSL at the downstream boundary location was adopted from the 2024 BMT flood rasters assuming the non-coincident regional flooding method described above, for each flood AEP. The coincident regional flood event and resultant maximum regional WSL adopted as tailwater conditions for the Brook discharging to Bells Creek (South) are summarised below in **Table 11.**

TABLE 11 - ADOPTED TAILWATER CONDITIONS FOR AURA BROOK

DESIGN AEP	COINCIDENT REGIONAL FLOOD AEP (2024 BMT FLOOD RASTERS)	ADOPTED DOWNSTREAM BOUNDARY CONDITION (MAHD)
63%	Nil	0.1% slope boundary
39%	Nil	0.1% slope boundary
18%	39%	4.008
10%	18%	4.366
5%	18%	4.366
2%	5%	4.606
1%	2%	4.774
1% (Year 2100 Climate Change Scenario)	2%	4.774
0.05% (Year 2100 Climate Change Scenario)	1% (Climate Change)	5.088

Design AEP values above in addition to the 39% and 1% climate change AEPs have been provided for information purposes only.

It is noted that from the preliminary hazard and depth results, the model downstream boundary appears to be sufficiently far downstream from the area of interest to not cause significant distortion of the results. A sensitivity analysis of the adopted tailwater levels was therefore considered unnecessary.

4.3.6.1 Updated BMT 2024 Regional Flood Model

Subsequent to the EDQ's Decision Notice DEV2018/987 dated 9 February 2021 the *Aura Flood Risk Management Report 2020* (BMT 2020) was issued and ongoing iterations of the BMT regional flood modelling have been undertaken. For Revision E of this report, Egis have undertaken a review of the updated BMT 2024 maximum water height rasters from BMTs regional flood model, received by Egis on 6 February 2024. For reference in **Table 12** below, the previously adopted tailwater levels derived from the BMT 2017 report were compared with the 2024 regional flood modelling received from BMT on 6 February 2024 (previously provided in **Table 11** above).

TABLE 12 - COMPARISON OF UPDATED BMT REGIONAL TAILWATER CONDITIONS

DESIGN AEP	COINCIDENT REGIONAL FLOOD AEP	PREVIOUSLY ADOPTED DOWNSTREAM TAILWATER CONDITION (2017 BMT FLOOD RASTERS) (MAHD)	06/02/2024 BMT REGIONAL FLOOD LEVELS AT DOWNSTREAM MODEL BOUNDARY (MAHD)
63%	Nil	0.1% slope boundary	NA
39%	Nil	0.1% slope boundary	NA
18%	39%	4.198	4.008
10%	18%	4.606	4.366
5%	18%	4.606	4.366
2%	5%	4.889	4.606
1%	2%	5.141	4.774
1% (Year 2100 Climate Change Scenario)	2%	5.141	4.774
0.05% (Year 2100 Climate Change Scenario)	1% (Climate Change)	5.400	5.088

The regional tailwater conditions adopted for the flood investigations for the Aura Brook have been updated to the align with the latest 2024 regional flood modelling. As such, the local flood modelling for the Aura Brook has been updated to include tailwater conditions in accordance with the BMT 2024 regional flood levels for this Report Revision E. This is to ensure results produced are not overly conservative and provide representative internal flood levels.

4.3.7 1D Model Elements

The major stormwater infrastructure proposed to convey flows under the proposed road crossings and CAMCOS railway line has been represented by 1D elements. A 10% blockage factor has been applied to the culverts in accordance with ARR (Book 6, Chapter 6). A sensitivity analysis of increased culvert blockage was also undertaken and is detailed in **Section 4.5.**

In order to address the conditions of the *Preliminary approval and Part Approval* for *Operational work for Waterway barrier works* decided by the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP), dated 28 February 2019 (ref: 1710-2004 SDA), special consideration for fish passage is required in the design and modelling methodology for the proposed culvert structures. Provisions such as internal baffles, embedment depth, culvert length and gradient have been incorporated into the TUFLOW model for 1D elements.

Further details of the proposed culverts have been provided in **Appendix C** and summarised below in **Table 13**, **Table 14** and **Table 15**. A summary of the culvert structure results have been provided in **Appendix H.**

TABLE 13 - CULVERT STRUCTURE GROUP 3 DETAILS

CULVERT ID	CULV3_FP	CULV3_FP_RB	CULV3_FP_LB	CULV3_PED
Function	Hydraulic / Fish Passage	Hydraulic / Baffled Fish Passage	Hydraulic / Baffled Fish Passage	Hydraulic / Pedestrian Passage
Structure type	RCBC	RCBC	RCBC	RCBC
Structure size (mm)	2400 x 2100	2400 x 2100	2400 x 2100	3600 x 2700
No. barrels	3	1	1	1
Modelled width x height (mm)	2400 x 1800[1]	2250[2] x 1800[1]	2250[2] x 1800[1]	3600 x 2700
Structure Invert Upstream	2.96	2.96	2.96	4.7
Modelled Invert Upstream	3.26[1]	3.26[1]	3.26[1]	As above
Structure Invert Downstream	2.90	2.90	2.90	4.64
Modelled Invert Downstream	3.20 [1]	3.20 [1]	3.20 [1]	As above
Hydraulic Roughness (Manning's n)	0.014	0.028	0.028	0.014
Grade[3]	0.20%	0.20%	0.20%	0.20%
Approx. Length[4]	31	31	31	30

1 Culvert installed 300mm below bed level to enable fish passage design. First 300mm depth from structure invert assumed blocked. Modelled invert raised 300mm and modelled culvert height reduced 300mm to reflect hydraulic conveyance.
2 This outermost culvert cell incorporates rigid baffles on the bankside internal sidewalls with 150mm horizontal protrusion (width) into the flow. The resultant loss of flow width has been subtracted from the structure width. The resultant increase in culvert roughness has been modelled with Manning's n=0.028 in accordance with AR&R (Book 6, Chapter 2, Equation 6.2.33).
3 Culverts with fish passage function must be installed at no steeper gradient than the waterway bed gradient.
4 Desirable culvert length less than 30m, width maximum 40m for sufficient sunlight within culvert to promote fish passage.

TABLE 14 - ULTIMATE CULVERT STRUCTURE GROUP 4 (CAMCOS CORRIDOR) DETAILS

CULVERT ID	CULV4_FP	CULV4_FP_RB	CULV4_FP_LB	CULV4_PED
Function	Hydraulic / Fish Passage	Hydraulic / Baffled Fish Passage	Hydraulic / Baffled Fish Passage	Hydraulic / Pedestrian Passage
Structure type	RCBC	RCBC	RCBC	RCBC
Structure size (mm)	3600 x 2100	3600 x 2100	3600 x 2100	6000 x 2700
No. barrels	2	1	1	1

Modelled width x height (mm)	3600 x 1800[1]	3450[2] x 1800[1]	3450[2] x 1800[1]	6000 x 2700
Structure Invert Upstream	2.65	2.65	2.65	5.18
Modelled Invert Upstream	2.95 [1]	2.95 [1]	2.95 [1]	As above
Structure Invert Downstream	2.60	2.60	2.60	5.13
Modelled Invert Downstream	2.90 [1]	2.90 [1]	2.90 [1]	As above
Hydraulic Roughness (Manning's n)	0.014	0.028	0.028	0.014
Grade[3]	0.13%	0.13%	0.13%	0.12%
Approx. Length[4]	40	40	40	45

1 Culvert installed 300mm below bed level to enable fish passage design. First 300mm depth from structure invert assumed blocked. Modelled invert raised 300mm and modelled culvert height reduced 300mm to reflect hydraulic conveyance.
2 This outermost culvert cell incorporates rigid baffles on the bankside internal sidewalls with 150mm horizontal protrusion (width) into the flow. The resultant loss of flow width has been subtracted from the structure width. The resultant increase in culvert roughness has been modelled with Manning's n=0.028 in accordance with AR&R (Book 6, Chapter 2, Equation 6.2.33).
3 Culverts with fish passage function must be installed at no steeper gradient than the waterway bed gradient.
4 Desirable culvert length less than 30m, width maximum 40m for sufficient sunlight within culvert to promote fish passage.

TABLE 15 - ULTIMATE CULVERT STRUCTURE GROUP 5 DETAILS

CULVERT ID	CULV5_FP	CULV5_FP_RB	CULV5_FP_LB
Function	Hydraulic / Fish Passage	Hydraulic / Baffled Fish Passage	Hydraulic / Baffled Fish Passage
Structure type	RCBC	RCBC	RCBC
Structure size (mm)	3600 x 1500	3450 x 1500	3450 x 1500
No. barrels	2	1	1
Modelled width x height (mm)	3600 x 1200[1]	3450[2] x 1200[1]	3450[2] x 1200[1]
Structure Invert Upstream	2.40	2.40	2.40
Modelled Invert Upstream	2.70 [1]	2.70 [1]	2.70 [1]
Structure Invert Downstream	2.37	2.37	2.37
Modelled Invert Downstream	2.67 [1]	2.67 [1]	2.67 [1]
Hydraulic Roughness (Manning's n)	0.014	0.028	0.028
Grade[3]	0.1%	0.1%	0.1%
Approx. Length[4]	20	20	20

1 Culvert installed 300mm below bed level to enable fish passage design. First 300mm depth from structure invert assumed blocked. Modelled invert raised 300mm and modelled culvert height reduced 300mm to reflect hydraulic conveyance.
2 This outermost culvert cell incorporates rigid baffles on the bankside internal sidewalls with 150mm horizontal protrusion (width) into the flow. The resultant loss of flow width has been subtracted from the structure width. The resultant increase in culvert roughness has been modelled with Manning's n=0.028 in accordance with AR&R (Book 6, Chapter 2, Equation 6.2.33).
3 Culverts with fish passage function must be installed at no steeper gradient than the waterway bed gradient.
4 Desirable culvert length less than 30m, width maximum 40m for sufficient sunlight within culvert to promote fish passage.

All 1D elements incorporate SX connections to dynamically link to the 2D surface. Each SX line has been modelled with a SX Storage Factor equal to 3. The SX Storage Factor adds additional storage to the 1D/2D linking cells, thus providing increased stability within the 1D elements. A range of SX Storage Factor values were trialled, however results demonstrate the storage factor value of 3 provide stable 1D results whilst not causing in a loss or reduction in peak flows through the culverts.

4.3.8 Layered Flow Constrictions

Layered flow constrictions were incorporated into the 2D model to represent the six (6) boardwalk crossings expected to be present within the Brook as well as one road bridge (refer **Figure 4**). Details of the adopted flow constrictions are presented below in **Table 16**.

It is noted the road bridge has been assumed to be a single span bridge (approx. 20m span) and therefore no blockage below the deck has been adopted. Limitations of the layered flow constriction configuration parameters are such that constrictions are represented as horizontal layers in the 2D model. As such, the boardwalks have adopted larger deck thicknesses and reduced deck blockage to account for the vertical curvature of the deck. This allows the model to account for the range of levels in the water column where flow constriction occurs due to the curved deck configuration.

TABLE 16 - ADOPTED LAYERED FLOW CONSTRICTIONS (CONCEPT)

STRUCTURE	UNDERSIDE OF DECK LEVEL (MAHD)	PIER BLOCKAGE	DECK LEVEL (MAHD)	DECK BLOCKAGE	TOP OF HANDRAIL LEVEL (MAHD)	HANDRAIL BLOCKAGE
Boardwalk 1	12.50	10%	13.50	50%	14.70	45%
Boardwalk 2	11.55	10%	12.50	50%	13.70	45%
Boardwalk 3	9.50	10%	10.50	50%	11.70	45%
Road Bridge	9.00	0%	9.70	100%	10.90	45%
Boardwalk 3A	5.70	10%	6.70	50%	7.90	45%
Boardwalk 4	6.50	10%	7.50	50%	8.70	45%
Boardwalk 4A	5.00	10%	6.00	50%	7.20	45%

4.4 Model Scenarios

The 1% AEP Climate Change event as the Defined Flood Event (DFE) for the analysis. Further analysis of various sensitivity scenarios including varying severity of culvert blockage and hydraulic roughness were also analysed. As such, the minimum levels for allotments adjacent to the Brook have been derived from a maximum of the following:

- The Defined Flood Event + 350mm freeboard to the minimum allotment level; and
- Maximum WSL resulting from each of the sensitivity scenarios.

It is noted the minimum habitable floor level for each allotment should be a minimum of 150mm above the adopted minimum lot level, thus providing 500mm freeboard to habitable floor levels (refer **Section 4.2.1**)

A 10% blockage factor has been applied to the culverts in accordance with ARR (Book 6, Chapter 6) for all modelled scenarios, except where sensitivity scenarios modelled an increased culvert blockage as detailed in **Section 4.5.** For the design storm event flood plans, sensitivity event flood plans and water surface level results, refer to **Appendix E**, **Appendix F** and **Appendix G** respectively.

4.4.1 Design Storm

39% AEP Storm Event - To detail the conveyance efficiency of the low flow channel which runs the length of the Brook, the 39% AEP (2yr ARI) event was simulated for the six critical durations established in **Section 3.4.** A maximum of all flood results for depth, velocity and hazard were generated from a maximum envelope of these critical durations. Rainfall was established using ARR 2019 temporal patterns and rainfall intensities. Incorporating a maximum water surface level boundary condition as documented in **Table 11** , the results are presented in **Appendix E** and **Appendix G**.

1% AEP Climate Change - To set minimum allotment levels the 1% AEP storm event under climate change (2100yr) rainfall event was simulated for the six critical durations established in **Section 3.4.** A maximum of all flood results for depth, velocity and hazard were generated from a maximum envelope of these critical durations. Rainfall was established using ARR 2019 temporal patterns and rainfall intensities plus 20% to allow for climate change. Incorporating a maximum water surface level boundary condition as documented in **Table 11** , the results are presented in **Appendix E** and **Appendix G**.

4.5 Sensitivity Events

Sensitivity investigations have been undertaken to determine the robustness of the proposed design over its expected life. The sensitivity investigation undertaken includes significant increases in upstream vegetation causing a high Manning's roughness for the channel and also provisions for culvert blockages (ie. from high sediment loads or dislodged vegetation). Refer to **Appendix F** for the sensitivity scenario flood plans and **Table G.2** for the WSL throughout the Brook. The following scenarios were undertaken:

High Manning's Sensitivity - The analysis was undertaken for the 1% AEP Climate Change (2100) rainfall event, whereby the sensitivity scenario roughness was increased from 0.12 within the drain to 0.15.

1% AEP + CC, 50% Blockage Scenario – Under this scenario a 50% bottom up blockage has been applied to all culverts within the Brook for the 1% AEP Climate Change (2100) rainfall event. To report maximum WSL's each culvert blockage factor was iteratively increased from 10% to 50% (ie. not all 50% blocked simultaneously). The results presented in **Appendix F** document the maximum of all blockage scenarios for the critical durations throughout the Brook.

39% AEP, Severe Blockage Scenario – Under this scenario severe blockages were applied to all culverts for a 39% AEP (2yr ARI) rainfall event. The blockage factor for all Culvert 3 and 5 structures was increased from 10% to a 100% blockage scenario. Due to the CAMCOS Rail Line embankment level a blockage of 95% was applied for Culvert 4 instead of 100%. The adoption of a 95% blockage is still considered overly conservative based on the following:

- The upstream catchment is entirely urbanised (as opposed to heavily wooded areas which have a higher risk of generating fodder contributing to culvert blockages); and
- The large size of the culvert and number of cells make it extremely unlikely that 95% blockage would occur across the entire culvert bank (especially considering the pedestrian culvert inverts and obverts are more than two metres higher).

As noted previously, the delivery of the crossing underneath the CAMCOS line will be delivered in future works by others. The CAMCOS line is currently designed at an elevation higher than the surrounding residential areas. Therefore, any major blockage to the CAMCOS culverts may impact the surrounding residential areas. As a result, prior to the CAMCOS line being designed and constructed (by others) detailed blockage and risk analysis should be undertaken (by others) to prevent major blockages occurring.

4.5.1 Secondary Analysis

To confirm the capacity of the proposed Brook alignment and cross-sectional area, two Duration Independent Storm (DIS) rainfall events were modelled. The purpose of the analysis was to determine if the Brook has the appropriate capacity to convey flows during these DIS events. Refer to **Table G.1** in **Appendix G** for the WSL's within the Brook during the following DIS storm events.

1% AEP + CC DIS – Under this scenario the 1% AEP Climate Change DIS rainfall event was modelled. The Duration Independent Storm (DIS) temporal patterns were provided by Sunshine Coast Council and run to consider peak water levels within the Brook.

0.05% AEP DIS – Under this scenario the 0.05% AEP (2,000yr ARI) DIS rainfall event was modelled. The 0.05% AEP DIS event was undertaken to detail the impact to the lots bounding the Brook to inundation does not cause a threat to life within the effected properties or properties. It is noted this simulation is beyond the Design Flood Event (DFE) for designing lot levels.

4.6 Minimum Allotment Levels – WSL Results

A summary of the water surface levels provided by the TUFLOW model is tabulated in **Table G.2** in **Appendix G**. To define the minimum levels for allotments adjacent to the Brook the maximum of the below was adopted:

- The Defined Flood Event + 350mm freeboard; and
- Maximum WSL resulting from each of the sensitivity scenarios

Minimum lot levels are provided in **Table 17** below with WSL throughout the Brook presented on the flood plans provided in **Appendix E** and **Table G.2** in **Appendix G**.

It is noted the minimum habitable floor level for each allotment should be a minimum of 150mm above the adopted minimum lot level.

TABLE 17 - MINIMUM LOT LEVELS

REPORTING LOCATION	CRITICAL STORM SCENARIO	MINIMUM DESIGN LEVEL	REQUIRED MINIMUM LOT LEVELS (MAHD)	REQUIRED MINIMUM FLOOR LEVELS (MAHD)	APPROXIMATE LOT LEVELS ACHIEVED# (MAHD)	REVISION D REQUIRED MINIMUM FLOOR LEVEL DIFFERENCE
1	1% AEP Climate Change	DFE+350mm	12.05	12.20	13.12	0.060
2	1% AEP Climate Change	1% + CC DIS	8.76	8.91	11.1	-0.867
3	1% AEP Climate Change	1% + CC DIS	8.30	8.45	10.36	-1.328
4	1% AEP Climate Change	1% + CC DIS	7.50	7.65	8.86	-0.296
5	1% AEP Climate Change	1% + CC DIS	7.08	7.23	8.28	-0.275
6	1% AEP Climate Change	1% + CC DIS	6.72	6.87	7.54	-0.478
7	1% AEP Climate Change	1% + CC DIS	6.67	6.82	7.42	-0.467

8	1% AEP Climate Change	1% + CC DIS	6.61	6.76	7.47	-0.470
9	1% AEP Climate Change	1% + CC DIS	6.56	6.71	7.65	-0.485
10	1% AEP Climate Change	1% + CC DIS	6.29	6.44	7.88	-0.420
11	1% AEP Climate Change	1% + CC DIS	6.28	6.43	7.37	-0.416
12	1% AEP Climate Change	1% + CC DIS	6.25	6.40	7.15	-0.417
13	1% AEP Climate Change	DFE+350mm	5.90	6.05	6.55	-0.298

*Note - Refer to Appendix G for the water surface levels at each reporting location.
#Note – Achieved lot levels are minimum levels from properties approximately perpendicular to the direction of flow at each reporting location.

Apart from reporting location 1, all reporting locations have reduced minimum lot level requirements in comparison to the previous Revision D. Amended levels in the upper portions of the Brook have largely been influenced by the proposed topographic amendments. The reductions in the downstream portion of the Brook are more heavily influenced by the reduced downstream regional levels from the most recent 2024 BMT investigation.

4.6.1 Severe Storm WSL Results

The severe storm (2,000 year DIS storm event) results are presented on the Flood Plans **15-000340-S_E-2000-A** to **C** in **Appendix F**. Although results demonstrate the banks of the Brook are overtopped during a severe storm event, the lots bounding the Brook have a maximum depth*velocity product of 0.4 m^2/s. It is noted that inundation within the southern extents interact with the model boundary. As the purpose of this severe storm investigation is to predominately analyse flood hazard and risk to life, results in this area are considered conservative, since the model boundary artificially constricts flows. Furthermore, the culverts under the CAMCOS are preliminary only and to be designed and delivered by others.

4.6.2 Review of DFE within the Aura Brook

In order to address Condition 33 of the PDA decision notice dated 9 February 2021 as described in **Section 2.3**, a review of the DFE within the Aura Brook was undertaken. The review compared the 1% AEP Climate Change flood levels through the Brook presented on the flood plans provided in **Appendix F** and **Table G.2** in **Appendix G** against the regional 1% AEP Climate Change flood levels provided by BMT 2024. It was determined that the regional flood level supplied by BMT at the downstream boundary of the 2d TUFLOW model was 5.088mAHD for the 1% AEP Climate Change event (refer **Section 4.3.6** above). All reporting locations presented on the flood plans provided in **Appendix F** and **Table G.1** in **Appendix G** have a WSL above 5.4mAHD, with the lowest point in the channel adjacent to Residential lots Precinct 11, Location 13, having a WSL of 5.517 during a 1% AEP Climate Change event. Therefore, the regional flooding event is not governing the DFE levels at any of the nominated reporting locations.

4.7 1D Hydraulic Analysis

As stated in **Section 4.1** above, the primary aim of this report is to analyse the concept channel design, determine the conveyance capacity of the channel/major stormwater infrastructure and to set minimum allotment levels. To this end, the underlying assumptions of 2D TUFLOW modelling have aimed to be conservative with regard to peak water levels. It is recognised that these assumptions may result in the underestimation of peak flood hazard (as defined by a combination of flood depth and velocity) due to an inherent underestimation of flood velocity for some design storm events due to high manning values adopted.

In response to EDQ queries, a 1D hydraulic model was built in order to analyse different design scenarios throughout the Aura Brook which may result in increased peak flood velocity, and therefore peak flood hazard. The 1D hydraulic model of the Aura Brook was configured for the following scenarios in order to address Condition 33 of the PDA decision notice dated 9 February 2021 as described in **Section 2.3**;

- **Scenario 1: As Designed 1D Model** – The XPSWMM model that was developed for the hydrological analysis described in **Section 3** and was configured in Hydraulics mode to provide a 1d hydraulic model of the Aura Brook. The 1d hydraulic model adopted the same hydrologic inflow parameters represented by the nodes, while the hydraulic parameters were represented by a series of links. The hydraulic links were configured to represent the bulk earthworks TIN used in the TUFLOW model at discrete locations where changes occur in the cross-sectional flow area through the Aura Brook. Model links were also configured to represent the 1d model elements described in **Section 4.3.7**. This As Designed 1D Model was verified against the 2D model in **Section 4.7.1** below.
- **Scenario 2: Low Manning's** – To assess the potential risk of increased velocity and associated scour, an analysis was undertaken for the 1% AEP Climate Change (2100) rainfall event, whereby the sensitivity scenario roughness was decreased from 0.12 within the channel to a conservatively low manning's roughness of 0.04. A manning's roughness of 0.04 represents short grass where the water depth exceeds the grass height and on a slightly irregular surface (*SCC Flood Hazard Overlay Code* 2015). This low Manning's is not expected to be an ultimate roughness, with this investigation instead looking at interim periods during establishment of the proposed vegetation.
- **Scenario 3: Low Manning's, CAMCOS Culvert Removed, Free Draining Outlet** – Similar to above, a low Manning's of 0.04 was adopted in addition to removing the proposed Ultimate Scenario CAMCOS culverts and substituting for a channel. The channel configuration was interpolated from the channel design upstream and downstream of the CAMCOS railway embankment. This model scenario was further configured with a free draining outlet in order to remove the tailwater impacts of a coincident regional flooding event which may have otherwise reduced flow velocity within the channel. It is noted that the 39% AEP event assumes a free draining outlet in the 2D TUFLOW modelling as outlined in **Section 4.3.6**.

4.7.1 1D Model Verification

A 1D model operates on a number of different processes and underlying mathematics in comparison to the 2D TUFLOW model and hence results between the two models will differ. In order to verify the accuracy of the 1D model, a comparison against Water Surface Levels (WSLs) from the 2D model results was undertaken at the locations depicted in **Figure 6** below, for the 1% AEP Climate Change (2100) event.

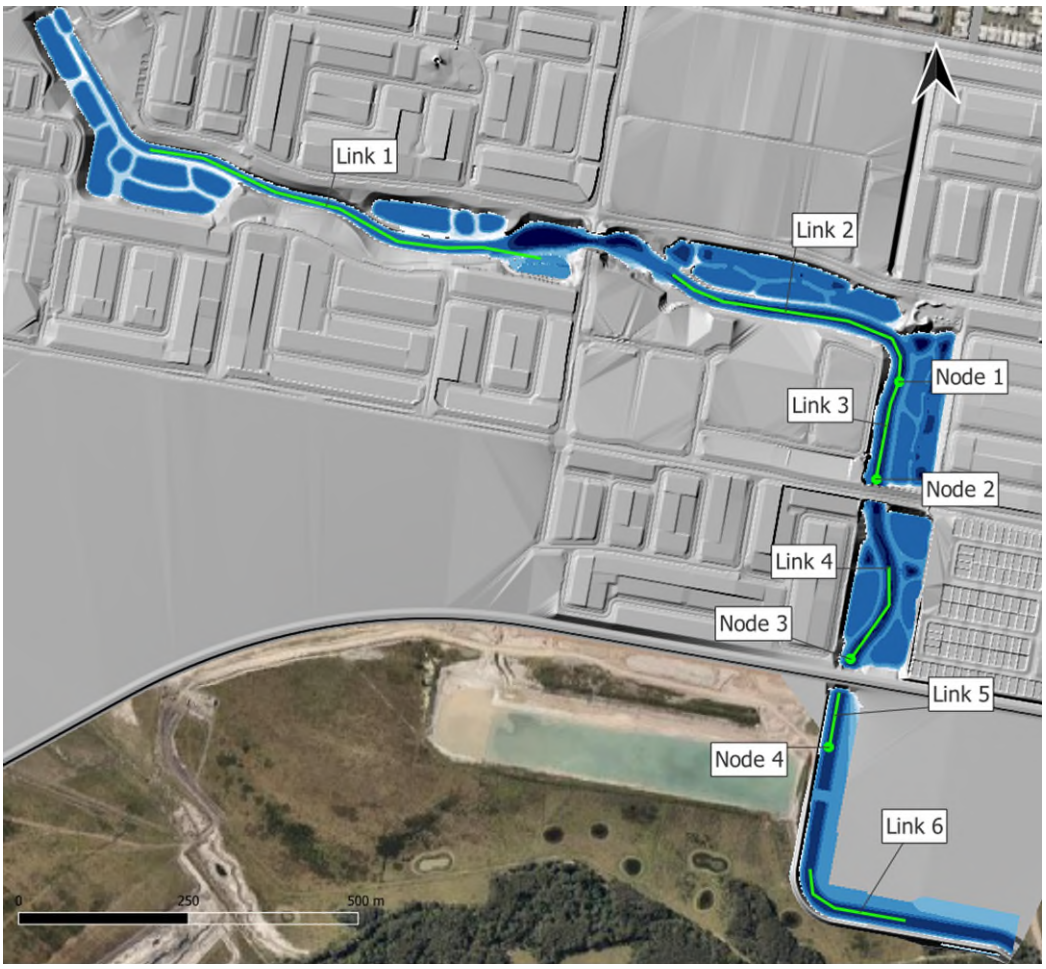


FIGURE 6 - SIMPLIFIED 1D LINK LAYOUT (SELECTED LOCATIONS)

This WSL comparison is presented in **Table 18** below.

TABLE 18 - 1D AND 2D MODEL WSL COMPARISONS

REPORTING LOCATION*	NODE INVERT (M AHD)	2D MODEL - 1% AEP CLIMATE CHANGE WSL (M AHD)	1D MODEL - 1% AEP CLIMATE CHANGE WSL (M AHD)	WSL DIFFERENCE (%)
Node 1	3.50	6.16	6.75	8.74%
Node 2	3.26	6.10	6.68	8.68%
Node 3	2.95	5.84	6.44	9.32%
Node 4	2.82	5.51	6.23	11.56%

*Note – Node numbers have been simplified for reporting purposes and differ from XP-SWMM model files.

The WSL comparison presented in **Table 18** shows that the differences in WSL at selected locations have an average difference of 9.6%, which is considered appropriate for the purpose of this 1D hydraulic analysis to consider velocity changes due to lower Manning's n roughness or tail water levels.

4.7.2 1D Model Results

The results presented in **Table 19** provide a summary of the velocity results for the three (3) 1D model scenarios for the 39% and 1% AEP with climate change storm events at the reporting locations depicted in **Figure 6** above.

TABLE 19 - CHANNEL VELOCITY COMPARISONS

REPORTING LOCATION*	SCENARIO 1 39% AEP (M/S)	SCENARIO 2 39% AEP (M/S)	SCENARIO 3 39% AEP (M/S)	SCENARIO 1 1% AEP CLIMATE CHANGE (M/S)	SCENARIO 2 1% AEP CLIMATE CHANGE (M/S)	SCENARIO 3 1% AEP CLIMATE CHANGE (M/S)
Link 1	0.49	1.19	2.28	0.60	1.52	2.20
Link 2	0.53	1.23	1.46	0.66	1.61	1.65
Link 3	0.48	0.82	1.12	0.59	1.06	1.21
Link 4	0.36	0.70	0.79	0.41	0.67	0.99
Link 5	0.46	1.00	0.98	0.43	1.00	1.24
Link 6	0.39	1.21	0.88	0.49	1.21	1.10

*Note – Link numbers have been simplified for reporting purposes and differ from XP-SWMM model files.

The above results generally show that velocities in the 1% AEP Climate Change (2100) event are not considerably higher than the lower flow 39% AEP event. This is the result of the 39% AEP event being contained within the low flow channel, whereas the 1% AEP Climate Change event is spread across a much wider flow width and shallow overbank flow, and hence the average velocity is reduced. Based on an assumed surface covering of grass a velocity of 2.0m/s can generally be adopted as the upper limit allowable. The maximum velocity identified within this assessment was 1.65m/s, significantly under the allowable limit of 2.0m/s.

The development of the Brook will be completed in several construction stages with each stage moving from earthworks, into establishment and finally maturation at different times. During the earthworks stage there may be erosion take place in areas where suitable ground cover is not established (i.e. bare dirt), as with any earthworks. Any erosion would be fixed as part of the earthworks and sediment captured within the downstream high efficiency sediment basins.

A review of the 39% AEP event peak velocity was completed for the third scenario where low Manning's were adopted and the CAMCOS culvert removed. It was identified that under this sensitivity the increased velocity does produce high peak flood hazard (depth-velocity products above 0.6 m^2/s) throughout the Brook, however this is within the low flow channel and outside of pedestrian areas. The Brook includes a number of pedestrian bridges allowing access over the low flow channel in the 39% AEP event. The analysis demonstrates that the peak flood hazard is only slightly higher than the values reported for the 2D model analysis and the pathway networks are located within areas of lower hazard.

5 CONCLUSION

Egis Consulting Pty Ltd has been commissioned by Stockland Development Pty Ltd to prepare a *Flood Investigation Report* for part of Precincts 11, 12 and 14 of the Aura Development. The aim of this report is to investigate flooding capacity of the Aura Brook and determine the minimum allotment levels of the surrounding lots. This investigation has concluded the following:

- Through the use of a 2D TUFLOW model, the water surface levels throughout the site for a range of design and sensitivity scenarios were determined;
- As shown in **Section 4.6**, minimum allotment levels and minimum habitable floor levels were determined in accordance with freeboard requirements from BMT's regional flood investigations;
- A number of sensitivity scenarios have been addressed investigating the effects of increased vegetation and potential blockage of the culvert structures demonstrating that the Brook channel has been designed to mitigate adverse flood impacts to the development;
- The channel downstream of the CAMCOS rail line has capacity to convey up to and including the 1% AEP climate change storm event flows from the Brook to Bells Creek (South);
- The low flow channel proposed along the extent of the Brook has sufficient capacity to convey the minor flows (39% AEP) whilst maintaining freeboard to the top of embankment of the various WSUD devices;
- It is confirmed that lots already constructed and designed adjacent to the Brook maintain the necessary minimum freeboard and have not been impacted by amendments to the DFE as part of this Revision E; and
- The 39% AEP (2yr ARI) event updated within this Revision E was confirmed to maintain the necessary immunity to existing pedestrian crossings already constructed within the Brook.

6 RECOMMENDATIONS

Based on the outcomes of the flood impact assessment it is recommended that the conceptual design and management strategies provided in this report be approved and incorporated into the final design. The concepts presented in this report can be amended provided that the design objectives are maintained.

Throughout future design development it is expected that some changes to the Brook will be made from what is modelled. It is recommended these changes be incorporated into a working model as required.

7 REFERENCES

- BMT WBM (2017) Aura Regional Flood Model – 2017 Revision – Addendum Report.
- BMT (2024) Updated Flood Rasters, received 6 February 2024.
- Institute of Public Works Engineering Australasia (Queensland Division) (2016), Queensland Urban Drainage Manual.
- Institution of Engineers, Australia 2019, Australian Rainfall and Runoff.
- Sunshine Coast Council (2015), Planning Scheme.
- Qld State Government (2017), State Planning Policy.

8 DISCLAIMER

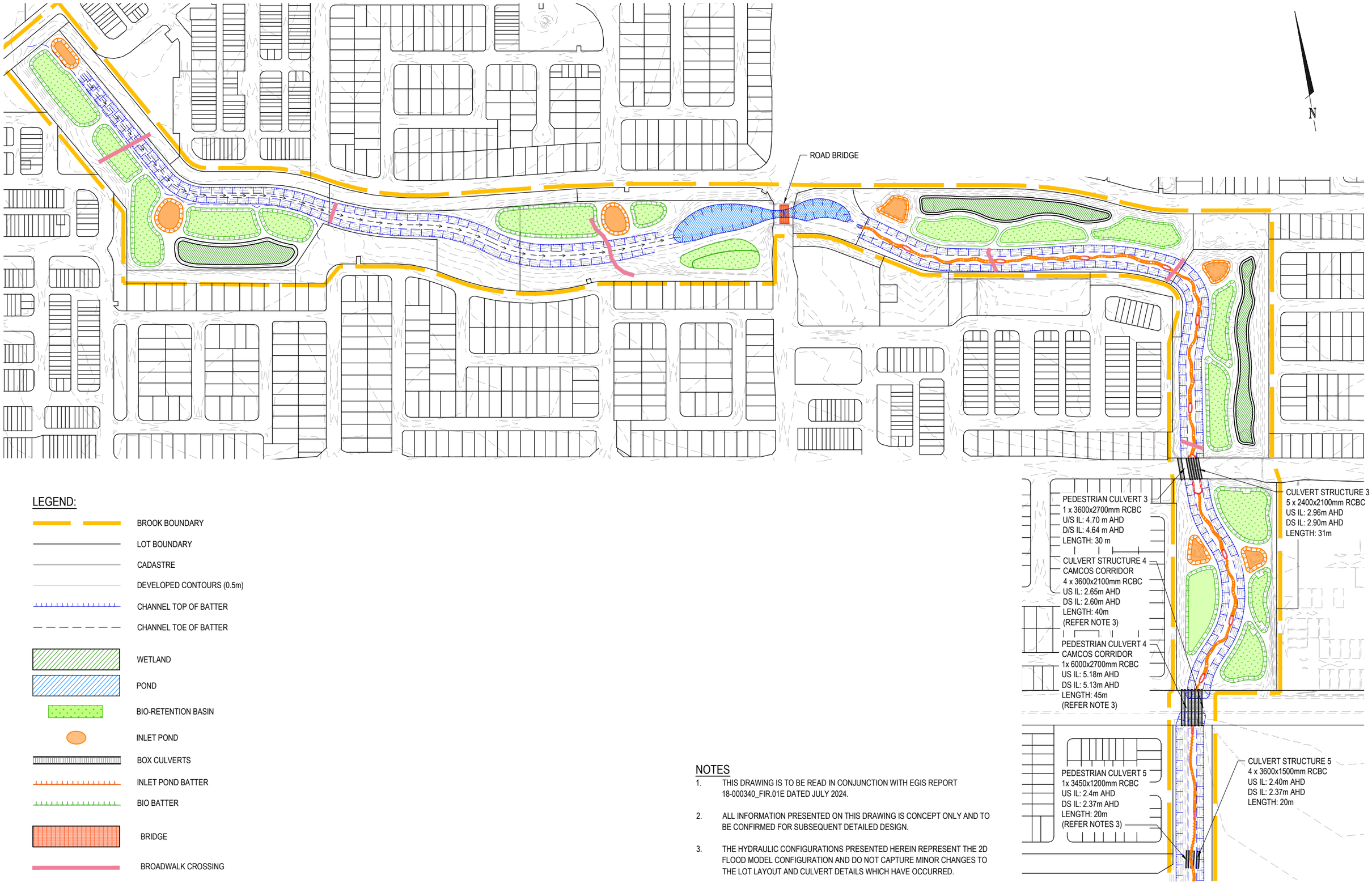
This report has been prepared on behalf of and for the exclusive use of Stockland Development Pty Ltd and is subject to and issued in accordance with the agreement between Egis Consulting Pty Ltd and Stockland Development Pty Ltd.

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APPENDIX A:
SITE LAYOUT



LEGEND:

- BROOK BOUNDARY
- LOT BOUNDARY
- CADASTRE
- DEVELOPED CONTOURS (0.5m)
- CHANNEL TOP OF BATTER
- CHANNEL TOE OF BATTER
- WETLAND
- POND
- BIO-RETENTION BASIN
- INLET POND
- BOX CULVERTS
- INLET POND BATTER
- BIO BATTER
- BRIDGE
- BROADWALK CROSSING

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH EGIS REPORT 18-000340_FIR.01E DATED JULY 2024.
2. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPT ONLY AND TO BE CONFIRMED FOR SUBSEQUENT DETAILED DESIGN.
3. THE HYDRAULIC CONFIGURATIONS PRESENTED HEREIN REPRESENT THE 2D FLOOD MODEL CONFIGURATION AND DO NOT CAPTURE MINOR CHANGES TO THE LOT LAYOUT AND CULVERT DETAILS WHICH HAVE OCCURRED.

AMENDMENTS	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
INITIAL ISSUE	MP	DMP			23.11.18	
B	RH	MC			30.07.19	LAYOUT UPDATED
C	DY	JC			12.06.20	RFI RESPONSE
D	DY	DC			04.03.21	UPDATED DRAWING NOTES

STATUS: PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
1:2000 20 0 20 40 60 80 100 A1
1:4000 A3

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CLIENT: STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT: AURA BROOK - NORTH CENTRAL LOCALITY PRECINCTS 11 & 12

DRAWING TITLE: AURA BROOK LAYOUT

PROJECT No.	DRAWING No.	REVISION
18-000340	SK3100	D

DISCLAIMER: ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY, DO NOT SCALE.

APPENDIX B: RATIONAL METHOD CALCULATIONS

Rational Method Peak Flow Estimation

File:	\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\2_Docs\Stormwater\FIR.01E\APPENDICES\Appendix B - Rational Calcs\[Rational Method Calculations.xlsx]Rational Method - B7
Date:	24/07/2024
Job:	18-000340
IFD:	ARR2016
IFD Ref:	IFD_ARR2016
IFD Source:	*Australian Government Bureau of Meteorology: Design Rainfall Data System (2016)*

Catchment B4

Time of Concentration Calculations

Reference	Equation Type / Method	Area (ha)	Length (m)	Av. Slope (%)	Pipe Diameter (mm)	Velocity (m/s)	Wetted Area (m^2)	Wetted Perimeter (m)	Hydraulic Radius R	Roughness (Mannings/ Hortons)	tc (mins)
Table 4.6.2 QUDM (2017)	Standard Inlet Time	17.95									**5**
4.6.6 QUDM (2017)	Overland Sheet Flow - Friend's Equation										
4.6.8 QUDM (2017)	Kerb and Channel Flow - Izzard's Equation										
4.6.9 QUDM (2017)	Pipe Flow Time - Figure 4.5		690	0.6							**22**
4.6.9 QUDM (2017)	Pipe Flow Time - Manning's Equation										
										Adopted tc	**27**

C10 VALUE

Development Category	f_i	$1I_{10}$ (mm/hr)	C10
30 min	0.78	73.6	0.86
		Adopted C10	**0.86**

Flow Calculations (QUDM Fourth Edition)

tc (min) 27

AEP (%)	Cy	$^{tc}I_y$	A (ha)	Q (m^3/s)
63.2	0.68	66	17.950	2.264
39	0.73	82	17.950	2.982
18	0.81	100	17.950	4.064
10	0.86	115	17.950	4.891
5	0.90	131	17.950	5.880
2	0.98	153	17.950	7.500
1	1.00	169	17.950	8.427

Rational Method Peak Flow Estimation

File:	\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\2_Docs\Stormwater\FIR.01E\APPENDICES\Appendix B - Rational Calcs\[Rational Method Calculations.xlsx]Rational Method - B7
Date:	24/07/2024
Job:	18-000340
IFD:	ARR2016
IFD Ref:	IFD_ARR2016
IFD Source:	*Australian Government Bureau of Meteorology: Design Rainfall Data System (2016)*

Catchment B5A

Time of Concentration Calculations

Reference	Equation Type / Method	Area (ha)	Length (m)	Av. Slope (%)	Pipe Diameter (mm)	Velocity (m/s)	Wetted Area (m^2)	Wetted Perimeter (m)	Hydraulic Radius R	Roughness (Mannings/ Hortons)	tc (mins)
Table 4.6.2 QUDM (2017)	Standard Inlet Time	6.9									**5**
4.6.6 QUDM (2017)	Overland Sheet Flow - Friend's Equation										
4.6.8 QUDM (2017)	Kerb and Channel Flow - Izzard's Equation										
4.6.9 QUDM (2017)	Pipe Flow Time - Figure 4.5		310	0.6							**11**
4.6.9 QUDM (2017)	Pipe Flow Time - Manning's Equation										
										Adopted tc	**16**

C10 VALUE

Development Category	f_i	$1I_{10}$ (mm/hr)	C10
30 min	0.8	73.6	0.86
		Adopted C10	**0.86**

Flow Calculations (QUDM Fourth Edition)

tc (min) 16

AEP (%)	Cy	$^{tc}I_y$	A (ha)	Q (m^3/s)
63.2	0.69	86	6.900	1.137
39	0.73	107	6.900	1.501
18	0.82	131	6.900	2.045
10	0.86	149	6.900	2.459
5	0.90	170	6.900	2.935
2	0.99	197	6.900	3.734
1	1.00	217	6.900	4.167

Rational Method Peak Flow Estimation

File:	\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\2_Docs\Stormwater\FIR.01E\APPENDICES\Appendix B - Rational Calcs\[Rational Method Calculations.xlsx]Rational Method - B7
Date:	24/07/2024
Job:	18-000340
IFD:	ARR2016
IFD Ref:	IFD_ARR2016
IFD Source:	*Australian Government Bureau of Meteorology: Design Rainfall Data System (2016)*

Catchment B7

Time of Concentration Calculations

Reference	Equation Type / Method	Area (ha)	Length (m)	Av. Slope (%)	Pipe Diameter (mm)	Velocity (m/s)	Wetted Area (m^2)	Wetted Perimeter (m)	Hydraulic Radius R	Roughness (Mannings/ Hortons)	tc (mins)
Table 4.6.2 QUDM (2017)	Standard Inlet Time	10.68									**5**
4.6.6 QUDM (2017)	Overland Sheet Flow - Friend's Equation										
4.6.8 QUDM (2017)	Kerb and Channel Flow - Izzard's Equation										
4.6.9 QUDM (2017)	Pipe Flow Time - Figure 4.5		424	0.6							**14**
4.6.9 QUDM (2017)	Pipe Flow Time - Manning's Equation										
										Adopted tc	**19**

C10 VALUE

Development Category	f_i	$1I_{10}$ (mm/hr)	C10
30 min	0.78	73.6	0.86
		Adopted C10	**0.86**

Flow Calculations (QUDM Fourth Edition)

tc (min) 19

AEP (%)	Cy	$^{tc}I_y$	A (ha)	Q (m^3/s)
63.2	0.68	80	10.680	1.616
39	0.73	99	10.680	2.129
18	0.81	120	10.680	2.905
10	0.86	138	10.680	3.499
5	0.90	156	10.680	4.170
2	0.98	182	10.680	5.315
1	1.00	201	10.680	5.951

APPENDIX C: TUFLOW MODEL CONFIGUARTIONS

TUFLOW Model Configuration - 1D Elements and Layered Flow Constrictions

File: \\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\2_Docs\Stormwater\FIR.01E\APPENDICES\Appendix C - TUFLOW Model Config\[Run021_ModelSetUp.xlsx]

Date:	8/07/2024
Job:	18-000340
By:	AM

Culvert Details

ID	Type	Ignore	UCS	Length	Manning's n	US Invert	DS Invert	Blockage	Width	Height	Number	Height Con	Width Cont	Entry Loss	Exit Loss
Culv3_FP_LB	R	F	T	-1	0.028	3.26	3.20	10	2.25	1.8	1	0.6	0.9	0.5	1
Culv3_FP	R	F	T	-1	0.014	3.26	3.20	10	2.4	1.8	3	0.6	0.9	0.5	1
Culv3_FP_RB	R	F	T	-1	0.028	3.26	3.20	10	2.25	1.8	1	0.6	0.9	0.5	1
Culv3_PED	R	F	T	-1	0.014	4.70	4.64	10	3.6	2.7	1	0.6	0.9	0.5	1
Culv4_FP_LB	R	F	T	-1	0.028	2.95	2.90	10	3.45	1.8	1	0.6	0.9	0.5	1
Culv4_FP	R	F	T	-1	0.014	2.95	2.90	10	3.6	1.8	2	0.6	0.9	0.5	1
Culv4_FP_RB	R	F	T	-1	0.028	2.95	2.90	10	3.45	1.8	1	0.6	0.9	0.5	1
Culv4_PED	R	F	T	-1	0.014	5.18	5.13	10	6	2.7	1	0.6	0.9	0.5	1
Culv5_FP_LB	R	F	T	-1	0.028	2.70	2.67	10	3.45	1.2	1	0.6	0.9	0.5	1
Culv5_FP	R	F	T	-1	0.014	2.70	2.67	10	3.6	1.2	2	0.6	0.9	0.5	1
Culv5_FP_RB	R	F	T	-1	2.67	2.95	2.67	10	3.45	1.2	1	0.6	0.9	0.5	1

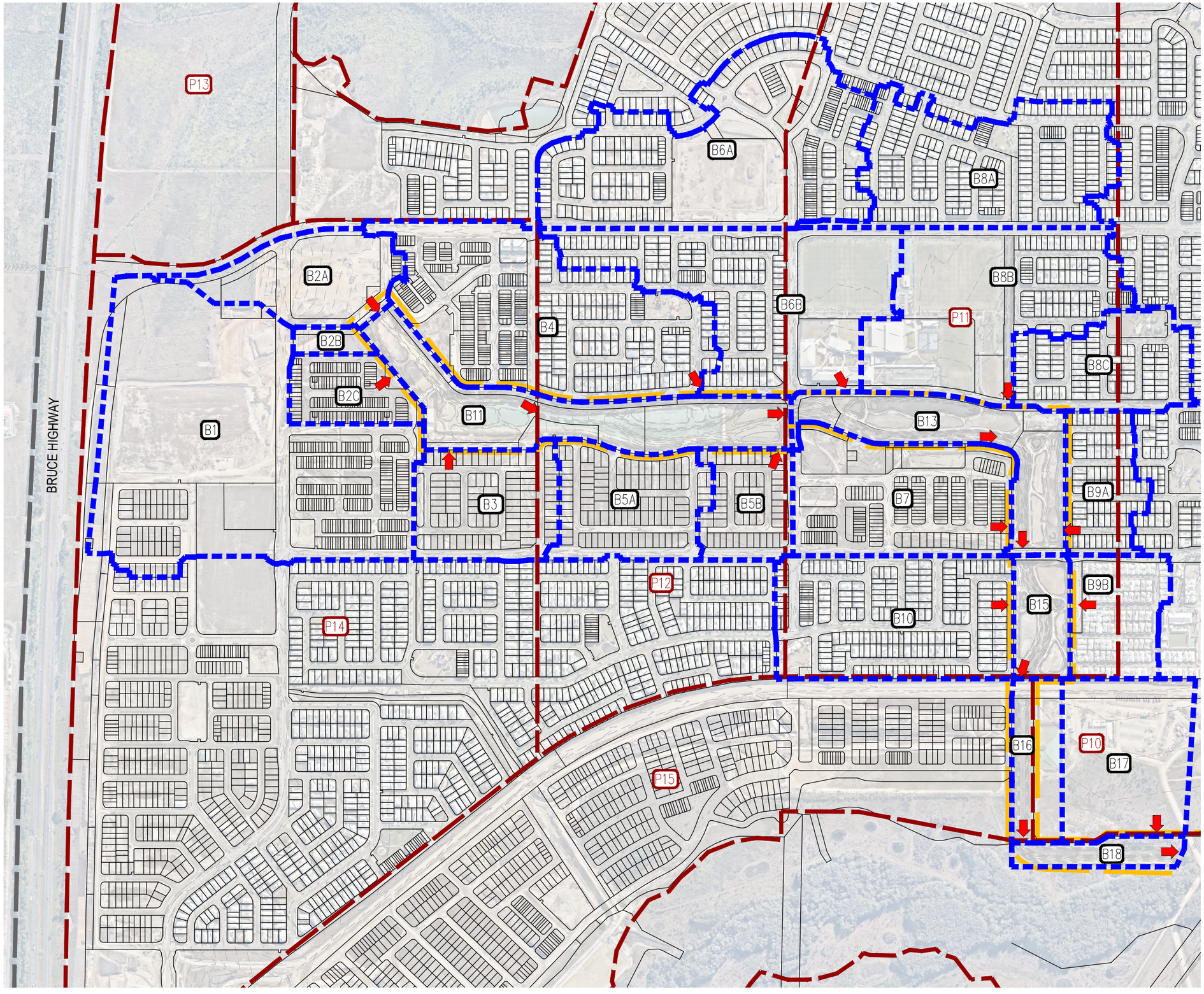
1D/2D Connections

ID	Type	Flag	Storage Factor
Culv3 (All)	SX	Z	3
Culv4 (All)	SX	Z	3
Culv5 (All)	SX	Z	3

Layered Flow Constrictions

Structure	Width	Layer 1 Obvert	Layer 1 Blockage	Layer 1 LFC	Layer 2 Depth	Layer 2 Blockage	Layer 2 LFC	Layer 3 Depth	Layer 3 Blockage	Layer 3 LFC
Boardwalk 1	4m	12.50	10%	0.3	1.0	50%	0.8	1.2	45%	0.5
Boardwalk 2	4m	11.50	10%	0.3	1.0	50%	0.8	1.2	45%	0.5
Boardwalk 3	3.4m	9.50	10%	0.3	1.0	50%	0.8	1.2	45%	0.5
Boardwalk 3A	2m	5.70	10%	0.3	1.0	50%	0.8	1.2	45%	0.5
Boardwalk 4	3m	6.50	10%	0.3	1.0	50%	0.8	1.2	45%	0.5
Boardwalk 4A	3m	5.00	10%	0.3	1.0	50%	0.8	1.2	45%	0.5
Road Bridge	10m	9.00	0%	-	0.7	100%	0.8	1.2	50%	0.5

APPENDIX D:
CONCEPT DRAWINGS



N

CATCHMENT DATA TABLE		
CATCHMENT	AREA (ha)	% IMPERVIOUS
B1	28.71	47%
B2A	6.13	83%
B2B	0.85	70%
B2C	3.42	85%
B3	6.66	78%
B4	17.95	78%
B5A	6.90	80%
B5B	4.10	80%
B6A	18.78	78%
B6B	15.32	62%
B7	10.68	78%
B8A	12.51	77%
B8B	14.01	53%
B8C	6.45	72%
B9A	4.35	80%
B9B	4.83	84%
B10	12.28	75%
B11	9.90	1%
B13	7.39	9%
B15	2.92	4%
B16	3.46	12%
B17	8.57	13%
B18	1.94	0%
TOTAL	208.11	-

LEGEND:

- BROOK BOUNDARY
- LOT BOUNDARY
- CADASTRE
- DEVELOPED CONTOURS (0.5m)
- DEVELOPED CATCHMENT BOUNDARY
- PRECINCT BOUNDARY
- A — DEVELOPED CATCHMENT LABEL
- A — PRECINCT LABEL
- DISCHARGE DIRECTIONS

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH EGIS REPORT 18-000340_FIR.01E DATED JULY 2024.
2. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPT ONLY AND TO BE CONFIRMED FOR SUBSEQUENT DETAILED DESIGN.
3. THE HYDRAULIC CONFIGURATIONS PRESENTED HEREIN REPRESENT THE 2D FLOOD MODEL CONFIGURATION AND DO NOT CAPTURE MINOR CHANGES TO THE LOT LAYOUT AND CULVERT DETAILS WHICH HAVE OCCURRED.

INITIAL ISSUE / AMENDMENTS	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	MP	DMP			23.11.18	
B	DY	DC			04.03.21	UPDATED DRAWING NOTES

STATUS: PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
1:4000 1:8000 40 0 40 80 120 160 200 A1 A3

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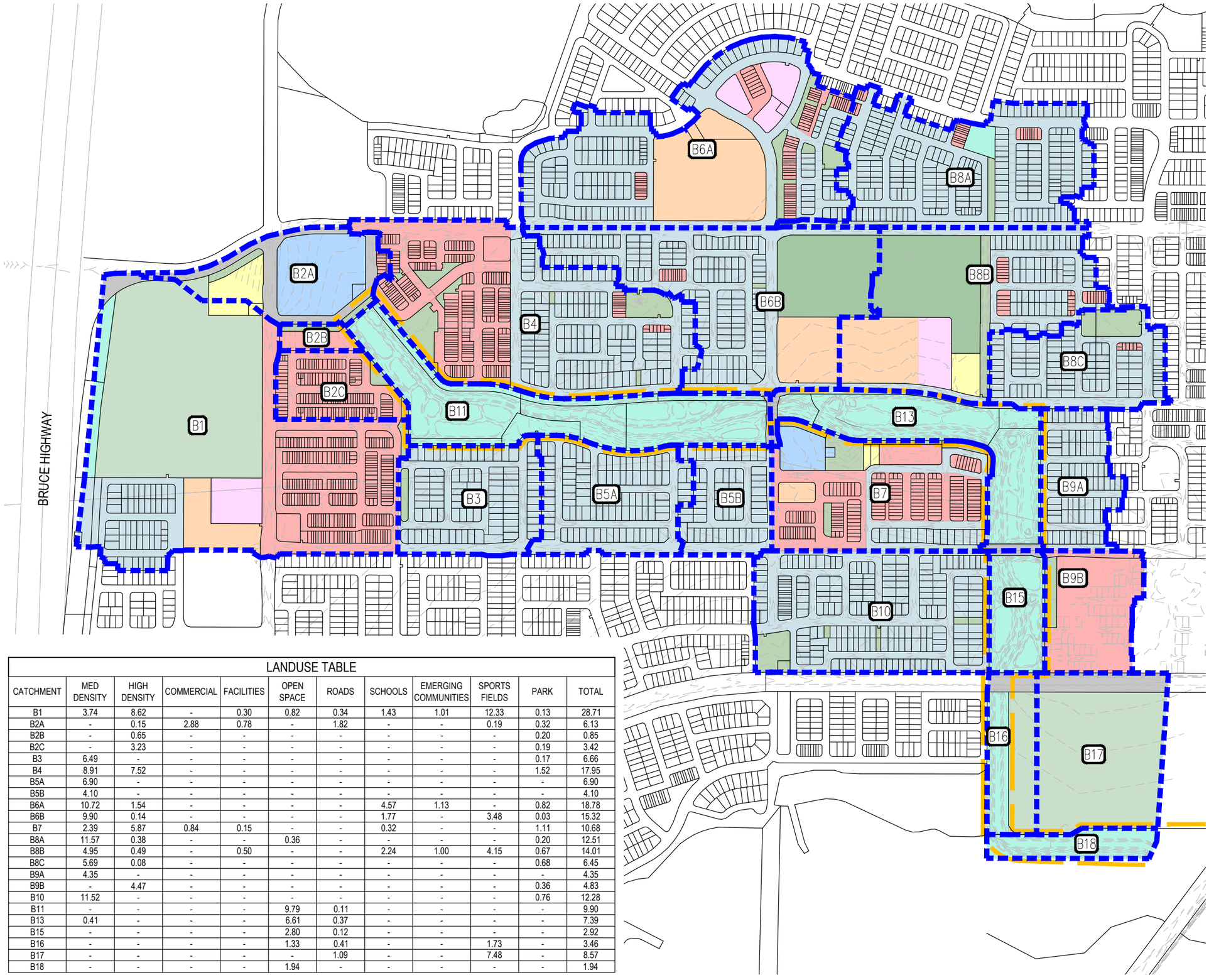
CLIENT: STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT: AURA BROOK - NORTH CENTRAL LOCALITY PRECINCTS 11 & 12

DRAWING TITLE: AURA BROOK CATCHMENT PLAN

PROJECT No.	DRAWING No.	REVISION
18-000340	SK3101	B

DISCLAIMER: ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY, DO NOT SCALE.



LEGEND:

- BROOK BOUNDARY
- LOT BOUNDARY
- CADASTRE
- DEVELOPED CATCHMENT BOUNDARY
- COMMERCIAL
- HIGH DENSITY
- MEDIUM DENSITY
- COMMUNITY FACILITIES
- OPEN SPACE
- EMERGING COMMUNITIES
- ROAD
- SCHOOL
- SPORTS FIELD
- PARK
- A — CATCHMENT LABEL

LANDUSE TABLE

CATCHMENT	MED DENSITY	HIGH DENSITY	COMMERCIAL	FACILITIES	OPEN SPACE	ROADS	SCHOOLS	EMERGING COMMUNITIES	SPORTS FIELDS	PARK	TOTAL
B1	3.74	8.62	-	0.30	0.82	0.34	1.43	1.01	12.33	0.13	28.71
B2A	-	0.15	2.88	0.78	-	1.82	-	-	0.19	0.32	6.13
B2B	-	0.65	-	-	-	-	-	-	-	0.20	0.85
B2C	-	3.23	-	-	-	-	-	-	-	0.19	3.42
B3	6.49	-	-	-	-	-	-	-	-	0.17	6.66
B4	8.91	7.52	-	-	-	-	-	-	-	1.52	17.95
B5A	6.90	-	-	-	-	-	-	-	-	-	6.90
B5B	4.10	-	-	-	-	-	-	-	-	-	4.10
B6A	10.72	1.54	-	-	-	-	4.57	1.13	-	0.82	18.78
B6B	9.90	0.14	-	-	-	-	1.77	-	3.48	0.03	15.32
B7	2.39	5.87	0.84	0.15	-	-	0.32	-	-	1.11	10.68
B8A	11.57	0.38	-	-	0.36	-	-	-	-	0.20	12.51
B8B	4.95	0.49	-	0.50	-	-	2.24	1.00	4.15	0.67	14.01
B8C	5.69	0.08	-	-	-	-	-	-	-	0.68	6.45
B9A	4.35	-	-	-	-	-	-	-	-	-	4.35
B9B	-	4.47	-	-	-	-	-	-	-	0.36	4.83
B10	11.52	-	-	-	-	-	-	-	-	0.76	12.28
B11	-	-	-	-	9.79	0.11	-	-	-	-	9.90
B13	0.41	-	-	-	6.61	0.37	-	-	-	-	7.39
B15	-	-	-	-	2.80	0.12	-	-	-	-	2.92
B16	-	-	-	-	1.33	0.41	-	-	1.73	-	3.46
B17	-	-	-	-	-	1.09	-	-	7.48	-	8.57
B18	-	-	-	-	1.94	-	-	-	-	-	1.94

NOTES

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INITIAL ISSUE	DES	DRN	CHK	APP	DATE	AMENDMENT DETAILS
	MP	DMP			23.11.18	
AMENDMENTS B	DY	DC			04.03.21	UPDATED DRAWING NOTES

STATUS: PRELIMINARY

APPROVED
BY: RPEQ NO:
SIGN: DATE:

SCALE
1:4000 40 0 40 80 120 160 200 A1
1:8000 A3

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CLIENT: STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

PROJECT: AURA BROOK - NORTH CENTRAL LOCALITY PRECINCTS 11 & 12

DRAWING TITLE: AURA BROOK LAND USE PLAN

PROJECT No.	DRAWING No.	REVISION
18-000340	SK3102	B

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APPENDIX E:
FLOOD PLANS – DESIGN EVENTS

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PROPOSED ROAD BRIDGE

1 10.84
2 7.48
3 6.66
4 5.78
5 5.69
6 4.81
7 4.51
8 4.39
9 4.28
10 4.22
11 4.15
12 4.07
13 3.94

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
D/S IL = 4.64m AHD
Length = 30m

CULVERT STRUCTURE 3:
5/2400X2100 RCBC
U/S IL = 2.96m AHD
D/S IL = 2.90m AHD
Length = 31m

PEDESTRIAN CULVERT 4:
1/6000X2700 RCBC
U/S IL = 5.18m AHD
D/S IL = 5.13m AHD
Length = 45m

CULVERT STRUCTURE 4:
4/3600X2100 RCBC
U/S IL = 2.65m AHD
D/S IL = 2.60m AHD
Length = 40m

PEDESTRIAN CULVERT 5:
1/3450X1200 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

CULVERT STRUCTURE 5:
4/3600X1500 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

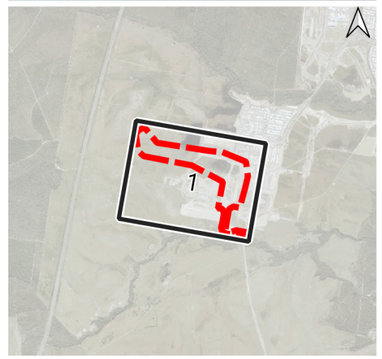
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- REPORTING POINTS
- FLOOD HEIGHT CONTOURS (mAHD)
- FLOOD EXTENT

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- > 3.0

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
2. RESULTS PRESENTED ARE THE MAXIMUM OF STANDARD DURATIONS FOR THE AEP EVENT PRESENTED.
3. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT DATUM (mAHD).

PLAN TITLE

ULTIMATE SCENARIO
63% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-U-001-A

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
D/S IL = 4.64m AHD
Length = 30m

CULVERT STRUCTURE 3:
5/2400X2100 RCBC
U/S IL = 2.96m AHD
D/S IL = 2.90m AHD
Length = 31m

CULVERT STRUCTURE 4:
4/3600X2100 RCBC
U/S IL = 2.65m AHD
D/S IL = 2.60m AHD
Length = 40m

PEDESTRIAN CULVERT 4:
1/6000X2700 RCBC
U/S IL = 5.18m AHD
D/S IL = 5.13m AHD
Length = 45m

PEDESTRIAN CULVERT 5:
1/3450X1200 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

CULVERT STRUCTURE 5:
4/3600X1500 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

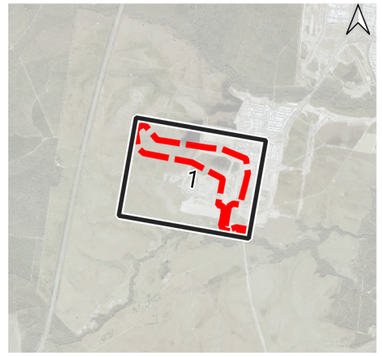
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- 3.0 TO 4.0
- > 4.0

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
2. RESULTS PRESENTED ARE THE MAXIMUM OF STANDARD DURATIONS FOR THE AEP EVENT PRESENTED.
3. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT DATUM (mAHD).

PLAN TITLE

ULTIMATE SCENARIO
63% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-U-001-B

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m

1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
D/S IL = 4.64m AHD
Length = 30m

CULVERT STRUCTURE 3:
5/2400X2100 RCBC
U/S IL = 2.96m AHD
D/S IL = 2.90m AHD
Length = 31m

PEDESTRIAN CULVERT 4:
1/6000X2700 RCBC
U/S IL = 5.18m AHD
D/S IL = 5.13m AHD
Length = 45m

CULVERT STRUCTURE 4:
4/3600X2100 RCBC
U/S IL = 2.65m AHD
D/S IL = 2.60m AHD
Length = 40m

PEDESTRIAN CULVERT 5:
1/3450X1200 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

CULVERT STRUCTURE 5:
4/3600X1500 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

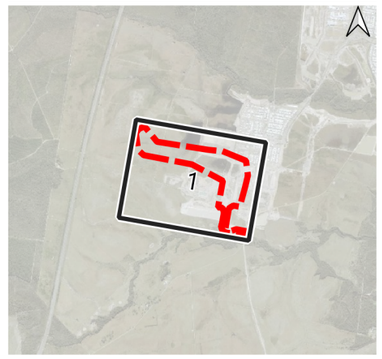
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
2. RESULTS PRESENTED ARE THE MAXIMUM OF STANDARD DURATIONS FOR THE AEP EVENT PRESENTED.
3. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT DATUM (mAHD).

PLAN TITLE

ULTIMATE SCENARIO
63% AEP STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-U-001-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
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PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m

1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

1 10.87
2 7.68
3 6.88
4 5.92
5 5.79
6 4.97
7 4.7
8 4.59
9 4.48
10 4.41
11 4.34
12 4.27
13 4.14

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
D/S IL = 4.64m AHD
Length = 30m

CULVERT STRUCTURE 3:
5/2400X2100 RCBC
U/S IL = 2.96m AHD
D/S IL = 2.90m AHD
Length = 31m

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U/S IL = 5.18m AHD
D/S IL = 5.13m AHD
Length = 45m

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U/S IL = 2.65m AHD
D/S IL = 2.60m AHD
Length = 40m

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1/3450X1200 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

CULVERT STRUCTURE 5:
4/3600X1500 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

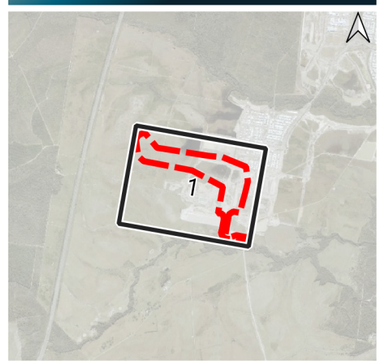
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT
- FLOOD HEIGHT CONTOURS (mAHD)

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- > 3.0

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
2. RESULTS PRESENTED ARE THE MAXIMUM OF STANDARD DURATIONS FOR THE AEP EVENT PRESENTED.
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PLAN TITLE

ULTIMATE SCENARIO
39% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-U-002-A

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
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PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

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U/S IL = 4.7m AHD
D/S IL = 4.64m AHD
Length = 30m

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PEDESTRIAN CULVERT 5:
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D/S IL = 2.37m AHD
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4/3600X1500 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

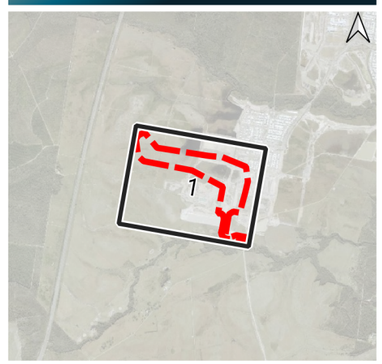
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- 3.0 TO 4.0
- > 4.0

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
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PLAN TITLE

ULTIMATE SCENARIO
39% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-U-002-B

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\6_Model\SF\GIS\FIA1E_FloodMaps\18-000340_FLOOD_PLANS.qgz

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PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
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Length = 30m

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4/3600X1500 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

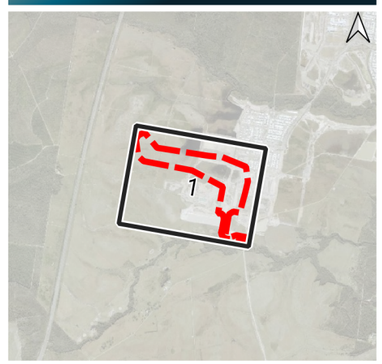
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
39% AEP STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-U-002-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

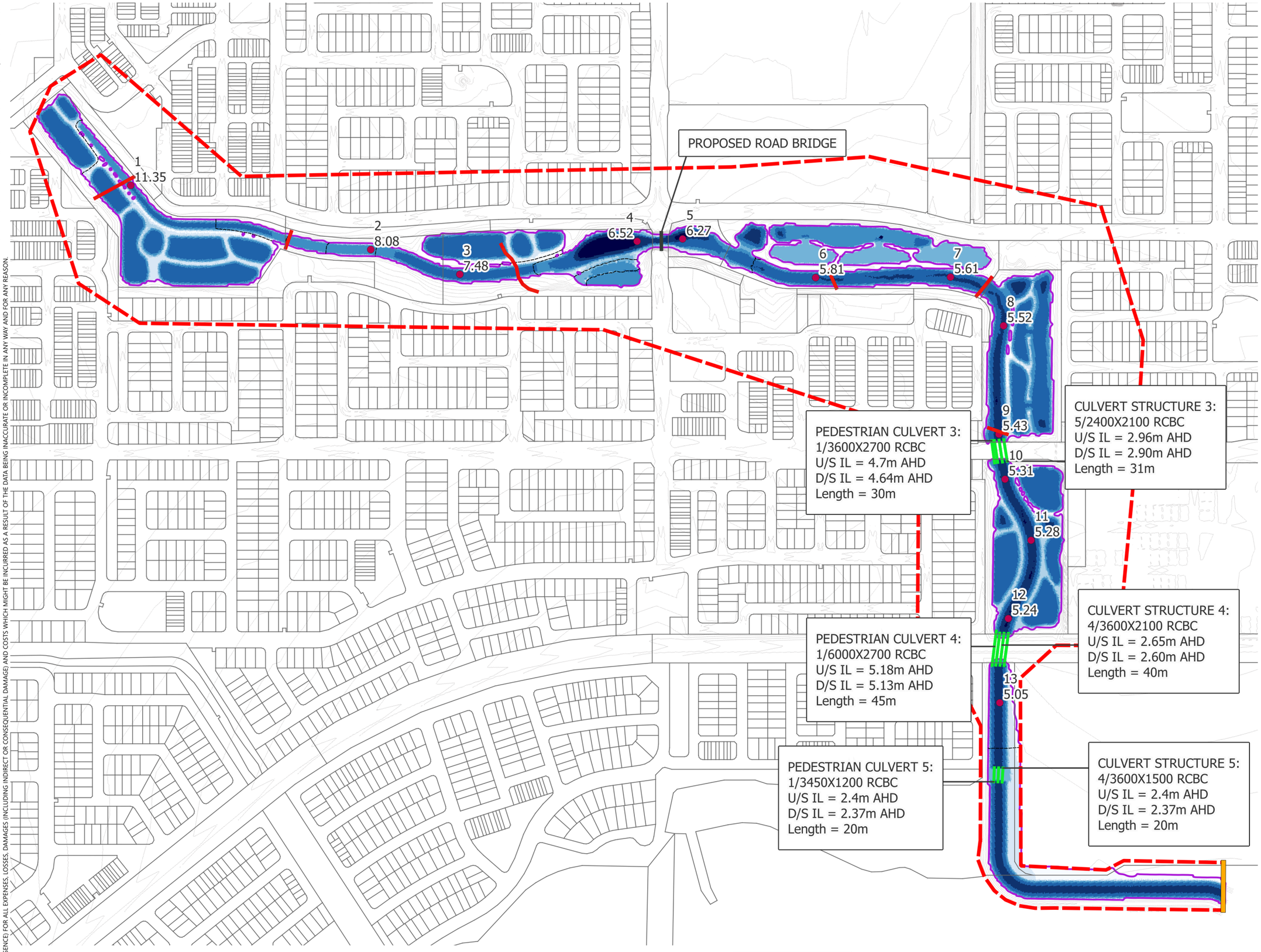
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egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994



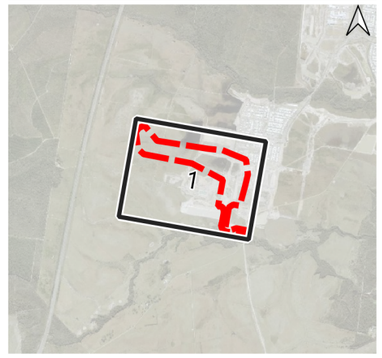
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- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- REPORTING POINTS
- FLOOD HEIGHT CONTOURS (mAHD)
- FLOOD EXTENT

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- > 3.0

INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
18% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-U-005-A

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
1:5000 (A3)
COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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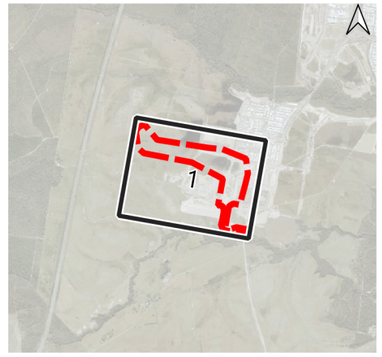
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- 3.0 TO 4.0
- > 4.0

INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
18% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-U-005-B

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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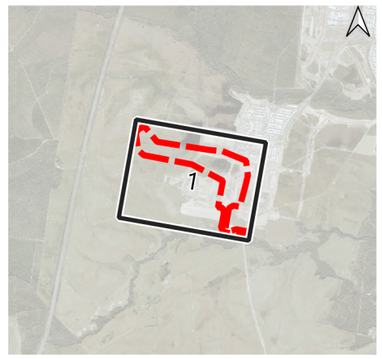
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
18% AEP STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-U-005-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

1
11.25

2
8

3
7.36

4
6.31

5
6.08

6
5.59

7
5.41

8
5.31

9
5.22

10
5.13

11
5.09

12
5.05

13
4.91

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
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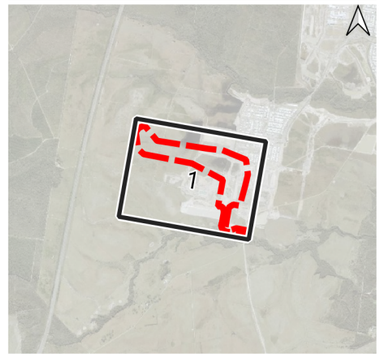
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- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- REPORTING POINTS
- FLOOD HEIGHT CONTOURS (mAHD)
- FLOOD EXTENT

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
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INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
10% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-U-010-A

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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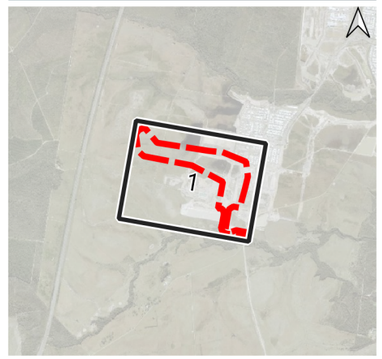
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
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INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
10% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-U-010-B

INITIAL	DATE	BY	CHK	
ISSUE	1.07.24	AM	LM	ISSUE DETAILS
A				
B				
C				
D				
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egis

Stockland

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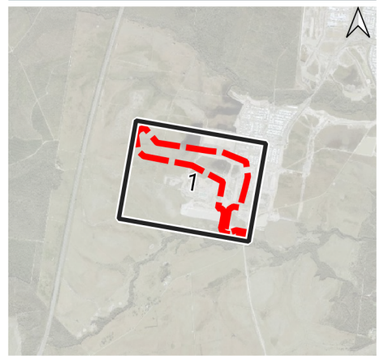
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- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
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- PROPOSED BOARDWALK CROSSINGS
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FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

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PLAN TITLE

ULTIMATE SCENARIO
10% AEP STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-U-010-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

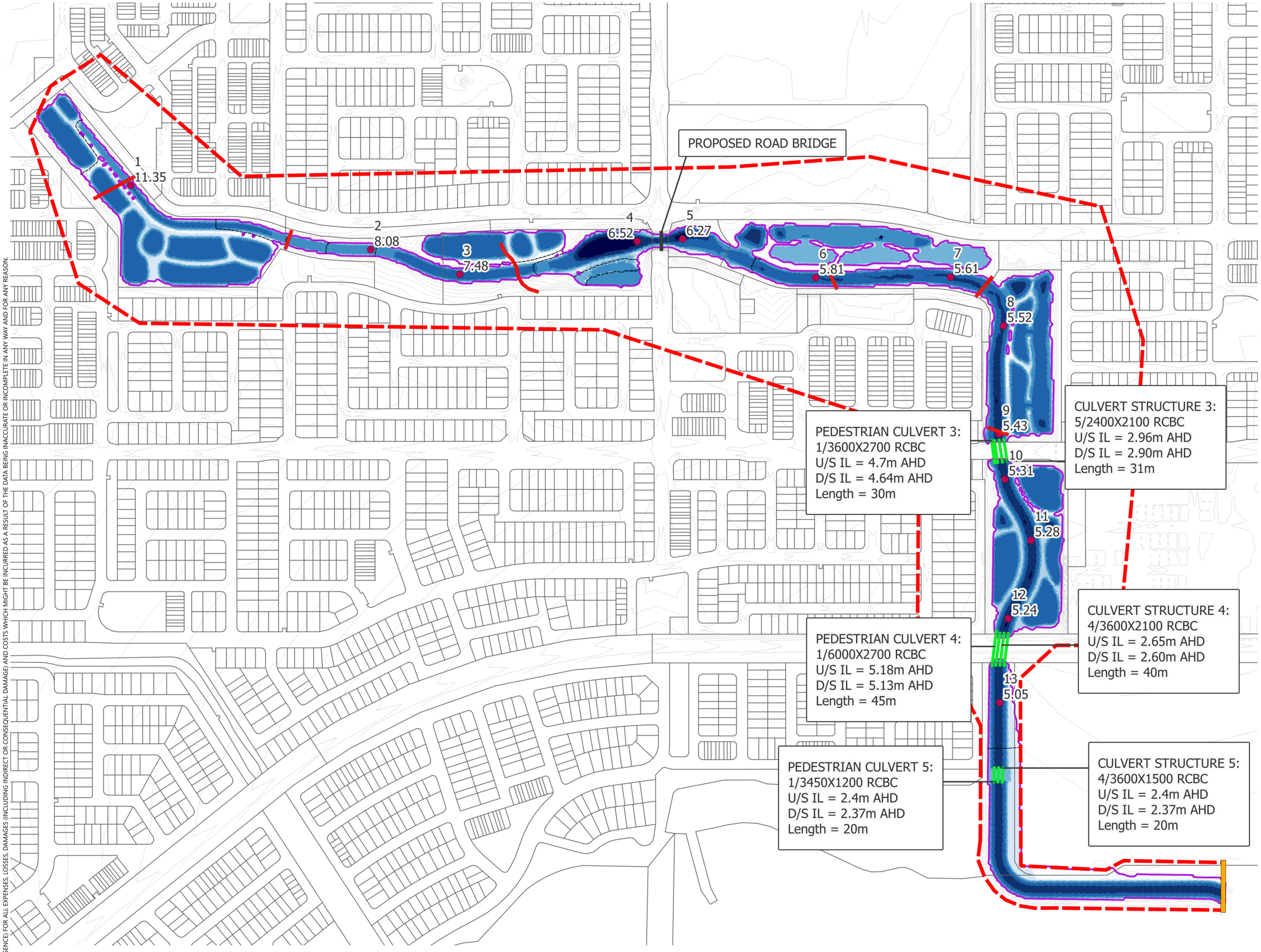
egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\6_Model\SF\GIS\FIA1E_FloodMaps\18-000340_FLOOD_PLANS.qgz



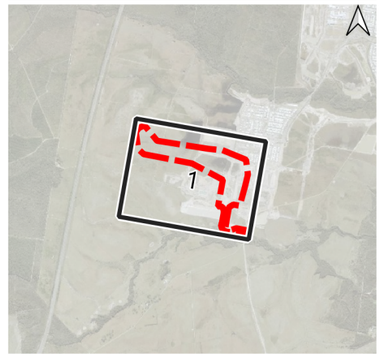
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- REPORTING POINTS
- FLOOD HEIGHT CONTOURS (mAHD)
- FLOOD EXTENT

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- > 3.0

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
2. RESULTS PRESENTED ARE THE MAXIMUM OF STANDARD DURATIONS FOR THE AEP EVENT PRESENTED.
3. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT DATUM (mAHD).

PLAN TITLE

ULTIMATE SCENARIO
5% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-U-020-A

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\6_Model\SF\GIS\FIA1E_FloodMaps\18-000340_FLOOD_PLANS.qgz

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
D/S IL = 4.64m AHD
Length = 30m

CULVERT STRUCTURE 3:
5/2400X2100 RCBC
U/S IL = 2.96m AHD
D/S IL = 2.90m AHD
Length = 31m

PEDESTRIAN CULVERT 4:
1/6000X2700 RCBC
U/S IL = 5.18m AHD
D/S IL = 5.13m AHD
Length = 45m

CULVERT STRUCTURE 4:
4/3600X2100 RCBC
U/S IL = 2.65m AHD
D/S IL = 2.60m AHD
Length = 40m

PEDESTRIAN CULVERT 5:
1/3450X1200 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

CULVERT STRUCTURE 5:
4/3600X1500 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

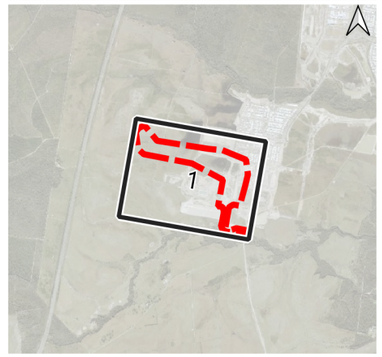
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- 3.0 TO 4.0
- > 4.0

INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
5% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-U-020-B

INITIAL	DATE	BY	CHK	
ISSUE	1.07.24	AM	LM	ISSUE DETAILS
A				
B				
C				
D				
E				
F				
G				

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\6_Model\SF\GIS\FIA1E_FloodMaps\18-000340_FLOOD_PLANS.qgz

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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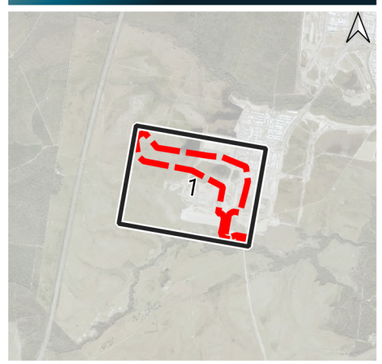
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
5% AEP STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-U-020-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\6_Model\SF\GIS\FIA1E_FloodMaps\18-000340_FLOOD_PLANS.qgz

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

1
11.42
2
8.12
3
7.5
4
6.58
5
6.33
6
5.91
7
5.74
8
5.67
9
5.61
10
5.5
11
5.48
12
5.44
13
5.23

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
D/S IL = 4.64m AHD
Length = 30m

CULVERT STRUCTURE 3:
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U/S IL = 2.96m AHD
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D/S IL = 2.37m AHD
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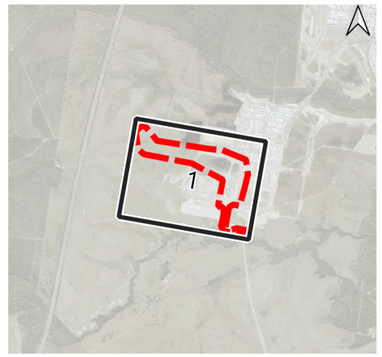
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- REPORTING POINTS
- FLOOD HEIGHT CONTOURS (mAHD)
- FLOOD EXTENT

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- > 3.0

INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
2% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-U-050-A

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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D/S IL = 2.37m AHD
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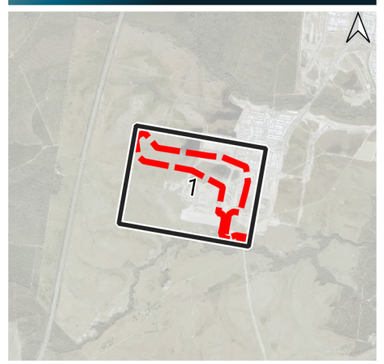
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- 3.0 TO 4.0
- > 4.0

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
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PLAN TITLE

ULTIMATE SCENARIO
2% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-U-050-B

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\6_Model\SF\GIS\FIA1E_FloodMaps\18-000340_FLOOD_PLANS.qgz

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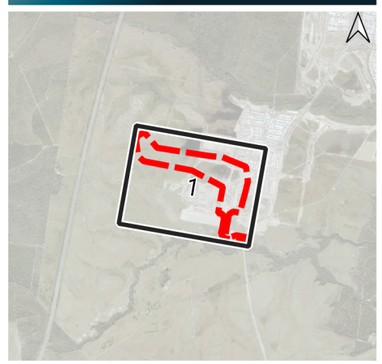
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
2% AEP STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-U-050-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
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PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
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PROPOSED ROAD BRIDGE

1 11.7
2 8.38
3 7.86
4 7.02
5 6.71
6 6.33
7 6.23
8 6.16
9 6.1
10 5.91
11 5.89
12 5.86
13 5.54

PEDESTRIAN CULVERT 3:
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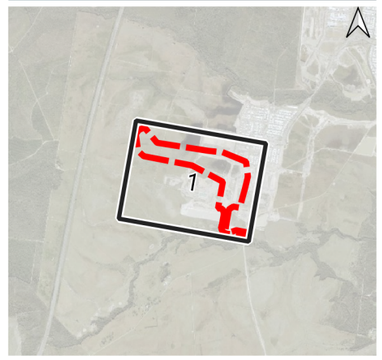
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- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD HEIGHT CONTOURS (mAHD)
- FLOOD EXTENT

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- > 3.0

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PLAN TITLE

ULTIMATE SCENARIO
1% AEP + CC STORM EVENT
MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-U-100CC-A

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\6_Model\SF\GIS\FIA1E_FloodMaps\18-000340_FLOOD_PLANS.qgz

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PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
D/S IL = 4.64m AHD
Length = 30m

CULVERT STRUCTURE 3:
5/2400X2100 RCBC
U/S IL = 2.96m AHD
D/S IL = 2.90m AHD
Length = 31m

PEDESTRIAN CULVERT 4:
1/6000X2700 RCBC
U/S IL = 5.18m AHD
D/S IL = 5.13m AHD
Length = 45m

CULVERT STRUCTURE 4:
4/3600X2100 RCBC
U/S IL = 2.65m AHD
D/S IL = 2.60m AHD
Length = 40m

PEDESTRIAN CULVERT 5:
1/3450X1200 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

CULVERT STRUCTURE 5:
4/3600X1500 RCBC
U/S IL = 2.4m AHD
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Length = 20m

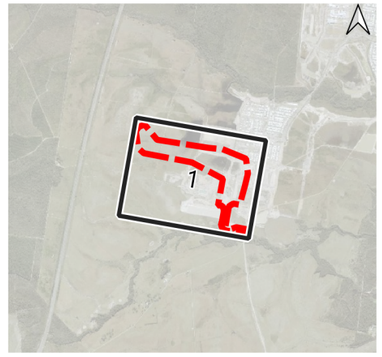
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- 3.0 TO 4.0
- > 4.0

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
2. RESULTS PRESENTED ARE THE MAXIMUM OF STANDARD DURATIONS FOR THE AEP EVENT PRESENTED.
3. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT DATUM (mAHD).

PLAN TITLE

ULTIMATE SCENARIO
1% AEP + CC STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-U-100CC-B

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
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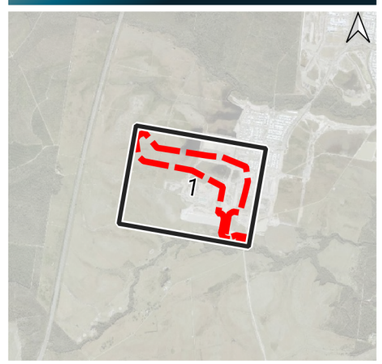
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



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PLAN TITLE

ULTIMATE SCENARIO
1% AEP + CC STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-U-100CC-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

APPENDIX F:
FLOOD PLANS – SENSITIVITY EVENTS

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PROPOSED ROAD BRIDGE

1
10.87

2
7.57

3
6.71

4
5.92

5
5.79

6
5.525

7
5.523

8
5.522

9
5.522

10
5.5

11
5.5

12
5.5

13
2.98

PEDESTRIAN CULVERT 3:
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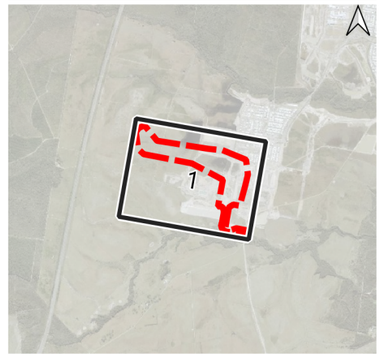
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- REPORTING POINTS
- FLOOD EXTENT
- FLOOD HEIGHT CONTOURS (mAHD)

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- > 3.0

INDEX MAP



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PLAN TITLE

SEVERE BLOCKAGE SCENARIO
39% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-S_A-002-A

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

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AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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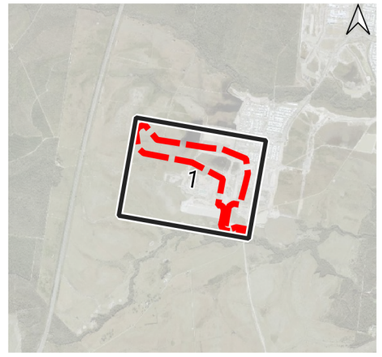
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- 3.0 TO 4.0
- > 4.0

INDEX MAP



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PLAN TITLE

SEVERE BLOCKAGE SCENARIO
39% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-S_A-002-B

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ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
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egis

Stockland

0 83 167 250 m

1:5000 (A3)

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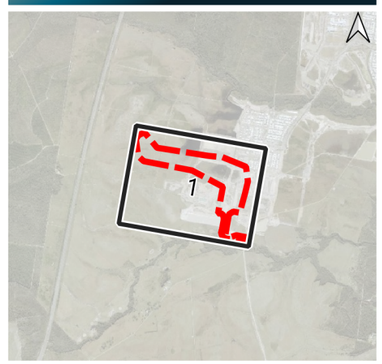
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



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PLAN TITLE

SEVERE BLOCKAGE SCENARIO
39% AEP STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-S_A-002-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

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STOCKLAND DEVELOPMENT

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0 83 167 250 m
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COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
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PROPOSED ROAD BRIDGE

1 11.7
2 8.38
3 7.86
4 7.05
5 6.79
6 6.59
7 6.56
8 6.53
9 6.51
10 6.13
11 6.12
12 6.1
13 5.45

PEDESTRIAN CULVERT 3:
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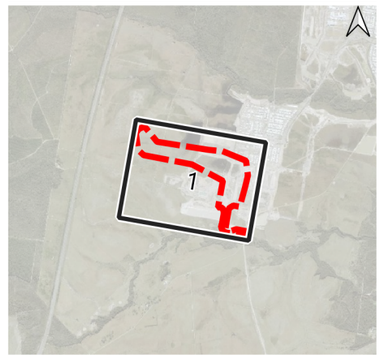
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- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT
- FLOOD HEIGHT CONTOURS (mAHD)

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
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PLAN TITLE

50% BLOCKAGE SCENARIO
1% AEP + CC STORM EVENT
MAXIMUM FLOOD DEPTH

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egis

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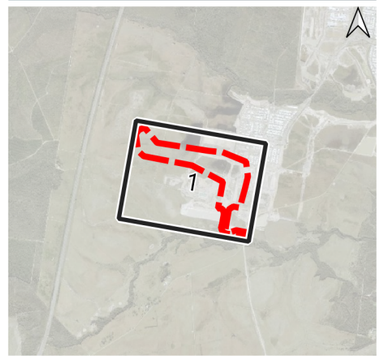
LEGEND

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- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
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PLAN TITLE

50% BLOCKAGE SCENARIO
1% AEP + CC STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-S_B-100CC-B

INITIAL	DATE	BY	CHK	
ISSUE	1.07.24	AM	LM	ISSUE DETAILS
A				
B				
C				
D				
E				
F				
G				

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\6_Model\SF\GIS\FIA1E_FloodMaps\18-000340_FLOOD_PLANS.qgz

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
D/S IL = 4.64m AHD
Length = 30m

CULVERT STRUCTURE 3:
5/2400X2100 RCBC
U/S IL = 2.96m AHD
D/S IL = 2.90m AHD
Length = 31m

PEDESTRIAN CULVERT 4:
1/6000X2700 RCBC
U/S IL = 5.18m AHD
D/S IL = 5.13m AHD
Length = 45m

CULVERT STRUCTURE 4:
4/3600X2100 RCBC
U/S IL = 2.65m AHD
D/S IL = 2.60m AHD
Length = 40m

PEDESTRIAN CULVERT 5:
1/3450X1200 RCBC
U/S IL = 2.4m AHD
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U/S IL = 2.4m AHD
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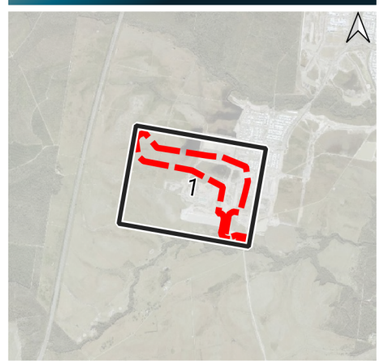
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
2. RESULTS PRESENTED ARE THE MAXIMUM OF STANDARD DURATIONS FOR THE AEP EVENT PRESENTED.
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PLAN TITLE

50% BLOCKAGE SCENARIO
1% AEP + CC STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-S_B-100CC-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

1
11.76

2
8.51

3
8.01

4
7.31

5
7.07

6
6.65

7
6.56

8
6.47

9
6.4

10
6.24

11
6.2

12
6.16

13
5.89

PEDESTRIAN CULVERT 3:
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U/S IL = 4.7m AHD
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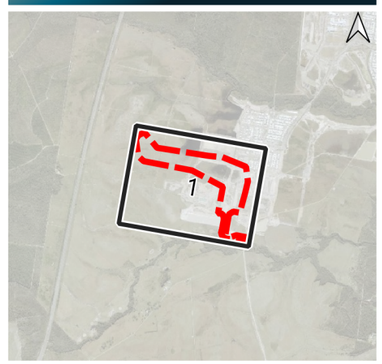
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT
- FLOOD HEIGHT CONTOURS (mAHD)

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- > 3.0

INDEX MAP



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PLAN TITLE

HIGH MANNINGS SCENARIO
1% AEP + CC STORM EVENT
MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-S_C-100CC-A

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

\\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\6_Model\SF\GIS\FIA1E_FloodMaps\18-000340_FLOOD_PLANS.qgz

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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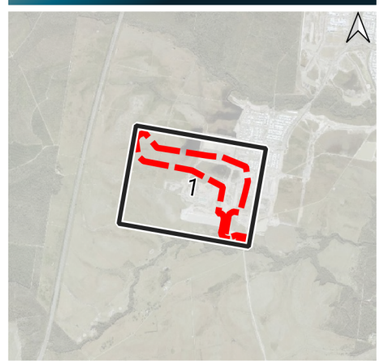
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- 3.0 TO 4.0
- > 4.0

INDEX MAP



NOTES

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PLAN TITLE

HIGH MANNINGS SCENARIO
1% AEP + CC STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-S_C-100CC-B

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

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STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
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COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
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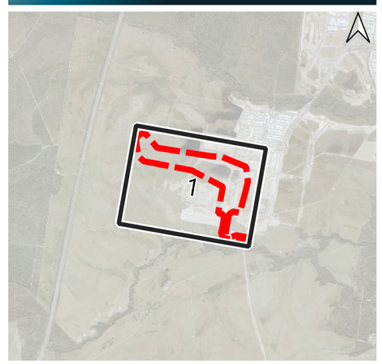
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



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PLAN TITLE

HIGH MANNINGS SCENARIO
1% AEP + CC STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-S_C-100CC-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

1 11.89
2 8.75
3 8.29
4 7.49
5 7.08
6 6.71
7 6.66
8 6.61
9 6.55
10 6.29
11 6.27
12 6.24
13 5.8

PEDESTRIAN CULVERT 3:
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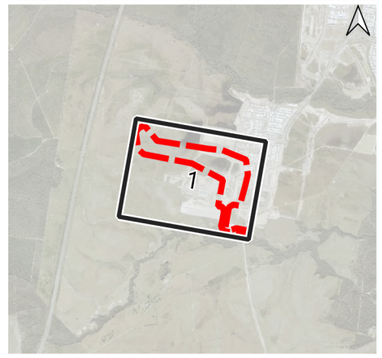
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- REPORTING POINTS
- FLOOD EXTENT
- FLOOD HEIGHT CONTOURS (mAHD)

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- > 3.0

INDEX MAP



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PLAN TITLE

1% AEP CC DIS STORM SCENARIO
1% AEP + CC STORM EVENT MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-S_D-100CC-A

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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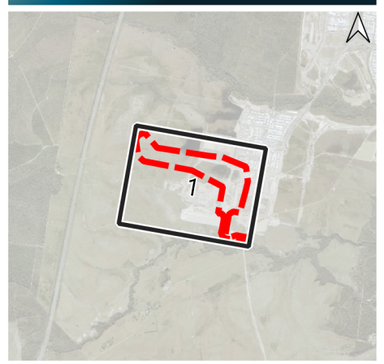
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- 3.0 TO 4.0
- > 4.0

INDEX MAP



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PLAN TITLE

1% AEP CC DIS STORM SCENARIO
1% AEP + CC STORM EVENT MAXIMUM FLOOD VELOCITY

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egis

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COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
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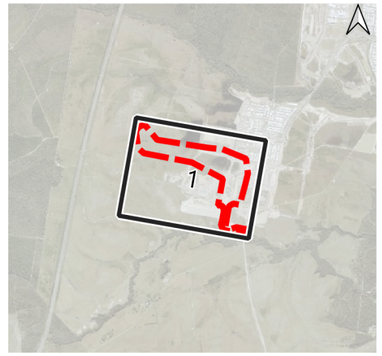
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- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
2. RESULTS PRESENTED ARE THE MAXIMUM OF STANDARD DURATIONS FOR THE AEP EVENT PRESENTED.
3. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT DATUM (mAHD).

PLAN TITLE

1% AEP CC DIS STORM SCENARIO
1% AEP + CC STORM EVENT MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-S_D-100CC-D

INITIAL DATE	BY	CHK	
ISSUE 1.07.24	AM	LM	ISSUE DETAILS
A			
B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

1 12.01
2 8.99
3 8.55
4 7.88
5 7.5
6 7.39
7 7.36
8 7.32
9 7.28
10 6.87
11 6.86
12 6.83
13 6.2

PEDESTRIAN CULVERT 3:
1/3600X2700 RCBC
U/S IL = 4.7m AHD
D/S IL = 4.64m AHD
Length = 30m

CULVERT STRUCTURE 3:
5/2400X2100 RCBC
U/S IL = 2.96m AHD
D/S IL = 2.90m AHD
Length = 31m

PEDESTRIAN CULVERT 4:
1/6000X2700 RCBC
U/S IL = 5.18m AHD
D/S IL = 5.13m AHD
Length = 45m

CULVERT STRUCTURE 4:
4/3600X2100 RCBC
U/S IL = 2.65m AHD
D/S IL = 2.60m AHD
Length = 40m

PEDESTRIAN CULVERT 5:
1/3450X1200 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

CULVERT STRUCTURE 5:
4/3600X1500 RCBC
U/S IL = 2.4m AHD
D/S IL = 2.37m AHD
Length = 20m

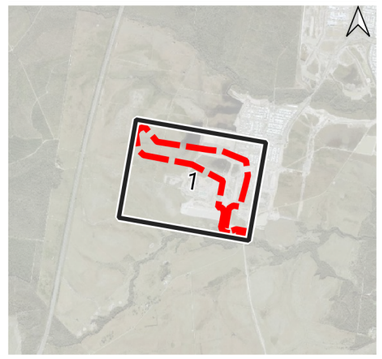
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- REPORTING POINTS
- FLOOD HEIGHT CONTOURS (mAHD)
- FLOOD EXTENT

FLOOD DEPTH (m)

- < 0.1
- 0.1 TO 0.2
- 0.2 TO 0.3
- 0.3 TO 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- > 3.0

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
2. RESULTS PRESENTED ARE THE MAXIMUM OF STANDARD DURATIONS FOR THE AEP EVENT PRESENTED.
3. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT DATUM (mAHD).

PLAN TITLE

0.05% AEP DIS STORM SCENARIO
0.05% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

PLAN NUMBER REV

18-000340-S_E-2000-A

INITIAL DATE	BY	CHK	
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B			
C			
D			
E			
F			
G			

PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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PROPOSED ROAD BRIDGE

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D/S IL = 4.64m AHD
Length = 30m

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U/S IL = 2.4m AHD
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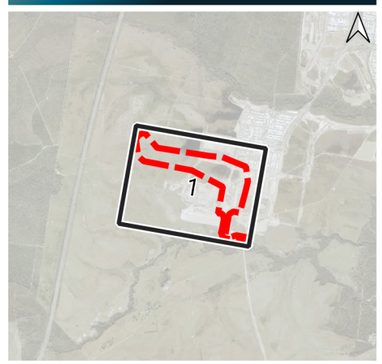
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD VELOCITY (m/s)

- < 0.5
- 0.5 TO 1.0
- 1.0 TO 2.0
- 2.0 TO 3.0
- 3.0 TO 4.0
- > 4.0

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
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3. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT DATUM (mAHD).

PLAN TITLE

0.05% AEP DIS STORM SCENARIO
0.05% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

PLAN NUMBER REV

18-000340-S_E-2000-B

INITIAL DATE	BY	CHK	
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B			
C			
D			
E			
F			
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PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

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Length = 30m

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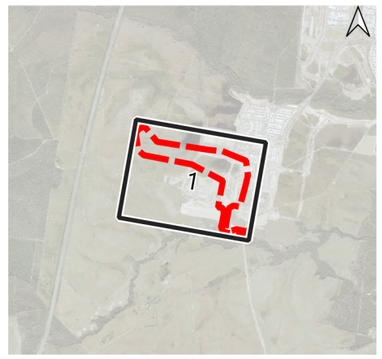
LEGEND

- MODEL BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT
- DOWNSTREAM BOUNDARY FLOW LINE
- PROPOSED CULVERTS
- PROPOSED ROAD BRIDGE
- PROPOSED BOARDWALK CROSSINGS
- FLOOD EXTENT

FLOOD DV (m^2/s)

- 0.01 to 0.05
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- 0.6 to 1

INDEX MAP



NOTES

1. REFER TO EGIS REPORT No. 18-000340.FIR.01E.LM.dy.am DATED JULY 2024.
2. RESULTS PRESENTED ARE THE MAXIMUM OF STANDARD DURATIONS FOR THE AEP EVENT PRESENTED.
3. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT DATUM (mAHD).

PLAN TITLE

0.05% AEP DIS STORM SCENARIO
0.05% AEP STORM EVENT
MAXIMUM FLOOD HAZARD

PLAN NUMBER REV

18-000340-S_E-2000-D

INITIAL DATE	BY	CHK	
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A			
B			
C			
D			
E			
F			
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PROJECT
AURA BROOK FLOOD INVESTIGATION

CLIENT
STOCKLAND DEVELOPMENT

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egis

Stockland

0 83 167 250 m
1:5000 (A3)

COORDINATE REFERENCE: GDA1994 / MGA ZONE 56
HEIGHT DATUM: GDA1994

APPENDIX G:
WATER SURFACE LEVEL RESULTS

2D Flood Results

18-000340 - Aura Brook 2D Flood Investigation

File: \\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\2_Docs\Stormwater\FIR.01E\APPENDICES\Appendix G - 2D Flood Results\

Date:	18/07/2024
By:	AM

Table G.1

Reporting Location	Design Storms		Sensitivity Scenarios				Severe Storm
	39% AEP	1%AEP+CC	39% AEP Major Blockage	1% AEP +CC 50% Blockage	1% AEP +CC High Mannings	1% AEP +CC DIS	0.05% AEP DIS
1	10.870	11.700	10.873	11.700	11.761	11.888	12.014
2	7.683	8.377	7.568	8.378	8.509	8.753	8.995
3	6.885	7.860	6.711	7.860	8.009	8.292	8.554
4	5.920	7.022	5.921	7.054	7.311	7.494	7.884
5	5.790	6.710	5.793	6.790	7.067	7.075	7.497
6	4.970	6.334	5.525	6.594	6.650	6.712	7.387
7	4.700	6.228	5.523	6.560	6.564	6.663	7.362
8	4.590	6.158	5.522	6.530	6.467	6.610	7.324
9	4.480	6.098	5.522	6.506	6.396	6.555	7.275
10	4.410	5.910	5.502	6.130	6.237	6.290	6.872
11	4.340	5.891	5.502	6.121	6.200	6.274	6.859
12	4.270	5.859	5.502	6.105	6.156	6.243	6.832
13	4.140	5.542	2.979	5.453	5.891	5.802	6.198

Table G.2

Reporting Location	Adopted Minimum Lot Level	Governing Scenario	Adopted Minimum Floor
1	12.05	1%AEP+CC Design Event + 350mm Freeboard	12.20
2	8.76	1%AEP+CC DIS Event	8.91
3	8.30	1%AEP+CC DIS Event	8.45
4	7.50	1%AEP+CC DIS Event	7.65
5	7.08	1%AEP+CC DIS Event	7.23
6	6.72	1%AEP+CC DIS Event	6.87
7	6.67	1%AEP+CC DIS Event	6.82
8	6.61	1%AEP+CC DIS Event	6.76
9	6.56	1%AEP+CC DIS Event	6.71
10	6.29	1%AEP+CC DIS Event	6.44
11	6.28	1%AEP+CC DIS Event	6.43
12	6.25	1%AEP+CC DIS Event	6.40
13	5.90	1%AEP+CC Design Event + 350mm Freeboard	6.05

Table G.3

Reporting Location	All Modelled Design Storms							
	63% AEP	39% AEP	18% AEP	10% AEP	5% AEP	2% AEP	1% AEP	1% AEP+CC
1	10.837	10.870	11.085	11.249	11.353	11.417	11.532	11.700
2	7.484	7.683	7.803	7.998	8.081	8.118	8.221	8.377
3	6.657	6.885	7.025	7.357	7.478	7.503	7.643	7.860
4	5.778	5.920	6.160	6.311	6.516	6.578	6.731	7.022
5	5.692	5.790	5.954	6.083	6.271	6.333	6.469	6.710
6	4.808	4.970	5.307	5.585	5.805	5.907	6.052	6.334
7	4.507	4.700	5.108	5.411	5.611	5.735	5.871	6.228
8	4.386	4.590	4.987	5.315	5.517	5.670	5.816	6.158
9	4.282	4.480	4.878	5.218	5.427	5.607	5.759	6.098
10	4.218	4.410	4.798	5.130	5.315	5.503	5.643	5.910
11	4.148	4.340	4.752	5.093	5.280	5.478	5.623	5.891
12	4.068	4.270	4.700	5.051	5.241	5.444	5.591	5.859
13	3.943	4.140	4.595	4.913	5.055	5.231	5.360	5.542

APPENDIX H:
1D STRUCTURE RESULTS

1D Structure Results

18-000340 - Aura Brook 2D Flood Investigation

File: \\egis.racine.local\bu_batiment\CAL\05_Projects\BNE\18\000340 - AURA Sustainability\2_Docs\Stormwater\FIR.01E\APPENDICES\Appendix H - 1D St

Date:	18/07/2024
By:	AM

Table H.1 - Flood Water Surface Levels

Struture ID		Design Storms		Sensitivity Scenarios				Severe Storm
		39% AEP	1%AEP+CC	39% AEP Major Blockage	1% AEP +CC 50% Blockage	1% AEP +CC High Mannings	1% AEP +CC DIS	0.05% AEP DIS
CULV3_FP	US	4.473	6.096	5.522	6.505	6.389	6.553	7.272
	DS	4.426	5.934	5.502	6.143	6.268	6.315	6.900
CULV3_FP_RB	US	4.483	6.107	5.522	6.510	6.401	6.565	7.288
	DS	4.427	5.935	5.502	6.143	6.273	6.318	6.903
CULV3_FP_LB	US	4.482	6.104	5.522	6.508	6.398	6.558	7.273
	DS	4.448	5.963	5.502	6.158	6.286	6.349	6.941
CULV3_PED	US	4.699	6.108	5.522	6.510	6.401	6.562	7.279
	DS	4.639	5.934	5.502	6.143	6.268	6.317	6.905
CULV4_FP	US	4.261	5.846	5.502	6.097	6.134	6.227	6.812
	DS	4.211	5.619	3.000	5.518	5.976	5.893	6.302
CUL4_FP_RB	US	4.261	5.845	5.502	6.096	6.130	6.224	6.807
	DS	4.216	5.637	2.998	5.532	5.995	5.919	6.339
CULV4_FP_LB	US	4.253	5.830	5.502	6.086	6.121	6.203	6.779
	DS	4.222	5.639	3.608	5.534	5.985	5.918	6.333
CULV4_PED	US	5.179	5.854	5.502	6.101	6.136	6.232	6.812
	DS	5.129	5.621	5.129	5.520	5.977	5.901	6.325
CULV5_FP	US	4.058	5.450	2.907	5.378	5.765	5.692	6.078
	DS	3.999	5.358	2.898	5.240	5.702	5.593	5.984
CULV5_FP_RB	US	4.055	5.446	2.910	5.375	5.766	5.687	6.072
	DS	4.010	5.378	2.909	5.254	5.715	5.613	6.000
CULV5_FP_LB	US	4.038	5.422	2.897	5.359	5.750	5.660	6.044
	DS	4.001	5.346	2.897	5.222	5.696	5.577	5.965

Table H.2 - Structure Flows and Velocities

Struture ID		Design Storms		Sensitivity Scenarios				Severe Storm
		39% AEP	1%AEP+CC	39% AEP Major Blockage	1% AEP +CC 50% Blockage	1% AEP +CC High Mannings	1% AEP +CC DIS	0.05% AEP DIS
CULV3_FP	Flow	6.182	15.571	Culverts are 100% blocked.	12.484	13.617	19.845	24.419
	Velocity	1.187	1.335		1.927	1.167	1.701	2.094
CULV3_FP_RB	Flow	1.725	4.037		2.964	3.532	5.110	6.262
	Velocity	1.194	1.108		1.464	0.969	1.402	1.718
CULV3_FP_LB	Flow	1.401	3.665		2.899	3.310	4.697	5.822
	Velocity	0.880	1.005		1.432	0.908	1.288	1.597
CULV3_PED	Flow	0.000	5.981		5.491	6.672	9.429	15.713
	Velocity	0.000	1.428		2.046	1.275	1.806	2.210
CULV4_FP	Flow	6.597	18.115		15.452	15.186	22.011	27.135
	Velocity	0.981	1.553		2.385	1.302	1.887	2.326
CUL4_FP_RB	Flow	2.466	6.568		5.478	5.330	7.980	9.863
	Velocity	0.721	1.175		1.764	0.954	1.428	1.765
CULV4_FP_LB	Flow	2.053	6.297		5.412	5.337	7.718	9.620
	Velocity	0.776	1.127		1.743	0.955	1.381	1.721
CULV4_PED	Flow	0.000	4.013		3.566	5.985	7.874	15.267
	Velocity	0.000	1.475		2.182	1.314	1.867	2.343
CULV5_FP	Flow	6.497	8.003		5.365	6.704	8.360	8.077
	Velocity	0.921	1.029		1.242	0.862	1.075	1.039
CULV5_FP_RB	Flow	0.000	2.781		1.952	2.454	2.928	2.878
	Velocity	0.721	0.747		0.943	0.659	0.786	0.772
CULV5_FP_LB	Flow	2.054	2.968		2.079	2.511	3.099	3.004
	Velocity	0.551	0.796		1.004	0.674	0.832	0.806

Egis Consulting Pty Ltd

www.egis-group.com

CONTACT US

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Level 4, Unit 402, 8 Market Lane, Maroochydore QLD 4558, Australia