Queensland Government

Department of
State Development, Manufacturing, Infrastructure and Planning

SARA reference: 1911-13966 SRA
Council reference: D/99-2019

4 December 2019

Chief Executive Officer
Rockhampton Regional Council
PO Box 1860
Rockhampton Qld 4700
enquiries@rrc.qld.gov.au

Attention: Amanda O'Mara

Dear Sir/Madam

SARA response—98 - 1002 Yaamba Road, Parkhurst; 1014 - 1016 Yaamba Road, Parkhurst

(Referral agency response given under section 56 of the *Planning Act 2016*)

The development application described below was confirmed as properly referred by the Department of State Development, Manufacturing, Infrastructure and Planning on 4 November 2019.

Response

Outcome:	Referral agency response – with conditions.
Date of response:	4 December 2019
Conditions:	The conditions in **Attachment 1** must be attached to any development approval.
Advice:	Advice to the applicant is in **Attachment 2**.
Reasons:	The reasons for the referral agency response are in **Attachment 3**.

Development details

Description:	Development permit	Material Change of Use for Short-term Accommodation and a Relocatable Home Park.
SARA role:	Referral Agency.	
SARA trigger:	Schedule 10, Part 9, div 4, sub 1, table 1 (Planning Regulation 2017)— Development application for a material change of use for an aspect of development stated in Schedule 20: Development impacting on State transport infrastructure and thresholds	

Fitzroy/Central regional office
Level 2, 209 Bolsover Street,
Rockhampton
PO Box 113, Rockhampton QLD 4700

	Schedule 10, Part 9, div 4, sub 2, table 4 (Planning Regulation 2017)—Development application for a material change of use of premises within 25m of a State transport corridor
SARA reference:	1911-13966 SRA
Assessment Manager:	Rockhampton Regional Council
Street address:	98 - 1002 Yaamba Road, Parkhurst; 1014 - 1016 Yaamba Road, Parkhurst
Real property description:	4SP307744; 80SP300143
Applicant name:	Marisa and Gabriele Demedio C/- ADAMS + SPARKES Town Planning and Development
Applicant contact details:	PO Box 1000 BUDDINA QLD 4575 admin@astpd.com.au
State-controlled road access permit:	This referral included an application for a road access location, under section 62A(2) of *Transport Infrastructure Act 1994*. Below are the details of the decision: • Approved • Reference: TMR19-028697 • Date: 2 December 2019 If you are seeking further information on the road access permit, please contact the Department of Transport and Main Roads at fitzroydistrict@tmr.qld.gov.au

Representations

An applicant may make representations to a concurrence agency, at any time before the application is decided, about changing a matter in the referral agency response (s.30 Development Assessment Rules) Copies of the relevant provisions are in **Attachment 4**.

A copy of this response has been sent to the applicant for their information.

For further information please contact Tracey Beath, Senior Planning Officer, on 07 4924 2917 or via email RockhamptonSARA@dsdmip.qld.gov.au who will be pleased to assist.

Yours sincerely

Anthony Walsh
Manager Planning

cc Marisa and Gabriele Demedio C/- ADAMS + SPARKES Town Planning and Development, admin@astpd.com.au

enc Attachment 1 - Referral agency conditions
Attachment 2 - Advice to the applicant
Attachment 3 - Reasons for referral agency response
Attachment 4 - Representations provisions
Attachment 5 - Approved plans and specifications

Attachment 1—Referral agency conditions

(Under section 56(1)(b)(i) of the *Planning Act 2016* the following conditions must be attached to any development approval relating to this application) (Copies of the plans and specifications referenced below are found at Attachment 5)

No.	Conditions	Condition timing
Material change of use		
Schedule 10, Part 9, div 4, sub 1, table 1 & Schedule 10, Part 9, div 4, sub 2, table 4 (Planning Regulation 2017)—The chief executive administering the *Planning Act 2016* nominates the Director-General of Department of Transport and Main Roads to be the enforcement authority for the development to which this development approval relates for the administration and enforcement of any matter relating to the following condition(s):		
1.	(a) Carry out the development generally in accordance with the report *Road Traffic Noise Assessment Motel Expansion and RV Home Sites* prepared by RoadPro Acoustics, dated 3 October 2019, reference 1277R1-R0 and Revision 0. In particular – i. Construct a noise barrier in the location shown on Figure 5 prepared by RoadPro Acoustics, dated 3 October 2019, reference 1277R1-R0 and Revision 0, as amended in red to note that noise barrier heights are relative to either local preconstruction ground level, localised pad level, or final design surface, whichever is higher. (b) The noise barrier must be designed in accordance with: i. the Department of Transport and Main Roads' Road Traffic Noise Management Code of Practice, Chapter 5' Specifications MRS15 and MRTS15; and ii. Standard Drawings Road Manual, Part 13. (c) RPEQ certification must be provided to the District Director (Fitzroy Region) within the Department of Transport and Main Roads, confirming that the development has been constructed in accordance with parts (a) and (b) of this condition.	Prior to the commencement of use and to be maintained at all times
2.	(a) The development must be in accordance with the Stormwater Management Plan prepared by Calibre Professional Services Pty Ltd dated 8 October 2019, reference 18-002864-CSMP01A in particular: • implementation of the proposed strategy to manage flows from the site, including mitigation of peak flows to ensure no adverse impact or actionable nuisances to downstream properties including the Bruce Highway • the provision of detention basins to demonstrate WQO's under the State Planning Policy 2017 (SPP) for Central Queensland Coast are met for the development. (b) RPEQ certification with supporting documentation must be provided to the District Director (Fitzroy Region) corridormanagement@tmr.qld.gov.au within the Department of Transport and Main Roads, confirming that the development has been designed and constructed in accordance with part (a) of this condition.	(a) At all times. (b) Prior to the commencement of use.
3.	(a) The road access location is to be located at approximate Chainage 11,7km (RHS) (lat -23.286790; long 150.510012) and	(a) At all times.

	generally in accordance with the Concept Road Functional Layout Plan shown in Figure 4.2 and Figure 4.3 of the *Engineering Infrastructure Report Proposed Development, 1014-1016 Yaamba Rd, Parkhurst* prepared by Calibre Professional Services Pty Ltd, dated 10 October 2019 and reference 18-002864. (b) Road access works comprising a fully lit Auxiliary Left Turn (AUL) treatment (at the road access location) must be provided generally in accordance with the Concept Road Functional Layout Plan, Figure 4.2 of the Calibre Professional Services Pty Ltd. Engineering Infrastructure Report 18-002864 dated 10 October 2019 by Calibre Professional Services Pty Ltd, including widening of the access throat (in accordance with Figure 4.3) to accommodate the simultaneous left in/left out movements of the maximum sized design vehicle (8.8m Medium Rigid Vehicle (MRV)). (c) The road access works must be designed and constructed in accordance with the relevant Department of Transport and Main Roads' Road Planning and Design Manual (2nd Edition) and Austroads Standards.	(b) and (c): Prior to the commencement of use.

Attachment 2—Advice to the applicant

General advice	
1.	Terms and phrases used in this document are defined in the *Planning Act 2016* its regulation or the State Development Assessment Provisions (SDAP) [v2.5]. If a word remains undefined it has its ordinary meaning.
2.	Under section 33 of the *Transport Infrastructure Act 1994,* written approval is required from the Department of Transport and Main Roads to carry out road works on a state-controlled road. Please contact the Department of Transport and Main Roads' on corridormanagement@tmr.qld.gov.au to make an application for road works approval. This approval must be obtained prior to commencing any works on the state-controlled road reserve. The approval process may require the approval of engineering designs of the proposed works, certified by a Registered Professional Engineer of Queensland (RPEQ). Please contact the Department of Transport and Main Roads' as soon as possible to ensure that gaining approval does not delay construction. Turn path details must be shown and resolved as part of the section 33 application.
3.	Mandatory Part (MP) 4.4 of the Queensland Development Code (QDC) commenced on 1 September 2010 and applies to building work for the construction or renovation of a residential building that is located within a designated Mandatory Transport Noise Corridor (TNC). MP4.4 seeks to ensure that the habitable rooms of Class 1, 2, 3 and 4 buildings located in a TNC are designed and constructed to reduce transport noise. The subject land is partially located within a designated Mandatory Transport Noise Corridor. Transport Noise Corridor (TNC) means land designated under Chapter 8B of the *Building Act 1975* as a TNC. Information about TNC's are available at state and local government offices. A free online search tool can be used to find out whether a property is located in a designated transport noise corridor. This tool is available at the Department of Housing and Public Works website www.hpw.qld.gov.au and allows searches on a registered lot number and/or property address to determine whether and how the QDC applies to the land. For further information about this matter, please visit the Department of Housing and Public Works website www.hpw.qld.gov.au.

Attachment 3—Reasons for referral agency response

(Given under section 56(7) of the *Planning Act 2016*)

The reasons for the department's decision are, the development:

- is for the expansion of a motel and for recreational vehicle (RV) home sites
- provides a suitable access to the state-controlled road with the application of conditions
- can be conditioned to mitigate stormwater impacts to the state-controlled road
- can be conditioned to mitigate noise impacts to dwellings near the state-controlled road
- does not compromise the safety and efficiency of the state-controlled road
- complies with State codes 1 & 6 with conditions.

Material used in the assessment of the application:

- The development application material and submitted plans
- *Planning Act 2016*
- Planning Regulation 2017
- The *State Development Assessment Provisions* (version 2.5), as published by the department
- The Development Assessment Rules
- SARA DA Mapping system

Attachment 4—Change representation provisions

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Attachment 5—Approved plans and specifications

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Development Assessment Rules—Representations about a referral agency response

The following provisions are those set out in sections 28 and 30 of the Development Assessment Rules[1] regarding **representations about a referral agency response**

Part 6: Changes to the application and referral agency responses

28 Concurrence agency changes its response or gives a late response

28.1. Despite part 2, a concurrence agency may, after its referral agency assessment period and any further period agreed ends, change its referral agency response or give a late referral agency response before the application is decided, subject to section 28.2 and 28.3.

28.2. A concurrence agency may change its referral agency response at any time before the application is decided if—

(a) the change is in response to a change which the assessment manager is satisfied is a change under section 26.1; or

(b) the Minister has given the concurrence agency a direction under section 99 of the Act; or

(c) the applicant has given written agreement to the change to the referral agency response.[2]

28.3. A concurrence agency may give a late referral agency response before the application is decided, if the applicant has given written agreement to the late referral agency response.

28.4. If a concurrence agency proposes to change its referral agency response under section 28.2(a), the concurrence agency must—

(a) give notice of its intention to change its referral agency response to the assessment manager and a copy to the applicant within 5 days of receiving notice of the change under section 25.1; and

(b) the concurrence agency has 10 days from the day of giving notice under paragraph (a), or a further period agreed between the applicant and the concurrence agency, to give an amended referral agency response to the assessment manager and a copy to the applicant.

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1 Pursuant to Section 68 of the *Planning Act 2016*

2 In the instance an applicant has made representations to the concurrence agency under section 30, and the concurrence agency agrees to make the change included in the representations, section 28.2(c) is taken to have been satisfied.

Part 7: Miscellaneous

30 Representations about a referral agency response

30.1. An applicant may make representations to a concurrence agency at any time before the application is decided, about changing a matter in the referral agency response.[3]

[3] An applicant may elect, under section 32, to stop the assessment manager's decision period in which to take this action. If a concurrence agency wishes to amend their response in relation to representations made under this section, they must do so in accordance with section 28.

Our ref TMR19-028697
Your ref
Enquiries Gideon Genade

Queensland Government

Department of
Transport and Main Roads

2 December 2019

M Demedio & G Demedio
c/- Adams + Sparks Town Planning + Development
PO Box 1000
Buddina QLD 4575

Decision Notice – Permitted Road Access Location

(s62(1) *Transport Infrastructure Act 1994***)**

This is not an authorisation to commence work on a state-controlled road[1]

Development application reference number D/99-2019, lodged with Rockhampton Regional Council involves constructing or changing a vehicular access between Lot 80 SP300143 the land the subject of the application, and Yaamba Road (a state-controlled road).

In accordance with section 62A(2) of the *Transport Infrastructure Act 1994* (TIA), this development application is also taken to be an application for a decision under section 62(1) of TIA.

Decision (given under section 67 of TIA)

It has been decided to approve the application, subject to the following conditions:

No.	Conditions of Approval	Condition Timing
1	The road access location is to be located at approximate Chainage 11,7km (RHS) (lat -23.286790; long 150.510012) and generally in accordance with the Concept Road Functional Layout Plan shown in Figure 4.2 and Figure 4.3 of the Engineering Infrastructure Report 18-002864 dated 10 October 2019 by Calibre Professional Services Pty Ltd, prepared for G & M Demedio for the Proposed Development, 1014-1016 Yaamba Rd, Parkhurst.	At all times.
2	Road access works comprising a fully lit AUL, (at the road access location) must be provided generally in accordance with the Concept Road Functional Layout Plan, Figure 4.2 of the Calibre Professional Services Pty Ltd Engineering Infrastructure Report 18-002864 dated 10 October 2019 by Calibre Professional Services Pty Ltd, including widening of the access throat (in accordance with Figure 4.3) to accommodate the simultaneous left in/left out movements of the maximum sized design vehicle (8.8m Medium Rigid Vehicle (MRV)).	Prior to commencement of use.
3	The largest vehicle permitted to use the access is a 8.8m MRV.	At all times.
4	The road access is to be constructed and maintained at no cost to the	At all times.

[1] Please refer to the further approvals required under the heading 'Further approvals'

No.	Conditions of Approval	Condition Timing
	department in accordance with section 64(1) of the *Transport Infrastructure Act 1994*.	

Reasons for the decision

The reasons for this decision are as follows:

a) To maintain the safety and efficiency of the state-controlled road.

Please refer to **Attachment A** for the findings on material questions of fact and the evidence or other material on which those findings were based.

Information about the Decision required to be given under section 67(2) of TIA

1. There is no guarantee of the continuation of road access arrangements, as this depends on future traffic safety and efficiency circumstances.
2. In accordance with section 70 of the TIA, the applicant for the planning application is bound by this decision. A copy of section 70 is attached as **Attachment B**, as required, for information.

Further information about the decision

1. In accordance with section 67(7) of TIA, this decision notice:
   a) starts to have effect when the development approval has effect; and
   b) stops having effect if the development approval lapses or is cancelled; and
   c) replaces any earlier decision made under section 62(1) in relation to the land.
2. In accordance with section 485 of the TIA and section 31 of the *Transport Planning and Coordination Act 1994* (TPCA), a person whose interests are affected by this decision may apply for a review of this decision only within 28 days after notice of the decision was given under the TIA. A copy of the review provisions under TIA and TPCA are attached in **Attachment C** for information.
3. In accordance with section 485B of the TIA and section 35 of TPCA a person may appeal against a reviewed decision. The person must have applied to have the decision reviewed before an appeal about the decision can be lodged in the Planning and Environment Court. A copy of the Appeal Provisions under TIA and TPCA is attached in **Attachment C** for information.

Further approvals

The Department of Transport and Main Roads also provides the following information in relation to this approval:

1. Road Access Works Approval Required – Written approval is required from the department to carry out road works that are road access works (including driveways) on a state-controlled road in accordance with section 33 of the TIA. This approval must be obtained prior to commencing any works on the state-controlled road. The approval process may require the approval of engineering designs of the proposed works, certified by a Registered Professional Engineer of Queensland (RPEQ). Please contact the department to make an application.

If further information about this approval or any other related query is required, Mr Anton DeKlerk (Principal Town Planner) should be contacted by email at FitzroyDistrict@tmr.qld.gov.au or on (07) 4931 1545.

Yours sincerely

Anton DeKlerk
Principal Town Planner

Attachments: Attachment A – Decision evidence and findings
Attachment B - Section 70 of TIA
Attachment C - Appeal Provisions
Attachment D - Concept Road Functional Layout Plan shown in Figure 4.2 and Figure 4.3 of the Engineering Infrastructure Report 18-002864 dated 10 October 2019 by Calibre Professional Services Pty Ltd

Attachment A

Decision Evidence and Findings

Findings on material questions of fact:

- The application is for a Material Change of Use to establish Short-term Accommodation and a Relocatable Home Park.
- The development will consist of ten (10) single storey Short-term Accommodation buildings, constructed in a similar manner to those already existing on site, and a total of 55 Relocatable Home Park site.
- The subject site has a frontage, with existing vehicle access, on the Yaamba Road a State-controlled Road.

Evidence or other material on which findings were based:

Title of Evidence / Material	**Prepared by**	**Date**	**Reference no.**	**Version/Issue**
Town Planning Report	Adams + Sparks Town Planning	October 2019	181201	-
Engineering Infrastructure Report	Calibre	10 October 2019	18002864	A
Concept Stormwater Management Plan & Flood Impact Assessment Report	Calibre	8 October 2019	18-002864-CSMP01A	A
Road Traffic Noise Assessment	RoadPro Acoustics	3 October 2019	1277R1-R0	0
Master Site Plan	Rufus Design Group	04/10/19	181015-01	01

Attachment B

Section 70 of TIA

Transport Infrastructure Act 1994
Chapter 6 Road transport infrastructure
Part 5 Management of State-controlled roads

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70 Offences about road access locations and road access works, relating to decisions under s 62(1)

(1) This section applies to a person who has been given notice under section 67 or 68 of a decision under section 62(1) about access between a State-controlled road and adjacent land.

(2) A person to whom this section applies must not—

(a) obtain access between the land and the State-controlled road other than at a location at which access is permitted under the decision; or

(b) obtain access using road access works to which the decision applies, if the works do not comply with the decision and the noncompliance was within the person's control; or

(c) obtain any other access between the land and the road contrary to the decision; or

(d) use a road access location or road access works contrary to the decision; or

(e) contravene a condition stated in the decision; or

(f) permit another person to do a thing mentioned in paragraphs (a) to (e); or

(g) fail to remove road access works in accordance with the decision.

Maximum penalty—200 penalty units.

(3) However, subsection (2)(g) does not apply to a person who is bound by the decision because of section 68.

Attachment C

Appeal Provisions

Transport Infrastructure Act 1994
Chapter 16 General provisions

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485 Internal review of decisions

(1) A person whose interests are affected by a decision described in schedule 3 (the *original decision*) may ask the chief executive to review the decision.

(2) The person is entitled to receive a statement of reasons for the original decision whether or not the provision under which the decision is made requires that the person be given a statement of reasons for the decision.

(3) The *Transport Planning and Coordination Act 1994*, part 5, division 2—

(a) applies to the review; and

(b) provides—

(i) for the procedure for applying for the review and the way it is to be carried out; and

(ii) that the person may apply to QCAT to have the original decision stayed.

485B Appeals against decisions

(1) This section applies in relation to an original decision if a court (the appeal court) is stated in schedule 3 for the decision.

(2) If the reviewed decision is not the decision sought by the applicant for the review, the applicant may appeal against the reviewed decision to the appeal court.

(3) The Transport Planning and Coordination Act 1994, part 5, division 3—

(a) applies to the appeal; and

(b) provides—

(i) for the procedure for the appeal and the way it is to be disposed of; and

(ii) that the person may apply to the appeal court to have the original decision stayed.

(4) Subsection (5) applies if—

(a) a person appeals to the Planning and Environment Court against a decision under section 62(1) on a planning application that is taken, under section 62A(2), to also be an application for a decision under section 62(1); and

(b) a person appeals to the Planning and Environment Court against a decision under the Planning Act on the planning application.

(5) The court may order—

(a) the appeals to be heard together or 1 immediately after the other; or

(b) 1 appeal to be stayed until the other is decided.

(6) Subsection (5) applies even if all or any of the parties to the appeals are not the same.

(7) In this section—

original decision means a decision described in schedule 3.

reviewed decision means the chief executive's decision on a review under section 485.

31 Applying for review

(1) A person may apply for a review of an original decision only within 28 days after notice of the original decision was given to the person under the transport Act.

(2) However, if—

(a) the notice did not state the reasons for the original decision; and

(b) the person asked for a statement of the reasons within the 28 days mentioned in subsection (1)

the person may apply within 28 days after the person is given the statement of the reasons.

(3) In addition, the chief executive may extend the period for applying.

(4) An application must be written and state in detail the grounds on which the person wants the original decision to be reviewed.

32 Stay of operation of original decision

(1) If a person applies for review of an original decision, the person may immediately apply for a stay of the decision to the relevant entity.

(2) The relevant entity may stay the original decision to secure the effectiveness of the review and any later appeal to or review by the relevant entity.

(3) In setting the time for hearing the application, the relevant entity must allow at least 3 business days between the day the application is filed with it and the hearing day.

(4) The chief executive is a party to the application.

(5) The person must serve a copy of the application showing the time and place of the hearing and any document filed in the relevant entity with it on the chief executive at least 2 business days before the hearing.

(6) The stay—

(a) may be given on conditions the relevant entity considers appropriate; and

(b) operates for the period specified by the relevant entity; and

(c) may be revoked or amended by the relevant entity.

(7) The period of a stay under this section must not extend past the time when the chief executive reviews the original decision and any later period the relevant entity allows the applicant to enable the applicant to appeal against the decision or apply for a review of the decision as provided under the QCAT Act.

(8) The making of an application does not affect the original decision, or the carrying out of the original decision, unless it is stayed.

(9) In this section—

relevant entity means—

(a) if the reviewed decision may be reviewed by QCAT—QCAT; or

(b) if the reviewed decision may be appealed to the appeal court—the appeal court.

35 Time for making appeals

(1) A person may appeal against a reviewed decision only within—

(a) if a decision notice is given to the person—28 days after the notice was given to the person; or

(b) if the chief executive is taken to have confirmed the decision under section 34(5)—56 days after the application was made.

(2) However, if—

(a) the decision notice did not state the reasons for the decision; and

(b) the person asked for a statement of the reasons within the 28 days mentioned in subsection (1)(a);

the person may apply within 28 days after the person is given a statement of the reasons.

(3) Also, the appeal court may extend the period for appealing.

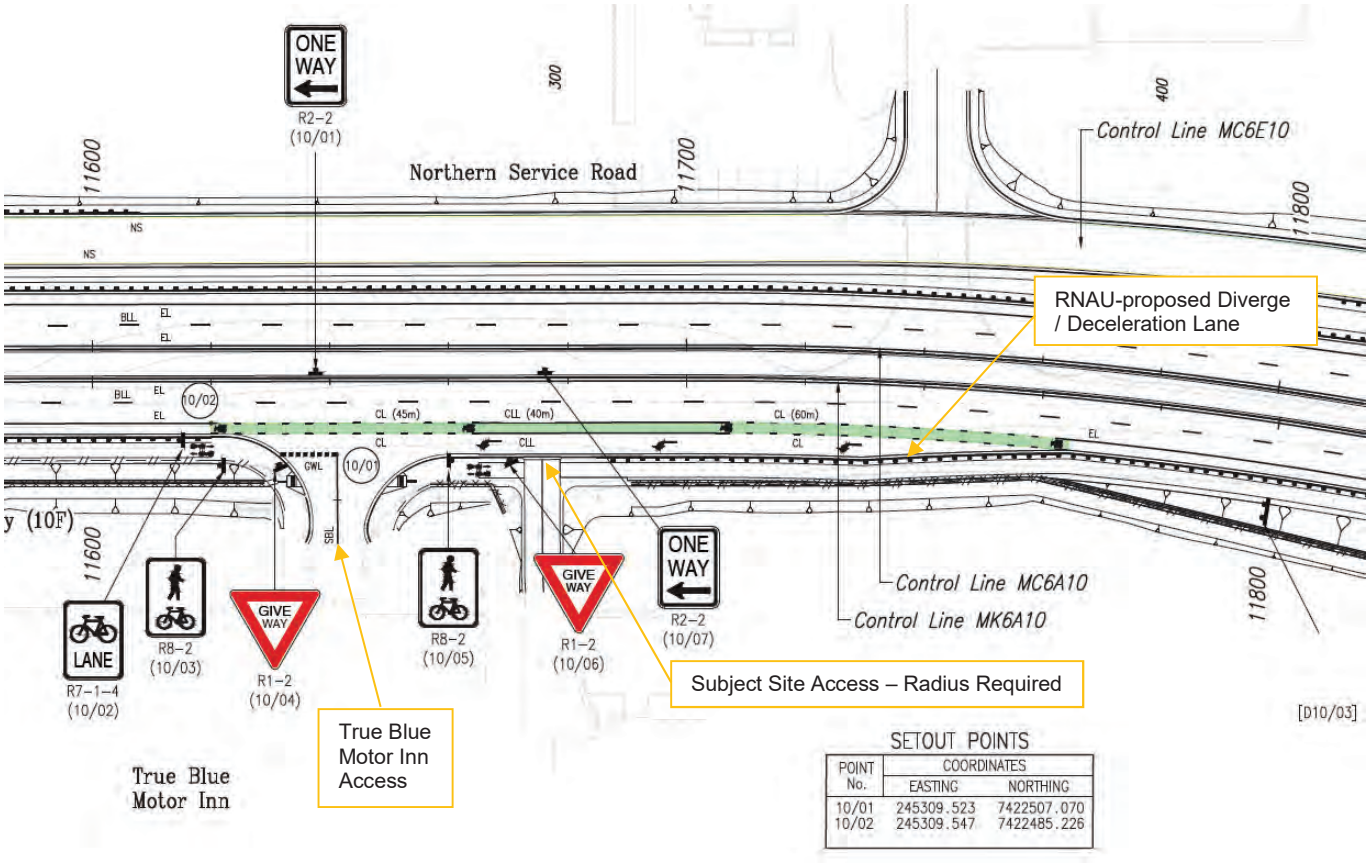


Figure 4.2 Access Arrangement Proposed in RNAU Documentation (from August 2018)

The proposed access arranagement shown in the RNAU drawings received from TMR, currently shows the existing driveway connection to the Yaamba Road (Bruce Highway) corridor without any radius onto the proposed deceleration lane. In order to provide safe access / egress to the subject site from the deceleration lane for a 8.8m MRV, swept paths have been completed and show widening at the throat of the driveway by 1m, as well as an appropriate raduis will be required (see Figure 4.3 below).

Figure 4.3 Proposed Access Driveway Widening

PLANS AND DOCUMENTS referred to in the REFERRAL AGENCY RESPONSE
SARA ref: 1911-13966 SRA
Date: 4 December 2019

RoadPro ACOUSTICS

PLANS AND DOCUMENTS
referred to in the REFERRAL
AGENCY RESPONSE

Queensland

SARA ref: 1911-13966 SRA

Date: 4 December 2019

Road Traffic Noise Assessment
Motel Expansion and RV Home Sites

1014-1016 Yaamba Road
Parkhurst

Report 1277R1-R0

3 October 2019

Document Control

Report 1277R1-R0

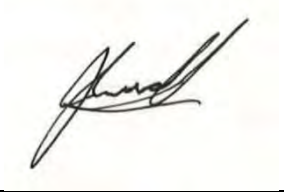
Version History:

Version	Date	Prepared by	Reviewed by	Description / nature of amendments
Draft 1	2-Oct-19	JC	JC	Initial draft
Revision 0	3-Oct-19	JC	JC	Final report

Contact for enquiries

Please direct any queries regarding the preparation of this document to:

Authorising Officer: **Joseph Carroll RPEQ 7798**
Director / Principal Engineer
RoadPro Acoustics



Job number: **1277**

Email: **joseph@roadpro.net.au**

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Table of Contents

1 Introduction

RoadPro Acoustics was engaged by Gabriele Demedio to assess potential road traffic noise impacts at a residential apartment site at 1014-1016 Yaamba Road, Parkhurst (the Site).

This Road Traffic Noise Assessment Report addresses the requirements of the Queensland Department of Transport and Main Roads, and the Rockhampton Regional Council.

The Site location is shown in **Figure 1**, and proposed site layout is shown in **Figure 2**. Plans are provided in **Appendix A**.

Figure 1: Site Location ("A") – 1014-1016 Yaamba Road, Parkhurst

Figure 2: Site layout - 1014-1016 Yaamba Road, Parkhurst

2 Noise Criteria

2.1 Road Traffic Noise

2.1.1 State Development Assessment Provisions

The *State Development Assessment Provisions* are consistent with development throughout Queensland and are applicable to this assessment. The DTMR conditions for the development reflect the SDAP (v2.0) as follows:

*"**PO23** Development involving an accommodation activity or land for a future accommodation activity minimises noise intrusion from a state-controlled road or type 1 multi-modal corridor in habitable rooms.*

***AO23.1** A noise barrier or earth mound is provided which is designed, sited and constructed to meet the following external noise criteria at all facades of the building envelope:*

≤60 dB(A) L_{10} (18 hour) façade corrected (measured L_{90} (8 hour) free field between 10pm and 6am ≤40 dB(A))
≤63 dB(A) L_{10} (18 hour) façade corrected (measured L_{90} (8 hour) free field between 10pm and 6am >40 dB(A))

in accordance with chapter 7 integrated noise barrier design of the Transport Noise Management Code of Practice – Volume 1 Road Traffic Noise, Department of Transport and Main Roads, 2013.

Note: To demonstrate compliance with the acceptable outcome, it is recommended that a RPEQ certified noise assessment report is provided, prepared in accordance with the State Development Assessment Provisions Supporting Information – Community Amenity (Noise), Department of Transport and Main Roads, 2013.

If the building envelope is unknown, the deemed-to-comply setback distances for buildings stipulated by the local planning instrument or relevant building regulations should be used.

In some instances the design of noise barriers and mounds to achieve the noise criteria above the ground floor may not be reasonable or practicable. In these instances, any relaxation of the criteria is at the discretion of the Department of Transport and Main Roads.

OR all of the following acceptable outcomes apply:

***AO23.2** Buildings which include a habitable room are setback the maximum distance possible from a state-controlled road or type 1 multi-modal corridor.*

AND

***AO23.3** Buildings are designed and oriented so that habitable rooms are located furthest from a state-controlled road or type 1 multi-modal corridor.*

AND

***AO23.4** Buildings (other than a relevant residential building or relocated building) are designed and constructed using materials which ensure that habitable rooms meet the following internal noise criteria:*

≤35 dB(A) Leq (1 hour) (maximum hour over 24 hours).

Statutory note: Noise levels from a state-controlled road or type 1 multi-modal corridor are to be measured in accordance with AS1055.1–1997 Acoustics – Description and measurement of environmental noise.

Note: To demonstrate compliance with the acceptable outcome, it is recommended that a RPEQ certified noise assessment report is provided, prepared in accordance with the State Development Assessment Provisions Supporting Information – Community Amenity (Noise), Department of Transport and Main Roads, 2013.

Habitable rooms of relevant residential buildings located within a transport noise corridor must comply with the Queensland Development Code MP4.4 Buildings in a transport noise corridor, Queensland Government, 2015. Transport noise corridors are mapped on the DA mapping system."

2.1.2 Rockhampton Regional Council Planning Scheme

Compliance with the SDAP / TMR criteria for road traffic noise is considered to address the requirements of the Rockhampton Regional Council Planning Scheme outcomes for road traffic noise.

3 CoRTN Model Verification

The CoRTN algorithm was used to calculate the present road traffic noise levels for comparison with the SPP noise mapping for model validation purposes at the points indicated in **Figure 3**.

Figure 3: Model validation points against SPP transport noise mapping

On-site noise measurements are typically carried out for this purpose. However, due to present roadworks and reduced speed limits on Yaamba Road, the data would be unreliable.

Traffic volume and heavy vehicle composition data were obtained from the Queensland Government SPP Interactive Mapping Tool as shown in **Table 1**.

The terrain heights used were 0.5 m contours interpolated from a 5 m grid spot height LIDAR dataset sourced from Geoscience Australia.

Table 1 Traffic count data – QLD Government SPP Interactive Mapping Tool

Roadway	Year	AADT	% HV
Yaamba Road	2015	12,823	12.44
	2025	20,887	12.44

The growth rate for Yaamba Road is 5%. The posted speed is 80 kph. The road surface is reported as PMB spray seal, which attracts a correction of +1 dB(A) as per the TMR Road Traffic Noise Management Code of Practice (Vol 1) Table 4.3.4.1.

Traffic Volumes and % heavy vehicles used for the 10-year future planning horizon are shown in **Table 2**. A growth rate of 5% pa was obtained from the mapping tool. The 18-hour traffic flow has been assumed to be 96% of AADT. A dense graded asphalt (DGA) surface has been assumed for the design year.

Table 2 Present and future traffic volumes

Roadway	Year	18-hour Traffic	% HV
Yaamba Road	2030	25,592	12.44

The calculated $L_{A10(18\ hour)}$ road traffic noise level at the logger location is shown in **Table 3**.

Table 3: Measured and Calculated Present Road Traffic Noise

Verification point	SPP Noise Level	PEN3D Noise Level	Difference
Yaamba Road	67.5	67.7	+0.2
Yaamba Road	72.5	72.6	+0.1

The calculated present-day noise levels are within an acceptable margin of error (±2 dB(A)) of the measured noise levels, and the model is verified and conservative.

4 Predicted Noise Levels

Future road traffic noise levels were predicted using the calculated future traffic volumes and receiver heights 1.8 m above local ground level. The future road alignment was input from plans of the reconfiguration of Yaamba Road presently under construction, with traffic evenly split between the carriageways.

A screen shot of the model scenario is shown in **Figure 4**.

Figure 4: Model scenario

The modelling indicates that there is potential for the external 60 dB $L_{A10(18\ hour)}$ façade-corrected criterion to be exceeded at Lots 1, 3 and 4.

Road traffic noise levels within the communal open space are expected to achieve the 60 dB $L_{A10(18\ hour)}$ (free-field) road traffic noise criterion.

Noise contours are provided in **Appendix B**.

5 Noise Attenuation

Note: **noise barrier heights are relative to either local preconstruction ground level, localised pad level, or final design surface, whichever is higher.**

5.1 External Noise

An acoustic barrier fence is recommended for the Site as indicated in **Figure 5**. The barrier is 2.5 m along the western boundary of Lot 3 and the outdoor green area, and returns east at the northern and southern ends, tapering down to a height of 2 m. Heights are relative to local ground level.

Figure 5: Noise barrier to achieve external noise criteria for residential building facades and private outdoor areas

The acoustic barrier must comply with the specifications of MRTS15 Noise Fences. In particular, the barrier must have a minimum surface density of 15 kg/m^2 and minimum Rw of 25.

5.2 Internal Noise

The *Queensland Development Code Mandatory Provisions 4.4* specifies building façade construction requirements based on external road traffic noise levels. MP4.4 defines *Noise Categories* with increasing building façade noise reduction requirements as shown in **Table 4**. Examples of constructions to achieve the R_W values are provided in **Appendix D**.

- Permanent residences constructed on Lots 1-6 will require *Noise Category 1* construction for the western facade.
- Lot 7 will require *Noise Category 1* construction for the south-western façade.
- Alternatively, pre-fabricated buildings moved to the Site do not require improvements for road traffic noise mitigation.

Amended in red by SARA on
4 December 2019

PLANS AND DOCUMENTS referred to in the REFERRAL AGENCY RESPONSE
SARA ref: 1911-13966 SRA
Date: 4 December 2019

Table 4 MP 4.4 Noise Categories and Requirements for Noise Reduction

Noise category	Minimum transport noise reduction (dB(A)) required for habitable rooms	Component of buildings external envelope	Minimum R_w required for building component
Category 1	25	Glazing	27 (where total area of glazing for a *habitable room* is greater than 1.8m2)
			24 (where total area of glazing for a *habitable room* is less than or equal to 1.8m2)
		External walls	35
		Roof	35
		Entry doors	28
Category 0	No additional acoustic treatment required – standard building assessment provisions apply.		

Note that the noise category construction applies only to habitable rooms.

6 Conclusion and Summary of Recommendations

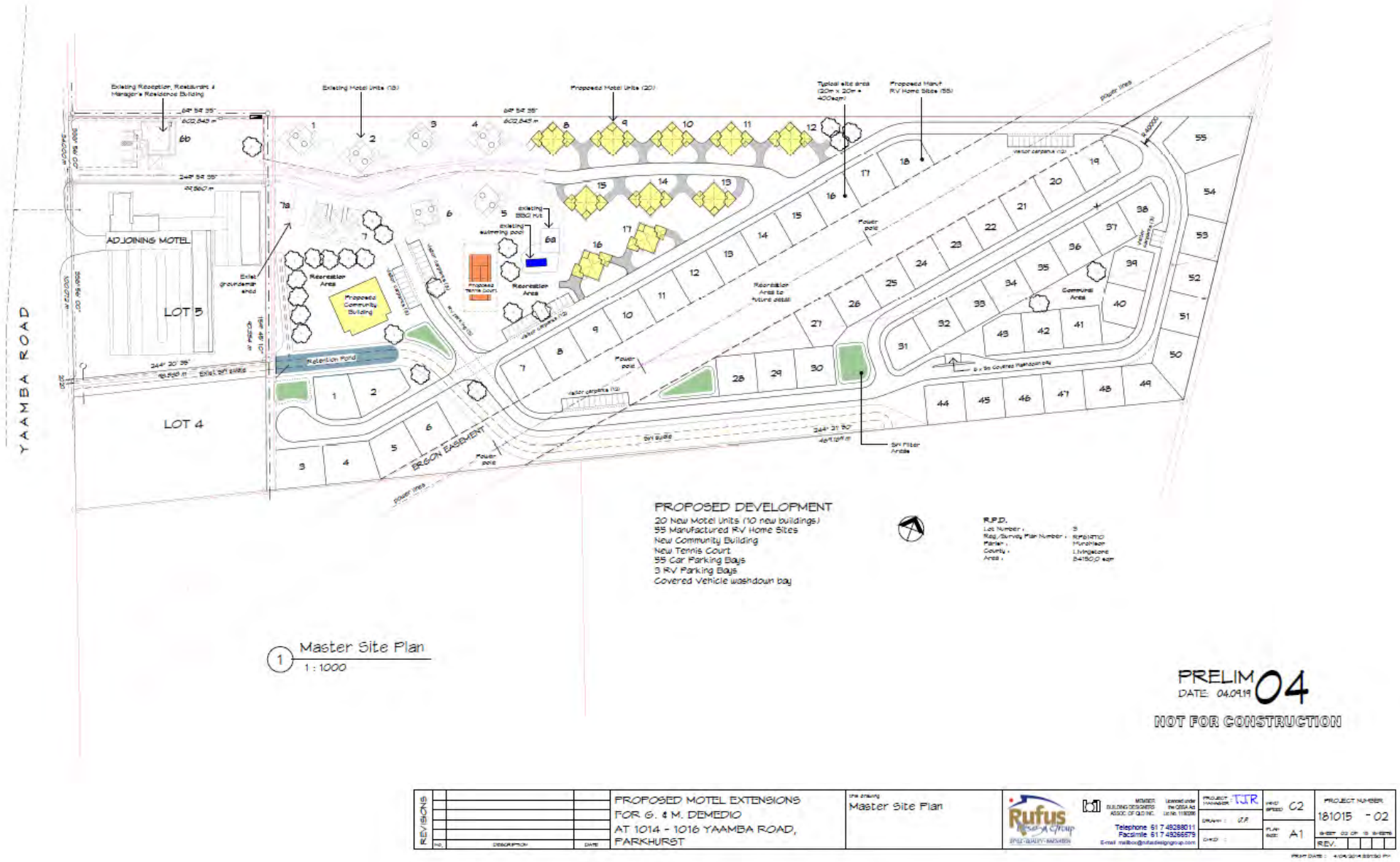
RoadPro Acoustics was engaged by Gabriele Demedio to assess potential noise emissions from road traffic noise at 1014-1016 Yaamba Road, Parkhurst.

A PEN3D noise model for the Site was validated against on-site noise measurements.

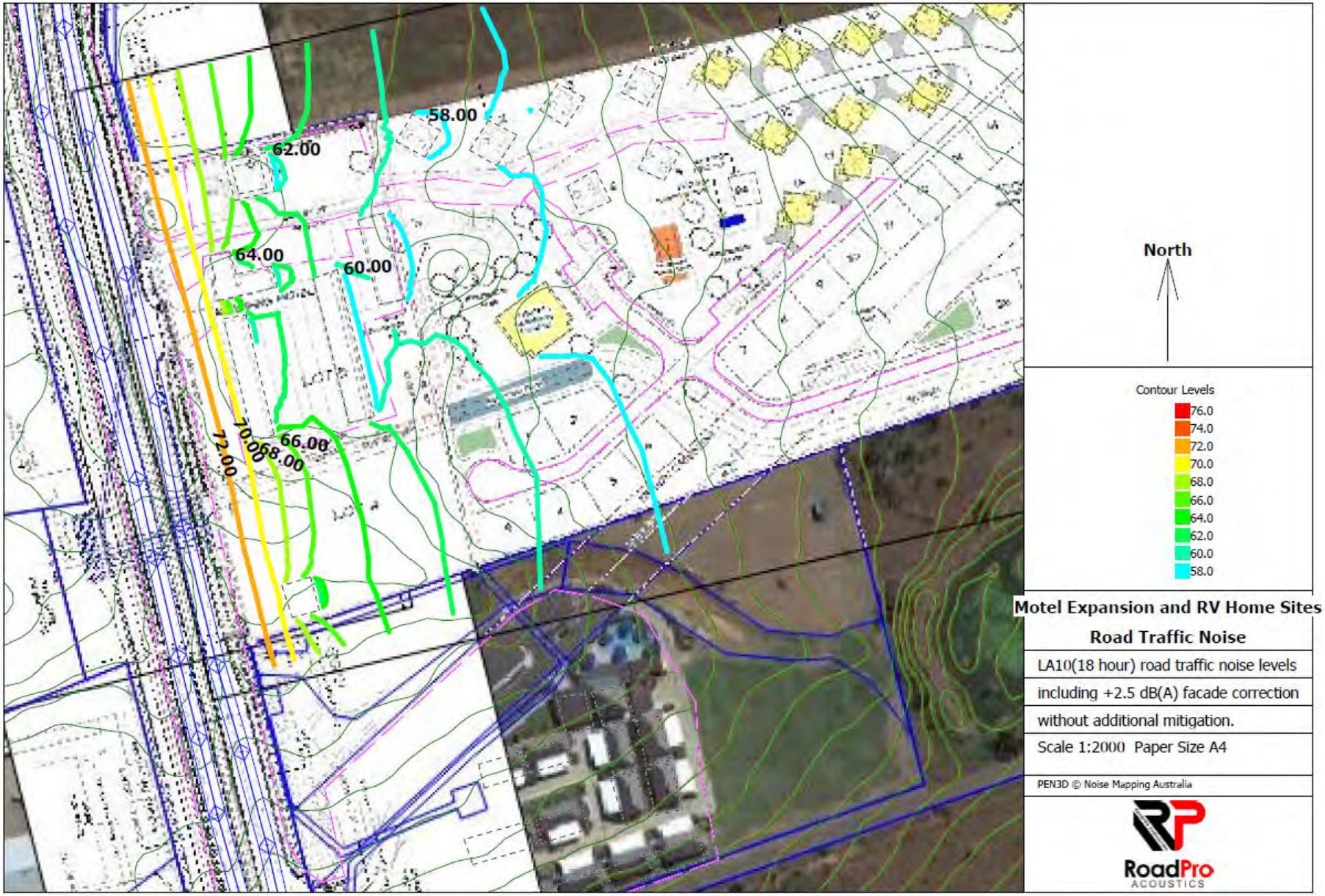
Predicted future noise levels show that:

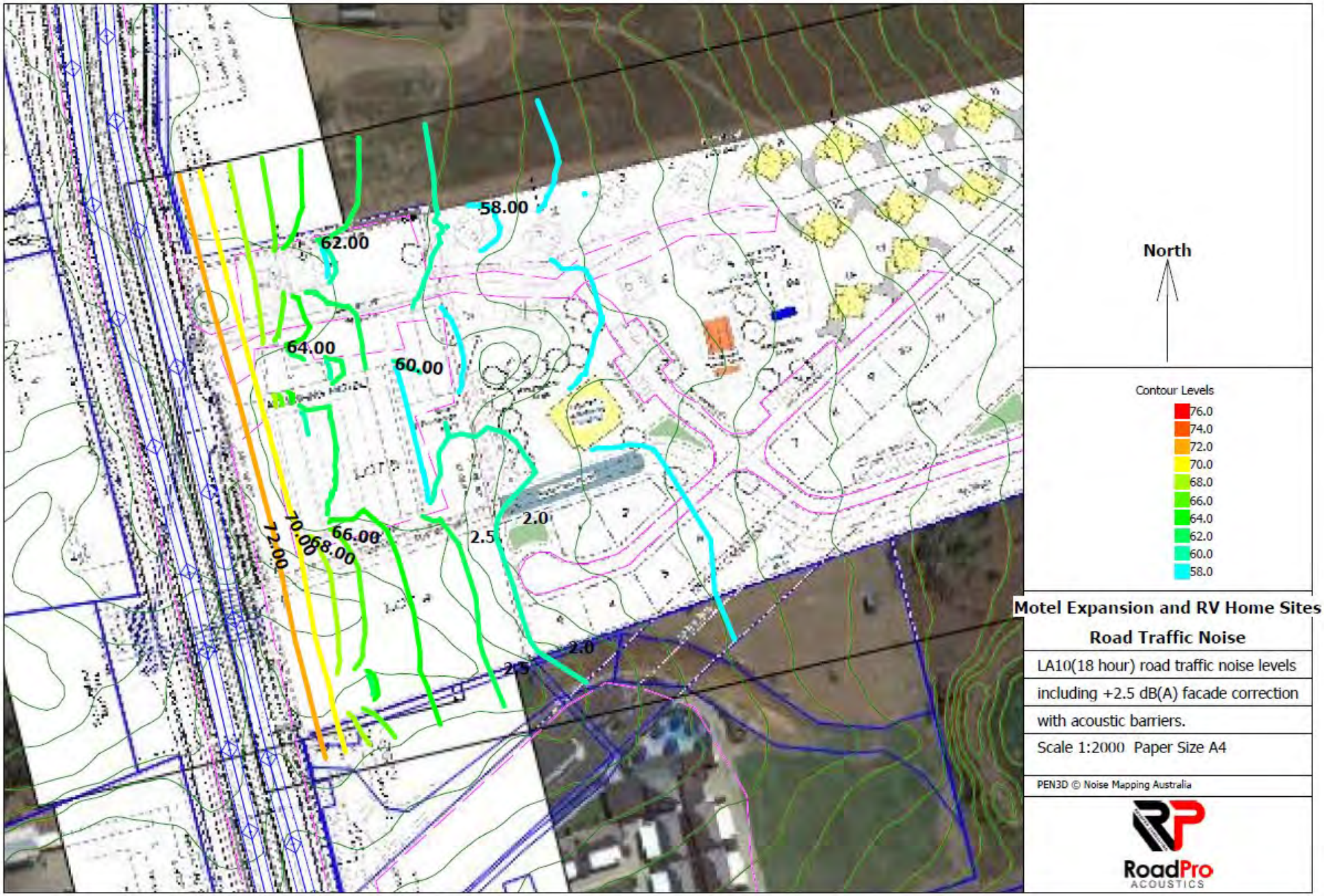
- Road traffic noise at some facades are expected to exceed the criterion without additional mitigation.
- A relatively minor acoustic barrier is recommended for road traffic noise levels at the Site to achieve all external noise criteria.
- Some minor façade upgrades to *Noise Category 1* will be required to comply with the State Development Assessment MP4.4.

Appendix A – Proposal Plans



Appendix B – Noise Contours




58.00
62.00
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68.00
70.00
72.00
2.0
2.5
2.0
2.5
North
Contour Levels
76.0
74.0
72.0
70.0
68.0
66.0
64.0
62.0
60.0
58.0
Motel Expansion and RV Home Sites
Road Traffic Noise
LA10(18 hour) road traffic noise levels
including +2.5 dB(A) facade correction
with acoustic barriers.
Scale 1:2000 Paper Size A4
PEN3D © Noise Mapping Australia
RoadPro
ACOUSTICS

Appendix C - Building Construction Requirements to Achieve Minimum Rw (from MP 4.4)

Component of building's external envelope	**Minimum Rw**	**Acceptable forms of construction**
Glazing	43	Double glazing consisting of two panes of minimum 5mm thick glass with at least 100mm air gap and full perimeter *acoustically rated seals*.
	38	Minimum 14.38mm thick laminated glass, with full perimeter *acoustically rated seals*; OR Double glazing consisting of one pane of minimum 5mm thick glass and one pane of minimum 6mm thick glass with at least 44mm air gap, and full perimeter *acoustically rated seals*
	35	Minimum 10.38mm thick laminated glass, with full perimeter *acoustically rated seals*.
	32	Minimum 6.38mm thick laminated glass with full perimeter *acoustically rated seals*.
	27	Minimum 4mm thick glass with full perimeter *acoustically rated seals*
	24	Minimum 4mm thick glass with standard weather seals
External walls	52	Two leaves of clay brick masonry, at least 270mm in total, with subfloor vents fitted with noise attenuators.
	47	Two leaves of clay brick masonry at least 110mm thick with: (i) cavity not less than 50mm between leaves; and (ii) 50mm thick mineral insulation or 50mm thick glass wool insulation with a density of 11kg/m3 or 50mm thick polyester insulation with a density of 20kg/m3 in the cavity. OR Two leaves of clay brick masonry at last 110mm thick with: (i) cavity not less than 50mm between leaves; and (ii) at least 13mm thick cement render on each face OR Single leaf of clay brick masonry at least 110mm thick with: (i) a row of at least 70mm x 35mm timber studs or 64mm steel studs at 600mm centres, spaced at least 20mm from the masonry wall; and (ii) Mineral insulation or glass wool insulation at least 50mm thick with a density of at least 11 kg/m3 positioned between studs; and (iii) One layer of plasterboard at least 13mm thick fixed to outside face of studs. OR Single leaf of minimum 150mm thick masonry of hollow, dense concrete blocks, with mortar joints laid to prevent moisture bridging.
	41	Two leaves of clay brick masonry at least 110mm thick with cavity not less than 50mm between leaves

Component of building's external envelope	**Minimum Rw**	**Acceptable forms of construction**
		OR Single leaf of clay brick masonry at last 110mm thick with: (i) a row of at least 70mm x 35mm timber studs or 64mm steel studs at 600mm centres, spaced at least 20mm from the masonry wall; and (ii) mineral insulation or glass wool insulation at least 50mm thick with a density of at least 11 kg/m3 positioned between studs; and (iii) One layer of plasterboard at least 10mm thick fixed to outside face of studs OR Single leaf of brick masonry at least 110mm thick with at least 13mm thick render on each face OR Concrete brickwork at least 110mm thick OR In-situ concrete at least 100mm thick OR Precast concrete at least 100mm thick and without joints.
	35	Single leaf of clay brick masonry at least 110mm thick with: (i) a row of at least 70mm x 35mm timber studs or 64mm steel studs at 600mm centres, spaced at least 20mm from the masonry wall; and (ii) One layer of plasterboard at least 10mm thick fixed to outside face of studs OR Minimum 6mm thick fibre cement sheeting or weatherboards or plank cladding externally, minimum 90mm deep timber stud or 92mm metal stud, standard plasterboard at least 13mm thick internally.
Roof	43	Concrete or terracotta tile or sheet metal roof with sarking, acoustically rated plasterboard ceiling at least 13mm thick fixed to ceiling joists, cellulose fibre insulation at least 100mm thick with a density of at least 45kg/m3 in the cavity. OR Concrete or terracotta tile or sheet metal roof with sarking, 2 layers of acoustically rated plasterboard at least 16mm thick fixed to ceiling joists, glass wool insulation at least 50mm thick with a density of at least 11kg/m3 or polyester insulation at least 50mm thick with a density of at least 20kg/m3 in the cavity.

Component of building's external envelope	**Minimum Rw**	**Acceptable forms of construction**
	41	Concrete or terracotta tile or metal sheet roof with sarking, plasterboard ceiling at least 10mm thick fixed to ceiling joists, glass wool insulation at least 50mm thick with a density of at least 11kg/m3 or polyester insulation at least 50mm thick with a density of at least 20kg/m3 in the cavity. OR Concrete suspended slab at least 100mm thick.
	38	Concrete or terracotta tile or metal sheet roof with sarking, plasterboard ceiling at least 10mm thick fixed to ceiling cavity, mineral insulation or glass wool insulation at least 50mm thick with a density of at least 11 kg/m3.
	35	Concrete or terracotta tile or metal sheet roof with sarking, plasterboard ceiling at least 10mm thick fixed to ceiling cavity.
Floors	51	Concrete slab at least 150mm thick.
	45	Concrete slab at least 100mm thick OR Tongued and grooved boards at least 19mm thick with: (i) timber joists not less than 175mm x 50mm; and (ii) mineral insulation or glass wool insulation at least 75mm thick with a density of at least 11kg/m3 positioned between joists and laid on plasterboard at least 10mm thick fixed to underside of joists; and (iii) mineral insulation or glass wool insulation at least 25mm thick with a density of at least 11kg/m3 laid over entire floor, including tops of joists before flooring is laid; and (iv) secured to battens at least 75mm x 50mm; and (v) the assembled flooring laid over the joists, but not fixed to them, with battens lying between the joists.
	35	Solid core timber not less than 45mm thick, fixed so as to overlap the frame or rebate of the frame by not less than 10mm, with full perimeter acoustically rated seals.
	33	Fixed so as to overlap the frame or rebate of the frame by not less than 10mm, fitted with full perimeter acoustically rated seals and constructed of - (i) solid core, wood, particleboard or blockboard not less than 45mm thick; and/or (ii) acoustically laminated glass not less than 10.38mm thick.
	28	Fixed so as to overlap the frame or rebate of the frame, constructed of - (i) Wood, particleboard or blockboard not less than 33mm thick; or

Component of building's external envelope	**Minimum Rw**	**Acceptable forms of construction**
		(ii) Compressed fibre reinforced sheeting not less than 9mm thick; or (iii) Other suitable material with a mass per unit area not less than 24.4kg/m2; or (iv) Solid core timber door not less than 35mm thick fitted with full perimeter acoustically rated seals.
Entry Doors	35	Solid core timber not less than 45mm thick, fixed so as to overlap the frame or rebate of the frame by not less than 10mm, with full perimeter *acoustically rated seals*.
	33	Fixed so as to overlap the frame or rebate of the frame by not less than 10mm, fitted with full perimeter acoustically rated seals and constructed of - (i) solid core, wood, particleboard or blockboard not less than 45mm thick; and/or (ii) acoustically laminated glass not less than 10.38mm thick.
	28	Fixed so as to overlap the frame or rebate of the frame, constructed of - (i) Wood, particleboard or blockboard not less than 33mm thick; or (ii) Compressed fibre reinforced sheeting not less than 9mm thick; or (iii) Other suitable material with a mass per unit area not less than 24.4kg/m2; or (iv) Solid core timber door not less than 35mm thick fitted with full perimeter acoustically rated seals.

Concept Stormwater Management Plan &
Flood Impact Assessment Report

Proposed Development, 1014-1016 Yaamba Rd, Parkhurst

PREPARED FOR G. & M. DEMEDIO

PLANS AND DOCUMENTS
referred to in the REFERRAL
AGENCY RESPONSE

Queensland Government

SARA ref: 1911-13966 SRA

Date: 4 December 2019

18-002864-CSMP01A | 8 October 2019

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DOCUMENT CONTROL

ISSUE	DATE	ISSUE DETAILS	AUTHOR	CHECKED	APPROVED
A	8/10/2019	Original Issue	AA	LM	AA (RPEQ 17828)

Executive Summary

Calibre has been commissioned by G. & M. Demedio to prepare a Concept Stormwater Management Plan & Flood Impact Assessment Report for the proposed development located at 1014-1016 Yaamba Rd, Parkhurst.

The aim of investigations and analysis documented in this report is to demonstrate the proposed management strategies adequately address local authority and state government requirements relating to stormwater quantity management, flooding and stormwater quality management.

A summary of the outcomes of the investigation and analysis is as follows:

- *Stormwater Management and Flood Investigation (Quantity)* – 1D and 2D modelling analysis (using XPRAFT and TUFLOW) were undertaken to determine the change in flood behaviour from the site as a result of the development. A stormwater quantity management strategy has been proposed to manage flows from the site, including mitigation of peak flows. The stormwater management strategy presented within this report has demonstrated no adverse impact or actionable nuisances to downstream properties. Refer to **Section 3** for more details.
- *Stormwater Management (Quality)* – A stormwater quality management plan is proposed utilising multiple bioretention basins to treat runoff from the development. The MUSIC modelling results demonstrates that WQO's under the State Planning Policy 2017 (SPP) for Central Queensland Coast are met for the development. For details of the bioretention basins configurations and Stormwater Quality Strategy refer to **Section 5**.

On this basis, it is recommended that the stormwater management plan and flood impact assessment strategies presented in this report be approved and incorporated into the final design.

Contents

Tables

Figures

Appendices

1 Introduction

Calibre Group has been commissioned by G. & M. Demedio to prepare a Concept Stormwater Management Plan & Flood Impact Assessment Report for the proposed development located at 1014-1016 Yaamba Rd, Parkhurst.

This report investigates and addresses the stormwater management strategy plan and flood impact assessment in accordance with the relevant Local and State Government Standards. This report provides a stormwater quantity and quality strategy for managing peak flows and pollutants discharging from the site and demonstrates that the development will not result in actionable nuisance or adverse impact to neighbouring properties. The flood impact assessment confirms no worsening to flood levels on any properties adjacent to the proposed development.

1.1 Scope of this Report

The scope of this report is as follow:

- *Flood Investigation* – A TUFLOW model was developed to determine existing and post development overland flow flooding conditions within and surrounding the site. The proposed stormwater management strategy (utilising detention / bioretention basins / channels) was incorporated into the analyses to determine the optimum configuration of these drainage elements to mitigate adverse changes in flood conditions resulting from the development. Refer to **Section 3** for more details.
- *Stormwater Quality Management* – A stormwater quality model using MUSIC software was created to determine the adequacy of the proposed Stormwater Quality Improvement Devices (SQID's) in meeting the Water Quality Objective (WQO's) required under the SPP (2017). Details for construction, operational and maintenance of (SQID's) have also been provided. Refer to **Section 5**.

2 Background

2.1 Location

The proposed development is located on Yaamba Road (Bruce Highway), Parkhurst, on land described as Lot 80 on SP300143. The site is bound by existing properties to the north, south and east, and Yaamba Road and existing properties to the west. Parkhurst is directly north of Rockhampton, approximately 5km from the city centre. Refer **Figure 2-1** below for site location.

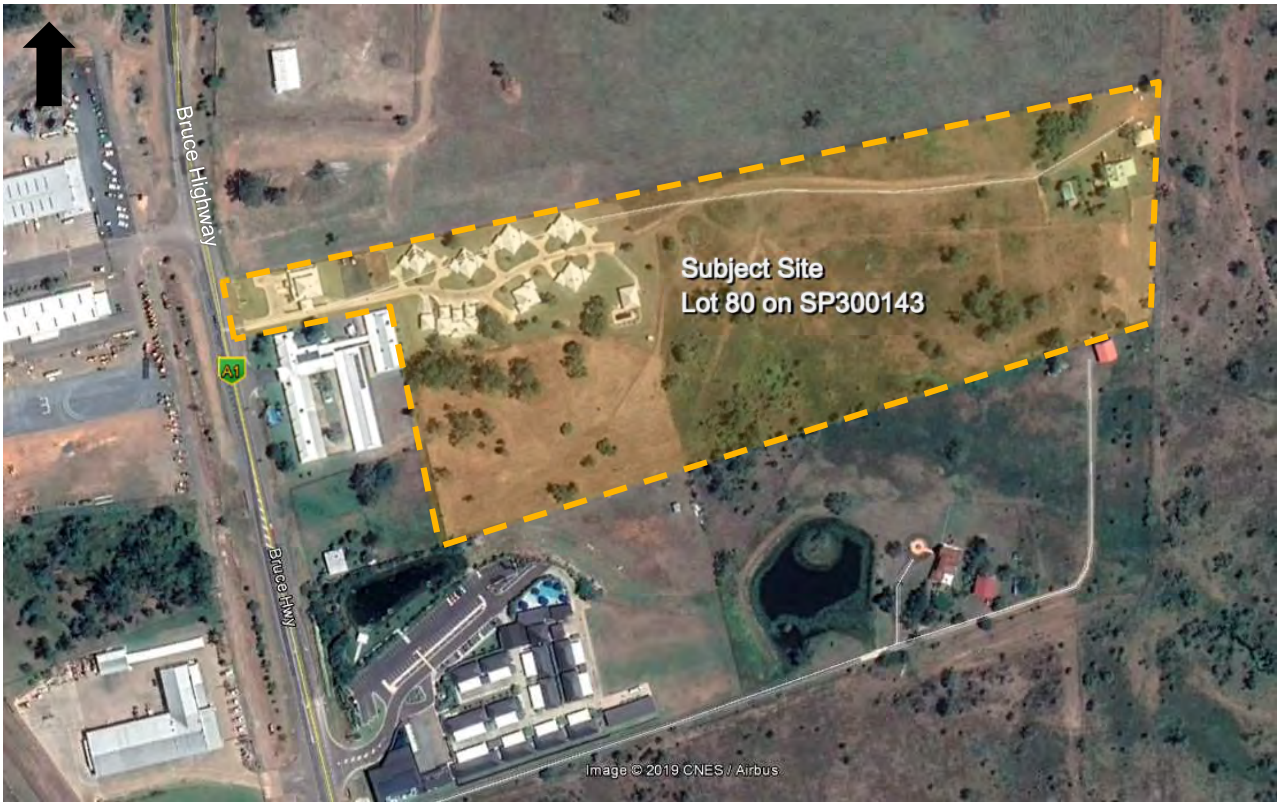


Figure 2-1: Site Location (Google Earth).

2.2 Existing Land Use, Topography and Surrounding Flood Behaviour

The existing land use of the site is best described as rural with groundcover generally being characterised as long grass with scattered trees/scrub.

The site falls from east to west, with a small range of hills to the west of the site and Ramsay Creek to the north and east. Slope within the study area varies from 2.5% in the east to 1% in the west. The site has an area of 8.4 ha.

Figure 2-2 presents the drainage characteristics for the site. External catchments to the south east drain through the site, joining flows from within, which are then conveyed in an existing small natural channel through the site to the southern discharge location. Flows then travel through an existing drainage easement in the parcel of land to the south of True Blue Hotel, to the existing set of culverts under the Bruce Highway, and into Ramsay Creek to the west of the site.

Some local flows to the north of the site join with a smaller portion of the internal flows in the north of the site and drain through the existing road pipe system and discharge at the northern discharge location. These flows then head south along the Bruce Highway to join the other site flows entering the existing culverts beneath the Bruce Highway.

Ramsay Creek flows generally east to west, to the north of the site and then to the west of the site. During larger events, such as the Q100, a small portion of Ramsay Creek breaks its banks to the north of the site and flows generally south along the Bruce Highway. These flows pass through the very north western corner of the site and join with the flows from the site at the northern discharge location and then onward to eventually re-join Ramsay Creek.

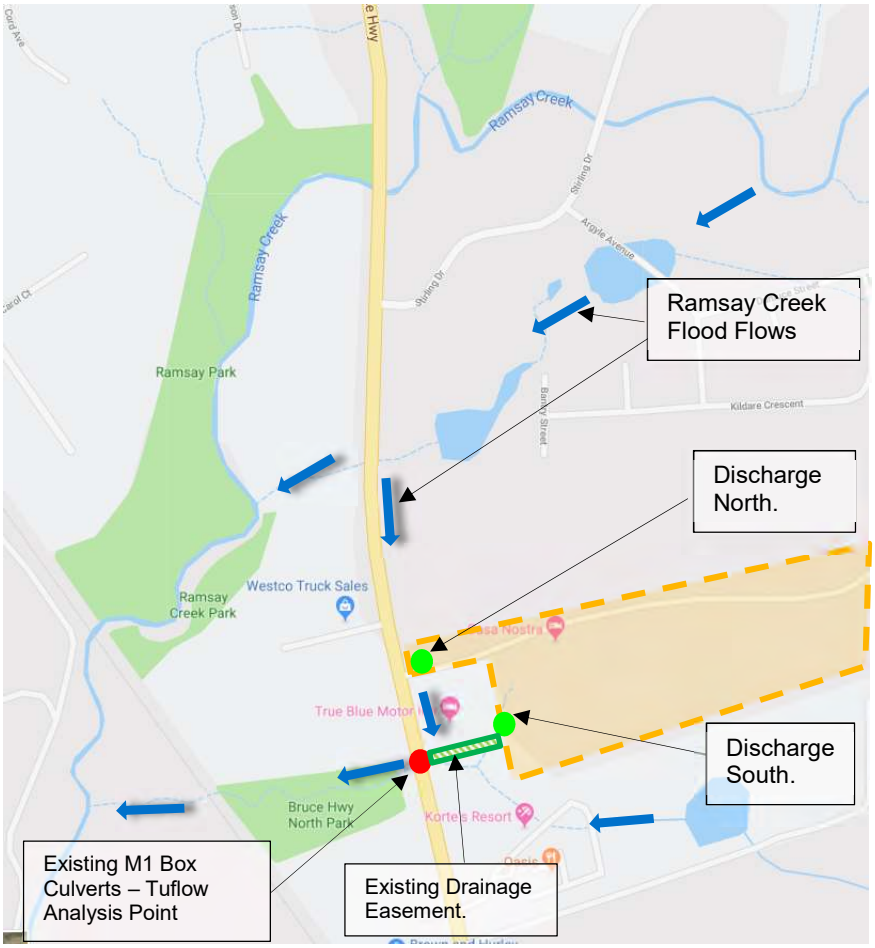


Figure 2-2: Site Flows, Analysis Point and Discharge Locations.

2.3 Site Discharge Location

As identified in **Figure 2-2**, under existing conditions, site runoff discharges to two (2) locations:

- Northern Discharge Location – The north west of the site has been previously developed and discharges through an existing internal road and stormwater pipe network. These flows discharge to the verge of the Bruce Highway and then drain to the south towards the existing culverts under the highway.
- Southern Discharge Location – Runoff flows from the remainder of the site discharge through an existing small natural drain, which then drains through an existing drainage easement between Lot 1000 and 1012 and is then conveyed through the existing box culverts under the highway.

The stormwater mitigation strategy has been developed to ensure there is no actionable afflux in the properties surrounding the site as well as downstream at the culverts under the Bruce Highway (M1). Refer to Drawing No. **18-002772-SK01** attached in **Appendix D** for the results of the flood difference mapping.

3 Flood Investigation TUFLOW

Analysis has been undertaken to demonstrate the adequacy of the stormwater management strategy in achieving no adverse flood impact or no actionable nuisance to downstream or adjacent properties or infrastructure, as a result of the development.

The flood investigation has been undertaken using combined 1D/2D flood model software to analyse both pre and post site development conditions. Comparing the results of both scenarios demonstrates the effectiveness of the stormwater management strategy to ensure mitigation of flows before entering the existing set of box culverts under the Bruce Highway.

3.1 Stormwater Management Strategy

The development of the site (without mitigation) is expected to increase peak flows, flood levels and/or velocities both within and adjacent to the site. To mitigate the potential increases the following strategies are proposed:

- Stormwater Quality Management Strategy: - Conceptual bioretention basins have been proposed for each of the developed catchments to treat the runoff pollutants from the site. This analysis is conceptual only and will require further refinement during detail design to ensure the products are constructed correctly enabling them to perform to their intended standard.
- Stormwater Quantity Management Strategy: - Due to external overland flows entering the site at the south eastern boundary, a constructed channel drain is proposed to convey internal and external flows through the site to the southern discharge location. A detention basin has been included at this location to ensure flows leaving the site are adequately mitigated. A further section of constructed channel is then required to convey flows through the existing drainage easement to the inlet to the existing set of culverts beneath the Pacific Highway (M1). This strategy will ensure there are no increases to flood levels in adjacent properties or at the existing set of culverts under the Bruce Highway. Results demonstrate that some of the adjacent properties will in fact have significant reductions in flood levels. Refer to **Figure 2-2** for analysis point and discharge locations.

3.2 Flood Model Approach

The base flood model used was provided by Rockhampton Regional Council (RRC). The model was developed using TUFLOW two-dimensional (2) hydrodynamic modelling package flood behaviour within the model area. The hydrologic inputs to the 2D model are discussed in **Section 3.2.1**.

3.2.1 Model Hydrology

Boundary Conditions

The main waterway in the area is Ramsay Creek which flows from east to west, to the north of the site. The TUFLOW model includes only the portion of Ramsay Creek that falls within the model boundary. Flows representing Ramsay Creek entering the model are included as boundary conditions on the eastern side of the model extent. Ramsay Creek is split at this point into three separate branches requiring three separate boundary condition locations, refer to **Figure 3-1** below. The outflow boundary is located on Ramsay Creek approximately 4km downstream of the site and is represented by two creek branches. A third outflow boundary is located to the north west of the site for a location where flood flows are lost from the catchment during large flood events such as the Q100.

The total model size is approximately 1,147 ha, refer to **Figure 3-1**. Adopting the RCC model allows for detailed 2D analysis of the site and surrounding properties, including existing flowpaths and stormwater infrastructure, as well as the proposed stormwater mitigation works for the site.

Direct Rainfall

The model has been constructed using Direct Rainfall method (rain on grid) for specific storms shown in **Table 3-1** below. Specific storm durations were analysed to determine the critical duration. The critical duration for the site was determined to be the 60 minute storm but the critical duration for the flows entering the existing culverts under the Bruce Highway is 90 minutes due to the influence of the Ramsey Creek flood flows at this location. Results for the 1% EAP have therefore been provided as an envelope of multiple durations to ensure the maximum water level is reported irrespective of storm duration. Temporal patterns and model losses have not been adjusted from those adopted by RRC to ensure consistency across models.

Table 3-1 Analysed Storms

ARI	AEP	Storm Durations
1	63%	90 mins
2	39%	90 mins
5	18%	90 mins
10	10%	90 mins
20	5%	90 mins
50	2%	90 mins
100	1%	60 & 90 mins, 2, 3, 4.5 and 6 hours

Topography

The digital terrain model (DTM) provided by RRC has been adopted for the model with a grid size of 3m, which is considered adequate for describing flooding behaviour given the rural nature of the study area. This resolution also adequately represents the main features of the site and any major hydraulic structures. All stormwater pipes and culverts are expressed as 1D elements within the model. A computational time step 1.5 seconds has been adopted which is appropriate for a model of this size and is consistent with TUFLOW recommendations.

Alterations to the topography over the site in both the pre-developed and post developed scenarios is discussed in **Section 3.3.1**.

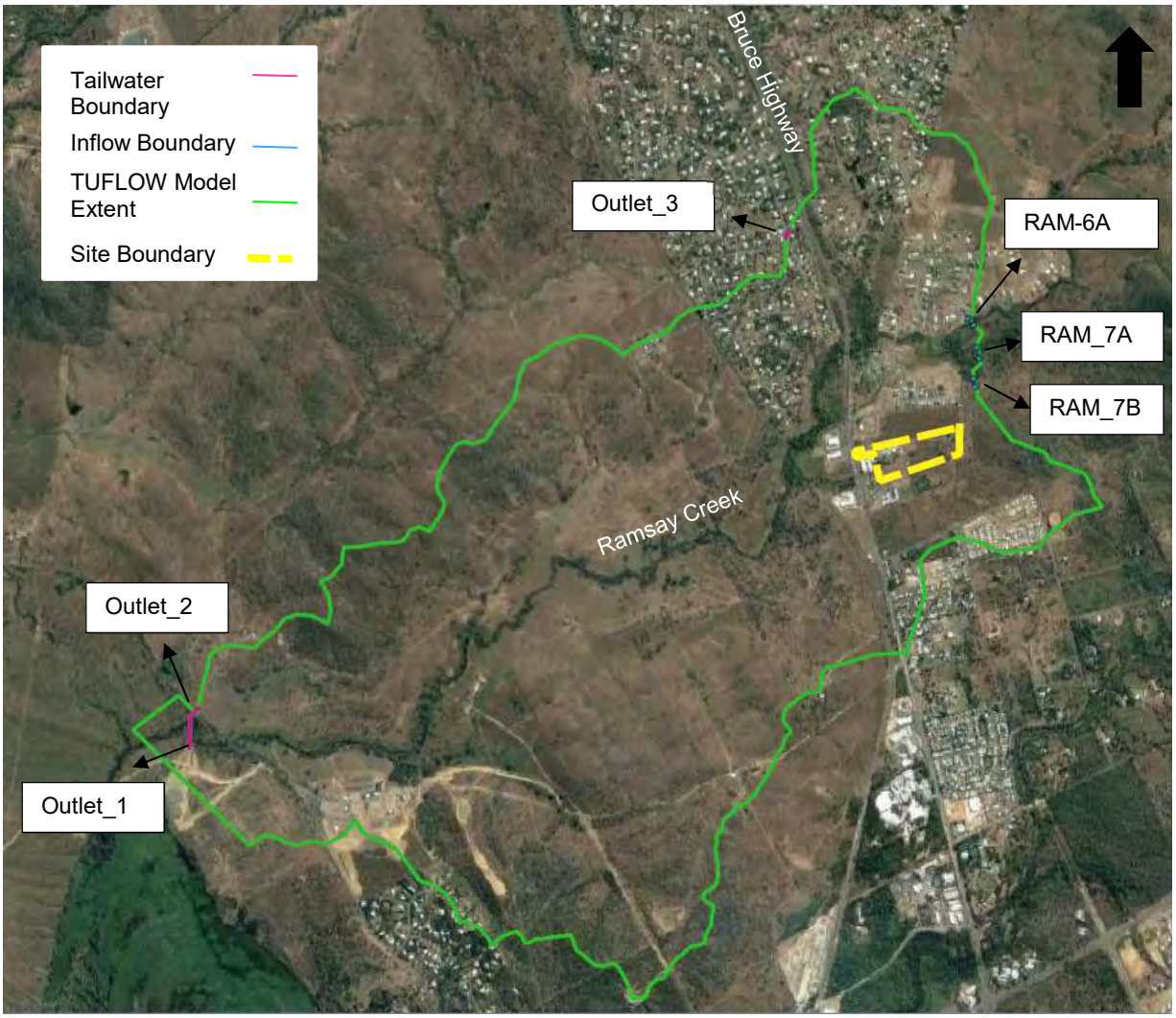


Figure 3-1: Model Boundary Conditions

3.3 Hydraulic Analysis

The TUFLOW 2D model simulates hydraulic conditions for the model area, through solving the depth averaged two-dimensional momentum and continuity equations for free surface flow. The following sub-sections detail the components of the flood model development.

The TUFLOW model was used to simulate both pre and post, site development scenarios. Some minor modifications were made to the pre-developed scenario model to better simulate the current conditions of the site. Further modifications were made to the post-developed scenario model to reflect the changes to the site resultant of the proposed development as well as the required stormwater mitigation measures identified in this report. The details of the model amendments are provided in the following sections.

3.3.1 Model Configuration

Material File

The material file within the model holds all the information pertaining to the ground surface conditions for various areas, such as the manning's "n" and infiltration losses at varying flow depths. The material type adopted for the site by the RRC is Low Density Residential, refer to **Figure 3-2** below. It is assumed this is a generic material type assigned to areas that have been identified for future development. Adopting a material file commensurate with an ultimate future development scenarios provides a more accurate model result that is less likely to be eroded over time.

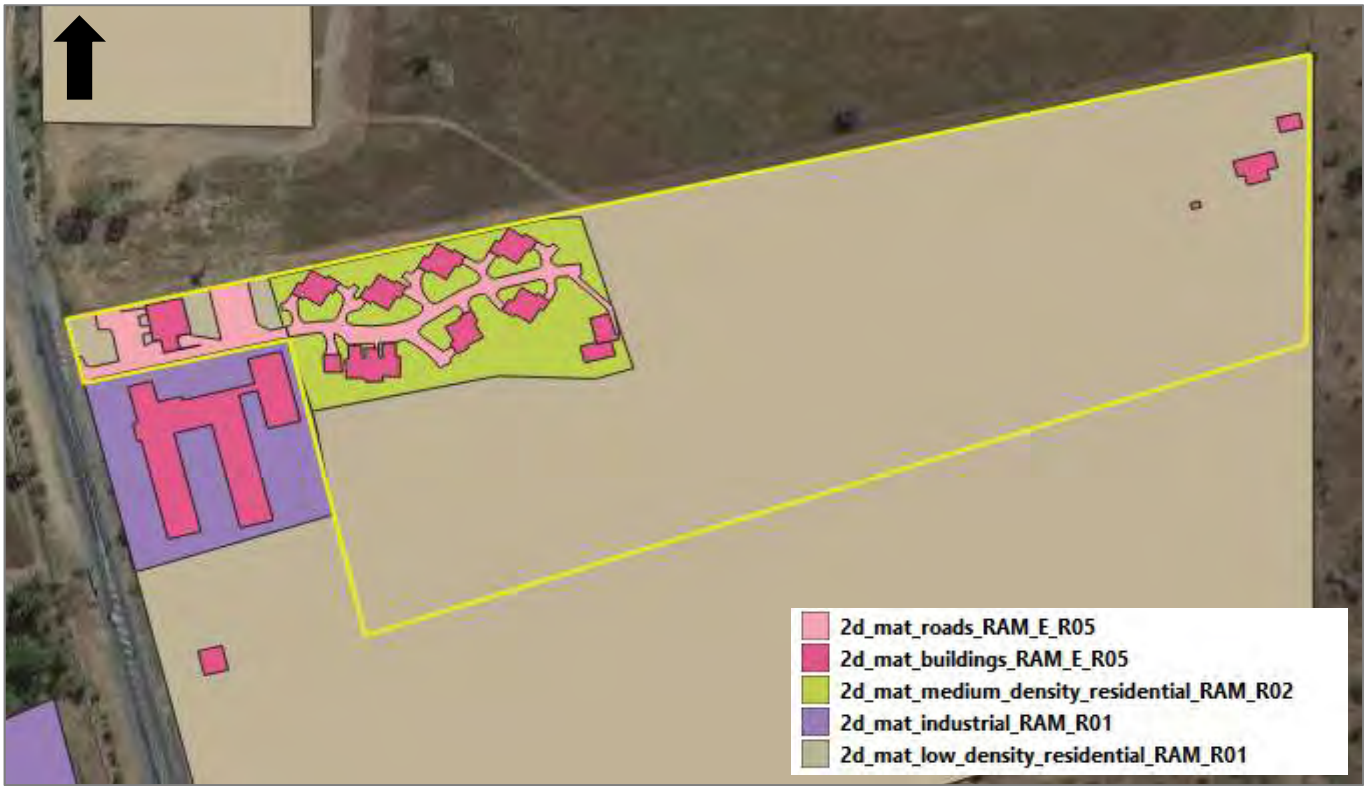


Figure 3-2: RRC Model Material Configuration.

The material file for the project pre-developed scenario has been adjusted to more accurately model the site under its current land use. Instead of using a single material file for the whole site a number of files have been used. A material file representing low density vegetation has been chosen for the open grass areas of the site and a material file representing buildings and roads has been used for the buildings and roads that currently exist on the site. The area of the site, in the north-west, that has previously been developed has not been amended, refer to **Figure 3-3** below.

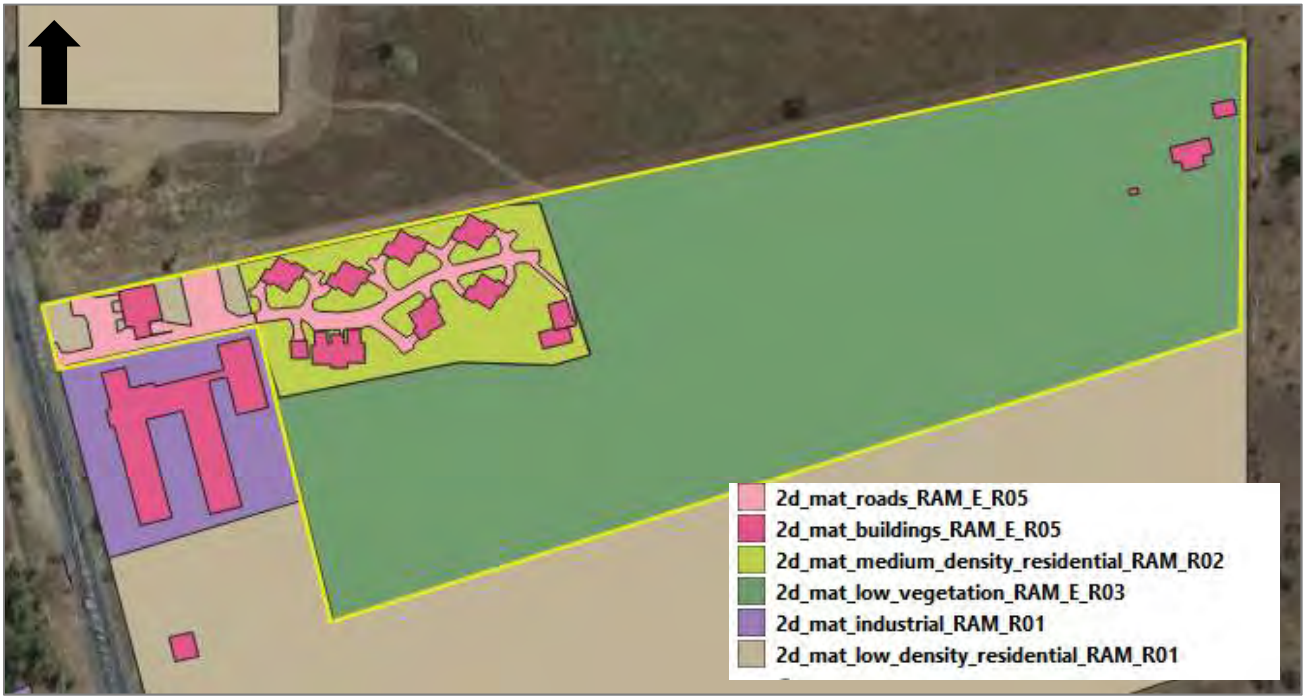


Figure 3-3: Pre-Development Model Configuration

The Mannings “n” for buildings was increased to 0.5 to reflect the impediment to flows that would be caused but the building structure. This method of modelling houses is considered more appropriate for a 2D model as raising the level of the ground (as is sometimes used) can provide unacceptable instabilities in a model using the rain on grid rainfall methodology.

The material file for the project post-developed scenario has adopted the same material files as those used in the pre-development scenario, with further modifications representing the proposed development. The additional buildings and roads have had their material files amended to reflect their respective characteristics and the proposed constructed channel has been changed to medium density vegetation, refer to **Figure 3-4** below.

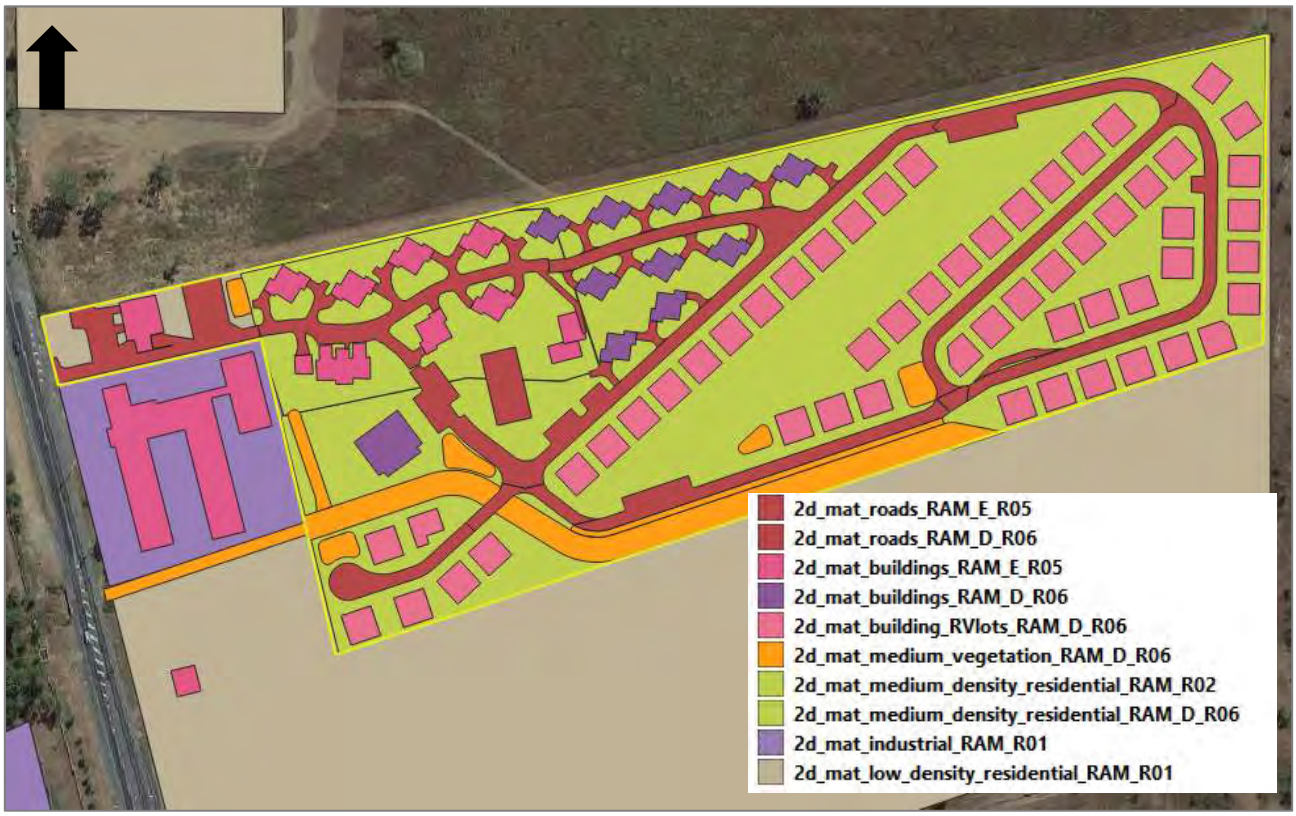


Figure 3-4: Post-development Mitigated Model Material Configuration

The parameters assigned to each of the material types has been provided in the RCC model.

Topography (DTM) Modifications

Survey was carried out on the site, as part of the design process, and used to develop a natural surface TIN (Triangular Irregular Network) and a final design TIN. Both these TINs have been integrated into the RRC model. The natural surface TIN is shown in **Figure 3-5** below and the final design TIN in **Figure 3-6.**

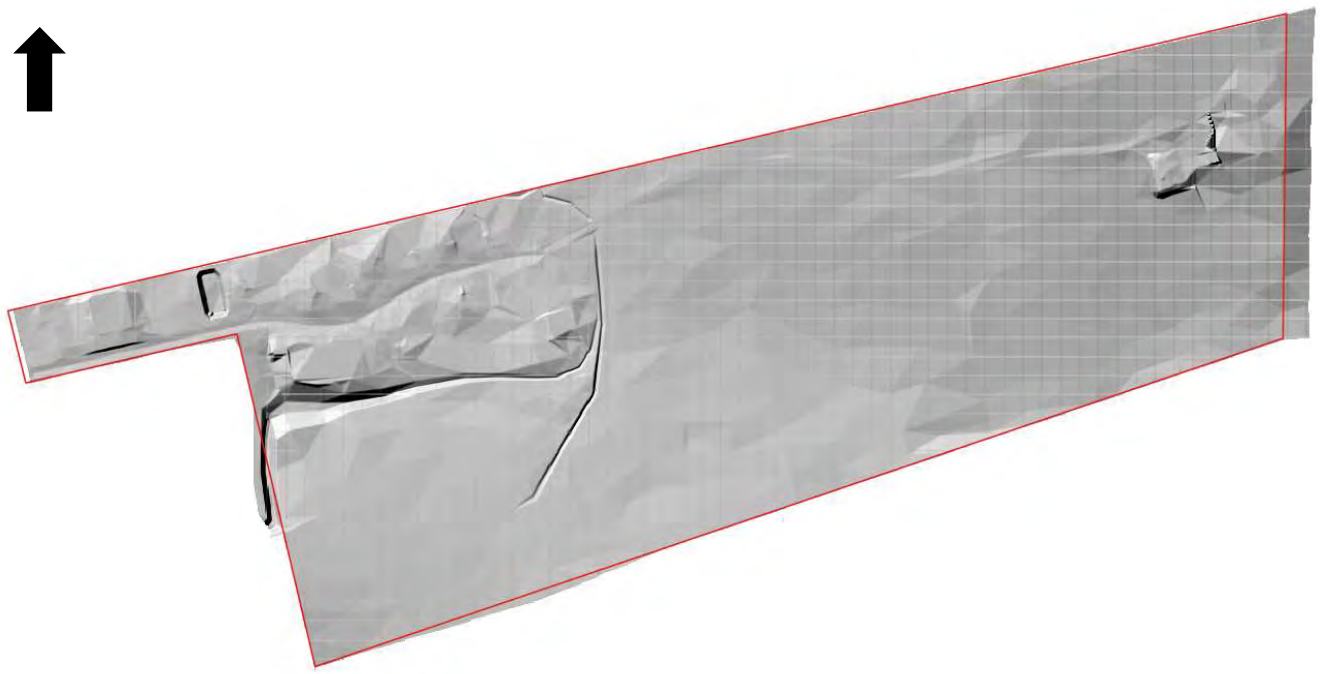


Figure 3-5: Natural Surface Survey TIN

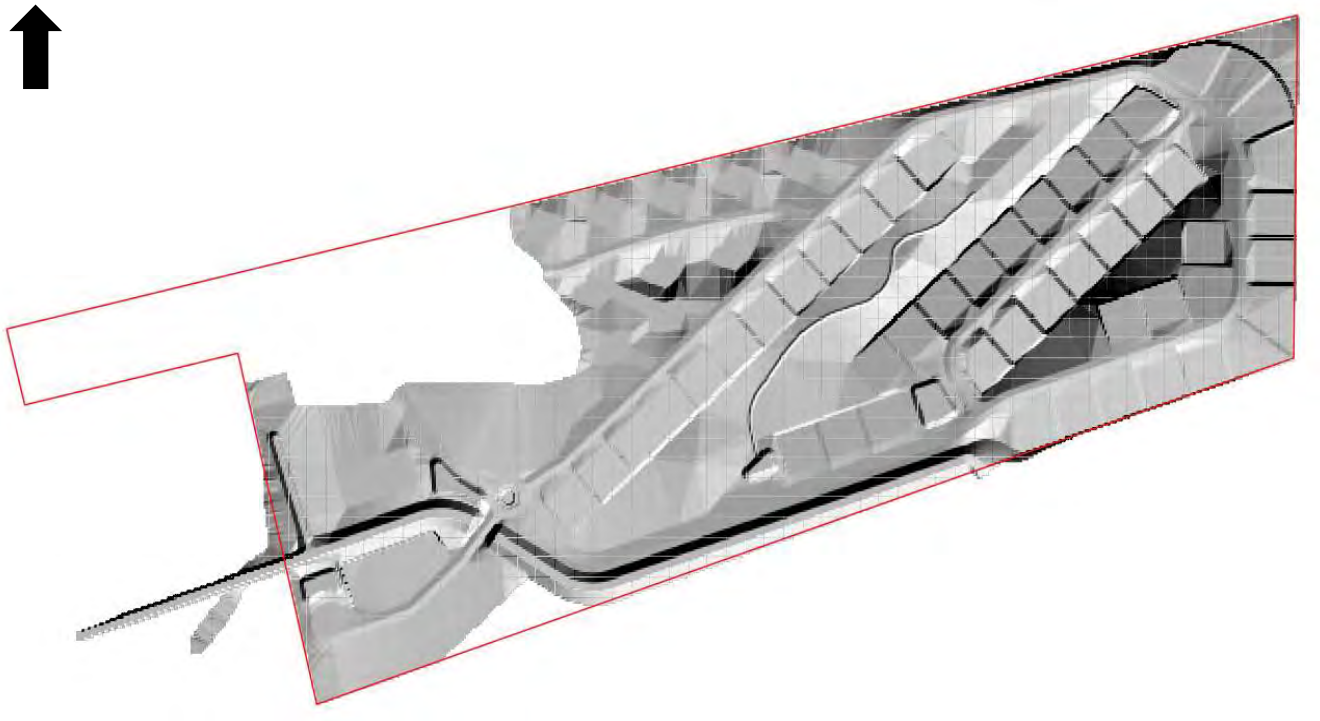


Figure 3-6: Final Design TIN

Assessment of the natural surface survey TIN compared to the Lidar TIN used in the RRC model identified the survey TIN to be consistently lower than the corresponding Lidar TIN. Some of the anomalies are resultant of vegetation, new buildings or earthworks carried out since the Lidar survey was collected (2015), and cannot be reasonably compared. Comparison of the remaining area of the site resulted in an average elevation difference of 114mm. Differences in survey of this nature are not uncommon and it is considered reasonable to adjust one, to ensure they align, such that the resultant model is hydraulically accurate. As such, for the purposes of this modelling procedure, the existing RRC model remains without alteration and the site survey has been raised by 114mm.

Figure 3-7 below shows the difference between the natural surface survey TIN and the RRC model Lidar TIN. The majority of the site is light or dark blue, which represents -100 and -150 mm of difference between the two TIN's respectively.

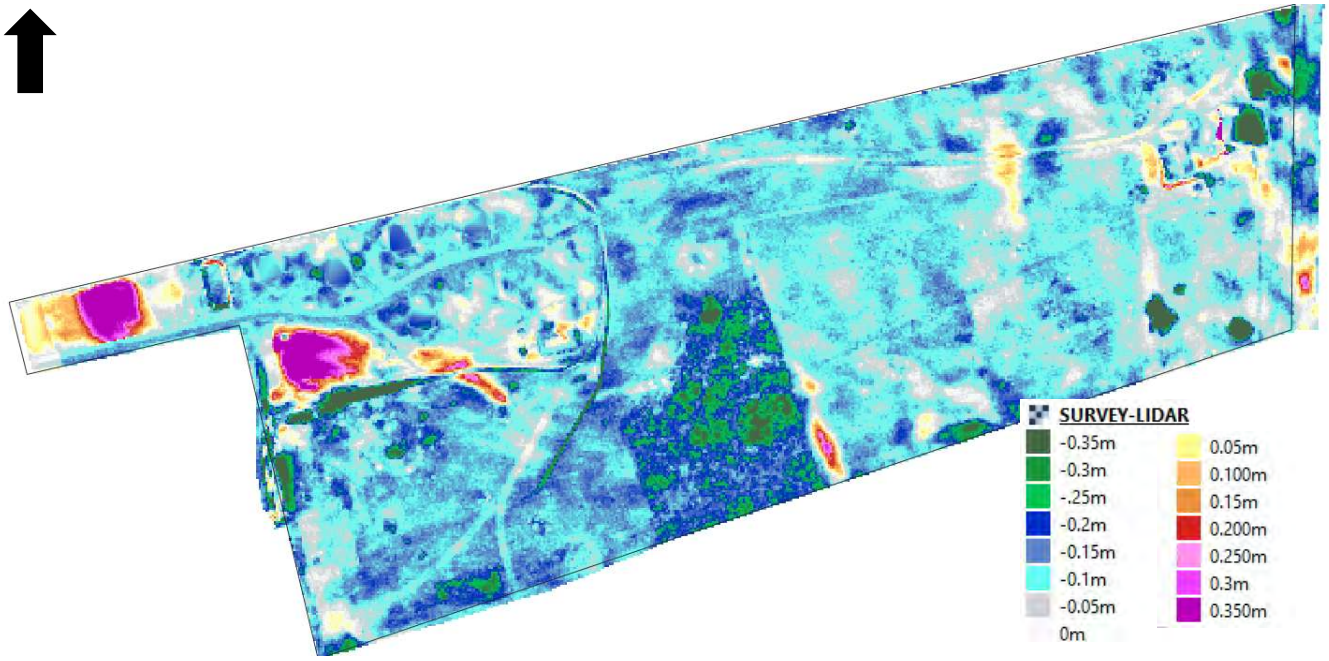


Figure 3-7: Lidar TIN - Natural TIN

Figure 3-8 below presents a cross section of the various TINs at a point on the boundary of the site. The figure compares the RRC Model Lidar TIN (red), with the current natural site survey TIN (dark blue) and the final model TIN (light blue). The final model TIN combines the raised natural survey data (by 114mm) for the site and Lidar data for areas external to the site.

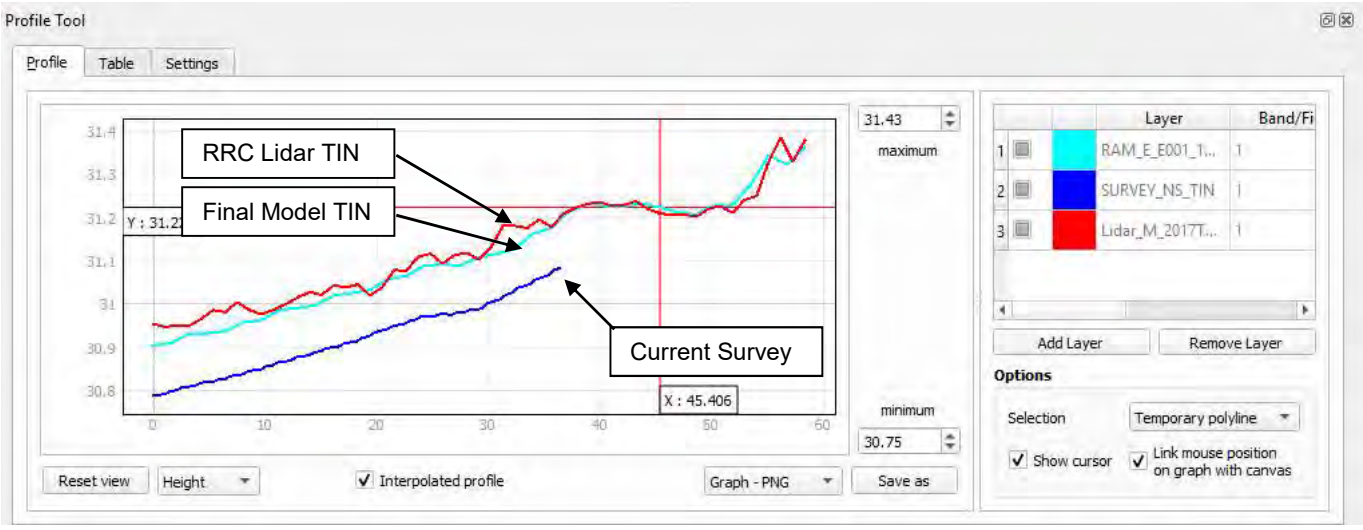


Figure 3-8: Adjusted Survey TIN

The results for the pre-developed scenario with the final model TIN were compared with the results from the existing pre-developed model with the original RRC Lidar TIN. The results didn't cause any notable afflux and had good agreement.

3.3.2 Design Detention Storages

A stormwater mitigation strategy has been designed to manage flows on and off the site to ensure no increase in flood levels on the site or in surrounding properties. Flood levels are assessed using flood maps for the model extents.

The stormwater mitigation strategy is required to meet the requirements of flow management as well as meeting the aesthetic and practical requirements of the site. The following mitigation measures have been adopted for this site:

- Formalisation of the existing natural drainage path through the site with a constructed channel
- Provision of a detention channel at the downstream extent of the site.
- Provision of an embankment and culverts across the constructed channel at the downstream extent of the site.
- Provision of a set of culverts beneath the internal road.

Constructed Channel

A constructed channel is being used to convey external and internal flows through the site and to assist in meeting site flow requirements. The formalisation of a constructed channel will also reduce flood levels within the site making the land more amenable for use. The channel is approximately 5m wide at the base and 12 m wide at the top and has been sized to accommodate the Q100 flows.

An additional section of detention channel has been included at the downstream end of the site to provide additional detention of flows. There will also be a formalisation of the existing channel downstream of the site. **Figure 3-13** below shows the location of the constructed channels.

Figure 3-9 below shows a typical cross section of the constructed channel through the site, **Figure 3-10** a typical cross section of the detention channel and **Figure 3-11** shows a cross section of the section of channel downstream of the site.

Figure 3-9: Constructed Channel Typical Section

Figure 3-10: Detention Channel Typical Section

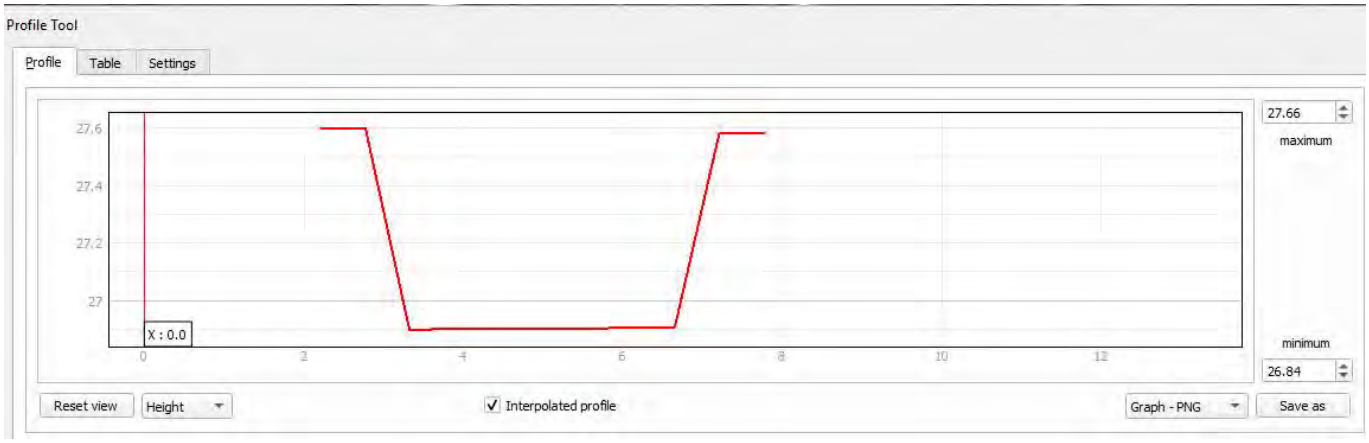


Figure 3-11: Downstream Channel Typical Section

A slight modification was required to the constructed channel to remove impacts on water levels in adjacent properties. Additional excavation was required at the upstream extent of the constructed channel to allow flows external to the site to enter the channel without any backing up of water upstream. This was done by creating a 2d_zsh file that lowered the model cells in the required location. The cells have been lowered to the level of the invert of the constructed channel, effectively extending the channel approximately 10m to the east. The location of the modification is show below in **Figure 3-12.**

A set of internal culverts has been provided for, where the constructed channel crosses with the internal road network. These culverts have been optimised to ensure depth velocity (hazard profile) results are acceptable at this location. A set of 5 (600X600) RCBC's has been provided.

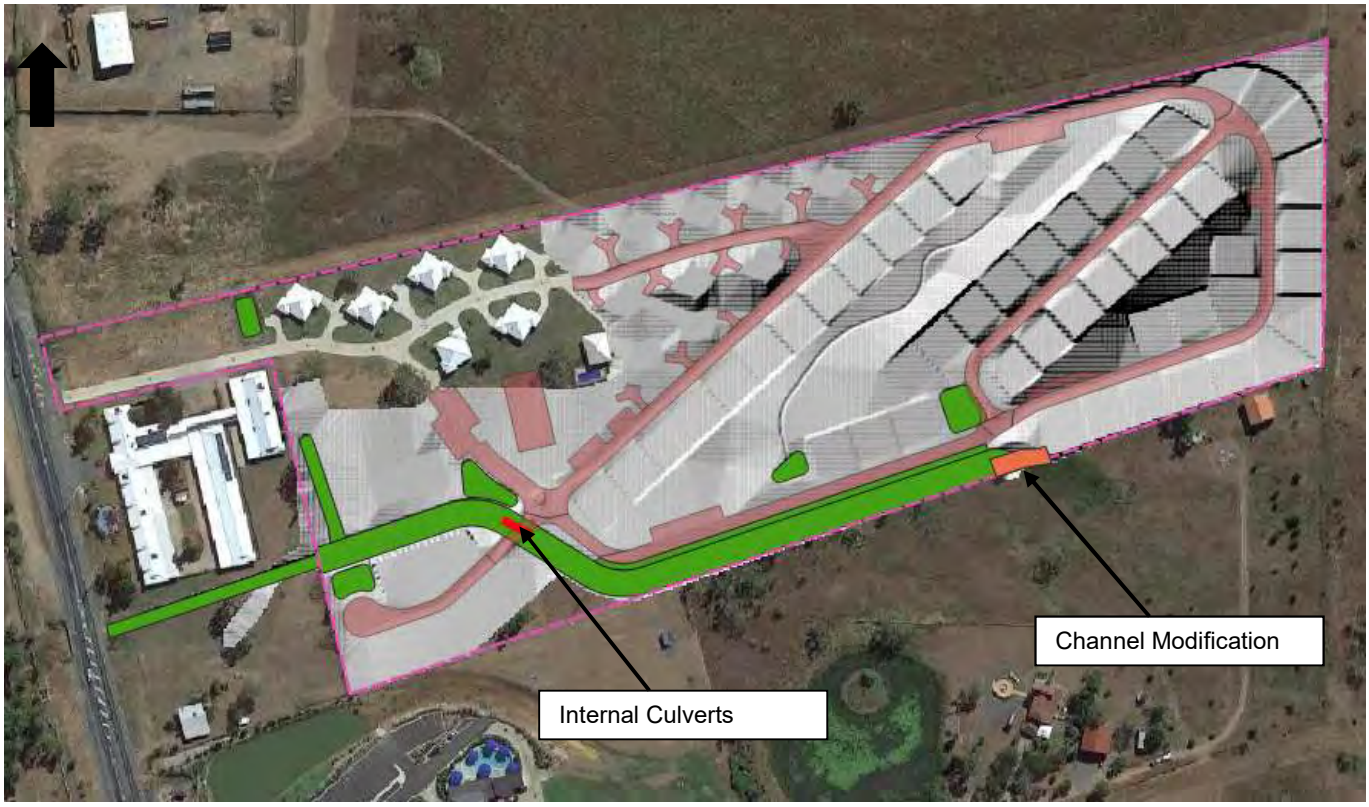


Figure 3-12: Channel Modification Location

Detention Storage

An embankment has been included at the downstream extent of the site to help utilise the detention potential of the constructed channel and to control the flows leaving the site. The embankment includes a set of outlet culverts 2(900X600) beneath it to control storage outflows. The embankment, shown in **Figure 3-13** below, transverses the constructed channel and continues around the extent of the detention channel to prevent flows from entering the downstream property (True Blue Hotel). The detention created by the embankment and culverts is required to ensure there is no afflux downstream of the site at the existing M1 culverts.

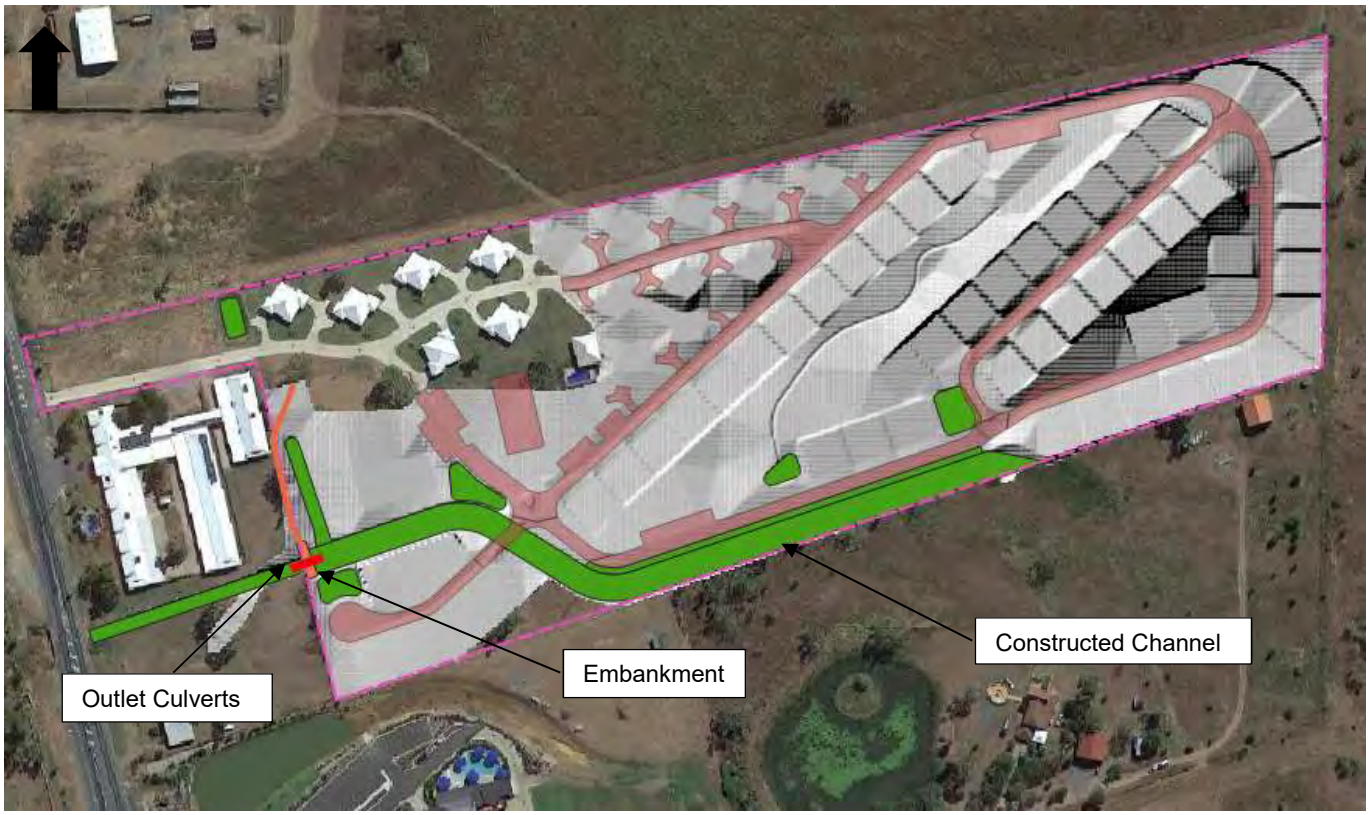


Figure 3-13: Constructed Channel and Embankment

Details of the storage have been provided in **Table 3-2** below and the stage storage relationship is provided in **Table 3-3**. It should be noted these levels are AHD relative to the survey undertaken for the site, the model levels are 114mm higher than those reported due to the raising of the site TIN, as described in **Section 3.3.1**.

Table 3-2 Detention Basin Parameters.

Parameter	Detention
Detention Storage	1640 m3
Storage Invert Level	27.5 m AHD
Width of the Downstream Channel	3 m
IL of the Downstream Channel	27.4 m AHD
Embankment Length	12 m
Top of the Embankment	29.0 m AHD
Outlet Culverts	2 (900X600) RCBC

Table 3-3 Detention Basin Stage–Storage Relationship.

Stage (m AHD)	Storage (m^2)
27.5	0
27.6	2
27.7	9
27.8	25
27.9	53
28	94
28.1	147
28.2	213
28.3	297
28.4	404
28.5	539
28.6	702
28.7	893
28.8	1112
28.9	1360
29	1638

3.4 Results

Results have been extracted from the model to clearly articulate the impacts of the development on the site and surrounding properties. The following results have been provided for the pre-developed and post-developed scenarios:

- Basin water level
- Flood impact assessment or flood maps (2D) showing flood inundation extents, depths, heights and velocities as well as flood difference mapping for the site and surrounding properties.

3.4.1 Detention Basin

The constructed channel and the bund at the Southern Discharge location together form the detention basin for the site. **Table 3-4** below presents the results of the water level reached in the basin for the 63% to the 1% AEP storm events. The results provided are 114mm lower than those from the model due to the raising of the site TIN, as per **Section 3.3.1**.

Table 3-4: Basin Water Level.

AEP	Basin Water Level (m AHD)
63%	28.33
39%	28.70
18%	29.04
10%	29.08
5%	29.11
2%	29.12
1%	29.16

The *Rockhampton Regional Planning Scheme 2015* requires a minimum freeboard of 500mm, from the 1% AEP WSL in a basin, to a minimum habitable floor level. As presented in **Table 3-4** above, the 1%AEP WSL is 29.16 m, resulting in a minimum habitable floor level for the site of 29.66 m AHD for the site.

3.4.2 Flood Impact Assessment

Flood maps have been extracted from the pre-developed and post developed models to demonstrate the change to water depth and velocities throughout the site and surrounding properties. The following flood maps have been provided in Appendix C for each of the assessed AEP storm events:

- Flood height and flood height difference
- Flood velocity and flood velocity difference
- Flood hazard

Figure 3-14 and **Figure 3-15** below provide the 10% and 1% AEP flood level difference for the 1% and 10% AEP events respectively.

Figure 3-14: Flood Difference Map 1% AEP Storm Event

Figure 3-15: Flood Difference Map 10% AEP Storm Event

The results indicate there are no increases in flood heights on surrounding properties or downstream at the M1 culverts for either the 10% AEP or the 1% EAP flood events. There are considerable decreases in flood levels throughout the site resultant of the stormwater mitigation strategy. There are also decreases in water levels on adjacent properties and downstream of the site providing an improvement for these areas.

4 Waterway Stability Management

Runoff from the development will effectively discharge to the existing drainage network located at the different discharge locations. Based on this water stability management requirements are not applicable.

5 Stormwater Quality

To improve the stormwater quality leaving the proposed development, a treatment train comprised of Stormwater Quality Improvement Devices (SQIDs) is proposed. The SQIDs will intercept and capture pollutants so that potential stormwater quality impacts are reduced and WQOs are achieved.

The scope of works for the stormwater quality analysis was to:

- Identify key stormwater pollutants associated with the proposed development;
- Identify the WQOs applicable for the site;
- Propose SQIDs for stormwater quality management; and
- Model the proposed SQIDs to asses if they achieve the required WQOs.

5.1 Pollutants of Concern

Typical key pollutants expected to be generated during the operational (post-construction) phase of the development are listed below. The capitalised pollutants are the key pollutants to be targeted for treatment.

- LITTER
- SEDIMENT
- Oxygen demanding substances (possibly present)
- NUTRIENTS (N & P)
- Pathogens / Faecal coliforms
- Hydrocarbons
- HEAVY METALS (associated with fine sediments)
- Surfactants
- Organochlorines & organophosphates
- Thermal pollution
- pH altering substances

Only the capitalised key pollutants are further addressed in this report. However, the treatment train developed will also mitigate other pollutants. As heavy metals are predominately associated with fine sediments, the controls proposed to reduce total suspended solids will also reduce heavy metal loads.

5.2 Water Quality Objectives

The load reduction WQOs for the site are shown in **Table 5-1** and have been adopted from *Appendix 3* of the *SPP* (2017).

Table 5-1: WQOs for the Site (Central Queensland, South)

	Total Suspended Solids (TSS)	Total Phosphorus (TP)	Total Nitrogen (TN)	Gross Pollutants (GP)
Load Reduction Target	85%	60%	45%	90%

5.3 Stormwater Quality Management Strategy

To improve the stormwater quality discharging from the site, bioretention basins and swales are proposed. Refer to Drawing No. **18-002772-SK03** in **Appendix D** for the proposed treatment train configuration.

Bioretention systems utilise sandy loam soil based media to filter runoff. Sediment particle and suspended solids are trapped within vegetation and on the surface of the filter media while micro-organisms and vegetation remove dissolved nutrients (Nitrogen and Phosphorus) through biological uptake processes. Subsoil drainage provided below the filter media allows for the treated runoff to discharge from the bioretention systems.

Five conceptual bioretention basins are proposed to treat runoff flows before leaving the site. Refer to Quality Catchment Plan Drawing No. **18-002772-SK03** in **Appendix D** for location of the bioretentions and related catchment areas.

5.4 MUSIC Modelling Methodology

Water quality modelling was undertaken using MUSIC modelling software. MUSIC was developed by the Cooperative Research Centre for Catchment Hydrology. It conceptualises the transfer of pollutants through a stormwater drainage system and quantifies the effectiveness of the proposed stormwater quality treatment trains. MUSIC only provides quantitative modelling for total suspended solids (TSS), total Phosphorous (TP), total Nitrogen (TN) and gross pollutants (GP). The MUSIC model was setup in accordance with Mackay Regional Council's *MUSIC Guidelines – Version 1.1* (2008) and Water by Design *MUSIC Modelling Guidelines* (2010).

5.4.1 Meteorological Data

Six (6) minute pluviographic data was sourced from the Bureau of Meteorology (BOM) for Rockhampton Aero (Station No. 39083). The 10 year rainfall period from 31 March 2000 to 31 March 2010 was adopted for analysis. Mean potential evapotranspiration (PET) values were sourced from the BOM.

5.4.2 Source Nodes

Source nodes represent the catchment areas modelled. The catchment delineation is shown on Drawing No. **18-002772-SK03** in **Appendix D.** The split catchment approach has been adopted with roof, road and ground areas being measured from the development layout. Roof areas include all impervious surface areas on individual lots. Percentage impervious assumptions for the required node types are detailed below in **Table 5-2**.

Table 5-2: Adopted Surface Type Percentage Impervious (%)

Surface Type	Adopted Percentage Impervious
Roof	100%
Road	100%
Ground	0%

The area of the source nodes for each catchments, and the area of each of the bioretention basins, is presented below in **Table 5-3**. MUSIC modelling has been undertaken adopting the above noted percentage impervious for each of the listed source nodes. The area for each of the bioretention basins has been excluded from the source nodes in the MUSIC model.

Table 5-3: Source Node Catchment Areas

	1	2	3	4	5	6
Total Area (ha)	2.093	0.353	0.893	2.050	0.445	1.199
Road Area (ha)	0.284	0.133	0.095	0.505	0.064	0.038
Roof Area (ha)	0.734	0.068	0.023	0.454	0.131	0.058
Ground (ha)	1.055	0.148	0.758	1.074	0.238	0.660
Basin (ha)	0.019	0.005	0.017	0.017	0.011	na

Base and storm flow pollutant concentrations and soil properties have been adopted from *Table 8* and *Table 9* of *Mackay Regional Council MUSIC Guidelines – Version 1.1 (2008)*. Stochastic generation estimation and serial autocorrelation set to zero has also been adopted.

5.4.3 Treatment Nodes

Bioretention Basins

Five (5) conceptual bioretention basins were modelled as part of the development. The minimum filter areas required to achieve the SPP (2017) WQO's are presented in **Table 5-4**. Refer to concept stormwater management drawing attached in **Appendix D** for further details of the basin's locations and concept formations.

Table 5-4: Bioretention Basin Areas

Catchment	Filter Area (m2)
1	192
2	50
3	168
4	170
5	109

The following parameters were applied across bioretention basins 1, 3, 4 and 5:

- 300mm Extended detention depth;
- 500mm filter media depth;
- Overflow weir was modelled as 10% of the filter area;
- 30mg/kg filter media Orthophosphate content;
- 400mg/kg filter media TN content; and
- 180mm/hr filter media saturated hydraulic conductivity.

Basin 2 is identical in all respects excepting its extended detention depth, which is 100mm. The Orthophosphate and TN content in the filter media were adopted from Healthy Waterways (2016).

Swales

A swale is a vegetated channel that can be used to filter coarse and medium sediments from stormwater flows. Catchment 6, which is the area of the site adjacent to the constructed drain running through the site, has utilised the drain as a treatment swale. This drain will in fact provide additional treatment for the entire site but has only been utilised for the treatment of Catchment 6 in the music modelling. Half the length of the drain has been used to calculate the area of filtration for the purposes of modelling.

Table 5-5: Swale Surface Area

Catchment	Area (m2)
6	660

5.5 MUSIC Modelling Results

Table 5-6 to **Table 5-11** below present the results from each of the water quality treatment devices for each of the catchments.

Table 5-12 presents the combined MUSIC results for the entire site.

Table 5-6: MUSIC Results - Bioretention 1

Pollutant	TSS	TP	TN	GP
Source Loads (kg/year)	868	1.93	13.3	151
Residential Load (kg/year)	140	0.51	6.69	0
Reduction Required for WQO	85%	60%	45%	90%
Reduction Achieved	83.9%	73.8%	49.6%	100
Reduction Achieved > Reduction required	NO	YES	YES	YES

Table 5-7: MUSIC Results - Bioretention 2

Pollutant	TSS	TP	TN	GP
Source Loads (kg/year)	332	0.593	2.55	29.9
Residential Load (kg/year)	46.6	0.138	1.35	0
Reduction Required for WQO	85%	60%	45%	90%
Reduction Achieved	86%	76.8%	47%	100%
Reduction Achieved > Reduction required	YES	YES	YES	YES

Table 5-8: MUSIC Results - Bioretention 3

Pollutant	TSS	TP	TN	GP
Source Loads (kg/year)	275	0.473	1.97	17.6
Residential Load (kg/year)	20.3	0.042	0.615	0
Reduction Required for WQO	85%	60%	45%	90%
Reduction Achieved	92.6%	91.2%	68.7%	100
Reduction Achieved > Reduction required	YES	YES	YES	YES

Table 5-9: MUSIC Results - Bioretention 4

Pollutant	TSS	TP	TN	GP
Source Loads (kg/year)	1340	2.51	12.5	143
Residential Load (kg/year)	221	0.592	6.53	0
Reduction Required for WQO	85%	60%	45%	90%
Reduction Achieved	83.5%	76.4%	48%	100%
Reduction Achieved > Reduction required	NO	YES	YES	YES

Table 5-10: MUSIC Results - Bioretention 5

Pollutant	TSS	TP	TN	GP
Source Loads (kg/year)	189	0.391	2.53	29
Residential Load (kg/year)	9.89	0.049	0.889	0
Reduction Required for WQO	85%	60%	45%	90%
Reduction Achieved	94.8%	87.6%	64.9%	100
Reduction Achieved > Reduction required	YES	YES	YES	YES

Table 5-11: MUSIC Results - Swale 6

Pollutant	TSS	TP	TN	GP
Source Loads (kg/year)	144	0.275	1.57	14.3
Residential Load (kg/year)	12.9	0.102	1.13	0
Reduction Required for WQO	85%	60%	45%	90%
Reduction Achieved	91.1%	63%	27.9%	100
Reduction Achieved > Reduction required	YES	YES	NO	YES

Table 5-12: MUSIC Results – Entire Site

Pollutant	TSS	TP	TN	GP
Source Loads (kg/year)	3150	6.17	34.4	385
Residential Load (kg/year)	451	1.43	17.2	0
Reduction Required for WQO	85%	60%	45%	90%
Reduction Achieved	86%	77%	50%	100
Reduction Achieved > Reduction required	YES	YES	YES	YES

Results in **Table 5-12** demonstrates that WQO's have been achieved for the entire site. The above results demonstrate that the proposed stormwater quality management strategy achieves the WQOs required under the *SPP* (2017).

5.6 Construction, Establishment & Maintenance of SQIDs

Outlined below are the proposed procedures and methodology for the construction and operational management as well as the maintenance of the bioretention basins proposed as part of the development. The following methodology will be followed through the construction, establishment, and operational phases of each bioretention basin. Details provided in this section will be incorporated into the detailed design of the development.

5.6.1 Construction & Establishment Phases

Construction of the development and building works has the potential to mobilise large quantities of sediment in runoff. For bioretention systems to perform as designed there is a need to protect filter media and basin vegetation during this phase of the development. Therefore a staged construction and establishment method for construction of the bioretention systems will be followed.

It is proposed to follow an installation procedure for each bioretention system generally in accordance with *Option 1* of the *Staged Construction and Establishment Methodology* as outlined in *Table 3.6* and *Section 3.8.1* of the Water by Design *Construction and Establishment Guidelines* (2011). A summary of this methodology is presented below.

1. Civil Works (Functional Installation) – Initially the bioretention systems will be used as a sediment basins. Once the majority of the civil construction works are complete, earthworks and shaping to create the layout and functional elements of the bioretention system will be undertaken. The installation of functional elements (e.g. inlets, outlet structures, subsoil drainage, transition layers and filter media) shall be undertaken as per the methodology detailed in Section 3.9.1 in the Water by Design Construction and Establishment Guidelines (2011). Prior to the commencement of the Building Phase, sediment fences will be erected around the perimeter of the basins to avoid the entry of sediment. Laying a temporary filter cloth (or 25mm thick layer of course sand and 25mm of topsoil) over each basin shall protect the system during both the Civil Works and the Building Phase.

2. Building Phase (Building Construction) – During this phase the bioretention systems shall continue to operate as temporary sediment basins. Sediment fences shall remain around the perimeter of each basin (both around the filter media and the top of batter) to restrict sediment inflow. Clear indications of the restriction of traffic to each bioretention system shall also be displayed.

3. Landscape Establishment (Operational Establishment) – when the Building Phase is 80-90% complete, the temporary protective measures and accumulated sediments within the basin will be removed. The basin shall be planted with vegetation and landscaping as proposed. Sufficient watering and removal of weeds following planting shall be undertaken in accordance with Section 3.9.3 of the Water by Design Construction and Establishment Guidelines (2011).

5.6.2 Operational Phase

During Operational Phase, regular inspections of the bioretention systems is required to ensure vegetation establishes and the properties of the filter media remain effective.

Inspection Requirements

Checklists have been developed for the bioretention systems. The condition and maintenance carried out will be recorded on the checklist at the time the inspection and/or maintenance is undertaken. A copy of the checklist is presented in **Appendix E.**

Maintenance personnel should also be encouraged to report and document changes in vegetation type within the bioretention systems. Photographic documentation and mapping of vegetation types are to be recorded annually to determine changes in vegetation over time. Photographs of each device are to be taken at the same location annually.

Through these procedures a reliable maintenance database can be developed and used to determine if the maintenance undertaken is ensuring the SQID is functioning as intended.

Except for periods of extended wet weather, mosquitoes are unlikely to be an issue as surface water within the bioretention systems is not expected to remain for more than two days.

Weed Removal

Maintenance personnel will need to identify species of both terrestrial and semi-aquatic weeds common to the area. As the bioretention system are “dry” SQIDs, aquatic weed infestation is unlikely. When weeds have been identified they are to be removed by hand immediately or eradication methods scheduled before the infestation becomes larger and more difficult to control. It should be noted that herbicides should not be used in the removal of invasive weeds as this has negative impacts on downstream water quality.

Replanting

Replanting of vegetation is to be carried out to replace dead or damaged vegetation, vegetation that has been removed by scour or erosion, or vegetation that is being re-planted following tilling or the replacement of filter media. Removed vegetation should be replaced by plants of similar size and species, or as indicated on the appropriate Landscaping Plans.

Filter Inspection and Replacement

Fine sediment and silt may accumulate within the filter media of the bioretention systems over time. Removal of sediment and silt trapped within the filter media is expected to be the most costly maintenance requirement for bioretention systems.

It is recommended that a visual inspection of the infiltration properties be undertaken at least three times per year with more frequent inspections no greater than three months apart between October and May. This is to determine whether built-up fine sediment and silt has reached a point where the filter media has become clogged.

The infiltration properties of the filter media within the bioretention systems needs to be checked after a period of significant rainfall event, which is defined as a 24 hour period with rainfall greater than 200mm, or a shorter period with an average rainfall intensity greater than 50mm/hr. This is an ideal period to assess the infiltration properties as water should not pond for an extended period. Therefore inspections should occur 24 to 72 hours after an appropriate rainfall event.

In the event that isolated boggy patches occur within the bioretention systems then the subsoil drainage pipes could be blocked. If this is not the case and no other blockages have been observed then surface of the media is to be tilled (raked and aerated) to a depth of 150mm. This will require temporarily removing and storing the surface vegetation prior to tilling the surface. Should the infiltration properties be improved then the removed vegetation and coarse aggregate layer can be replanted. Should tilling prove unsuccessful or if an infiltration check indicates filter media to be clogged, then the top portion of the filter media is to be replaced as follows:

1. Removal of surface vegetation and coarse aggregate layer and store for re-establishment;
2. Remove the top 150mm of filter media and dispose of in an approved manner;
3. Till the remaining filter media to a further depth of 300mm;
4. Place a new layer of appropriate filter media as per the specification (refer to **Appendix C**), free from organic matter, clay and silt; and
5. Replant the removed vegetation.

If blockages occur frequently, a filter media with a higher saturated hydraulic conductivity should be considered. Reassessing the species and planting density of vegetation is also an option.

Unless changes to the filter media specification are made through a review of the SQID performance, the filter media to be used for the bioretention systems is to be a Sandy Loam as per the FAWB *Guidelines for Filter Media in Biofiltration Systems* (*Version 3.01,* 2009).

Subsoil Drainage Inspection & Cleanout

The build-up of fine sediment and silt within the subsoil drainage pipes is unlikely as it will be trapped by the filter media. However the subsoil drainage is to be checked annually for blockages that may be caused by foreign matter entering through cleanout inspection openings or by small fauna. This can be done by either:

- Observing the condition of the subsoil drain through the cleanout and inspection openings located towards the downstream end of a subsoil drainage pipe.
- Observing the amount of sediment and silt flushed into the downstream field inlet when water is pumped into the upstream end of the subsoil drainage line (through a cleanout and inspection opening).

If a considerable amount of sediment and silt is observed or carried into the downstream inlet, then each subsoil drainage line must be flushed out with high pressure water.

Water is to be pumped into each subsoil drainage pipe through the upstream cleanout inspection opening until all sediment has been ejected from the pipe. To collect the water and ejected sediment within the downstream pit a temporary barrier is to be placed over the downstream pipe opening (such as sand bags) and a pump used to draw the water, sediment and silt out of the pit and irrigated onto areas of open space away from each basin. This will ensure the sediment and silt does not enter the downstream waterway.

If frequent issues occur with the subsoil drainage system, CCTV checking could be undertaken to identify any damage subsoil drainage.

Monitoring

Visual monitoring of bioretention devices is proposed as part of the inspection and maintenance requirements for the devices. Visual inspections will occur at least three times per year with more frequent inspections to occur no more than three months apart between October and May. Inspection should be made not less than 24 hours and not more than 72 hours after the cessation of rainfall if the total rainfall on any day exceeds 30mm.

5.7 General Requirements

5.7.1 Yearly Review of Maintenance Management Plan

Each year a review is to be carried out to determine if the programmed inspection and maintenance (including checklists) is ensuring SQIDs are functioning as intended. The review should include an assessment of the maintenance database to determine whether the programmed inspections and maintenance is effective. Information on the database should be assessed to determine whether any noticeable changes are evident in vegetation, presence of fauna and operational efficiency of any structures or features of the device. This will further provide indicators as to whether sufficient information is being recorded for management purposes.

5.7.2 Maintenance Personnel Safety (OH&S)

The Workplace Safety Regulation 2011 requires that all reasonably practicable steps be taken to protect an employee's health in a workplace. Organisations involved in the inspection and maintenance of the SQIDs should therefore:

- Have a documented occupational health and safety policy in place;
- Ensure all staff and maintenance personnel are aware of and abide by the policy; and
- The policy provides a mechanism for review and improvement.

As part of the policy personnel involved in the maintenance of the SQIDs are to have sufficient resources (such as personnel protective equipment, training etc.) to carry out the task in a safe manner.

5.7.3 General Public Safety

The safety of the general public in the area of the SQID being maintained also needs to be ensured. Notices to inform the staff and public accessing the site regarding the SQID maintenance needs to be circulated prior to the scheduled date. Temporary signage and safety barriers need to be erected around maintenance work areas prior to the works commencing and are not to be removed until all works have finished.

6 Conclusion

Calibre Group has prepared this Concept Stormwater Management Plan & Flood Impact Assessment Report for the proposed development located at 1014-1016 Yaamba Rd, Parkhurst.

The report also documents the proposed stormwater quality plan designed to meet the required stormwater quality objectives.

The analysis presented in this report has demonstrated the following outcomes:

- *Stormwater Management (Quantity)* - TUFLOW 1D/2D food modelling was used to demonstrate that the proposed stormwater mitigation strategy ensures there are no increases to flood levels on the site or in surrounding properties. The results presented to articulate this outcome include:
    - No increase in water depth at the existing set of culverts beneath the Bruce Highway (M1) resultant of the proposed development.
    - Flood maps demonstrating no increase in peak flood water levels within the site or surrounding properties.

  The stormwater mitigation strategy proposed includes:
    - A constructed channel extending the length of the site to convey both site flows and external flows (up to the 1% AEP storm event) through the site.
    - A 1638 ML detention basin, utilising the constructed channel and an additional section of detention channel, at the Southern discharge Location to ensure peak flows leaving the site are not increased as a result of the proposed development.
- *Stormwater Management (Quality)* – A stormwater quality management plan utilising five bioretention basins to treat runoff from the development. The MUSIC Modelling results have demonstrated that WQO's under State Planning Policy 2017 (SPP) for Central Queensland Coast are met for the development. For details of the bioretention basins configuration and Stormwater Quality Strategy refer to **Section 5**.

7 Recommendation

It is recommended that the conceptual designs for the flood and stormwater management strategies presented in this report be approved and incorporated into the future detailed design.

Detailed design may result in changes to concept details but the design objectives are to be maintained.

8 References

QUDM 2017

Capricorn Municipal Development Guidelines 2017

State Planning Policy 2017

Rock Hampton Regional Planning Scheme2015

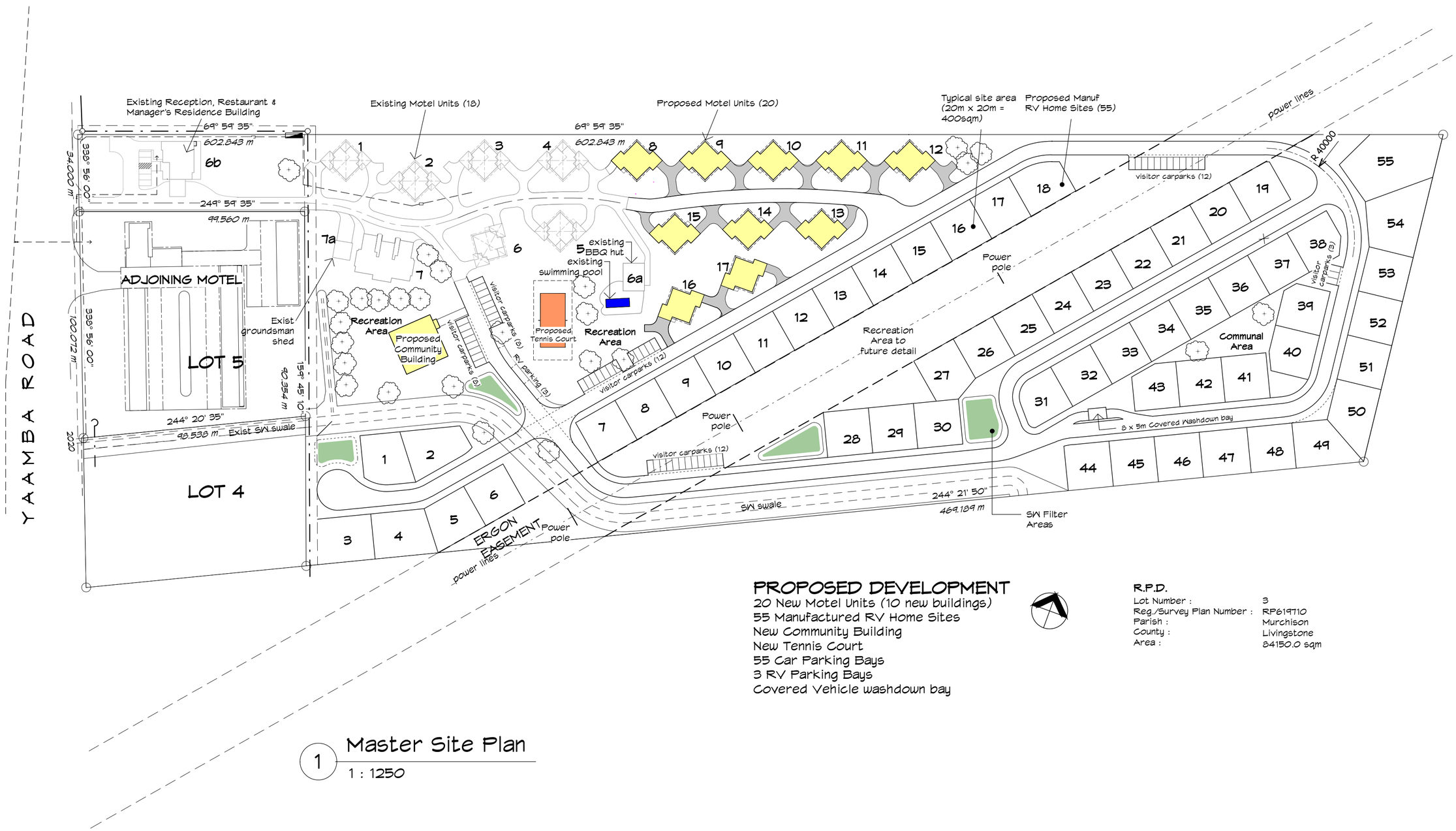
Rockhampton Regional Council Flood Management Strategy

Flood Hazard Overlays Rockhampton Region Planning Scheme

CONCEPT STORMWATER MANAGEMENT PLAN AND FLOOD IMPACT ASSESSMENT REPORT

Appendix A Site Layout

G. & M. DEMEDIO C/- RUFUS DESIGN GROUP



PROPOSED DEVELOPMENT

20 New Motel Units (10 new buildings)
55 Manufactured RV Home Sites
New Community Building
New Tennis Court
55 Car Parking Bays
3 RV Parking Bays
Covered Vehicle washdown bay

R.P.D.

Lot Number :	3
Reg./Survey Plan Number :	RP619710
Parish :	Murchison
County :	Livingstone
Area :	84150.0 sqm

1 Master Site Plan
1 : 1250

MCU APPLICATION
date: 04/10/19
REVISION 01

REVISIONS

No.	DESCRIPTION	DATE

PROPOSED MOTEL EXTENSIONS FOR G. & M. DEMEDIO AT 1014 - 1016 YAAMBA ROAD, PARKHURST

this drawing: Master Site Plan

Rufus Design Group
STYLE • QUALITY • INNOVATION
MEMBER BUILDING DESIGNERS ASSOC. OF QLD INC.
Licenced under the QBSA Act Lic No. 1180286
Telephone 61 7 49288011
Facsimile 61 7 49266579
E-mail mailbox@rufusdesigngroup.com

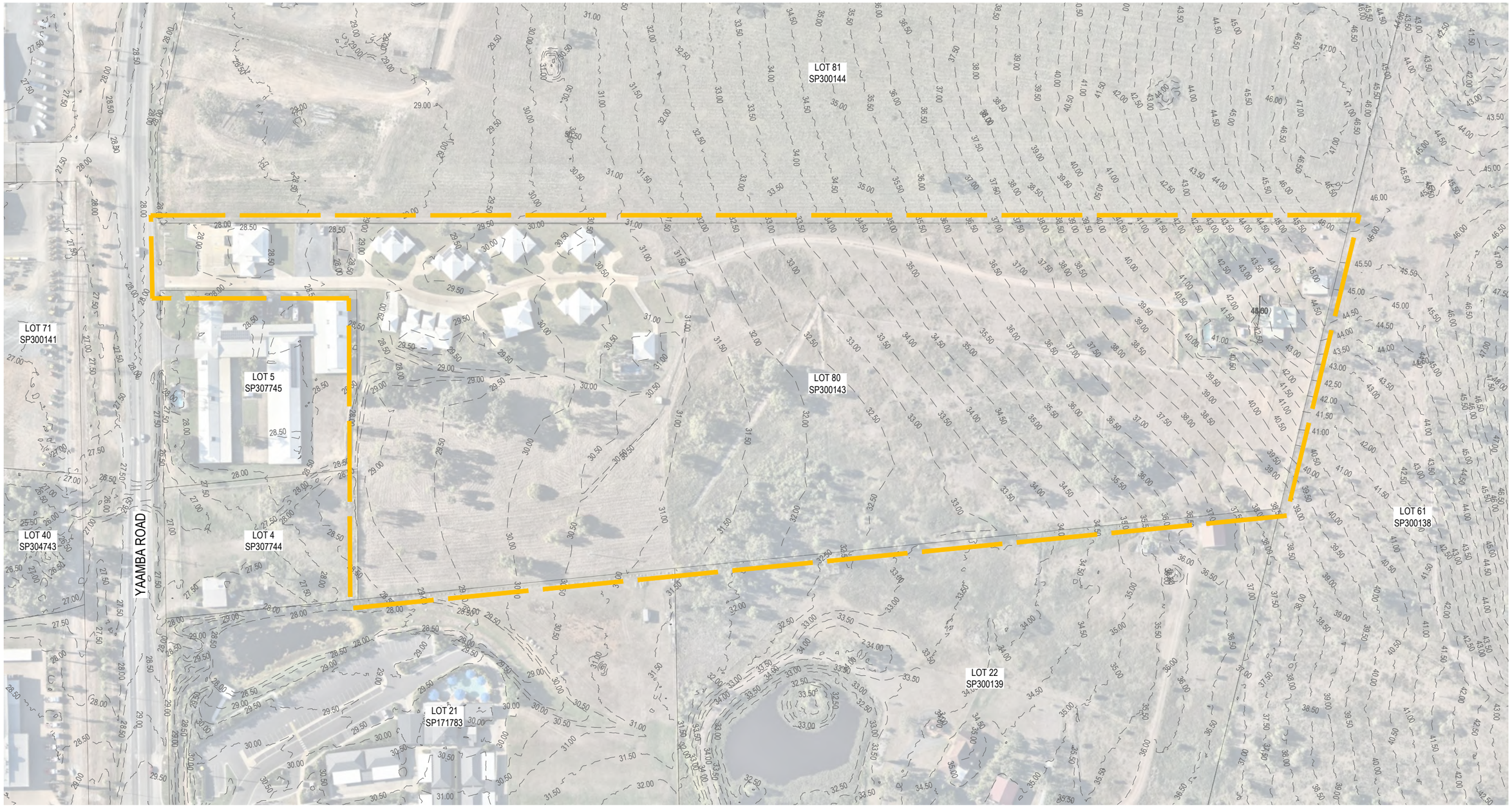
PROJECT MANAGER : T.J.R.
DRAWN : J.P.
CHKD :
WIND SPEED C2
PLAN SIZE: A2
PROJECT NUMBER 181015 - 01
SHEET 01 OF 07 SHEETS
REV.

PRINT DATE : 08-Oct-19 2:32:53 PM

CONCEPT STORMWATER MANAGEMENT PLAN AND FLOOD IMPACT ASSESSMENT REPORT

Appendix B Calibre Drawings

G. & M. DEMEDIO C/- RUFUS DESIGN GROUP



LEGEND

- SITE BOUNDARY
- CADASTRE
- EXISTING CONTOURS

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE REPORT NO. 18-002864-CSMP01A.

CONCEPT PLAN ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

REVISION	DATE	ISSUE DETAILS	DRAWN	DESIGN
A	08.10.19	ORIGINAL ISSUE	DMP	AA

DRAWN CHECK

DESIGN CHECK

STATUS: NOT □OR □ONSTRU□TION

APPROVED

SCALE: 1:1000 / 1:2000 — 10 0 10 20 30 40 50 — A1 / A3

CLIENT: □□□ M□DEMEDIO

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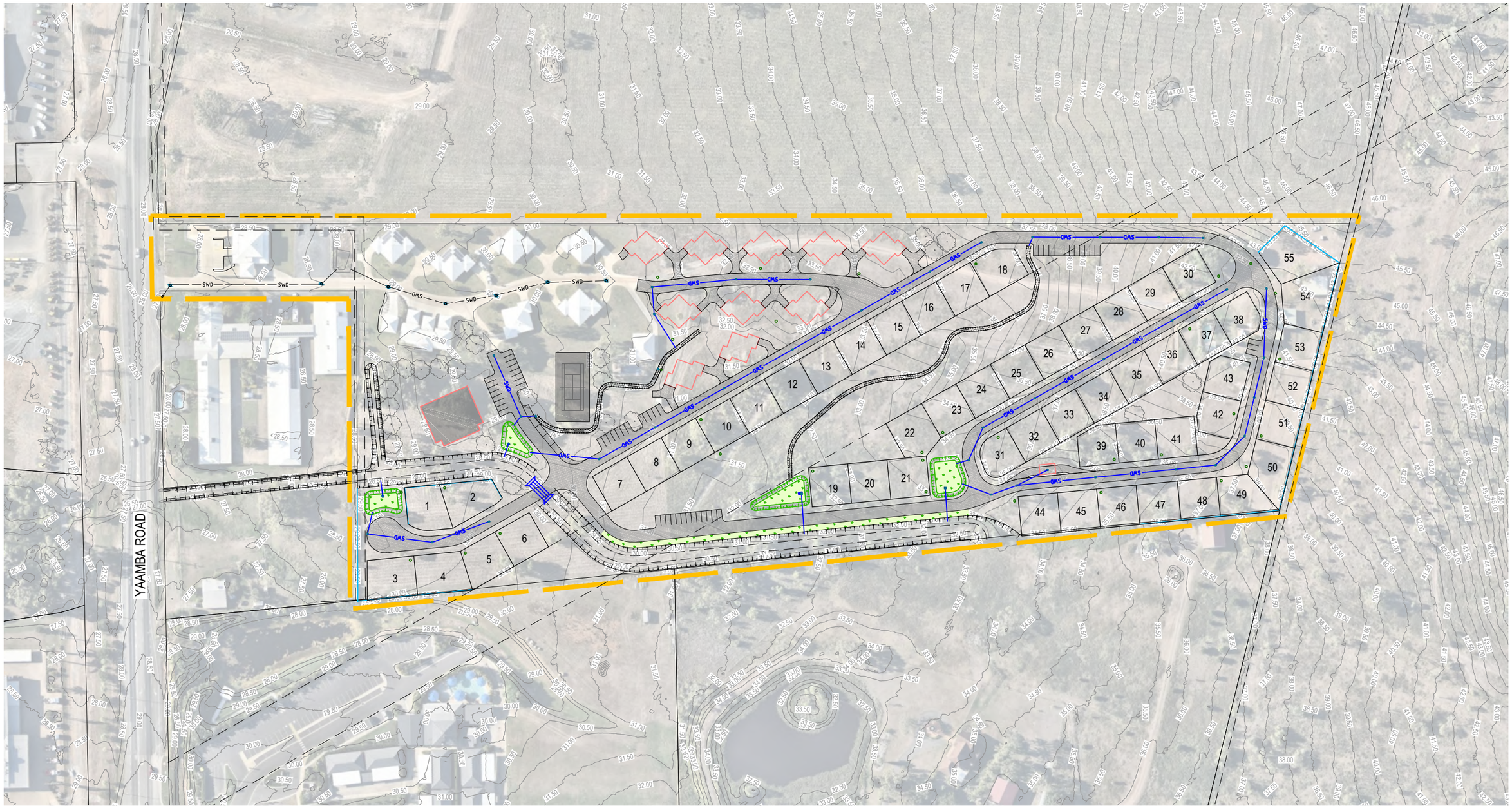
PROJECT: R□ HOMEBASE

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

DRAWING TITLE: EXISTIN□ SITE LAYOUT

PROJECT No.	DRAWING No.	REVISION
18-002864	SK01	A



LEGEND

- SITE BOUNDARY
- CADASTRE
- LOT BOUNDARY
- PROPOSED CONTOUR
- PROPOSED BUILDING
- EXISTING EASEMENT
- PROPOSED INTERNAL ROAD
- EXISTING STORMWATER LINE
- STORMWATER DRAINAGE LINE
- PROPOSED CHANNEL BATTER
- MANHOLE
- BIORETENTION FILTER

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE REPORT NO. 18-002864-CSMP01A.

CONCEPT PLAN ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

REVISION	DATE	ISSUE DETAILS	DRAWN	DESIGN
A	08.10.19	ORIGINAL ISSUE	DMP	AA

DRAWN CHECK

DESIGN CHECK

STATUS: **NOT □OR □ONSTRU□TION**

APPROVED

SCALE: 1:1000 / 1:2000 — 10 0 10 20 30 40 50 — A1 / A3

CLIENT: □□□ M□DEMEDIO

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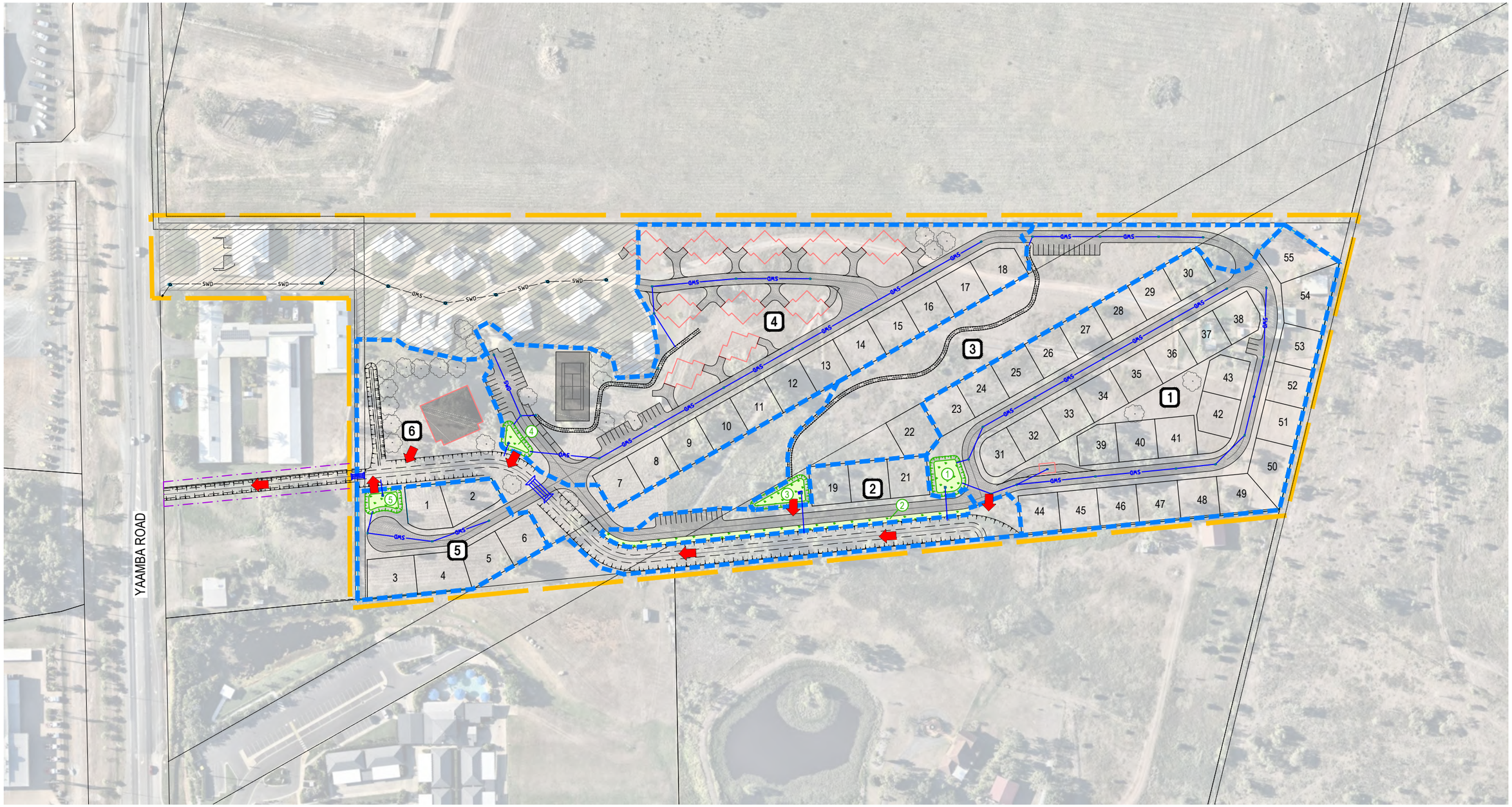
PROJECT: **R□ HOMEBASE**

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

DRAWING TITLE: **DE□ELOPED SITE LAYOUT**

PROJECT No.	DRAWING No.	REVISION
18-002864	SK02	A



LEGEND

- SITE BOUNDARY
- CADASTRE
- STORMWATER QUALITY CATCHMENT
- LOT BOUNDARY
- PROPOSED BUILDING
- PROPOSED ROAD
- EXISTING STORMWATER LINE
- STORMWATER DRAINAGE LINE
- DISCHARGE FLOW DIRECTION
- BIORETENTION FILTER
- AREA OF EXTERNAL WORKS (REFER NOTE 2)
- AREA OF EXISTING DEVELOPMENT (REFER NOTE 3)
- BIO-RETENTION BASIN LABEL
- DEVELOPED CATCHMENT LABEL

BIO-RETENTION BASIN TABLE

BASIN No.	FILTER AREA (m²)
1	190
2	50
3	168
4	170
5	109
6	NO BASIN PROPOSED

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE REPORT NO. 18-002864-CSMP01A.
2. EXTERNAL WORKS ARE PROPOSED WITHIN DOWNSTREAM PROPERTY. CONSENT FROM DOWNSTREAM PROPERTY OWNER TO BE PROVIDED.
3. PARTS OF THE SITE THAT HAVE ALREADY BEEN DEVELOPED ARE NOT INCLUDED IN THE STORMWATER QUALITY MANAGEMENT STRATEGY AS THEY HAVE BEEN DEVELOPED UNDER A SEPARATE DEVELOPMENT APPROVAL.
4. REFER TO DRAWING NO. 18-002864-SK04 FOR TYPICAL CHANNEL AND BIORETENTION FILTER DETAILS.

CONCEPT PLAN ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

REVISION	DATE	ISSUE DETAILS	DRAWN	DESIGN
A	08.10.19	ORIGINAL ISSUE	DMP	AA

DRAWN CHECK
DESIGN CHECK

STATUS: **NOT □OR □ONSTRU□TION**

APPROVED

SCALE: 1:1000 / 1:2000 — 10 0 10 20 30 40 50 — A1 / A3

CLIENT: □□ M□DEMEDIO

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PROJECT: R□ HOMEBASE

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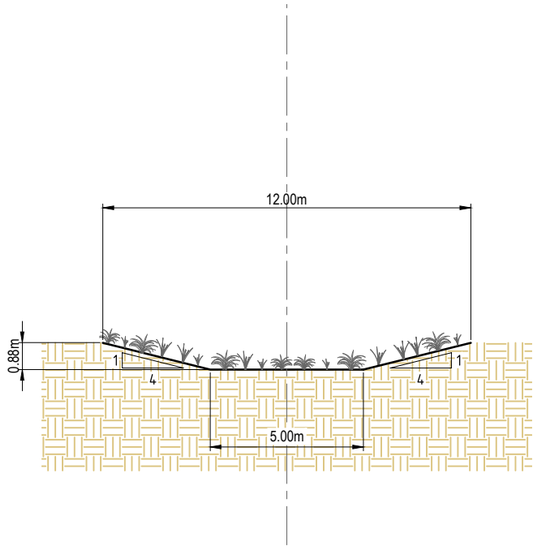
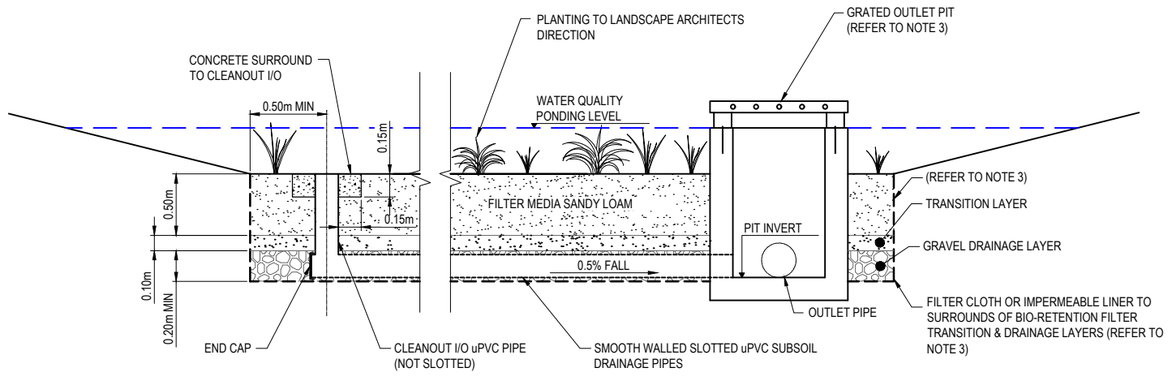
DRAWING TITLE: **STORM□ ATER MANA□EMENT PLAN**

PROJECT No.	DRAWING No.	REVISION
18-002864	SK0□	A



TYPICAL CHANNEL SECTION
SCALE 1:100 (A1)
SCALE 1:200 (A3)



TYPICAL BIO-RETENTION FILTER DETAIL
SCALE 1:20 (A1)
SCALE 1:40 (A3)

NOTES:

1. LAYOUT OF THE PRELIMINARY STORMWATER QUALITY IMPROVEMENT DEVICES IS CONCEPTUAL ONLY AND PROVIDED AS A GUIDE FOR THE TREATMENT TRAIN AND IS SUBJECT TO DETAILED DESIGN.

2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE REPORT NO. 18-002864-CSMP01A.

3. AN IMPERMEABLE LINER IN PLACE OF FILTER CLOTH WILL BE REQUIRED SHOULD IN-SITU SOILS BE UNCONSOLIDATED, SODIC, DISPERSIVE OR GROUNDWATER IS ENCOUNTERED.

CONCEPT PLAN ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

REVISION	DATE	ISSUE DETAILS	DRAWN	DESIGN
A	08.10.19	ORIGINAL ISSUE	DMP	AA

DRAWN CHECK
DESIGN CHECK
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APPROVED
SCALE: 1:20 0.2 0 0.2 0.4 0.6 0.8 1 A1 / 1:40 A3
CLIENT: **□□□ M□DEMEDIO**

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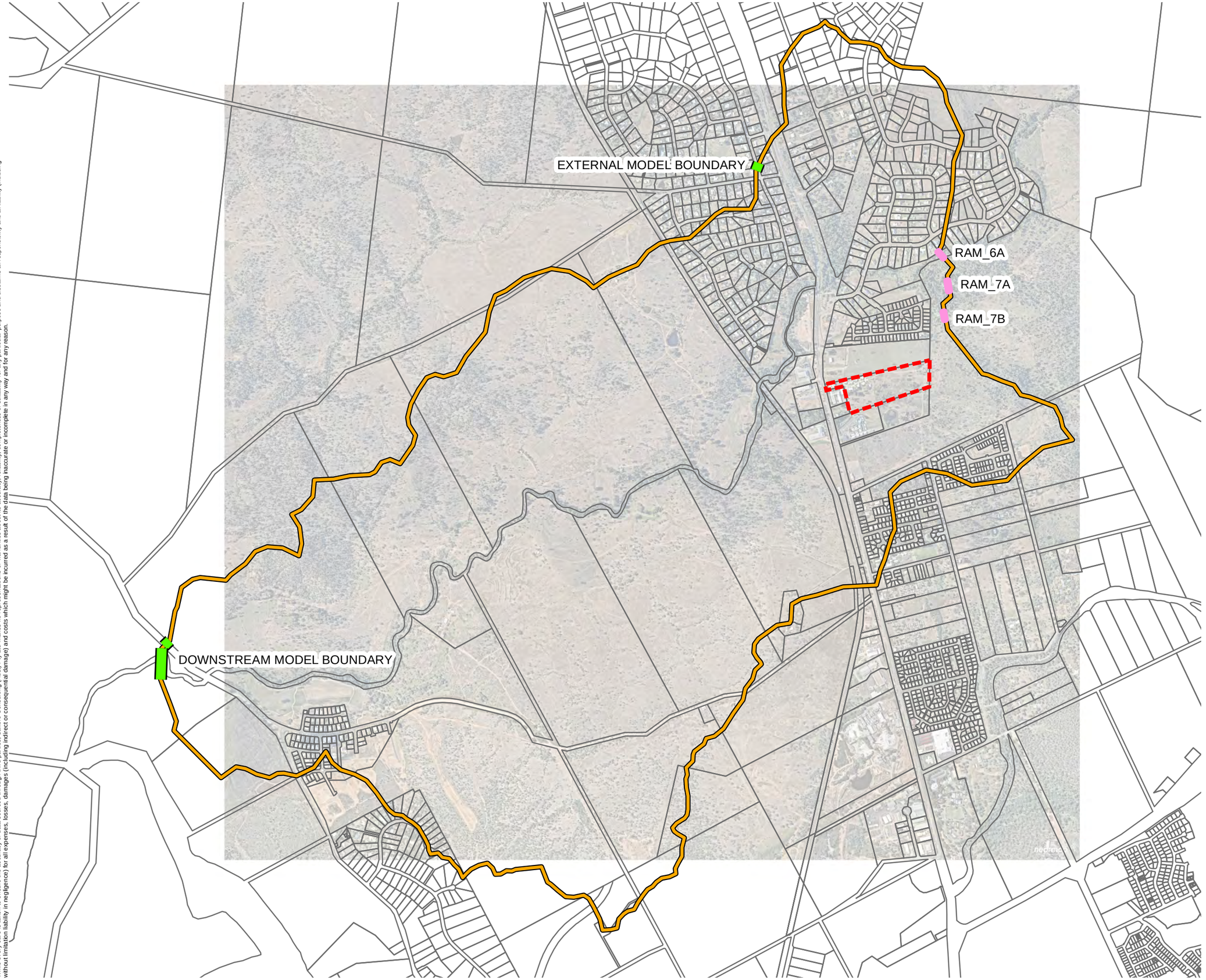
PROJECT: **R□ HOMEBASE**

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

DRAWING TITLE: **DETAIL SE□TION**

PROJECT No.	DRAWING No.	REVISION
18-002864	SK04	A



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- SITE BOUNDARY
- UPSTREAM INFLOWS
- DOWNSTREAM MODEL BOUNDARY
- MODEL EXTENT
- CADASTRE

NOTES:
1. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

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PROJECT:

RV HOMEBASE

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

TUFLOW MODEL DEVELOPED SCENARIO EXTENT AND BOUNDARY PLAN

DRAWING NO: **18-002864-SK05**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
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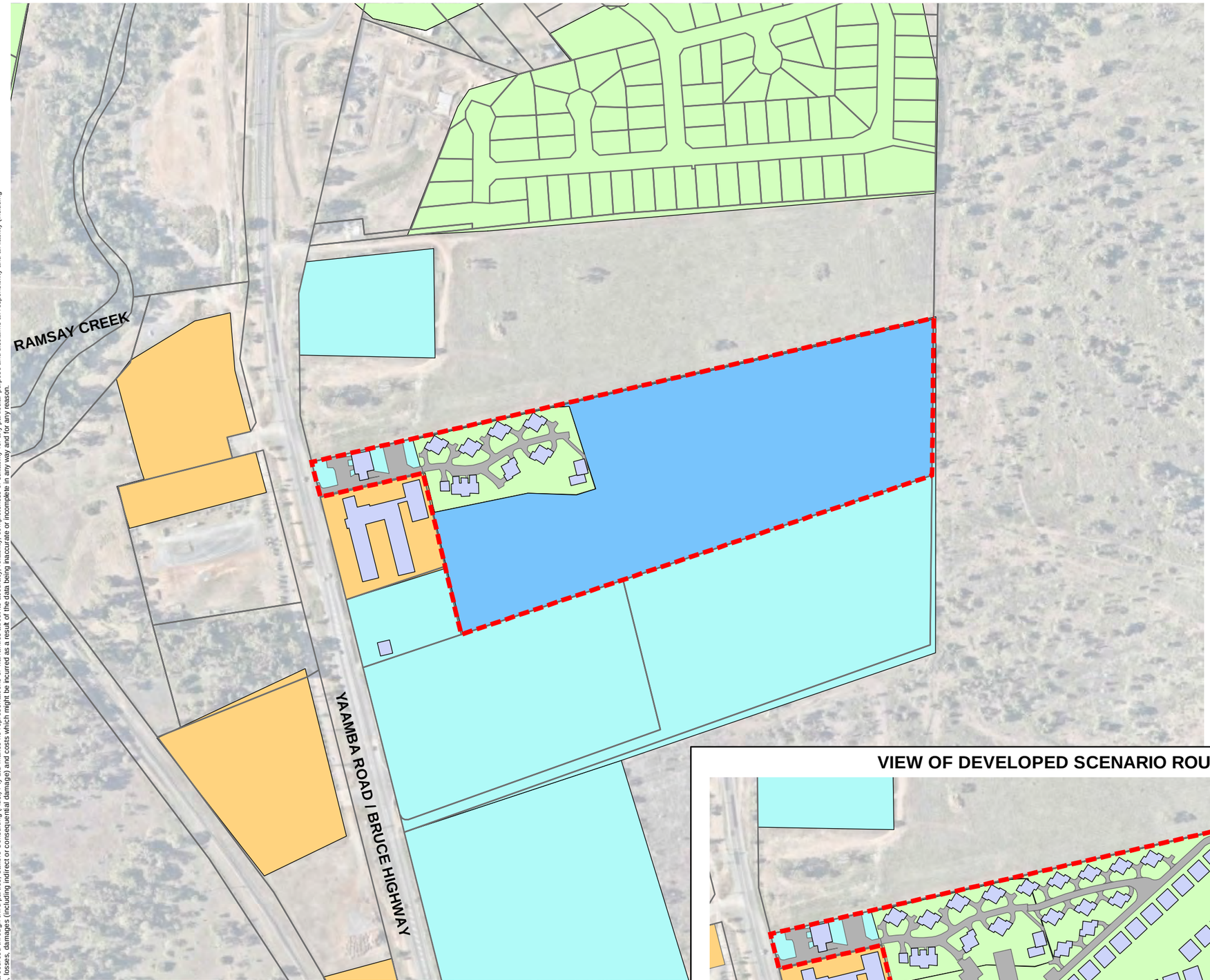
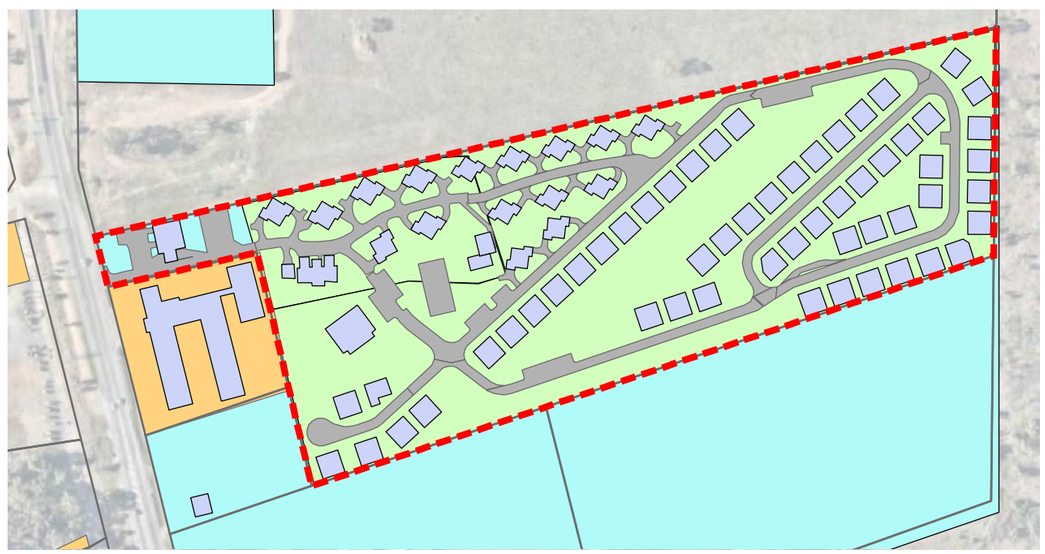


VIEW OF DEVELOPED SCENARIO ROUGHNESS



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- SITE BOUNDARY
- CADASTRE
- BUILDINGS
- ROADS
- LOW VEGETATION
- INDUSTRIAL
- MEDIUM DENSITY RESIDENTIAL
- LOW DENSITY RESIDENTIAL

NOTES:
1. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

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PROJECT:
RV HOMEBASE

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
TUFLOW MODEL EXISTING AND DEVELOPED SCENARIO MATERIAL ROUGHNESS PLAN

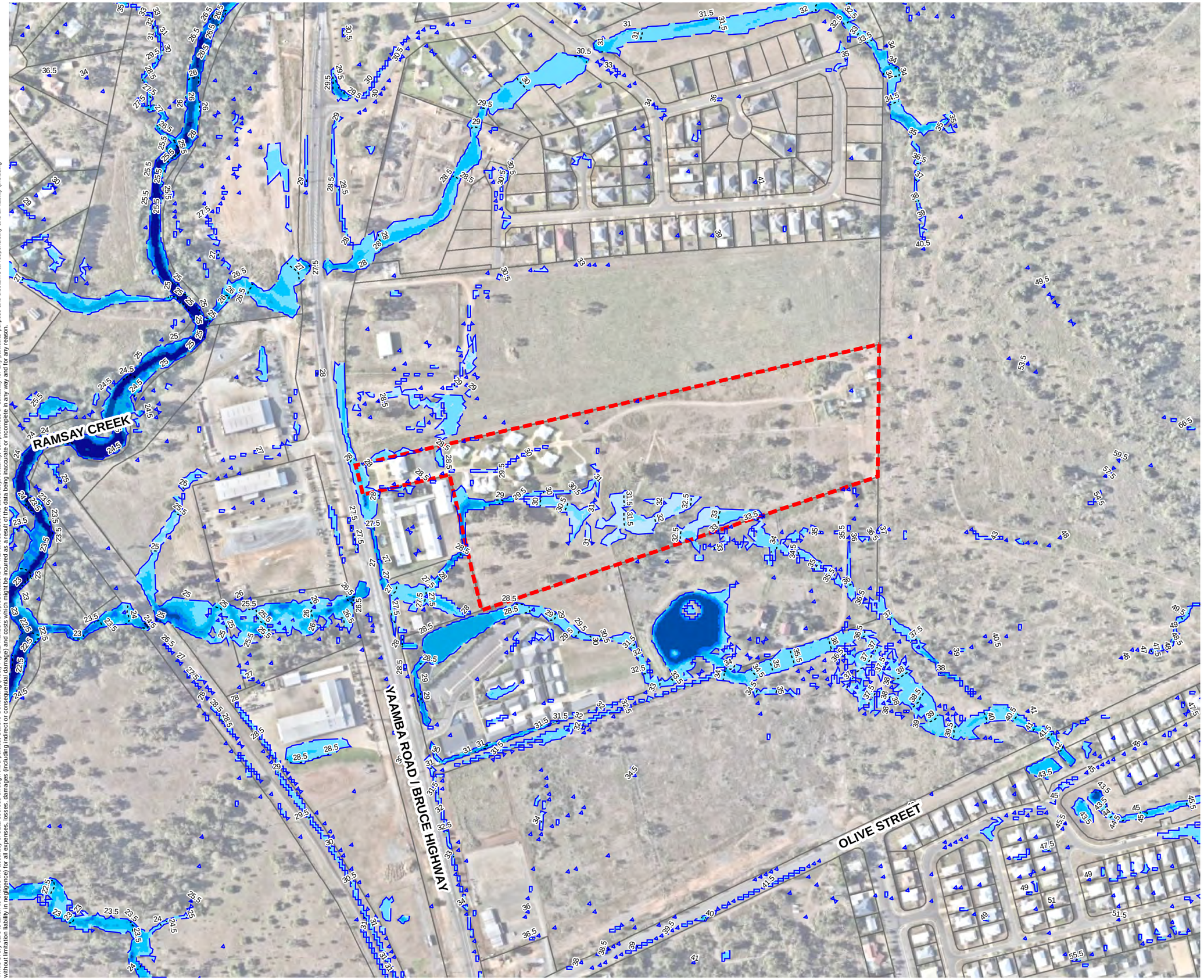
DRAWING NO: **18-002864-SK06**
ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	MC	AA	08.10.19	INITIAL ISSUE

CONCEPT STORMWATER MANAGEMENT PLAN AND FLOOD IMPACT ASSESSMENT REPORT

Appendix C Flood Plans

G. & M. DEMEDIO C/- RUFUS DESIGN GROUP



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calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOURS (m AHD)
- SITE BOUNDARY

MAX FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

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N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

63% AEP STORM EVENT

MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-002864-E-001-A**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
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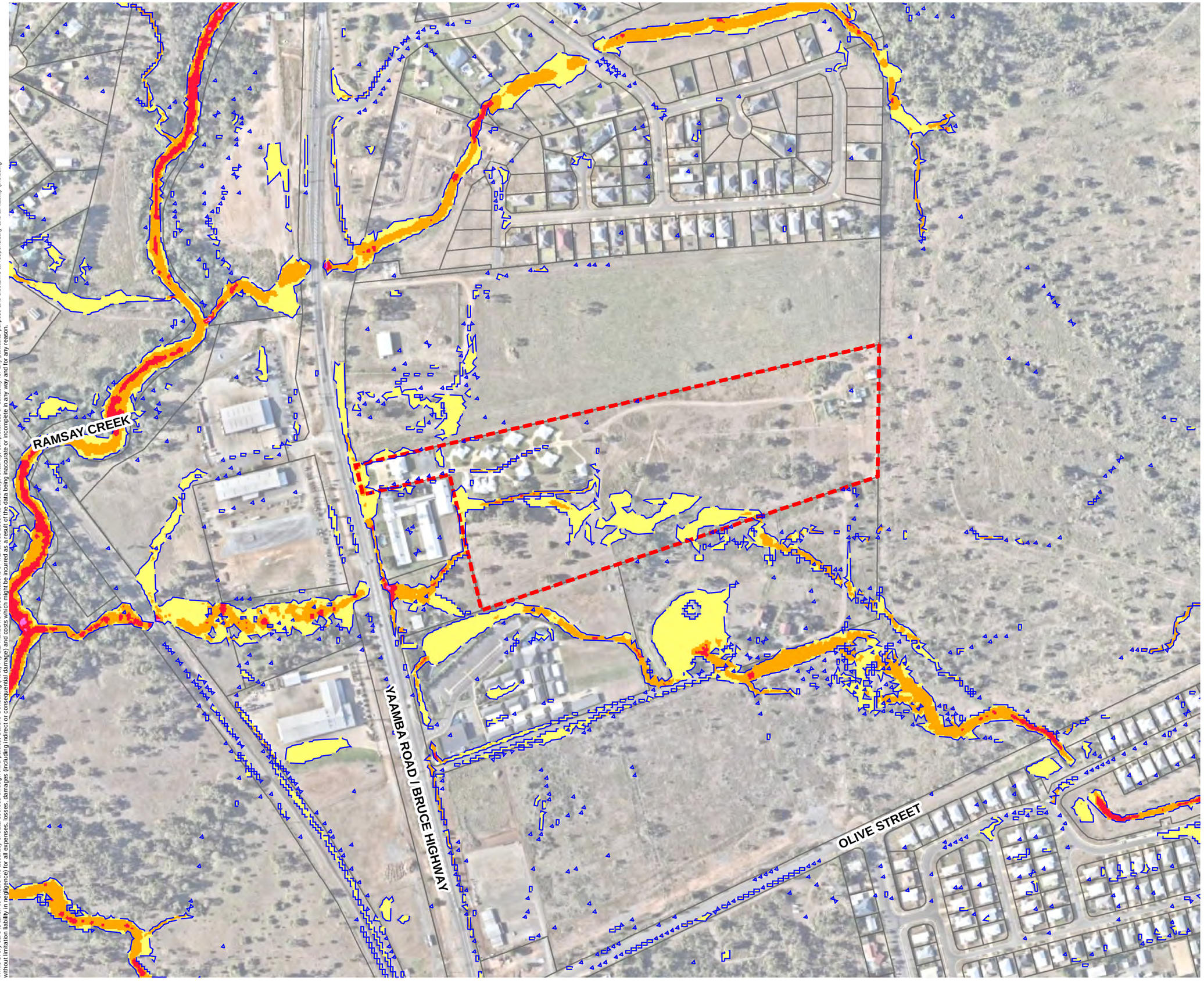

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

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PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

63% AEP STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-E-001-B**

ISSUE: **A**

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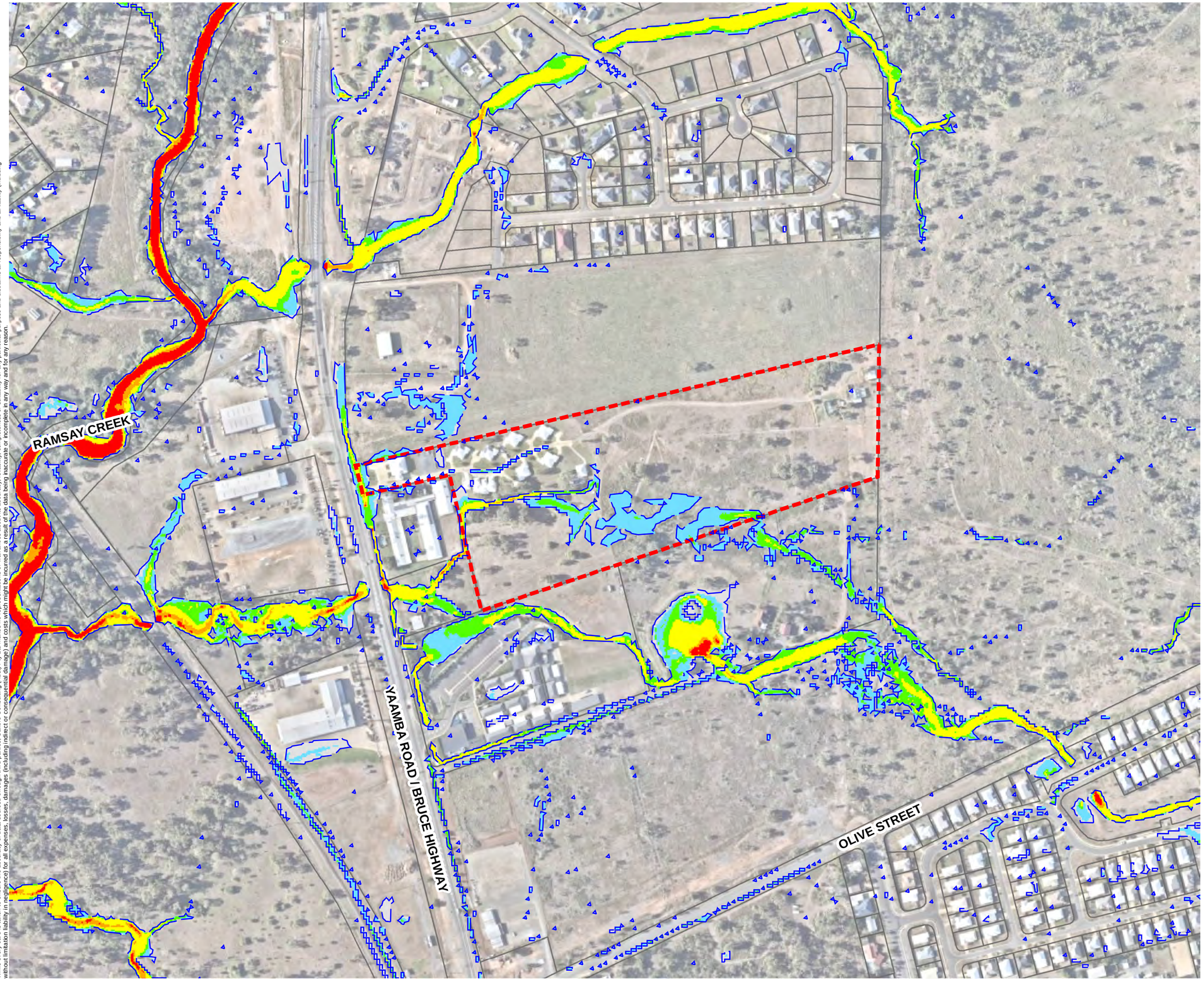

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

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PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

63% AEP STORM EVENT

MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-002864-E-001-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
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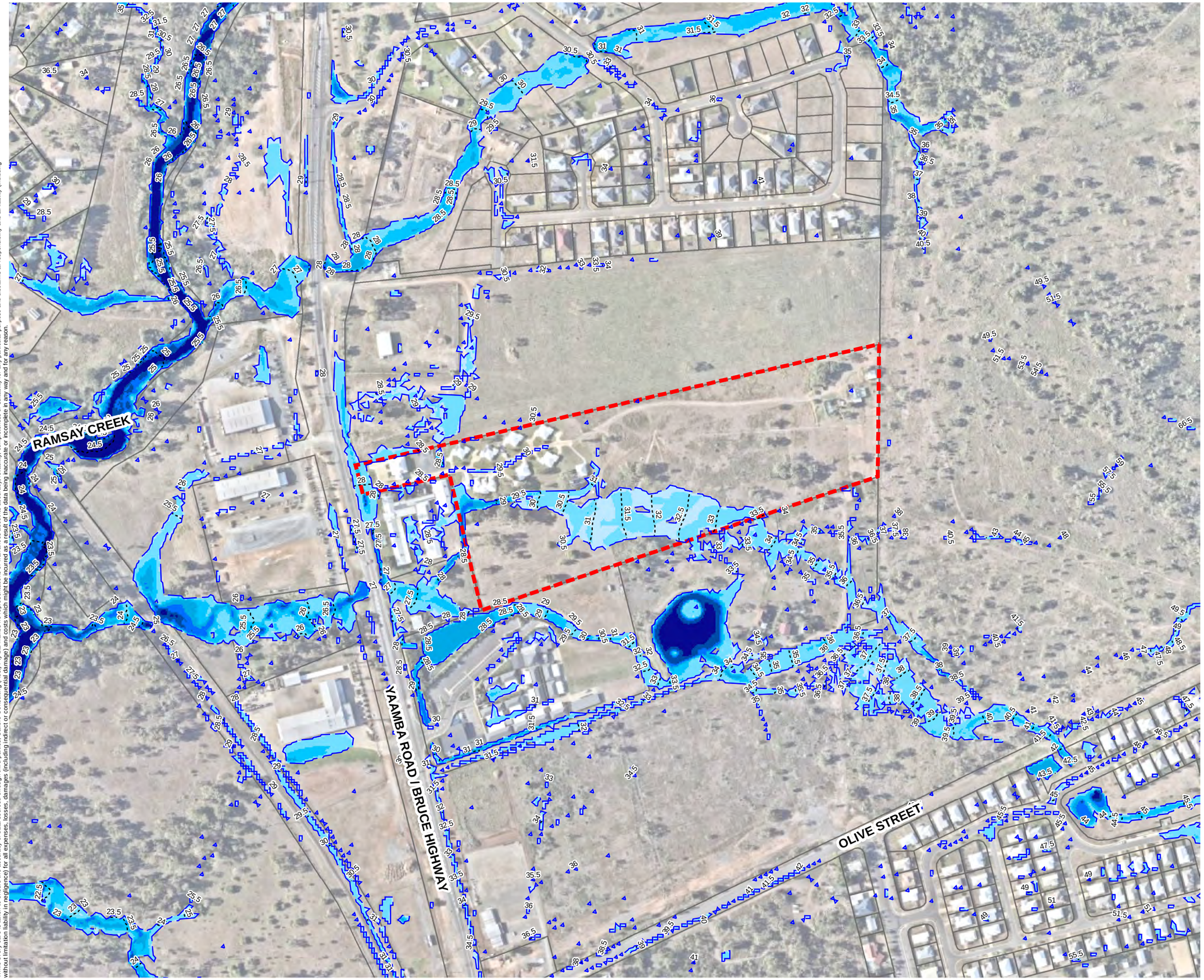

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calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOURS (m AHD)
- SITE BOUNDARY

MAX FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

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PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

39% AEP STORM EVENT

MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-002864-E-002-A**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
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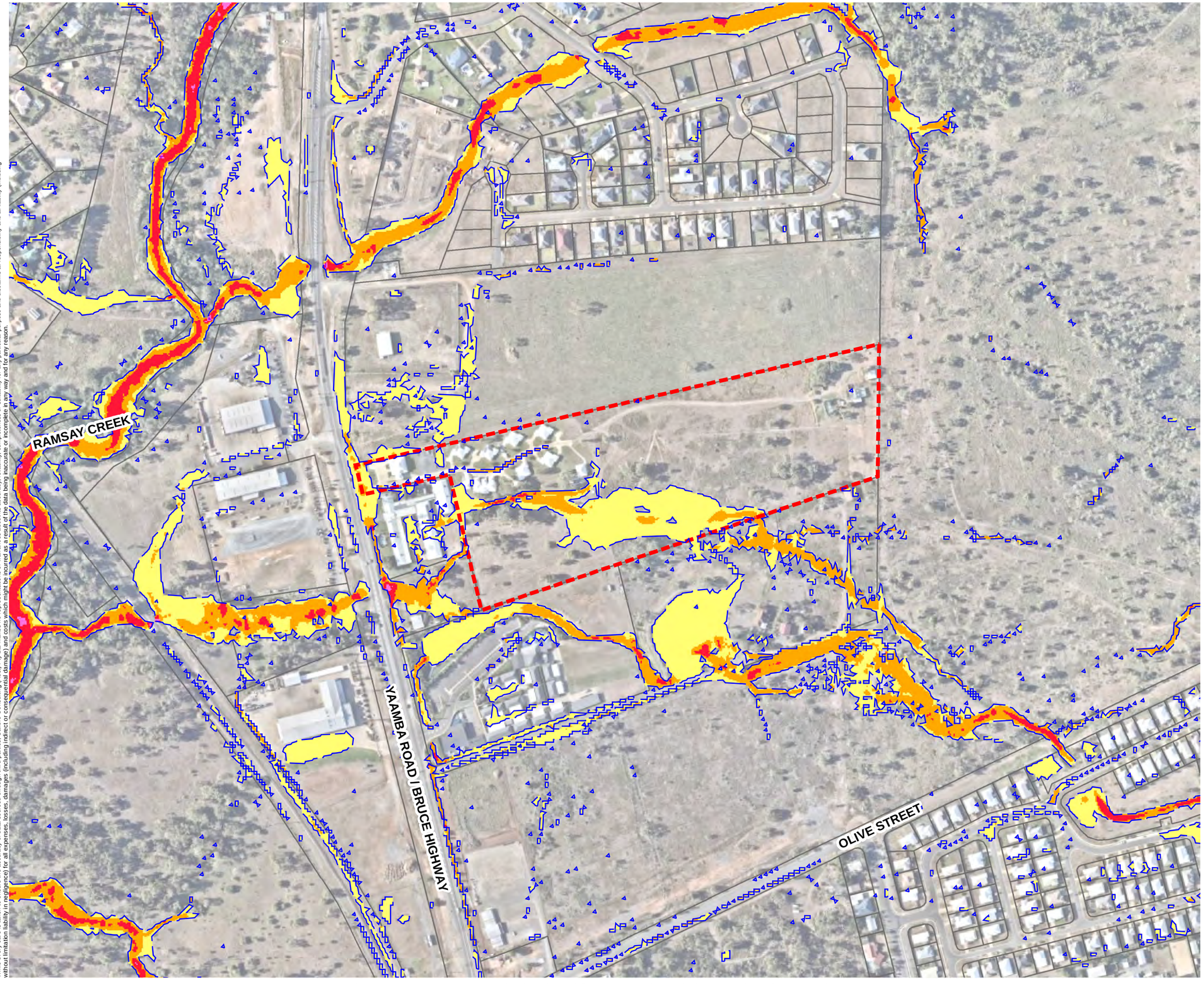

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

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PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

39% AEP STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-E-002-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
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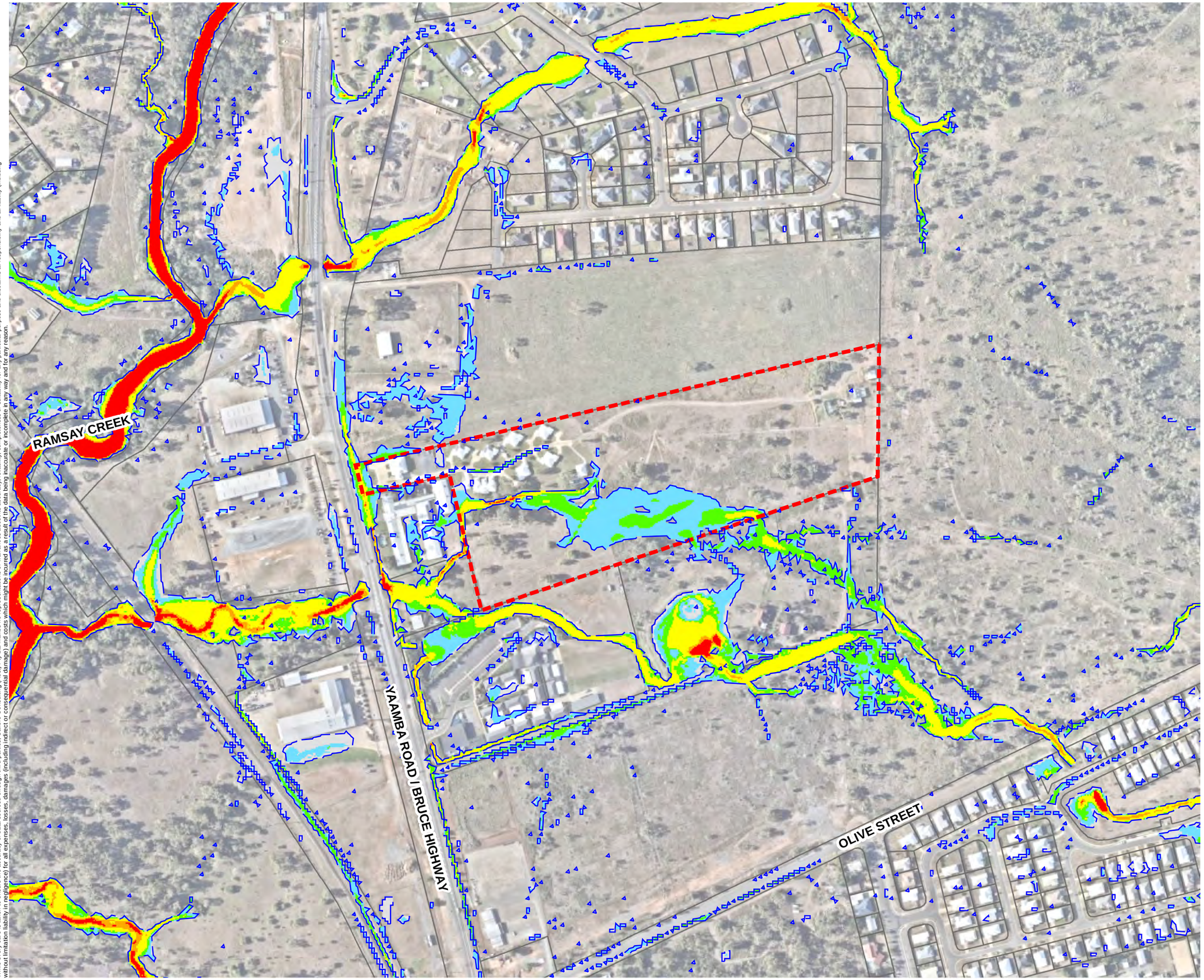

calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:
1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

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N

PROJECT:
1014-1016 YAAMBA ROAD PARKHURST

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
EXISTING SCENARIO
39% AEP STORM EVENT
MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-002864-E-002-C** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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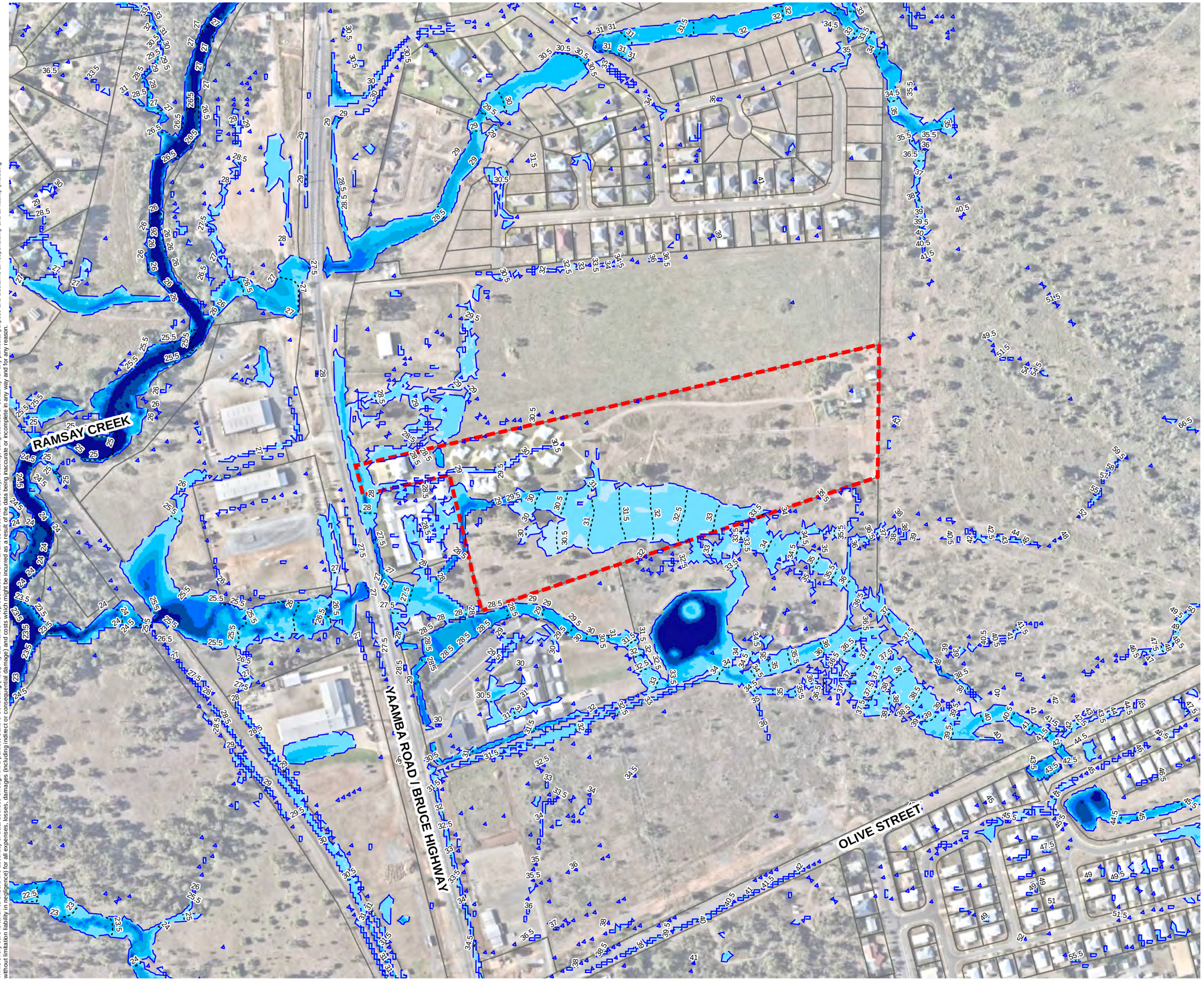

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOURS (m AHD)
- SITE BOUNDARY

MAX FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

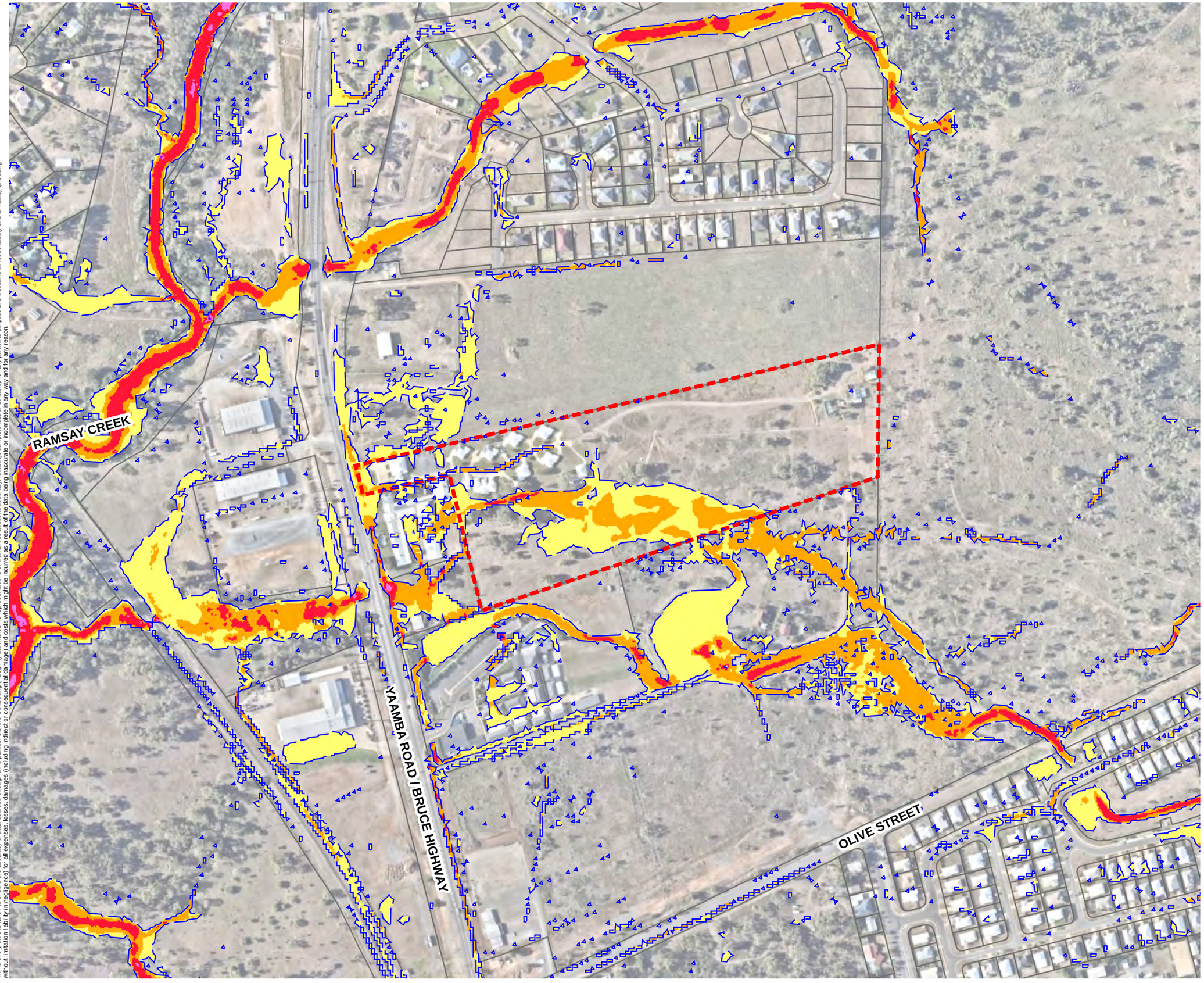
18% AEP STORM EVENT

MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-002864-E-005-A**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

18% AEP STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-E-005-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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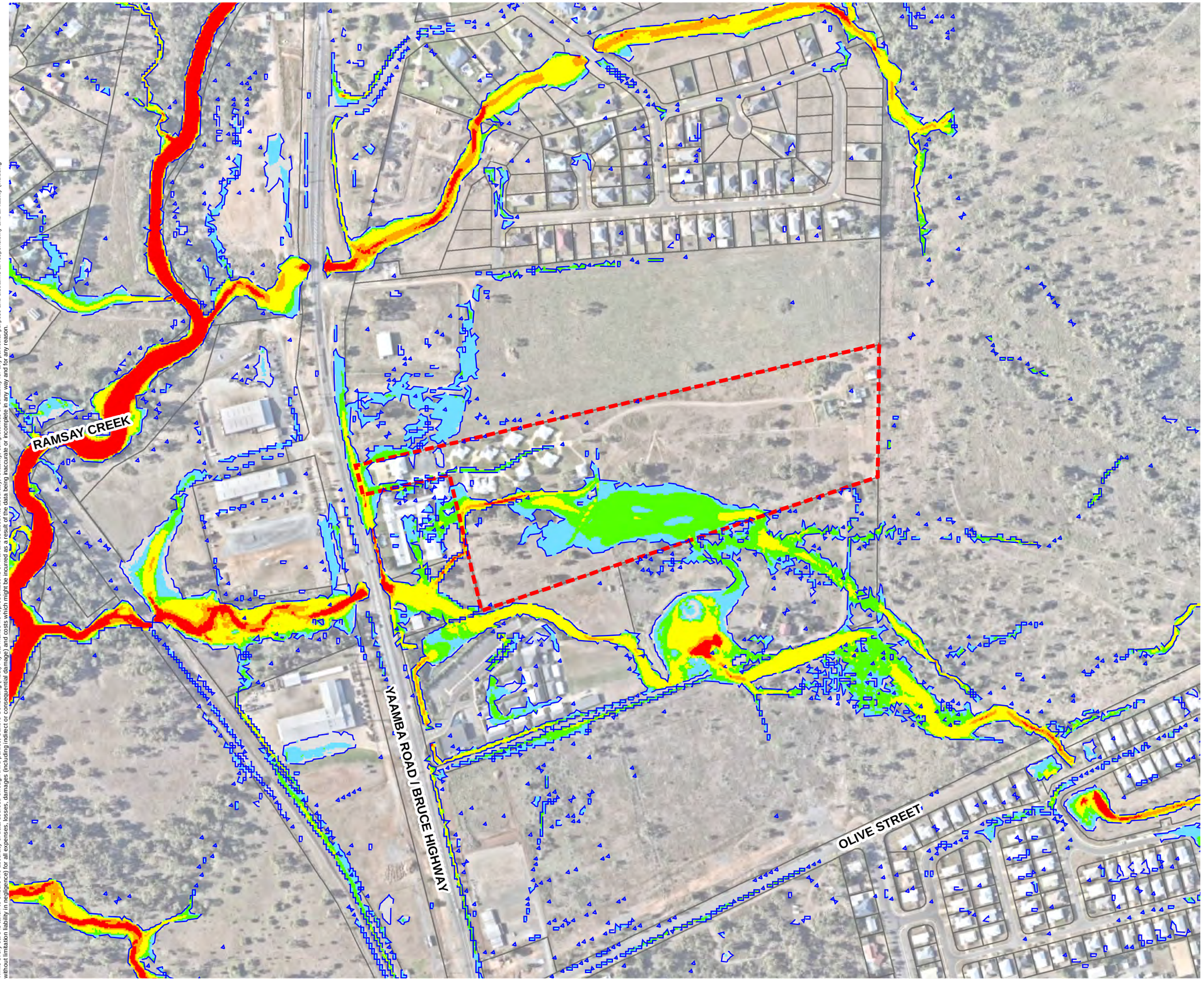

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

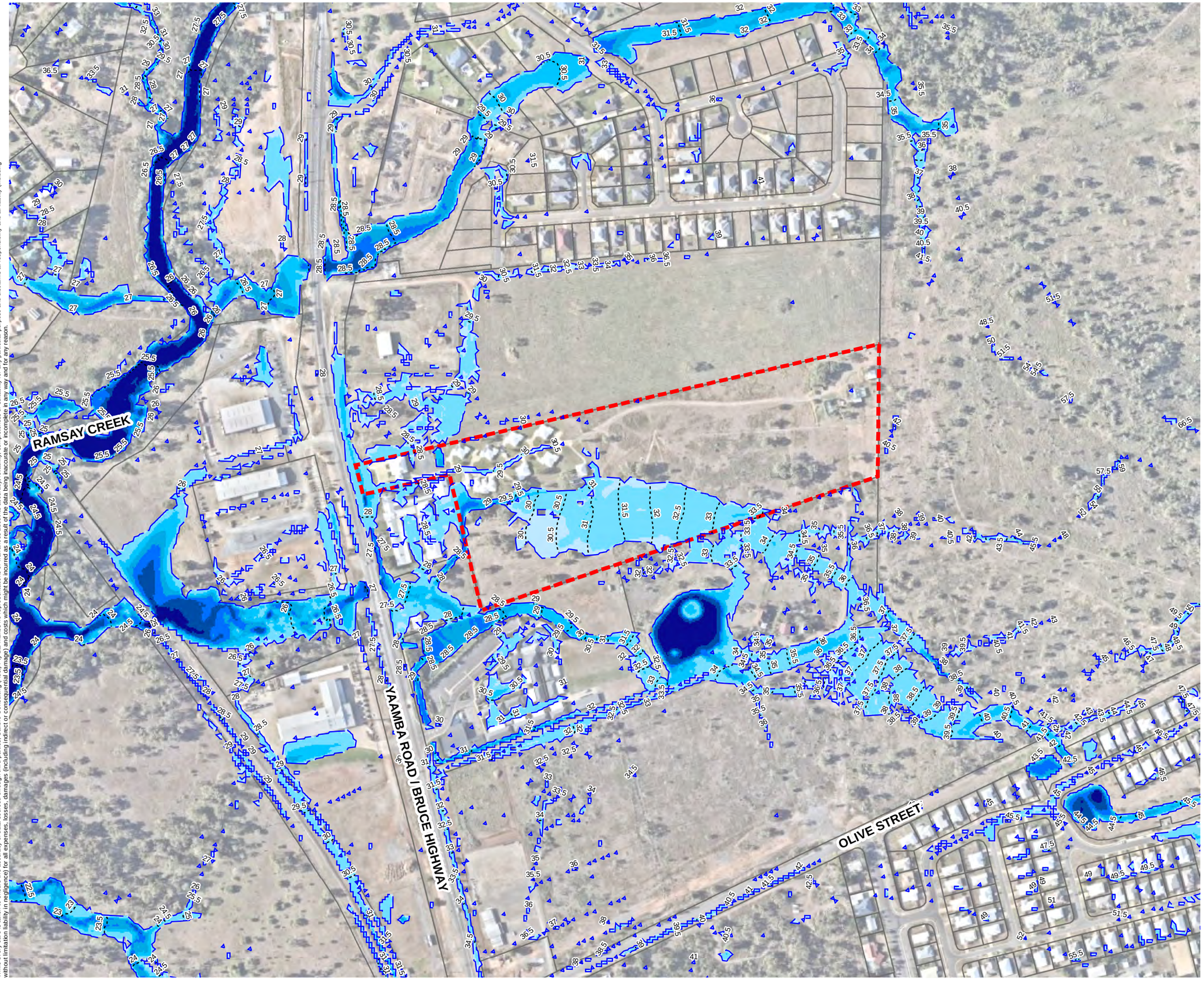
18% AEP STORM EVENT

MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-002864-E-005-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOUR (m AHD)
- SITE BOUNDARY

MAX FLOOD DEPTH (m)

- > 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

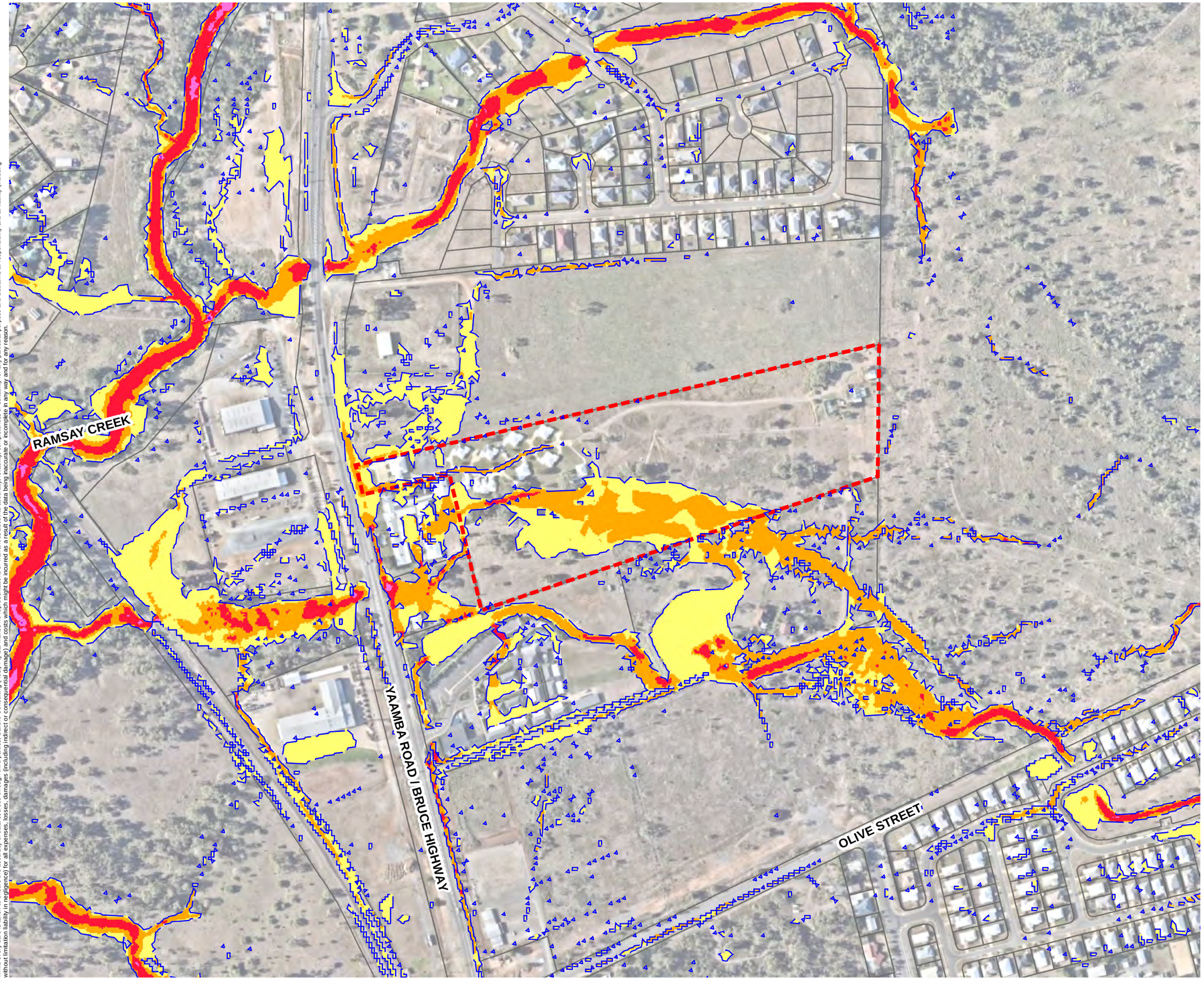
10% AEP STORM EVENT

MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-002864-E-010-A**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

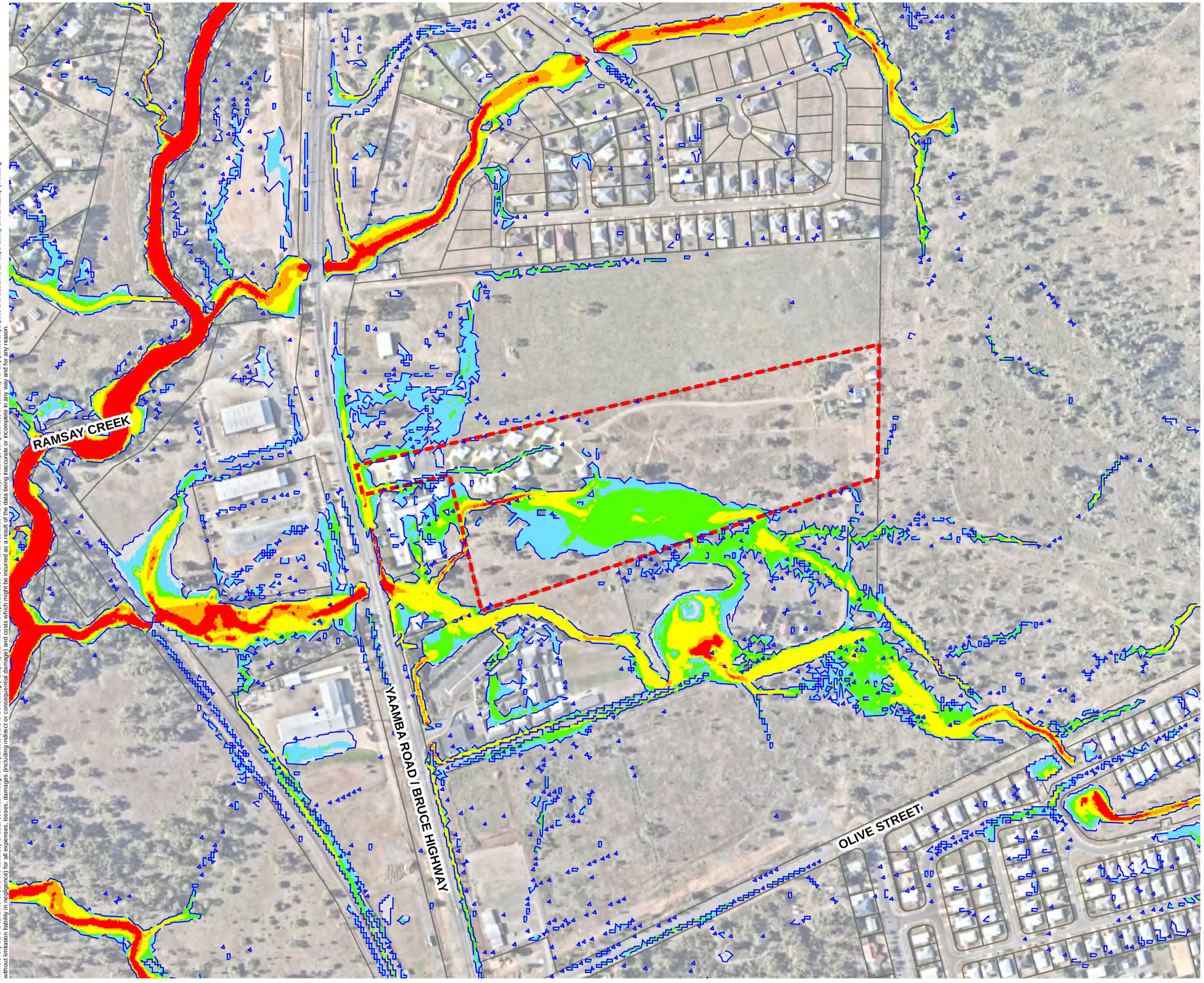
10% AEP STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-E-010-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

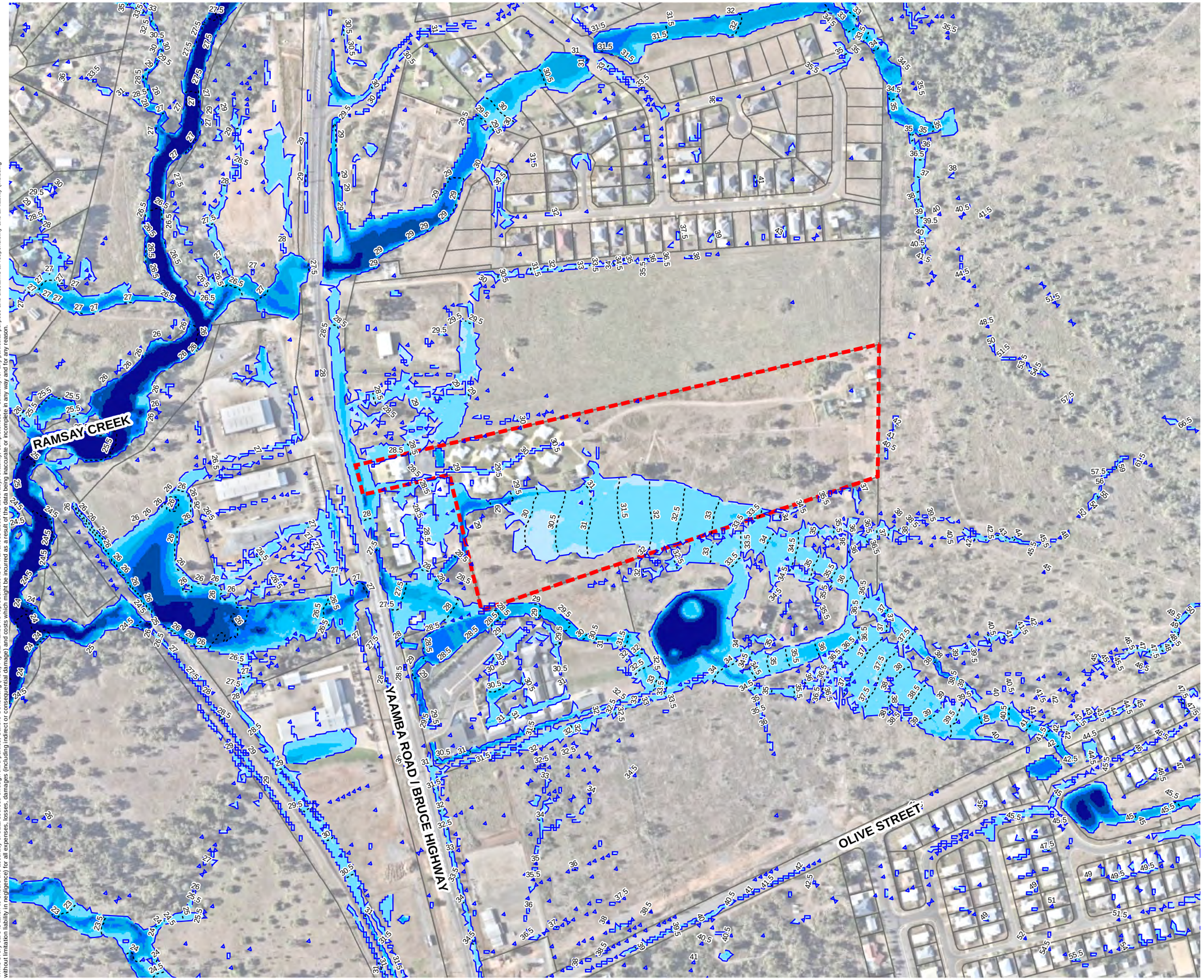
10% AEP STORM EVENT

MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-002864-E-010-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOUR (m AHD)
- SITE BOUNDARY

MAX FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

5% AEP STORM EVENT

MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-002864-E-020-A** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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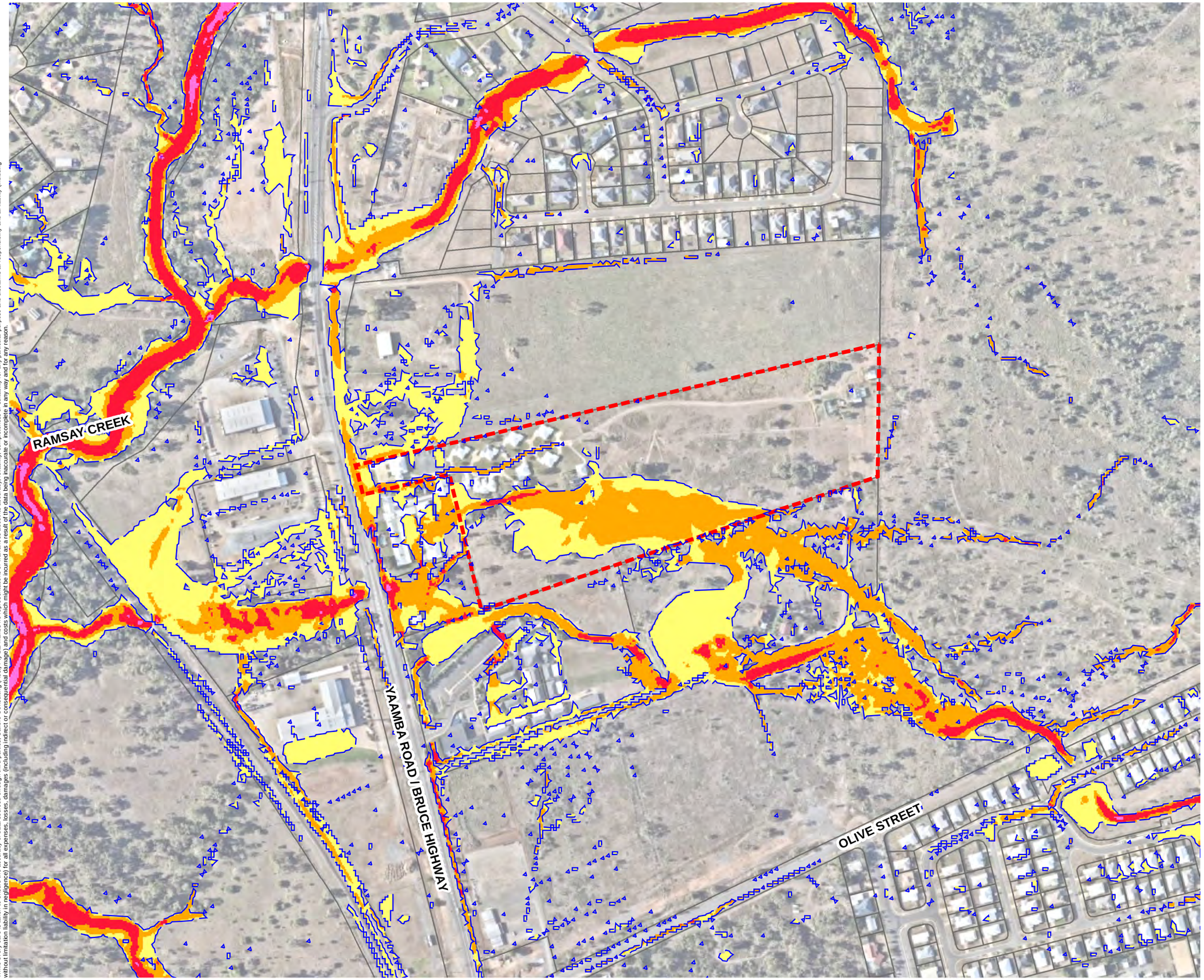

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

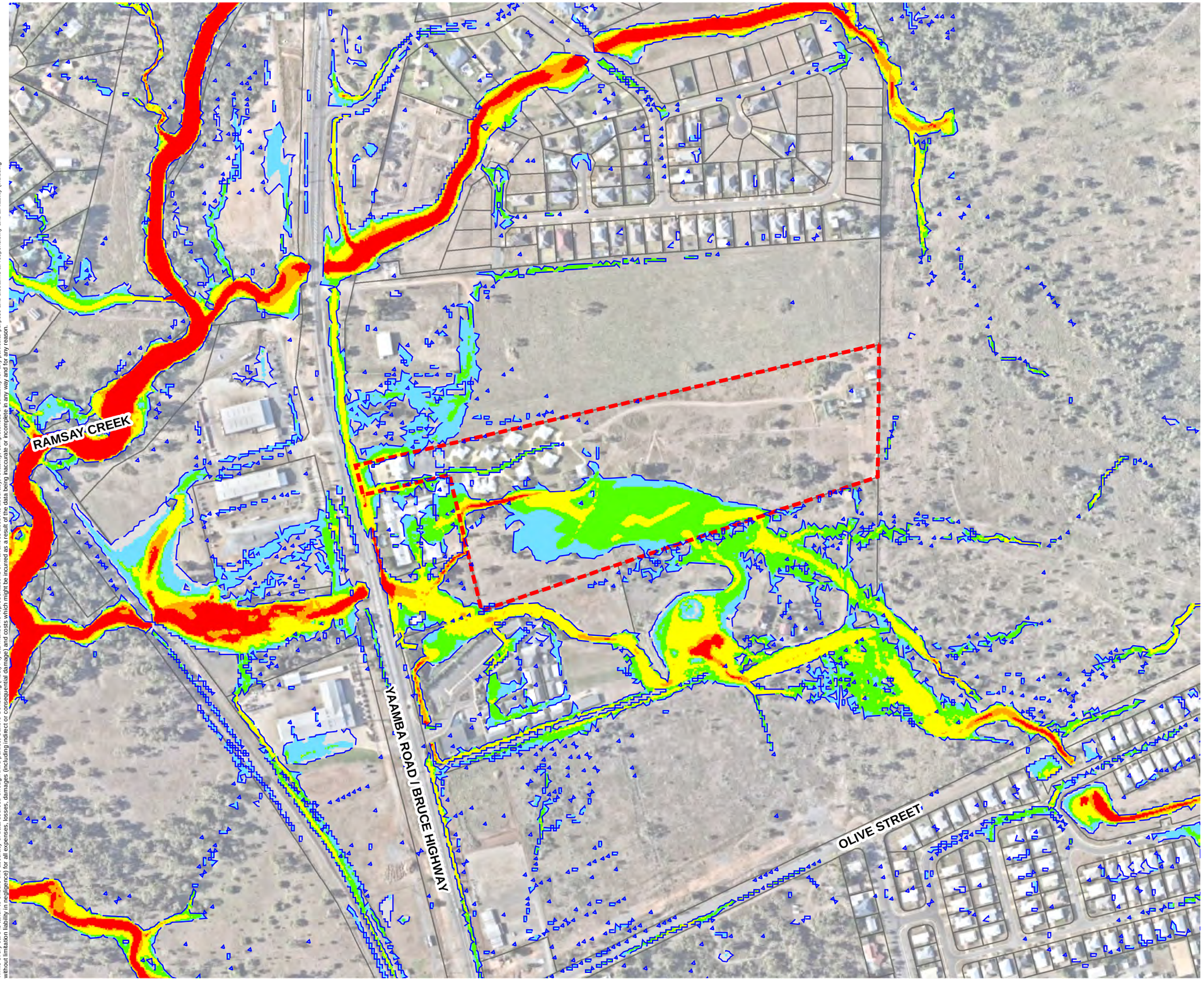
5% AEP STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-E-020-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

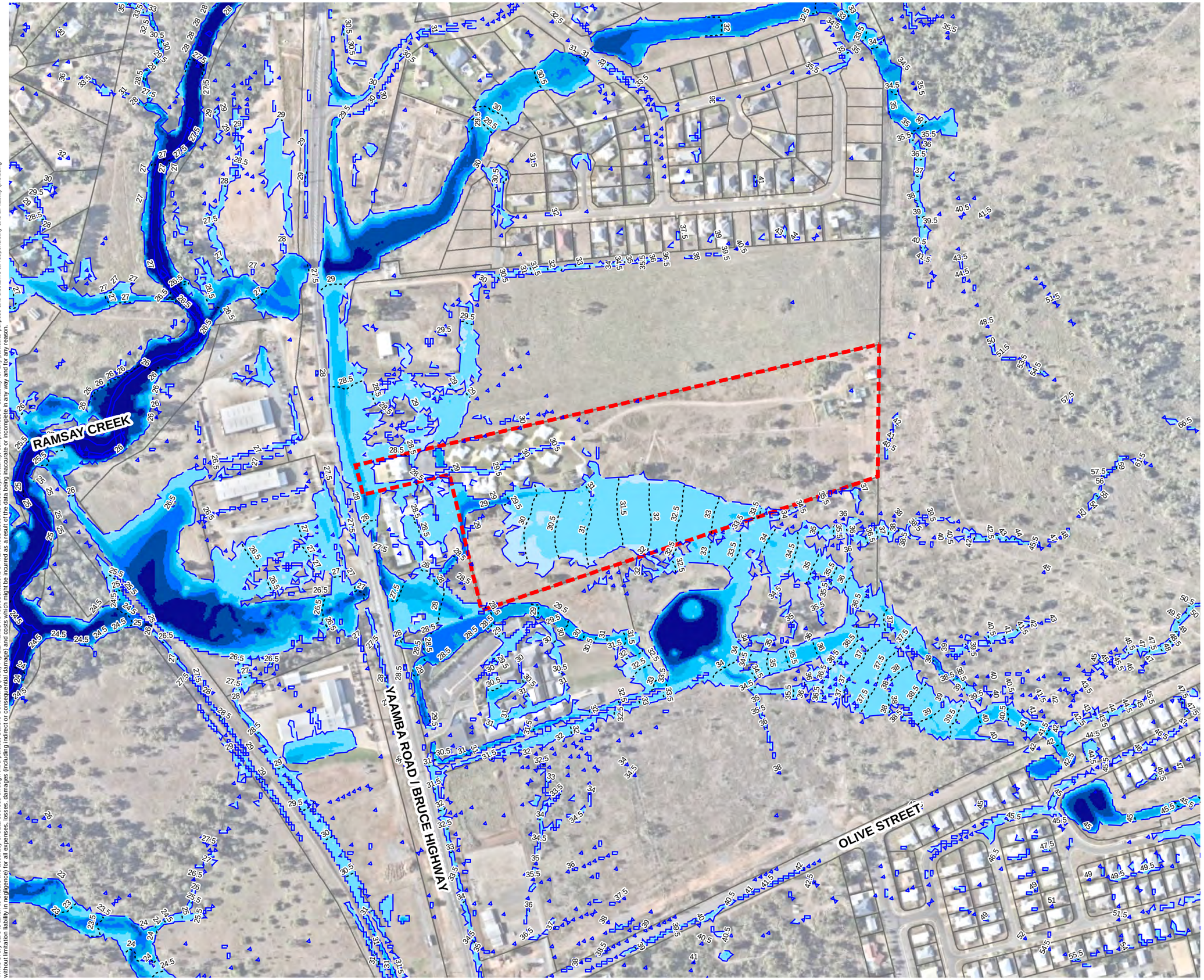
5% AEP STORM EVENT

MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-002864-E-020-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOUR (m AHD)
- SITE BOUNDARY

MAX FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

2% AEP STORM EVENT

MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-002864-E-050-A** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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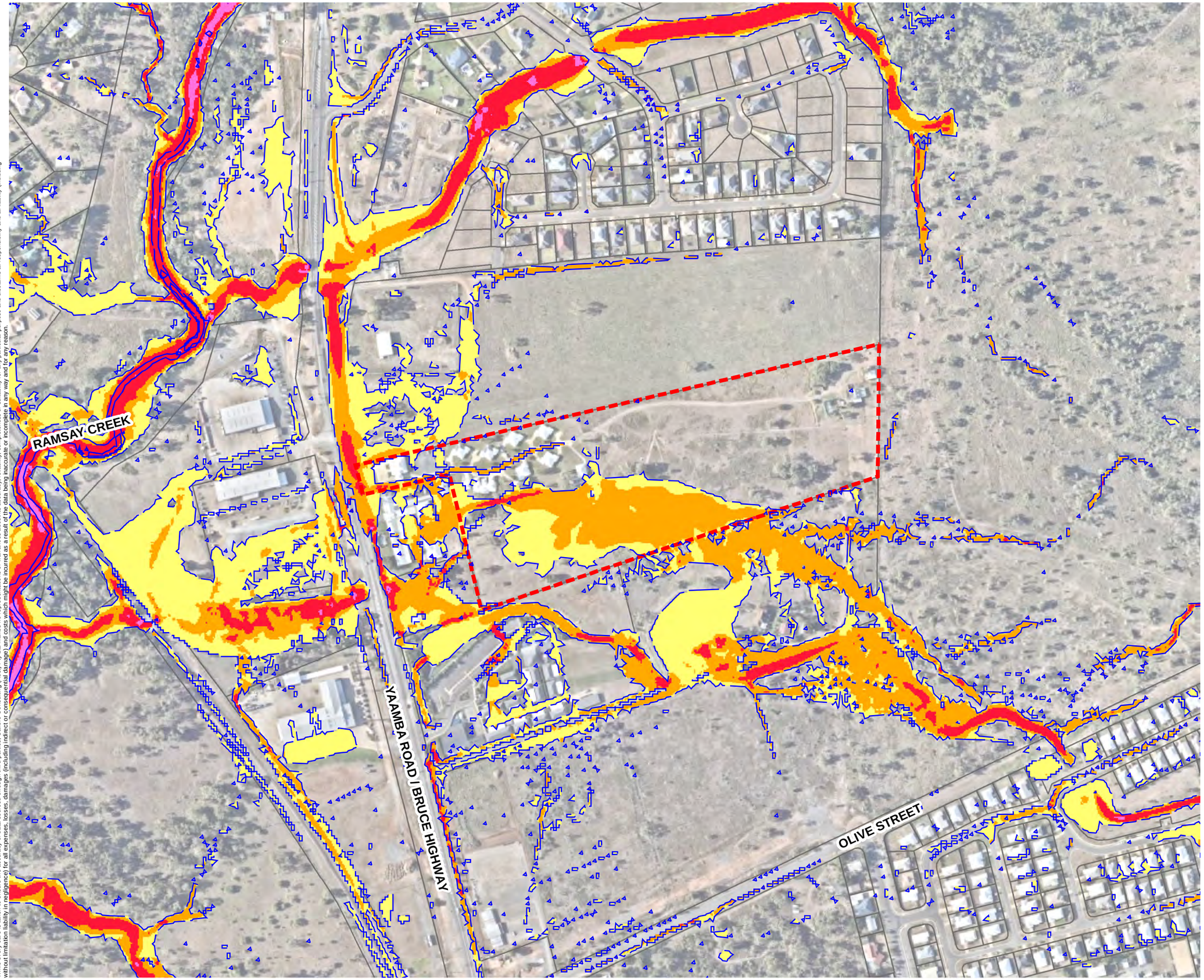

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

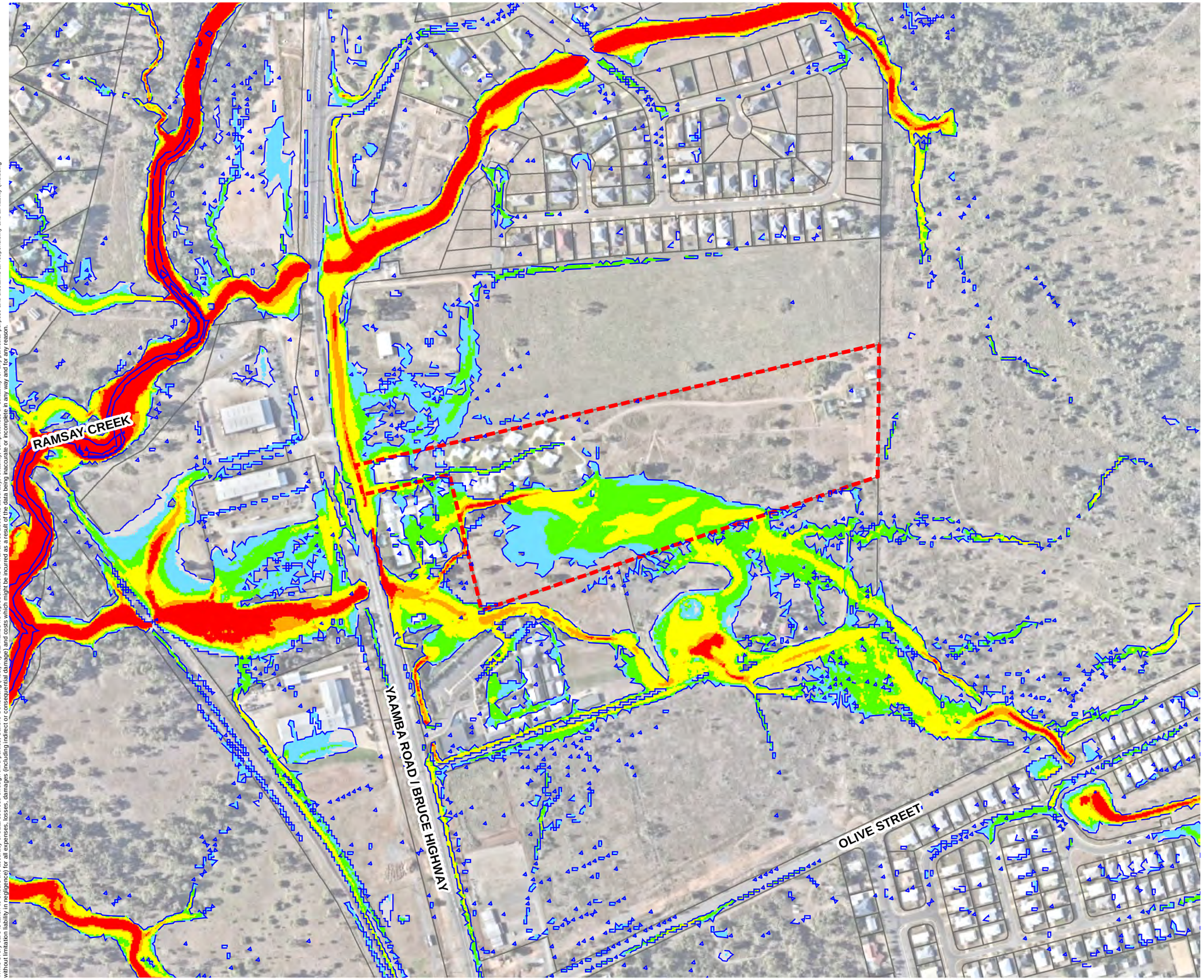
2% AEP STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-E-050-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

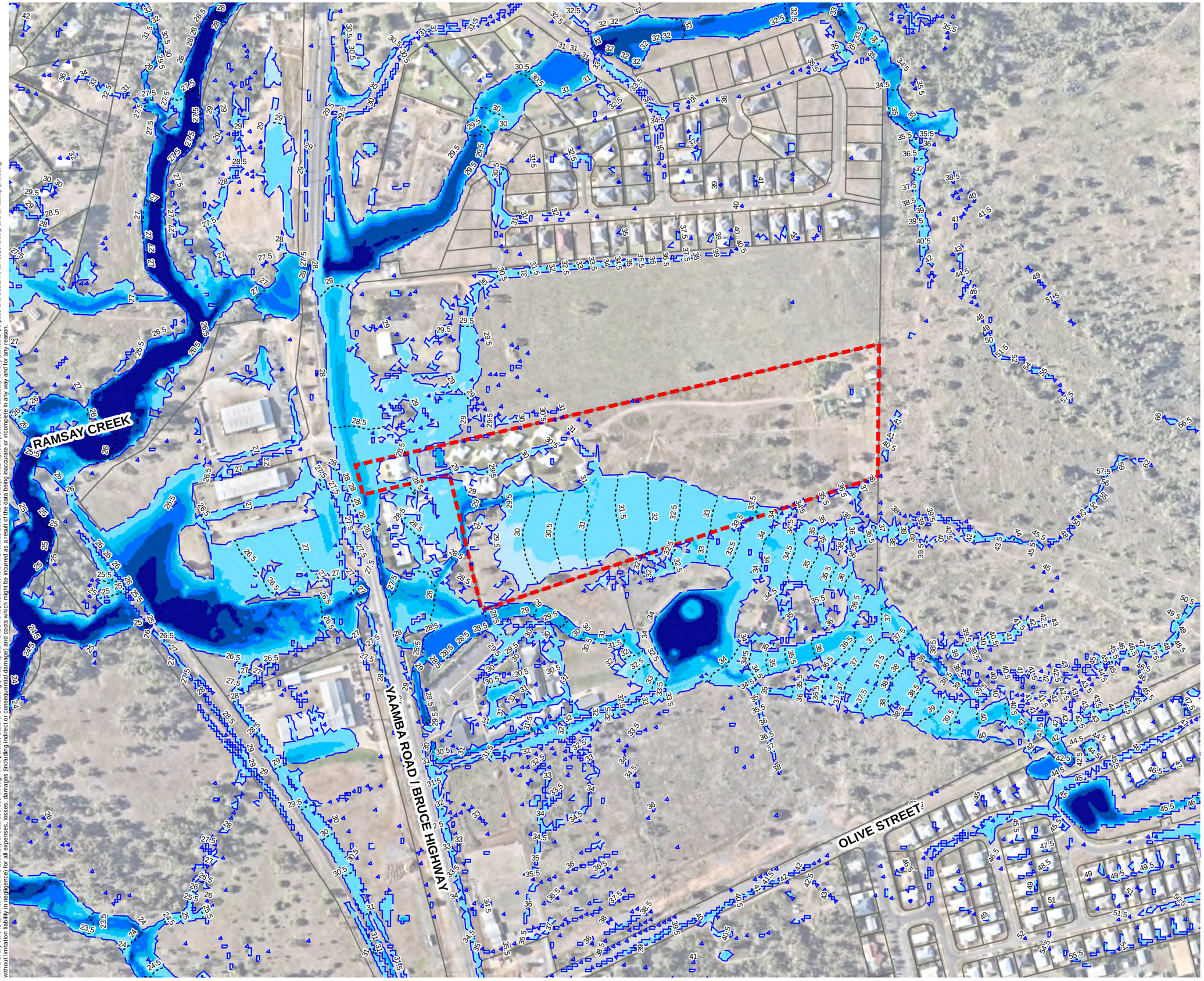
2% AEP STORM EVENT

MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-002864-E-050-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOURS (m AHD)
- SITE BOUNDARY

MAX FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

1% AEP STORM EVENT

MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-002864-E-100-A**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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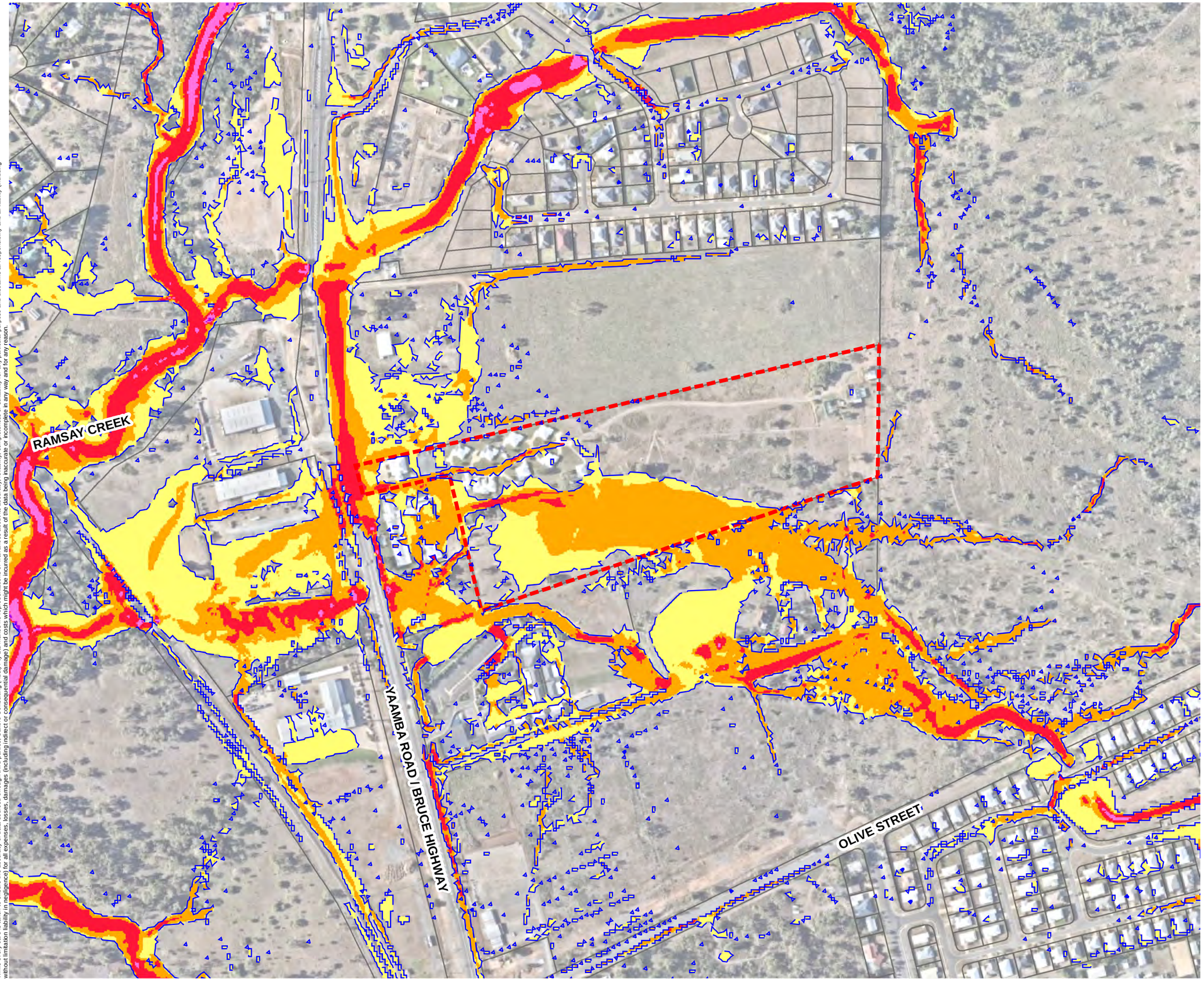

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

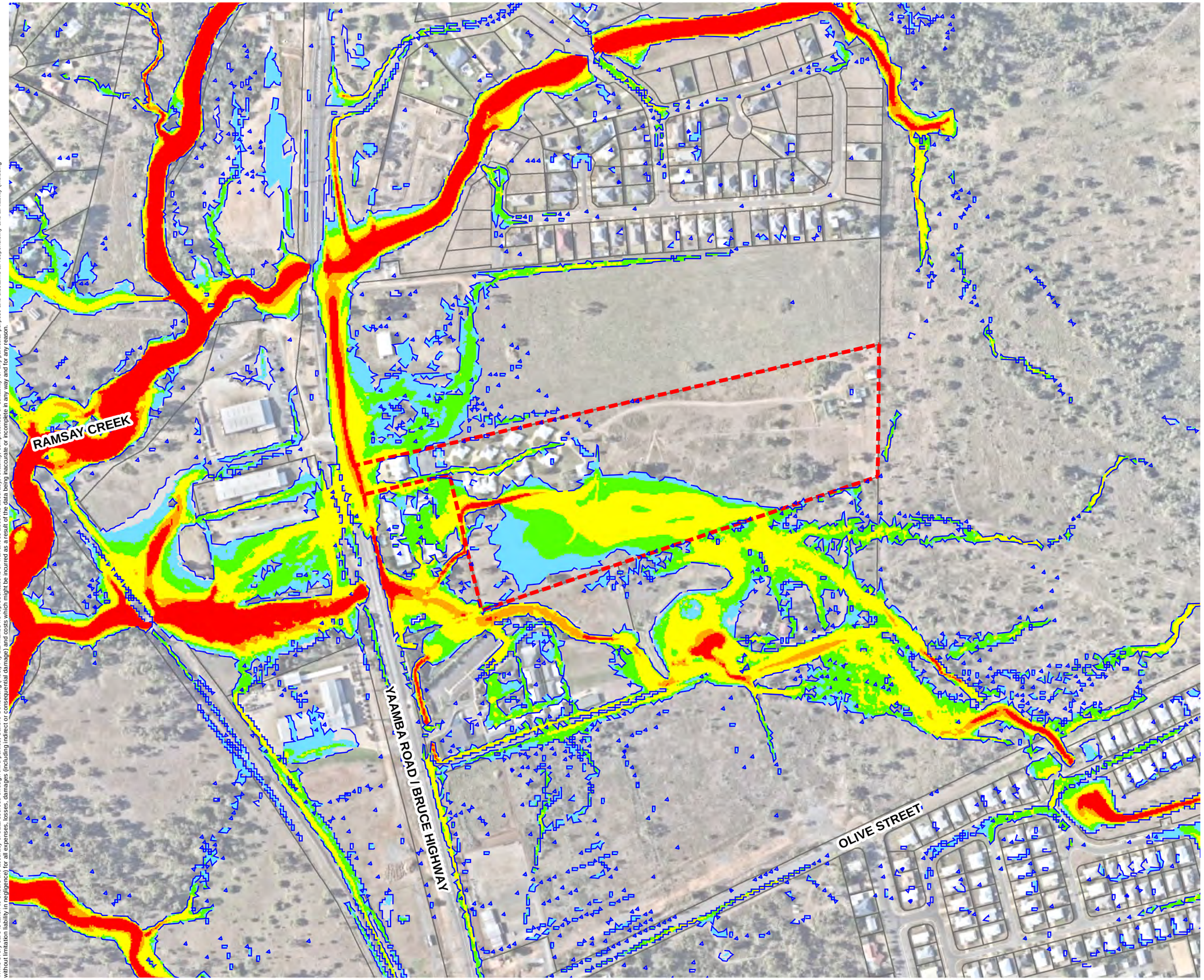
1% AEP STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-E-100-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

EXISTING SCENARIO

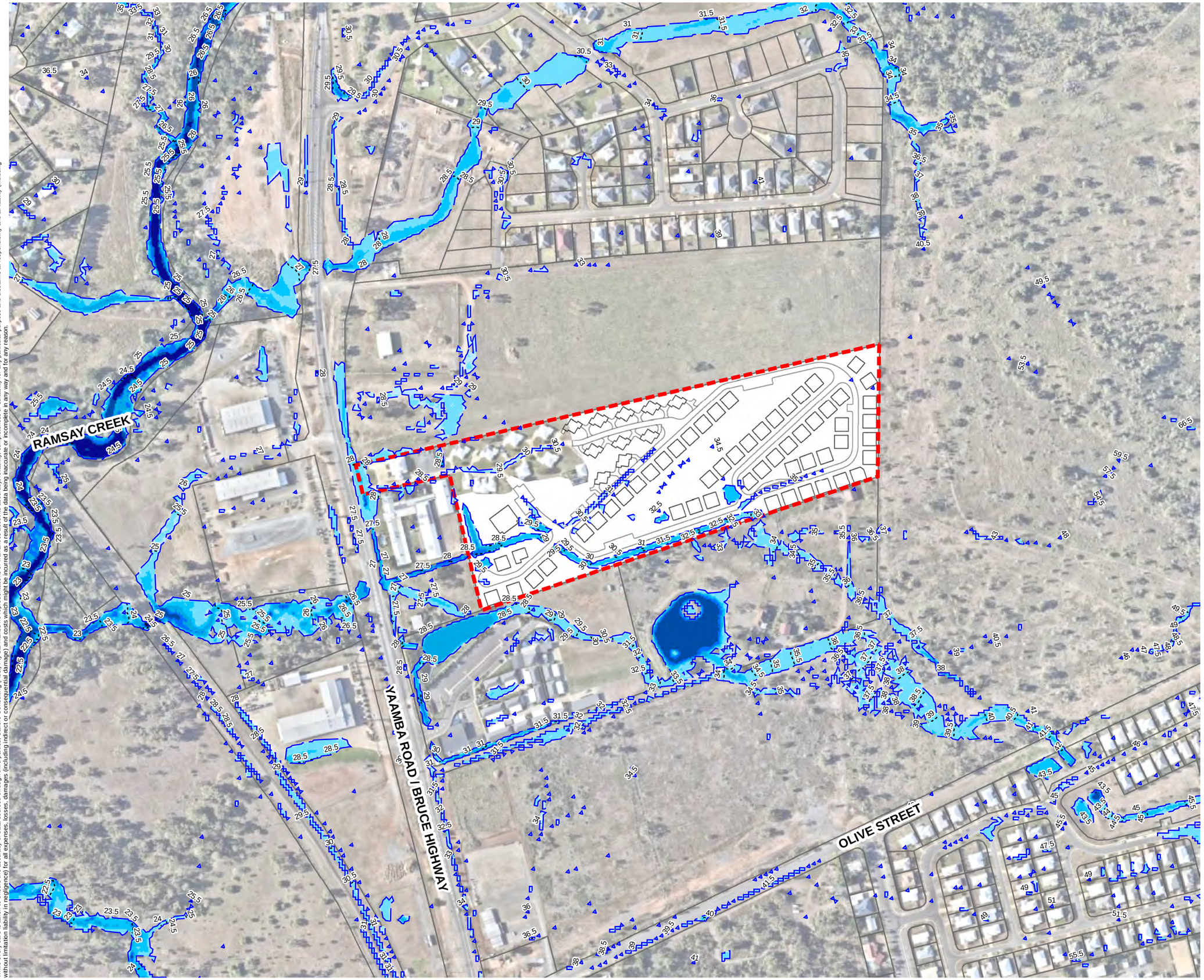
1% AEP STORM EVENT

MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-002864-E-100-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	08.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994 H:\18\002864 - 1014-1016 Yaamba Road Parkhurst\6_Model\SF\TUFLOW\DE\Results\E0\63p2_090m\010\2d\PP09102019\18-002864-D-001-A.mxd

calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOUR (m AHD)
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

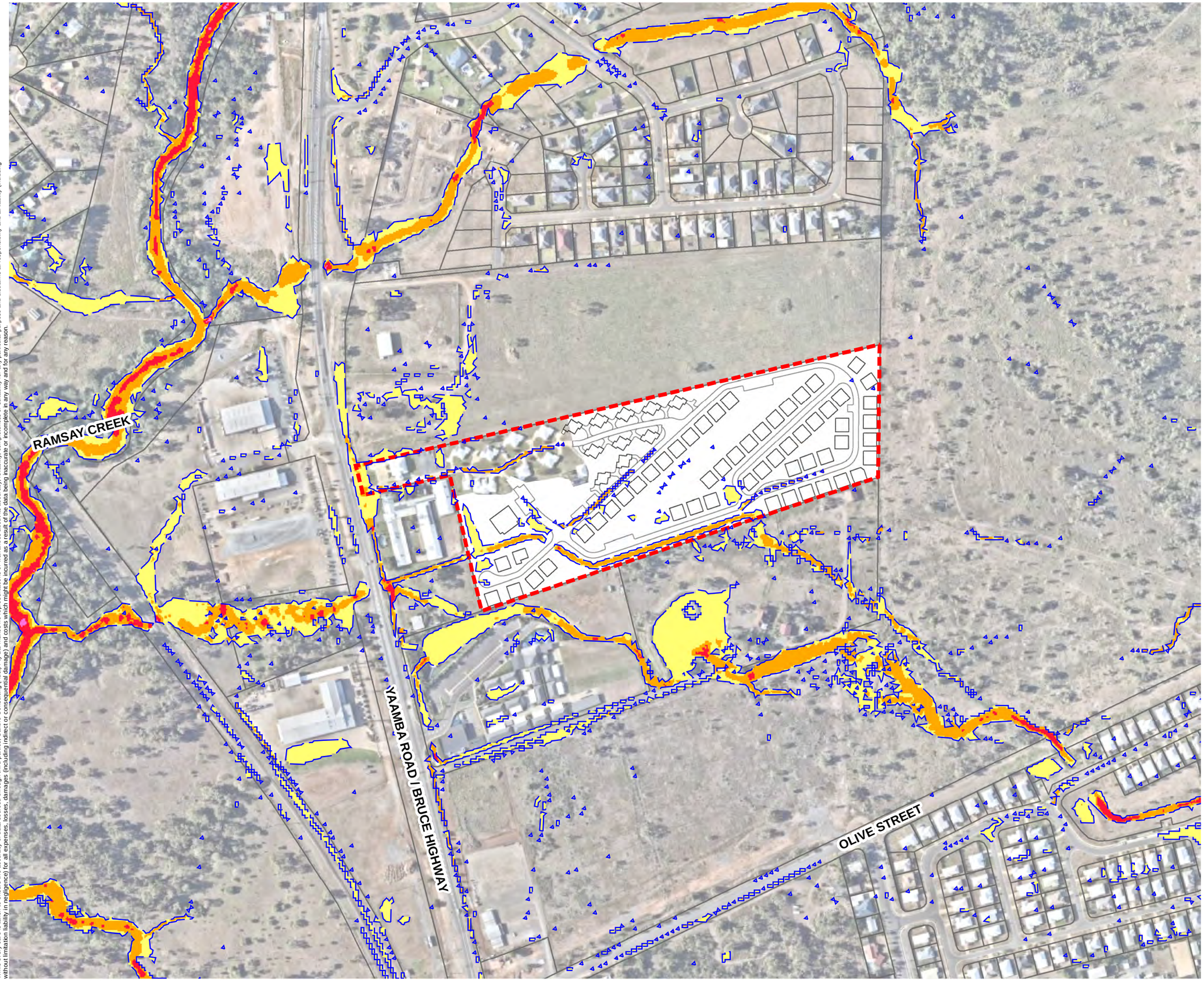
DEVELOPED SCENARIO

63% AEP STORM EVENT

MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-002864-D-001-A** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994 H:\18\002864 - 1014-1016 Yaamba Road Parkhurst\6_Model\SF\TUFLOW\DE\Results\E0\63p2_090m\010\2d\PP09102019\18-002864-D-001-B.mxd

calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

63% AEP STORM EVENT

MAX. FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-D-001-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE

RAMSAY CREEK

YAAMBA ROAD / BRUCE HIGHWAY

OLIVE STREET

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

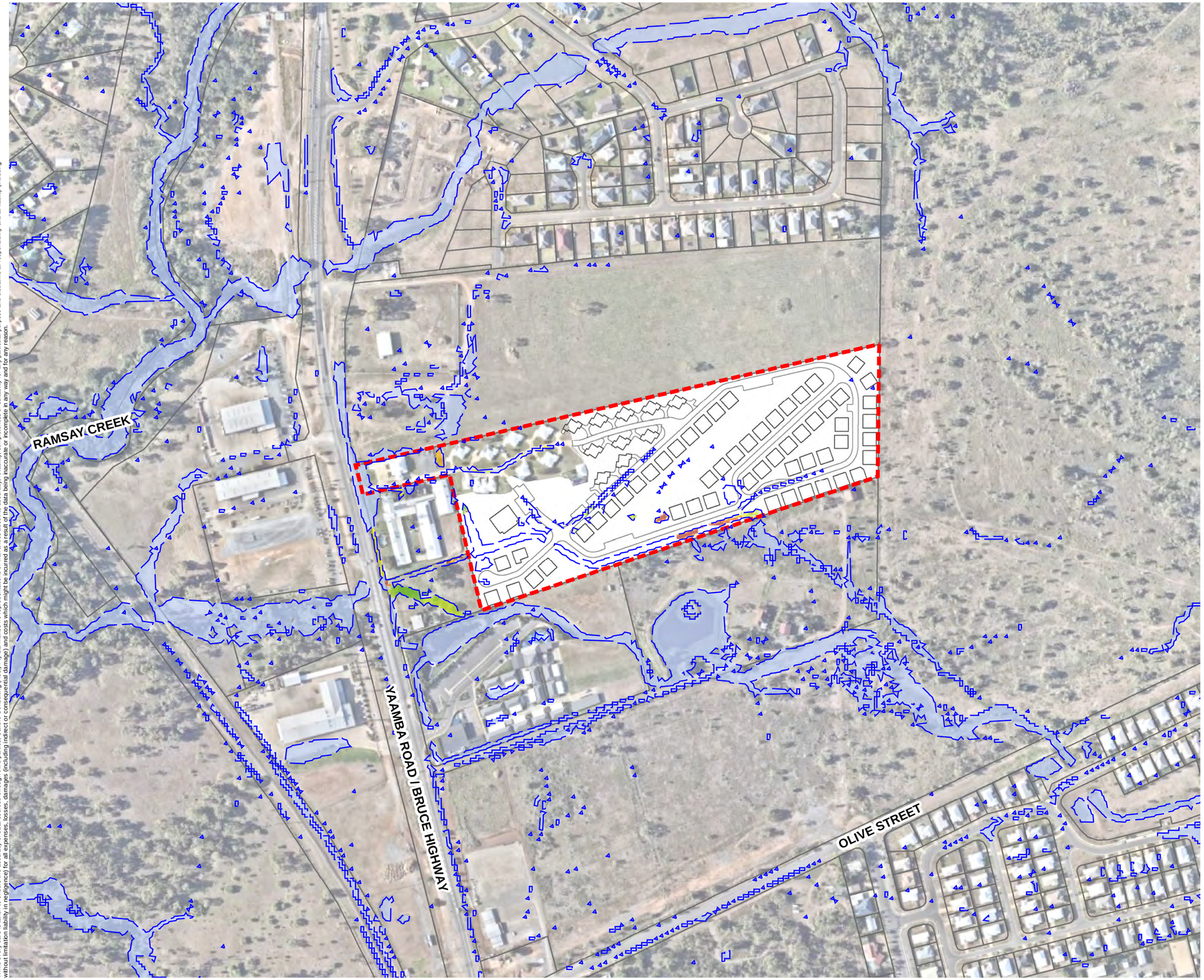
63% AEP STORM EVENT

MAX. FLOOD HAZARD PLAN

DRAWING NO: **18-002864-D-001-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD LEVEL DIFFERENCE (m)

- < -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- > 0.2
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

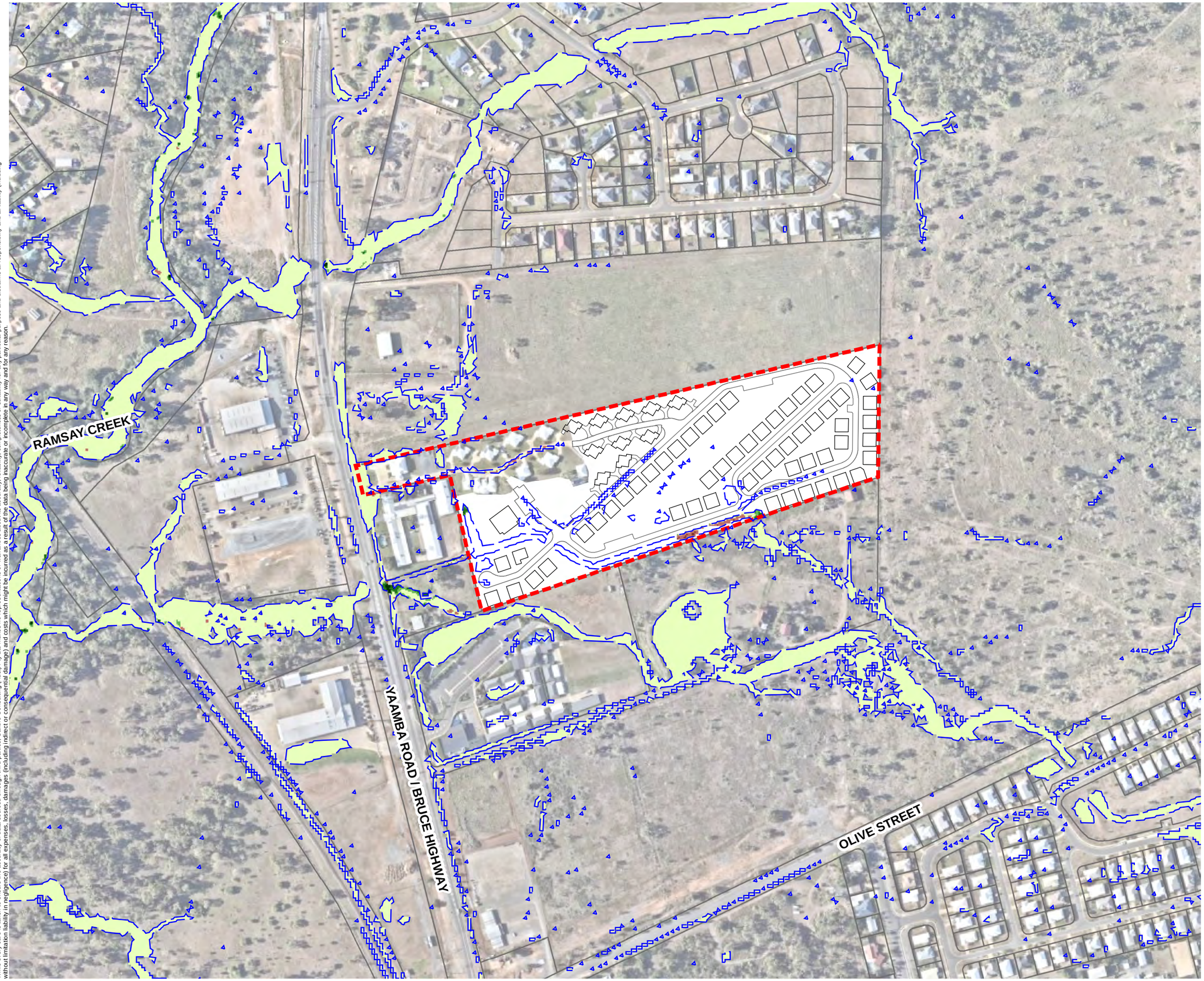
63% AEP STORM EVENT

MAX. FLOOD LEVEL DIFFERENCE PLAN

DRAWING NO: **18-002864-D-001-D**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY DIFFERENCE (m/s)

- < -0.45
- -0.45 to -0.2
- -0.2 to -0.1
- -0.1 to 0.1
- 0.1 to 0.5
- 0.5 to 1
- > 1.0
- CADASTRE

NOTES:
1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m
1:4,000 (A3)
N

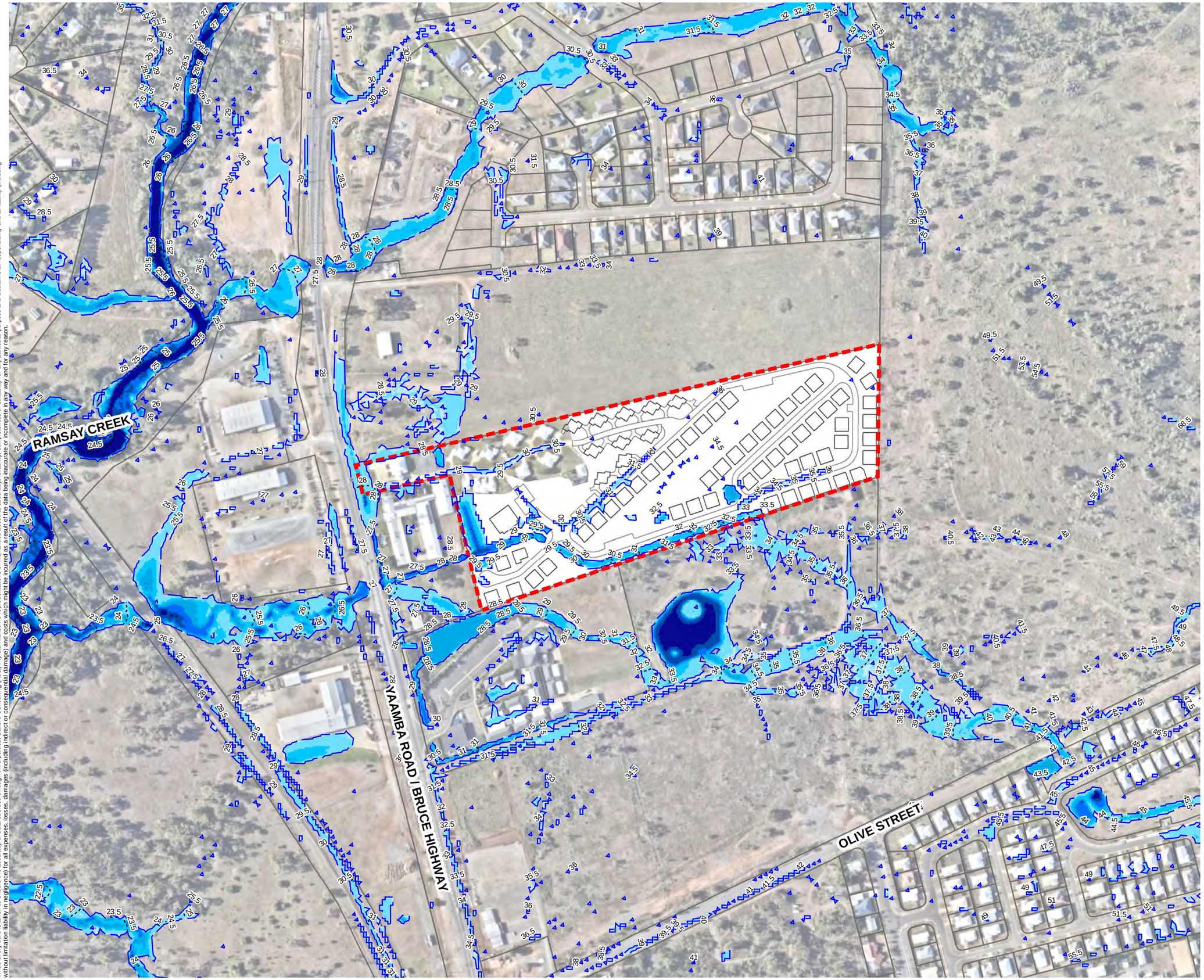
PROJECT:
1014-1016 YAAMBA ROAD PARKHURST

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
DEVELOPED SCENARIO
63% AEP STORM EVENT
MAX. FLOOD VELOCITY DIFFERENCE PLAN

DRAWING NO: **18-002864-D-001-E**
ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994 H:\18\002864 - 1014-1016 Yaamba Road Parkhurst\6_Model\SF\TUFLOW\DE\Results\E0\39p4_090m\010\2d\PP09102019\18-002864-D-002-A.mxd

calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOUR (m AHD)
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

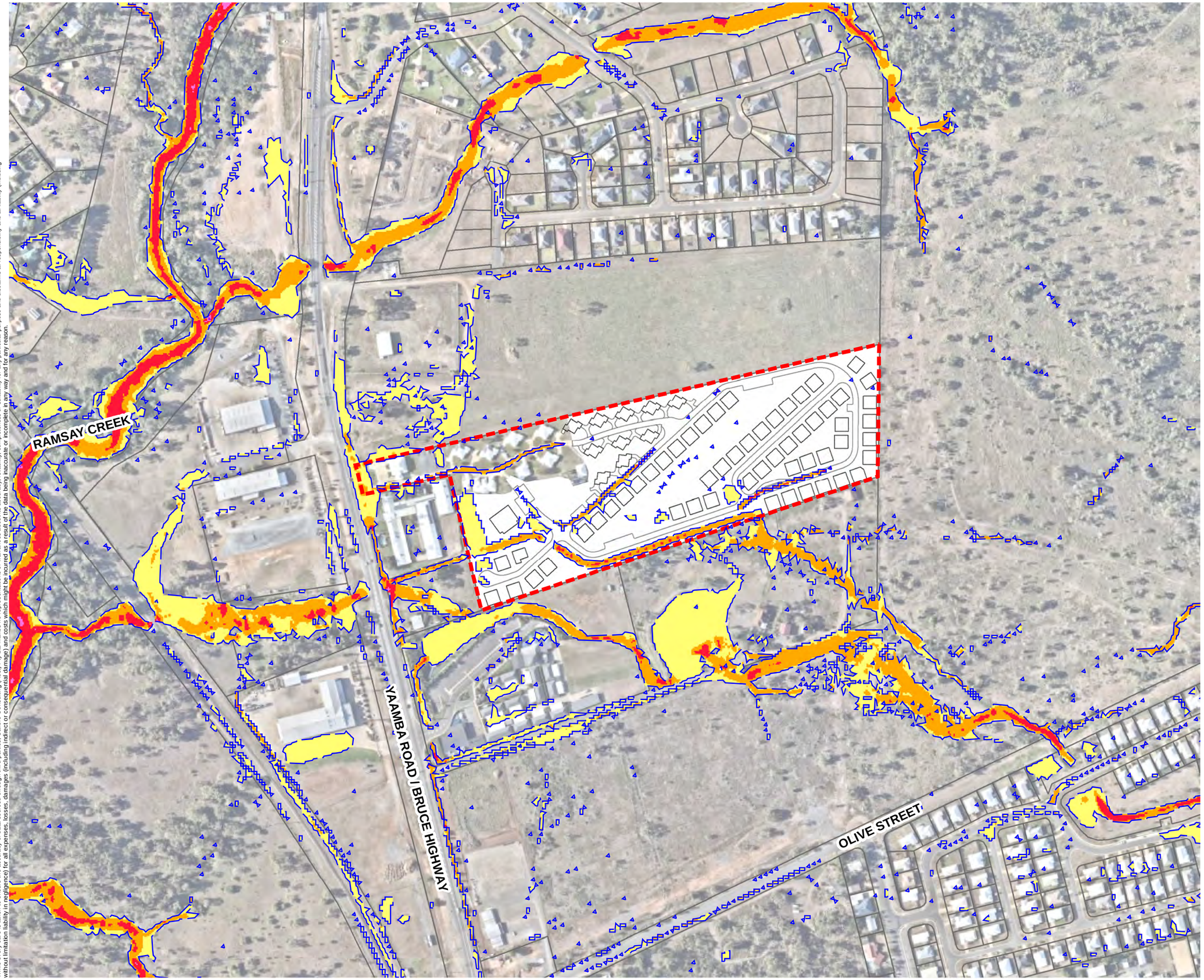
DEVELOPED SCENARIO

39% AEP STORM EVENT

MAX. FLOOD DEPTH PLAN

DRAWING NO: **18-002864-D-002-A** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

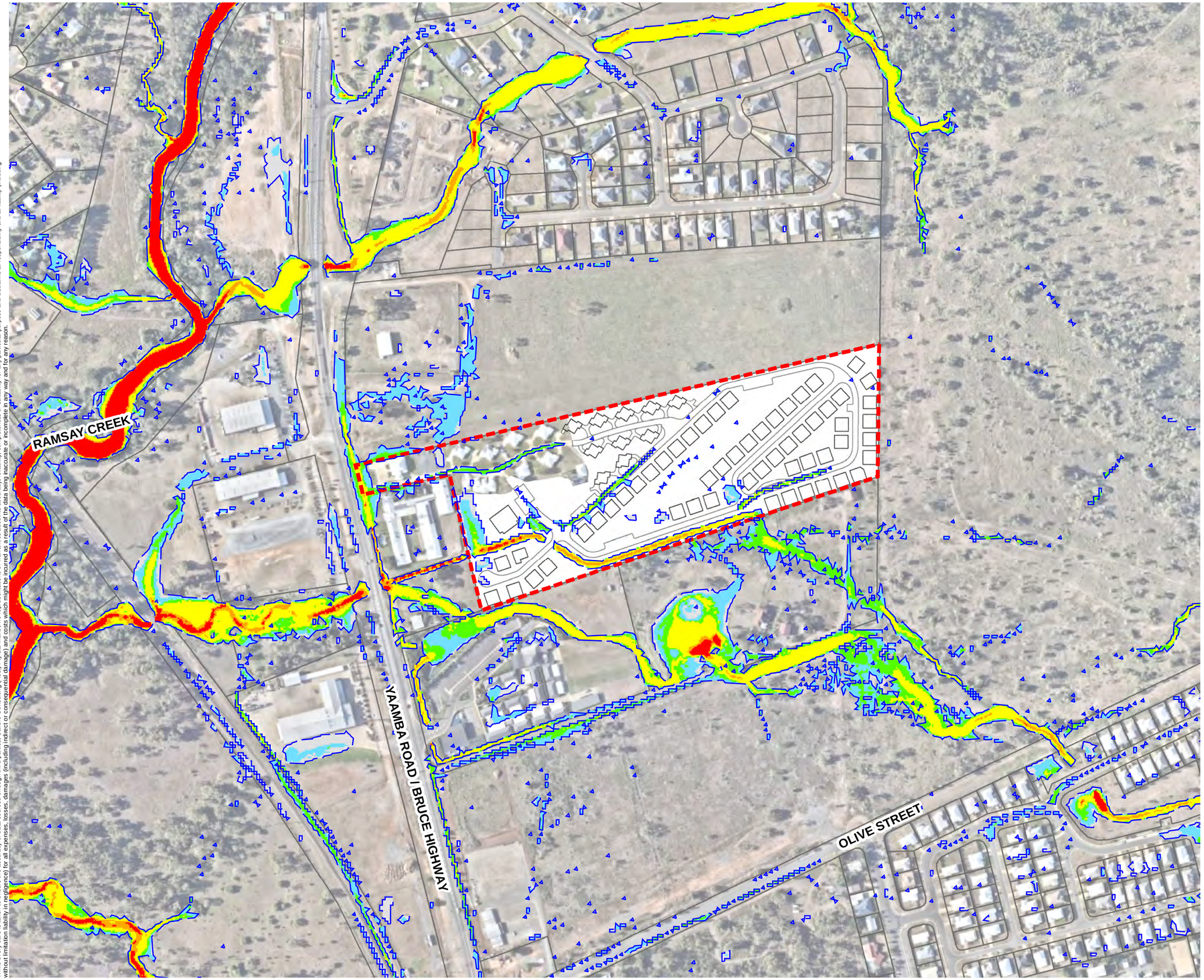
39% AEP STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-D-002-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994 H:\18\002864 - 1014-1016 Yaamba Road Parkhurst\6_Model\SF\TUFLOW\DE\Results\E0\39p4_090m\010\2d\PP09102019\18-002864-D-002-C.mxd

calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

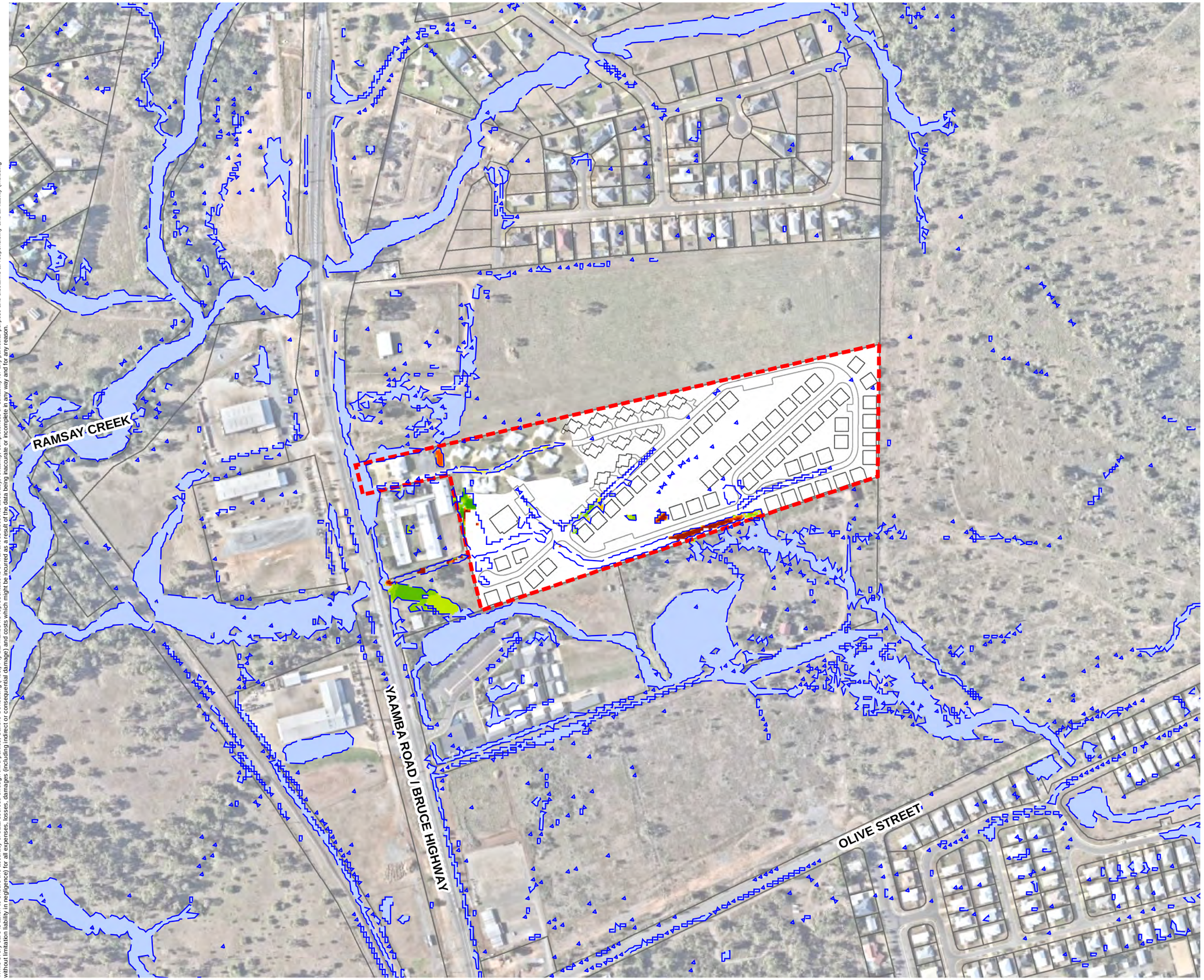
DEVELOPED SCENARIO

39% AEP STORM EVENT

MAX. FLOOD HAZARD PLAN

DRAWING NO: **18-002864-D-002-C** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD LEVEL DIFFERENCE (m)

- < -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- > 0.2
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

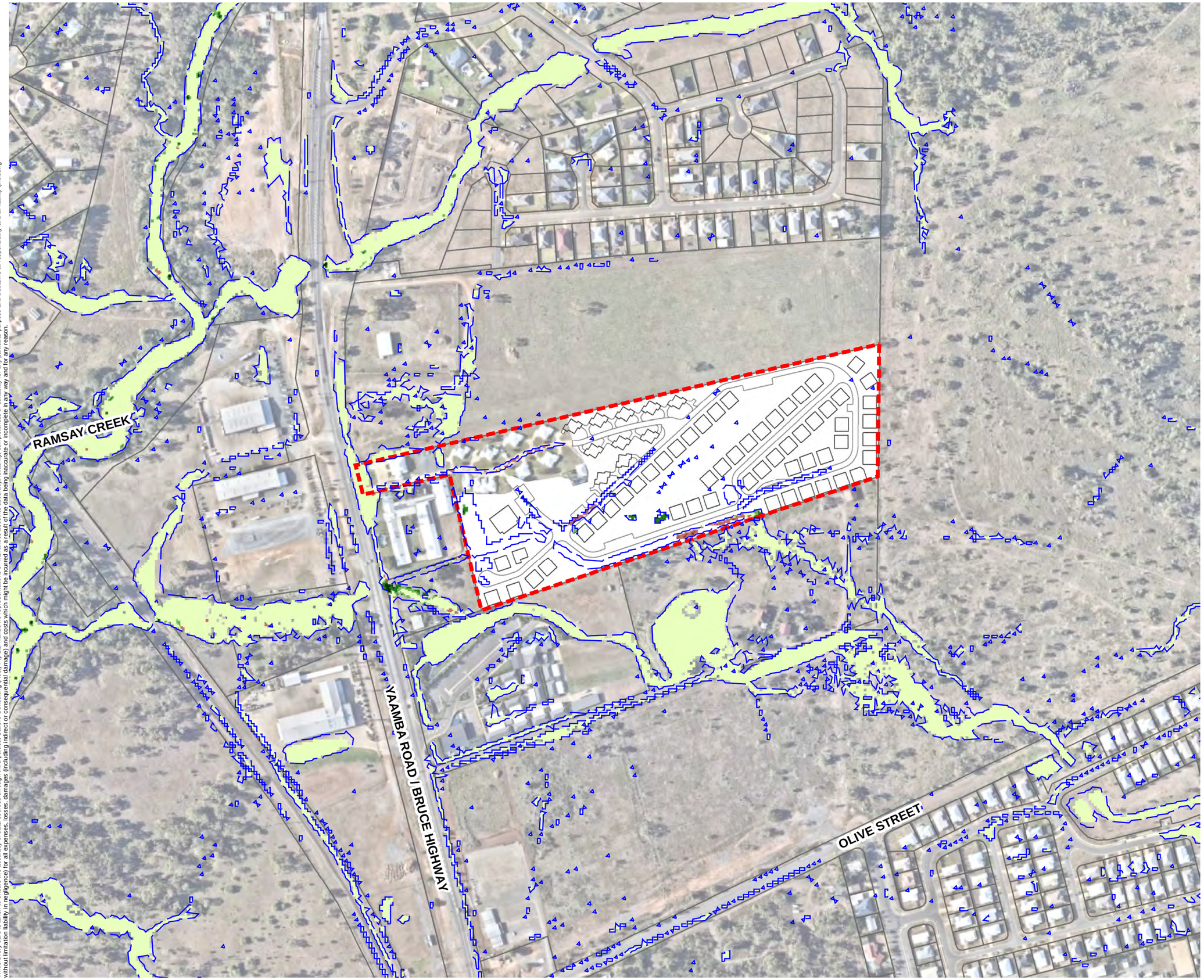
39% AEP STORM EVENT

MAX. FLOOD LEVEL DIFFERENCE PLAN

DRAWING NO: **18-002864-D-002-D**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY DIFFERENCE (m/s)

- < -0.45
- -0.45 to -0.2
- -0.2 to -0.1
- -0.1 to 0.1
- 0.1 to 0.5
- 0.5 to 1
- > 1.0
- CADASTRE

NOTES:
1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m
1:4,000 (A3)

N

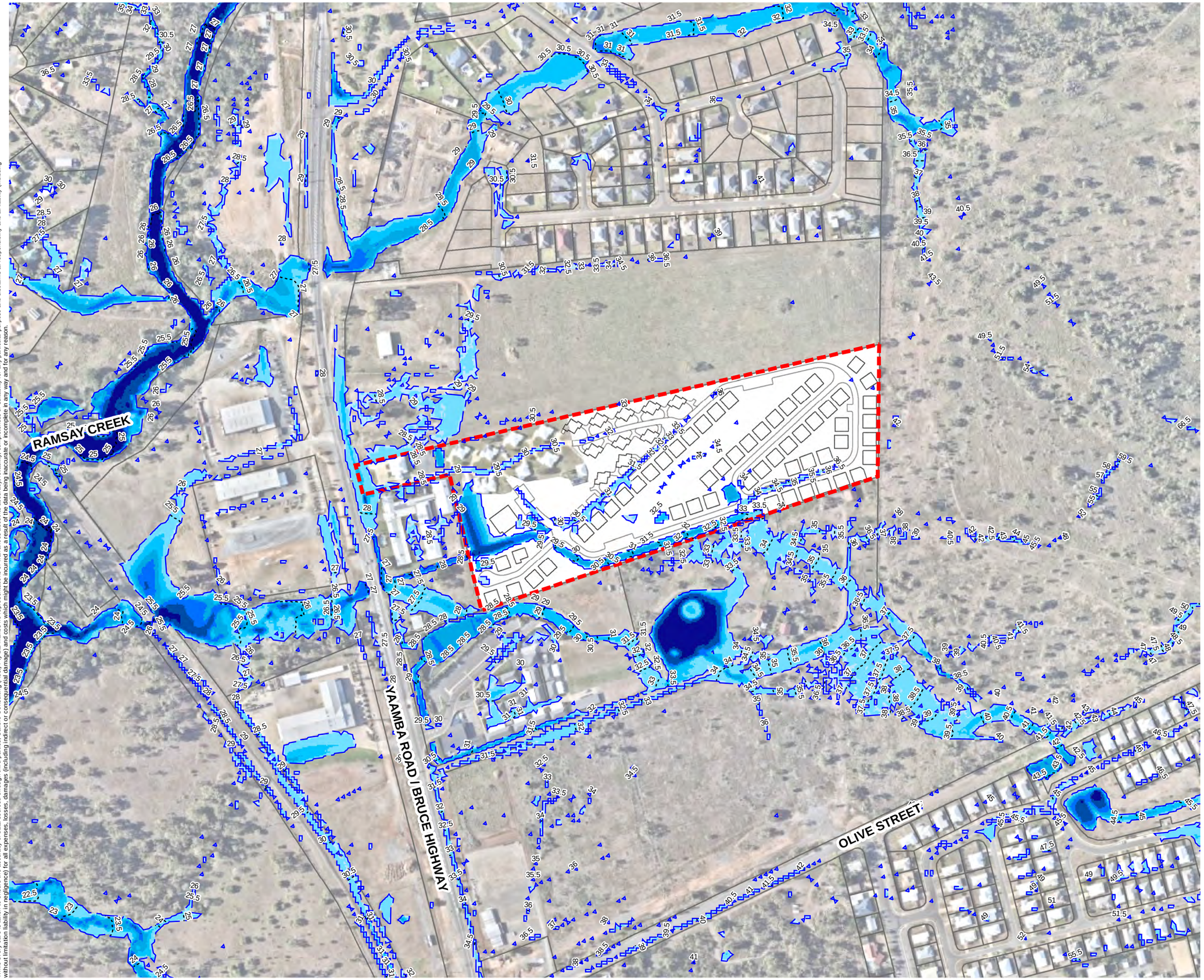
PROJECT:
1014-1016 YAAMBA ROAD PARKHURST

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
DEVELOPED SCENARIO
39% AEP STORM EVENT
MAX. FLOOD VELOCITY DIFFERENCE PLAN

DRAWING NO: **18-002864-D-002-E**
ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



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calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOUR (m AHD)
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

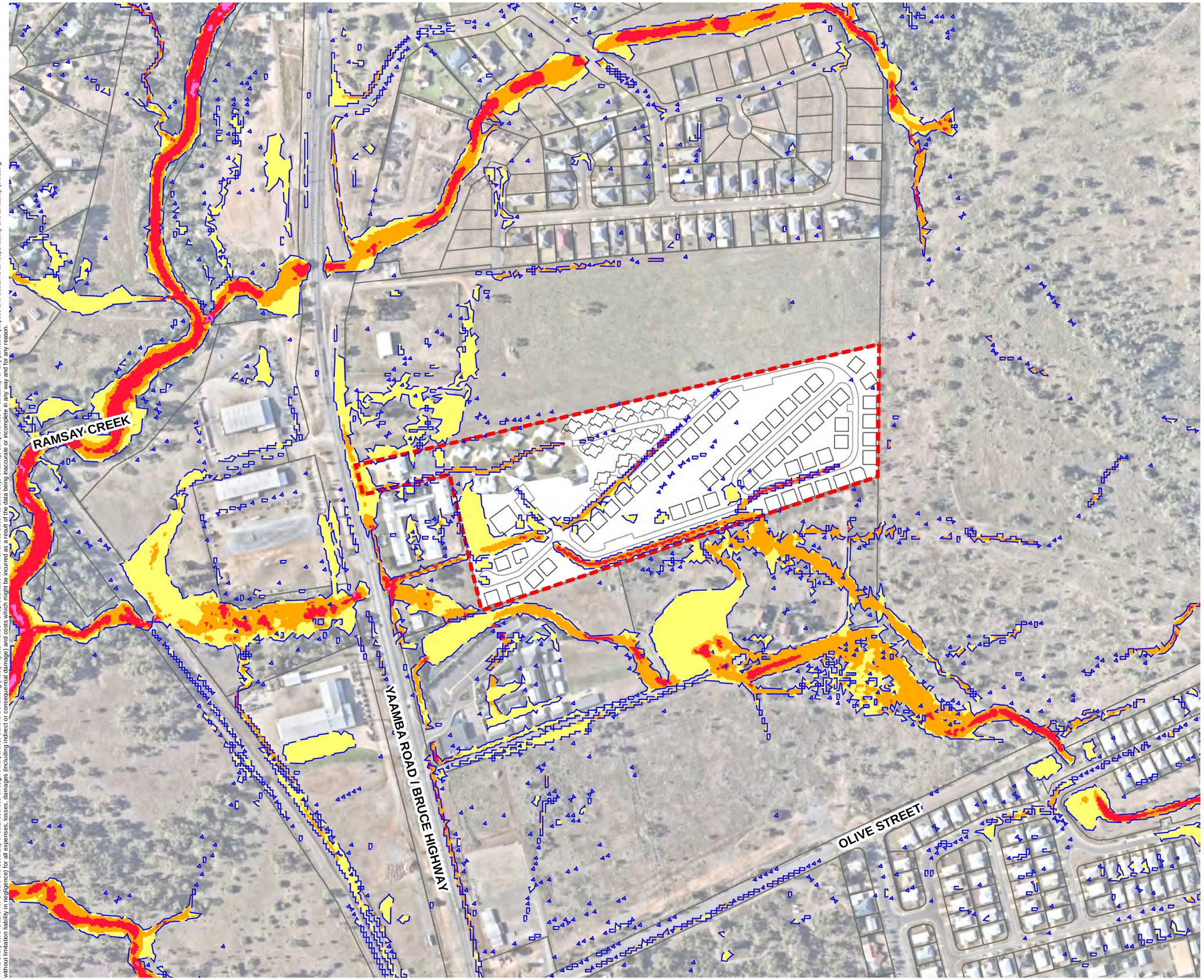
DEVELOPED SCENARIO

18% AEP STORM EVENT

MAX. FLOOD DEPTH PLAN

DRAWING NO: **18-002864-D-005-A** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

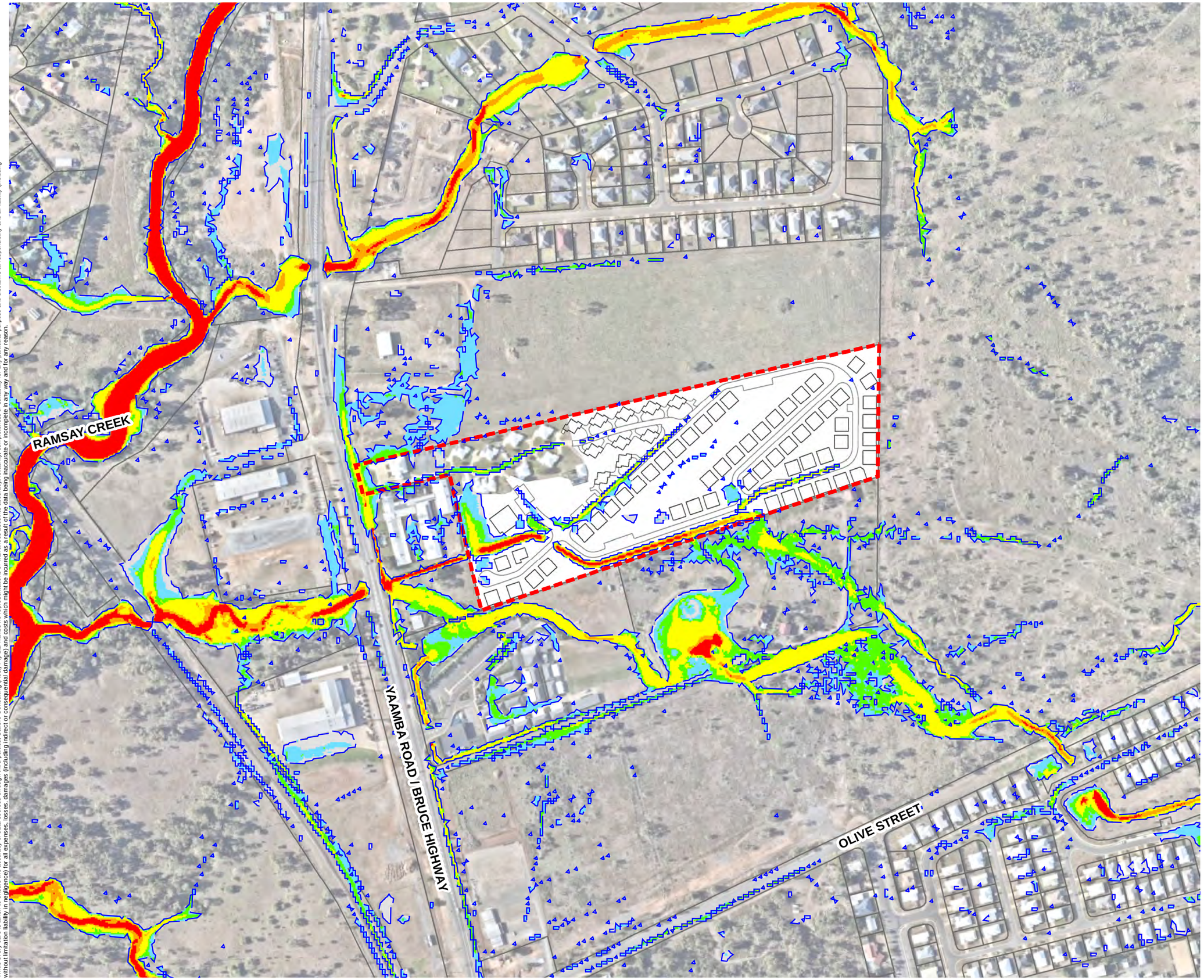
18% AEP STORM EVENT

MAX. FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-D-005-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994 H:\18\002864 - 1014-1016 Yaamba Road Parkhurst\6_Model\SF\TUFLOW\DE\Results\E0\18p1_090m\010\2d\PP09102019\18-002864-D-005-C.mxd

calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

18% AEP STORM EVENT

MAX. FLOOD HAZARD PLAN

DRAWING NO: **18-002864-D-005-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
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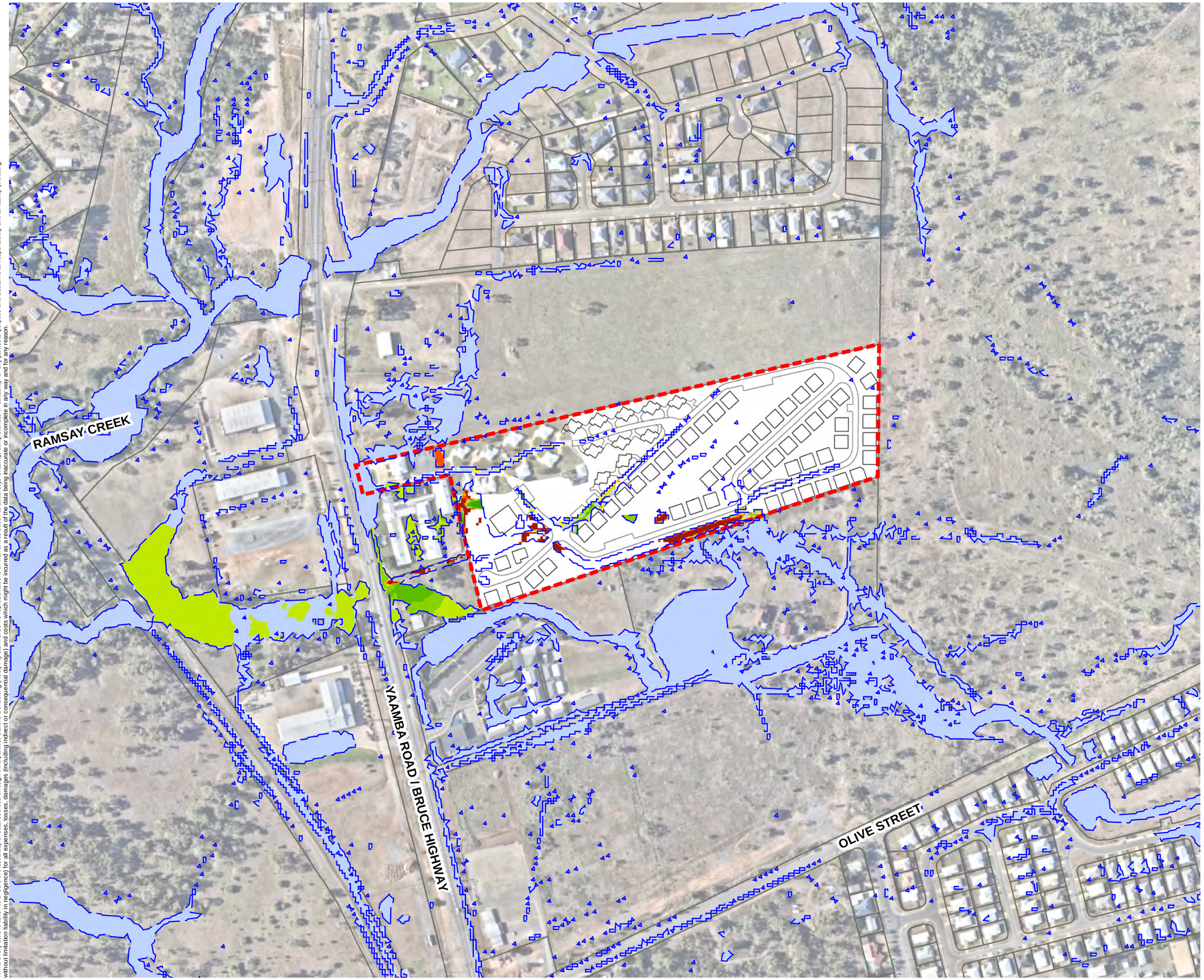

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD LEVEL DIFFERENCE (m)

- < -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- > 0.2
- CADASTRE

NOTES:
1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m
1:4,000 (A3)
N

PROJECT:
1014-1016 YAAMBA ROAD PARKHURST

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
DEVELOPED SCENARIO
18% AEP STORM EVENT
MAX. FLOOD LEVEL DIFFERENCE PLAN

DRAWING NO: **18-002864-D-005-D** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
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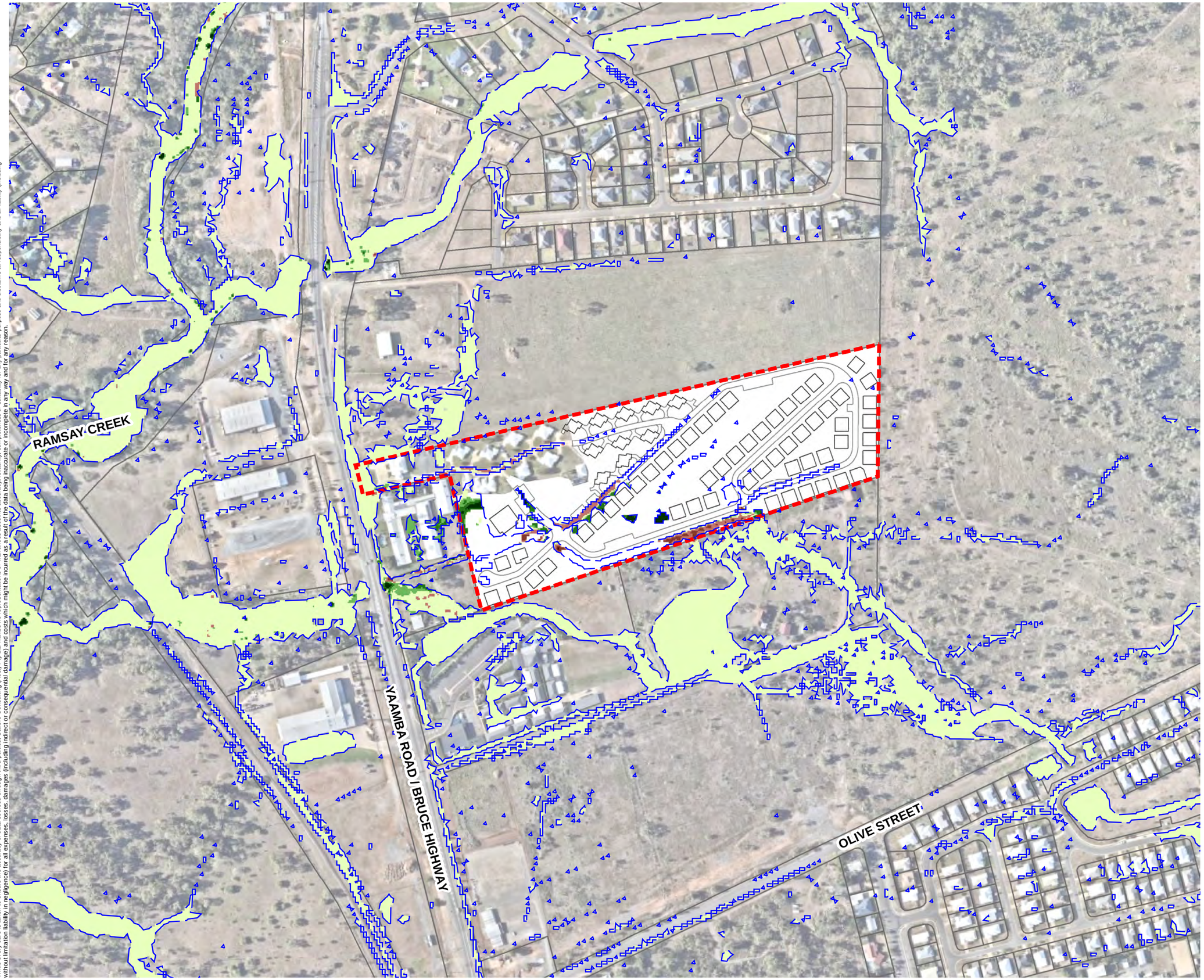

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY DIFFERENCE (m/s)

- < -0.45
- -0.45 to -0.2
- -0.2 to -0.1
- -0.1 to 0.1
- 0.1 to 0.5
- 0.5 to 1
- > 1.0
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

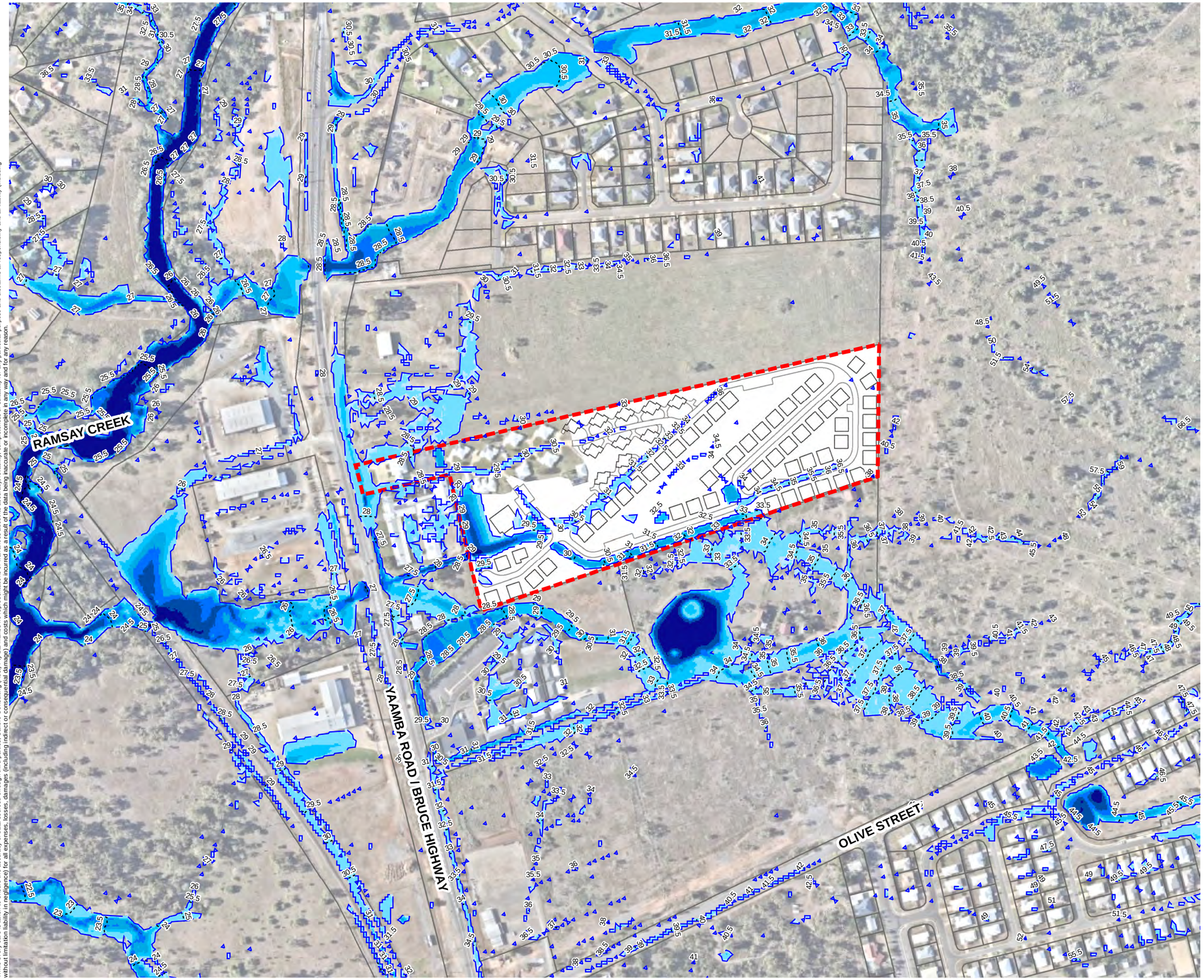
18% AEP STORM EVENT

MAX. FLOOD VELOCITY DIFFERENCE PLAN

DRAWING NO: **18-002864-D-005-E**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994 H:\18\002864 - 1014-1016 Yaamba Road Parkhurst\6_Model\SF\TUFLOW\DE\Results\E0\10p0_090m\010\2d\PP09102019\18-002864-D-010-A.mxd

calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOUR (m AHD)
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

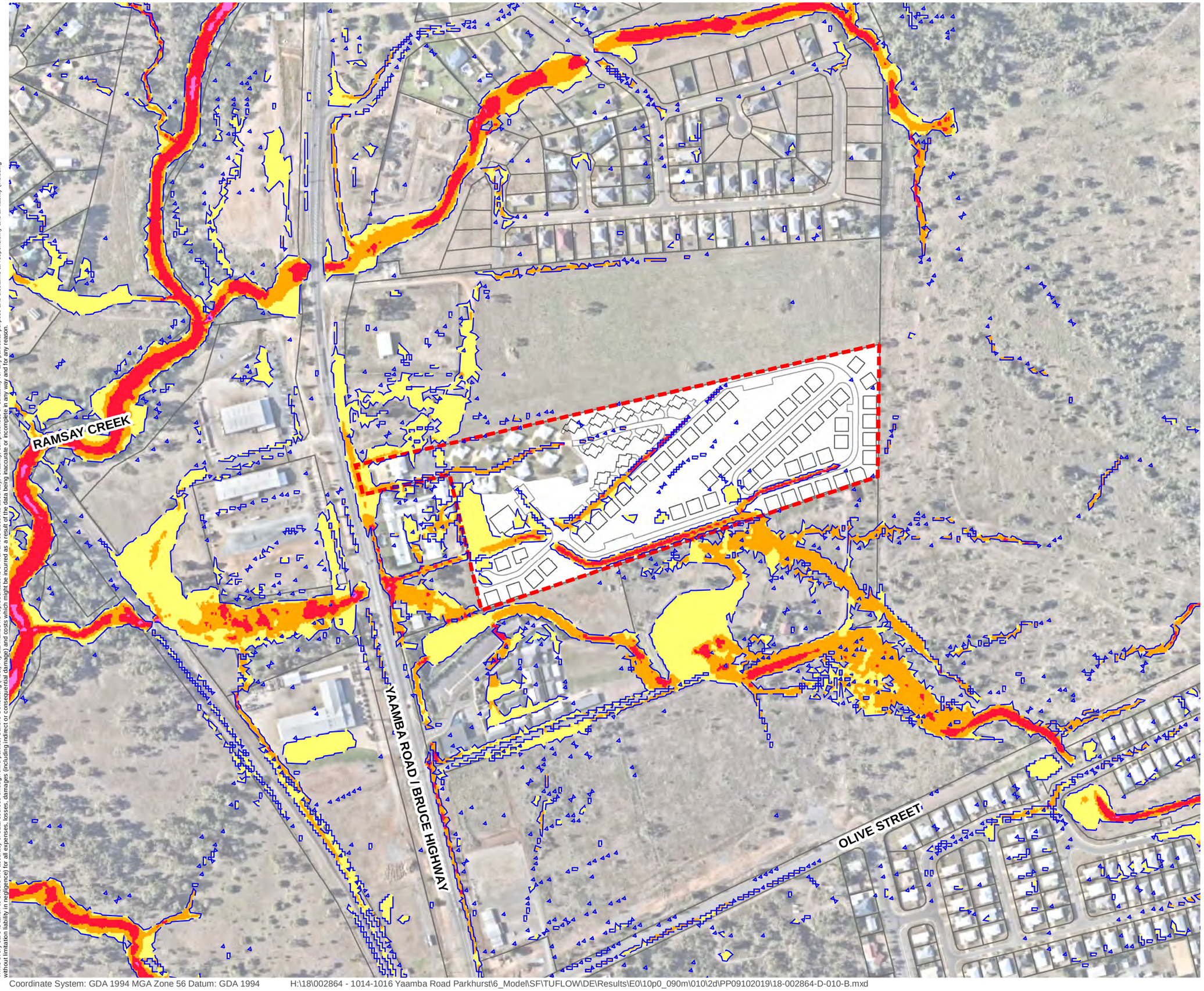
DEVELOPED SCENARIO

10% AEP STORM EVENT

MAX. FLOOD DEPTH PLAN

DRAWING NO: **18-002864-D-010-A** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

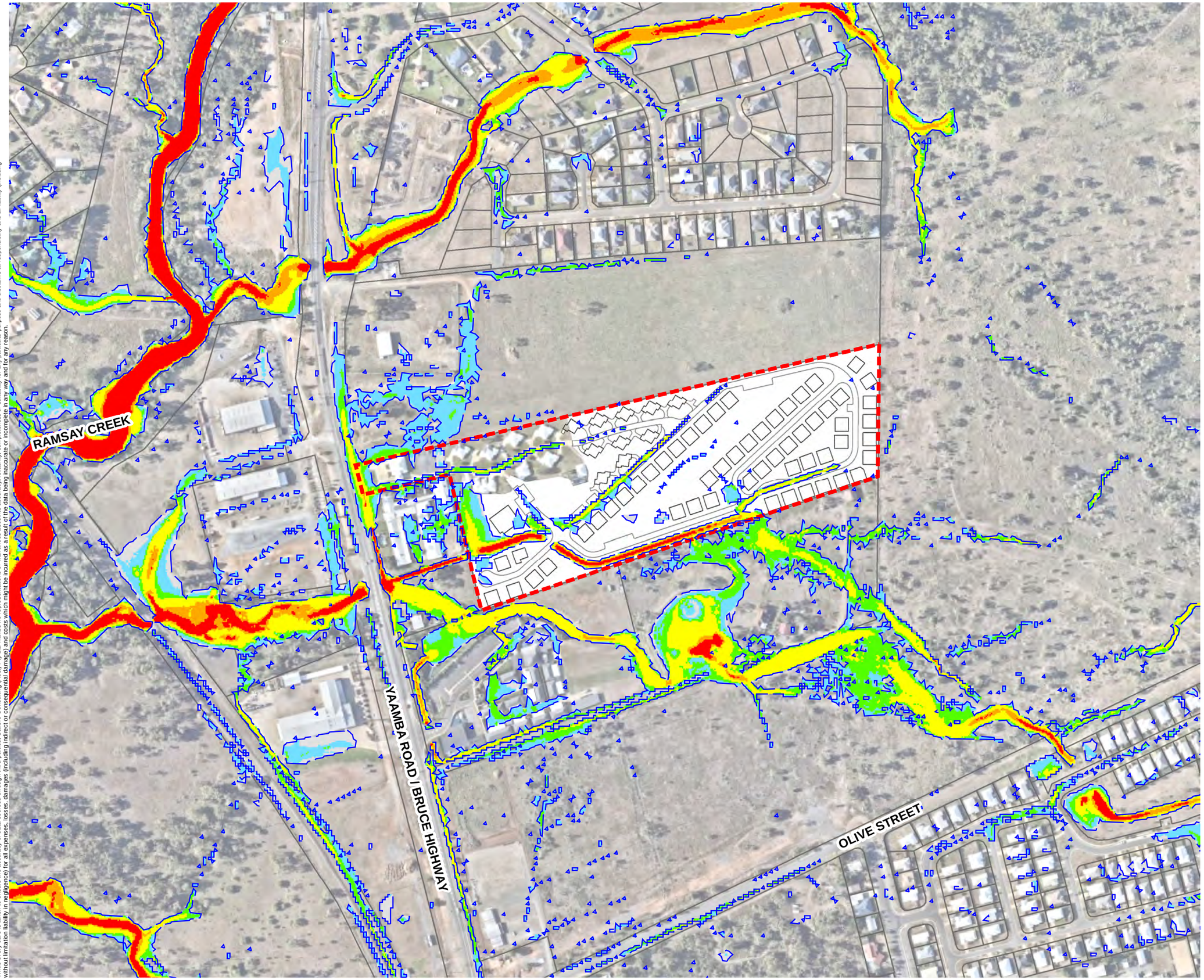
10% AEP STORM EVENT

MAX. FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-D-010-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

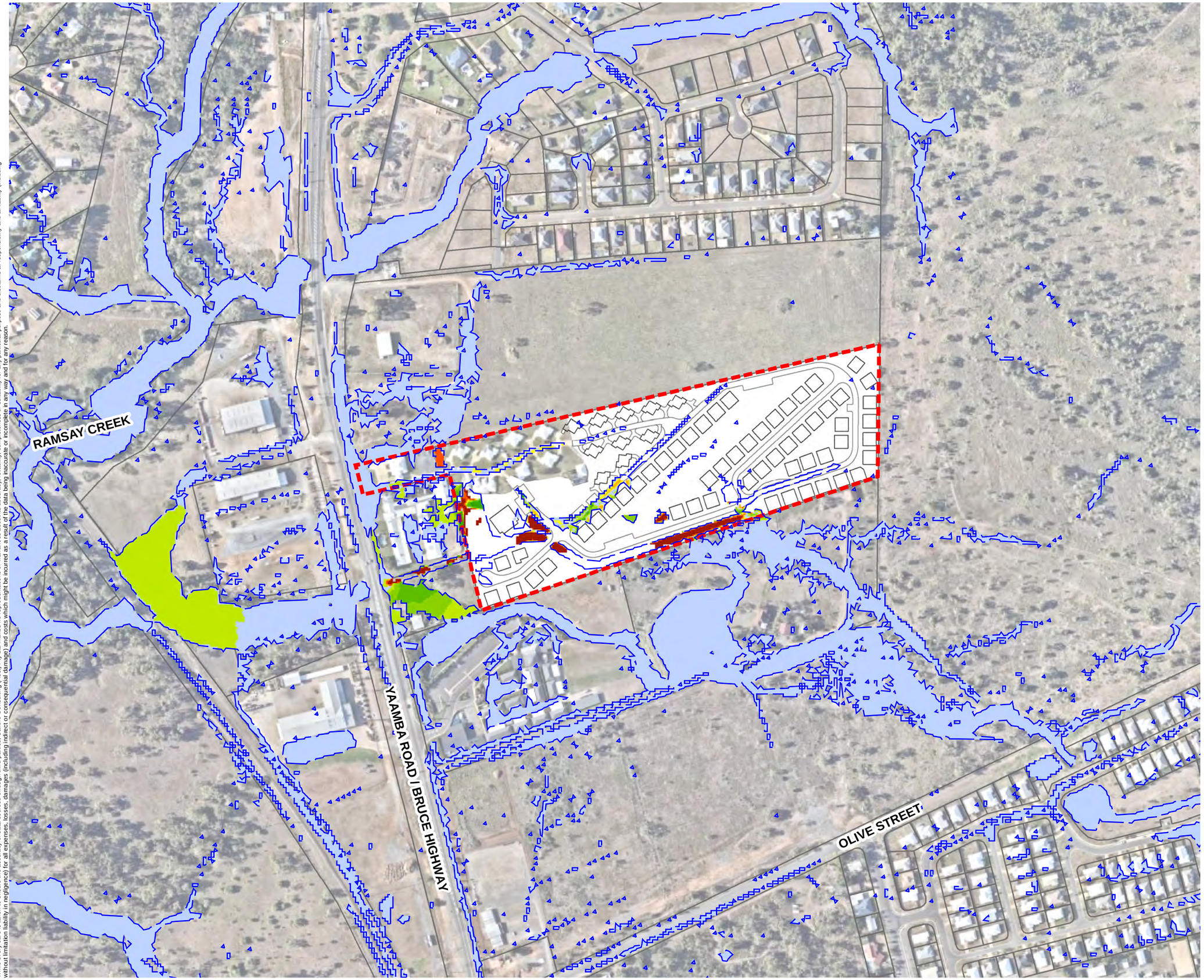
10% AEP STORM EVENT

MAX. FLOOD HAZARD PLAN

DRAWING NO: **18-002864-D-010-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994 H:\18\002864 - 1014-1016 Yaamba Road Parkhurst\6_Model\SF\TUFLOW\DE\Results\E0\10p0_090m\010\2d\PP09102019\18-002864-D-010-D.mxd

calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD LEVEL DIFFERENCE (m)

- < -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- > 0.2
- CADASTRE

NOTES:
1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m
1:4,000 (A3)

N

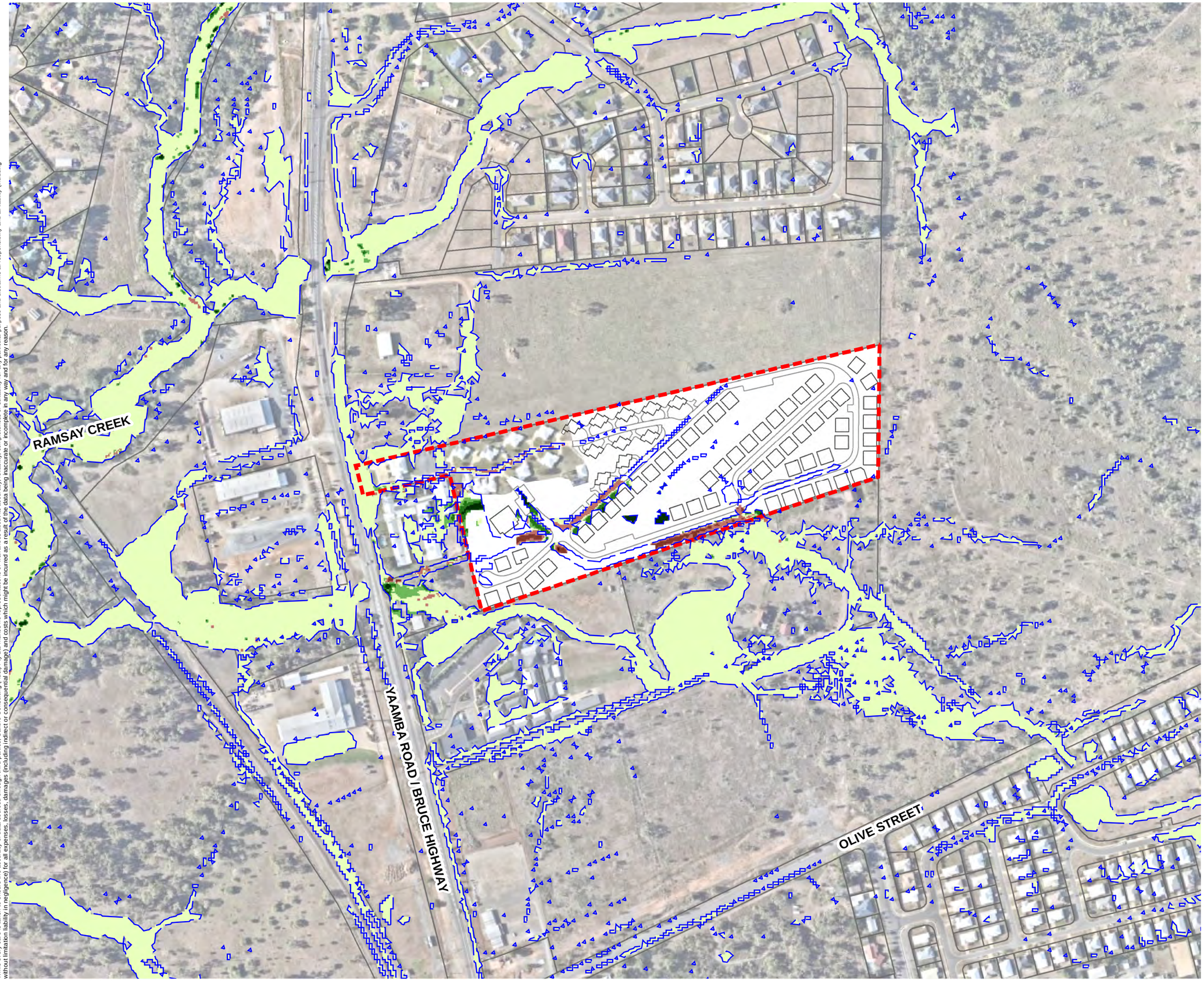
PROJECT:
1014-1016 YAAMBA ROAD PARKHURST

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
DEVELOPED SCENARIO
10% AEP STORM EVENT
MAX. FLOOD LEVEL DIFFERENCE PLAN

DRAWING NO: **18-002864-D-010-D** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994 H:\18\002864 - 1014-1016 Yaamba Road Parkhurst\6_Model\SF\TUFLOW\DE\Results\E0\10p0_090m\010\2d\PP09102019\18-002864-D-010-E.mxd

calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY DIFFERENCE (m/s)

- < -0.45
- -0.45 to -0.2
- -0.2 to -0.1
- -0.1 to 0.1
- 0.1 to 0.5
- 0.5 to 1
- > 1.0
- CADASTRE

NOTES:
1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m
1:4,000 (A3)
N

PROJECT:
1014-1016 YAAMBA ROAD PARKHURST

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
DEVELOPED SCENARIO
10% AEP STORM EVENT
MAX. FLOOD VELOCITY DIFFERENCE PLAN

DRAWING NO: **18-002864-D-010-E** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE

RAMSAY CREEK

YAAMBA ROAD / BRUCE HIGHWAY

OLIVE STREET

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOUR (m AHD)
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

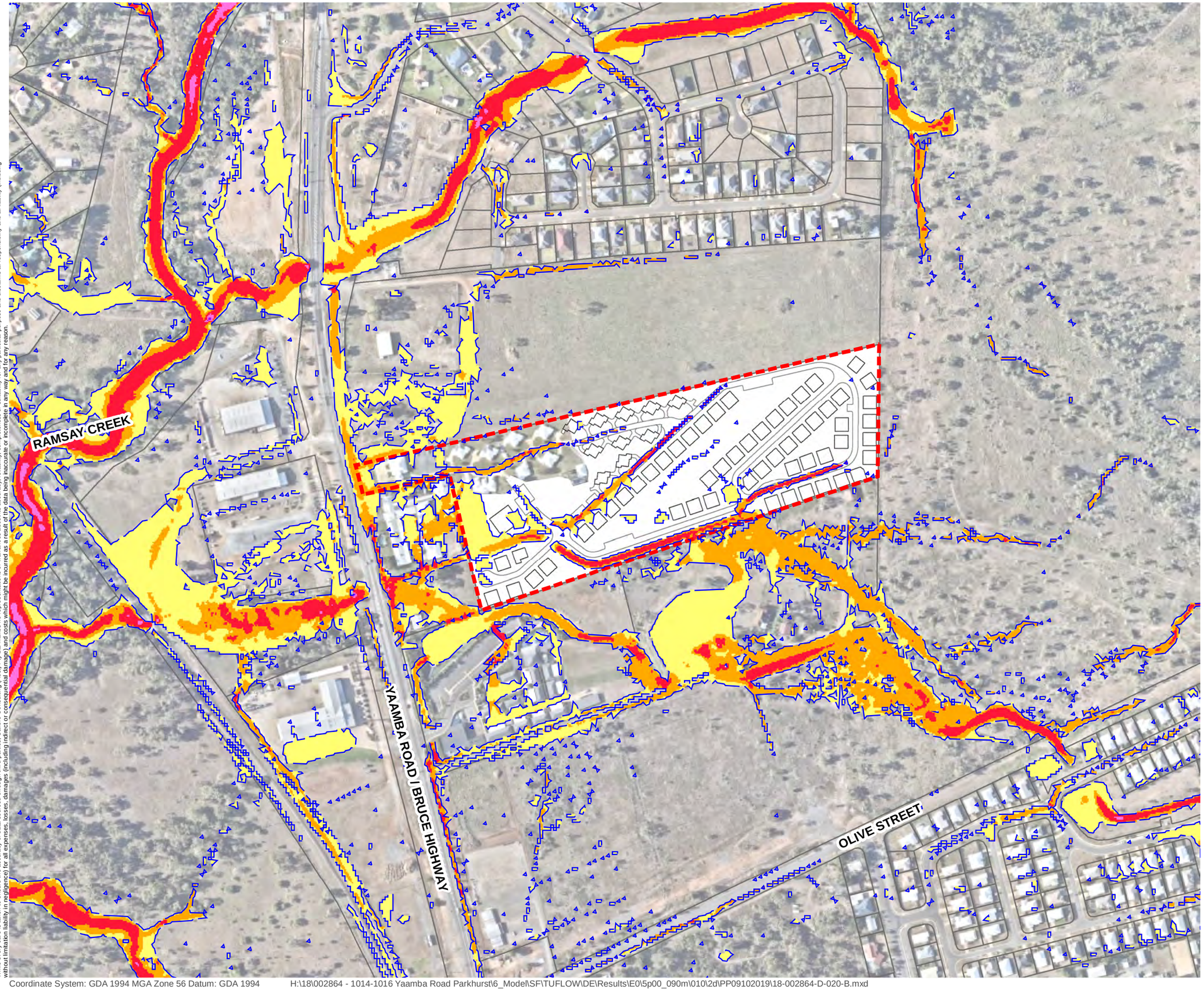
5% AEP STORM EVENT

MAX. FLOOD DEPTH PLAN

DRAWING NO: **18-002864-D-020-A**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994 H:\18\002864 - 1014-1016 Yaamba Road Parkhurst\6_Model\SF\TUFLOW\DE\Results\E0\5p00_090m\010\2d\PP09102019\18-002864-D-020-B.mxd

calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

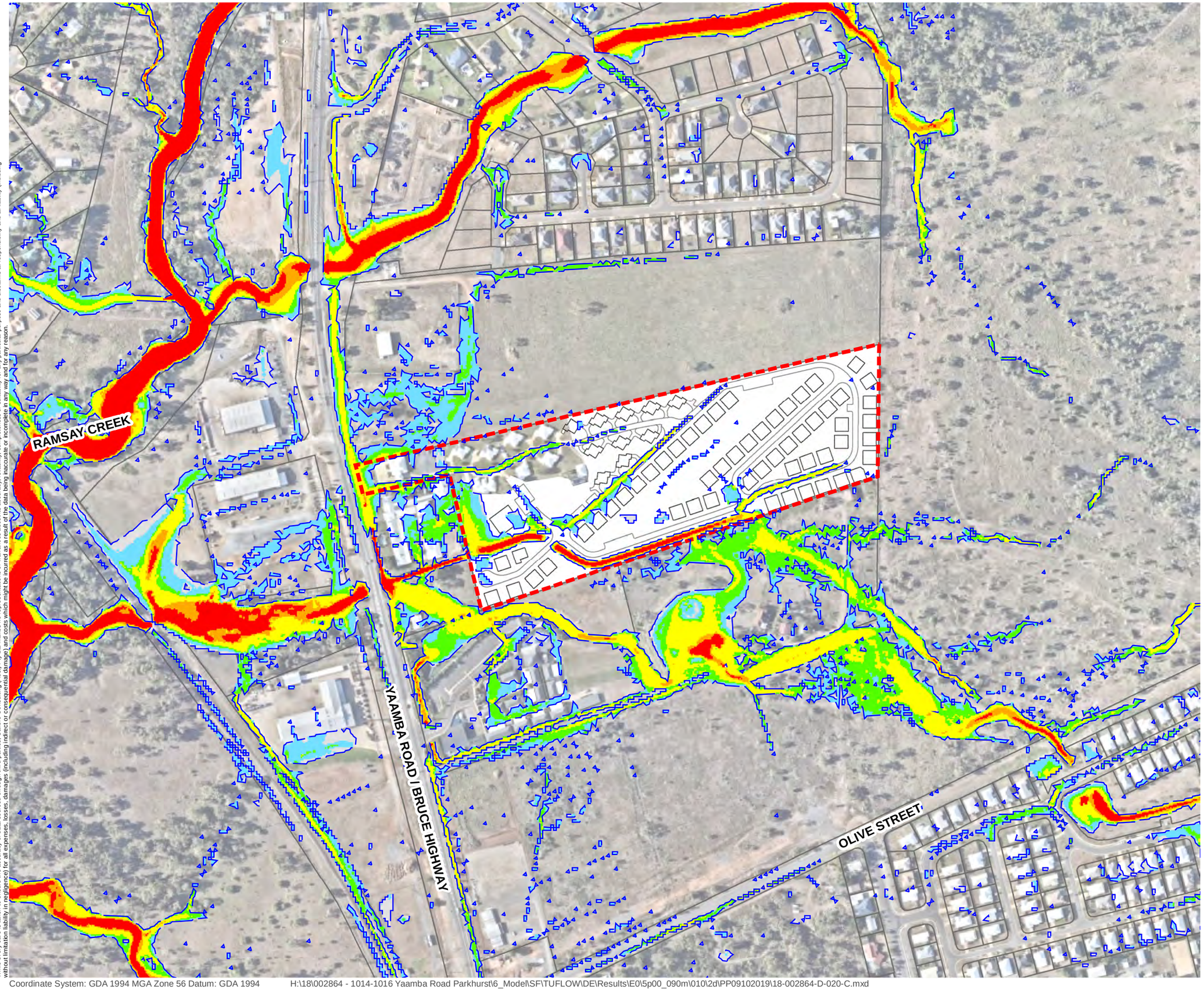
5% AEP STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-D-020-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

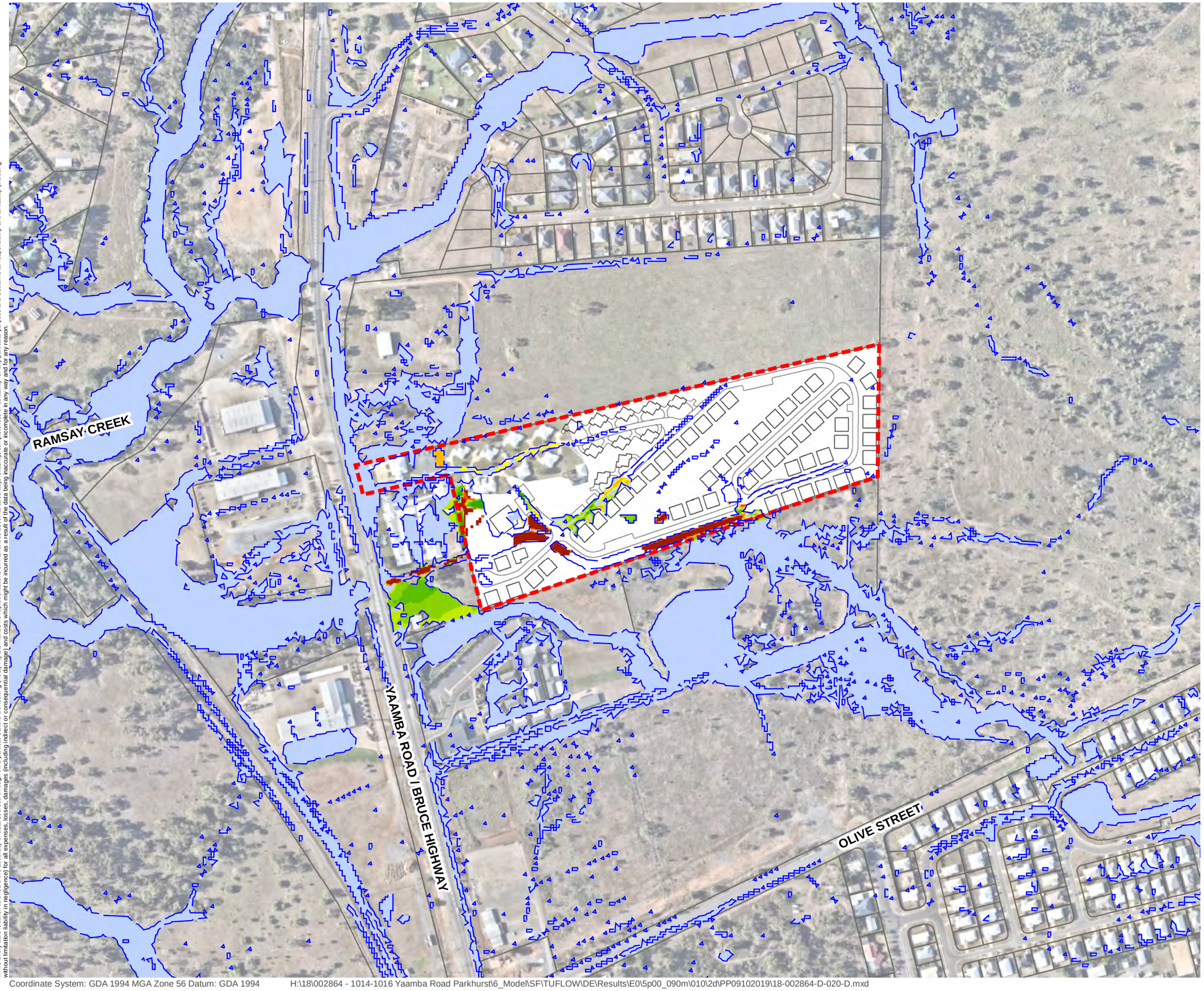
5% AEP STORM EVENT

MAX. FLOOD HAZARD PLAN

DRAWING NO: **18-002864-D-020-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD LEVEL DIFFERENCE (m)

- < -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- > 0.2
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

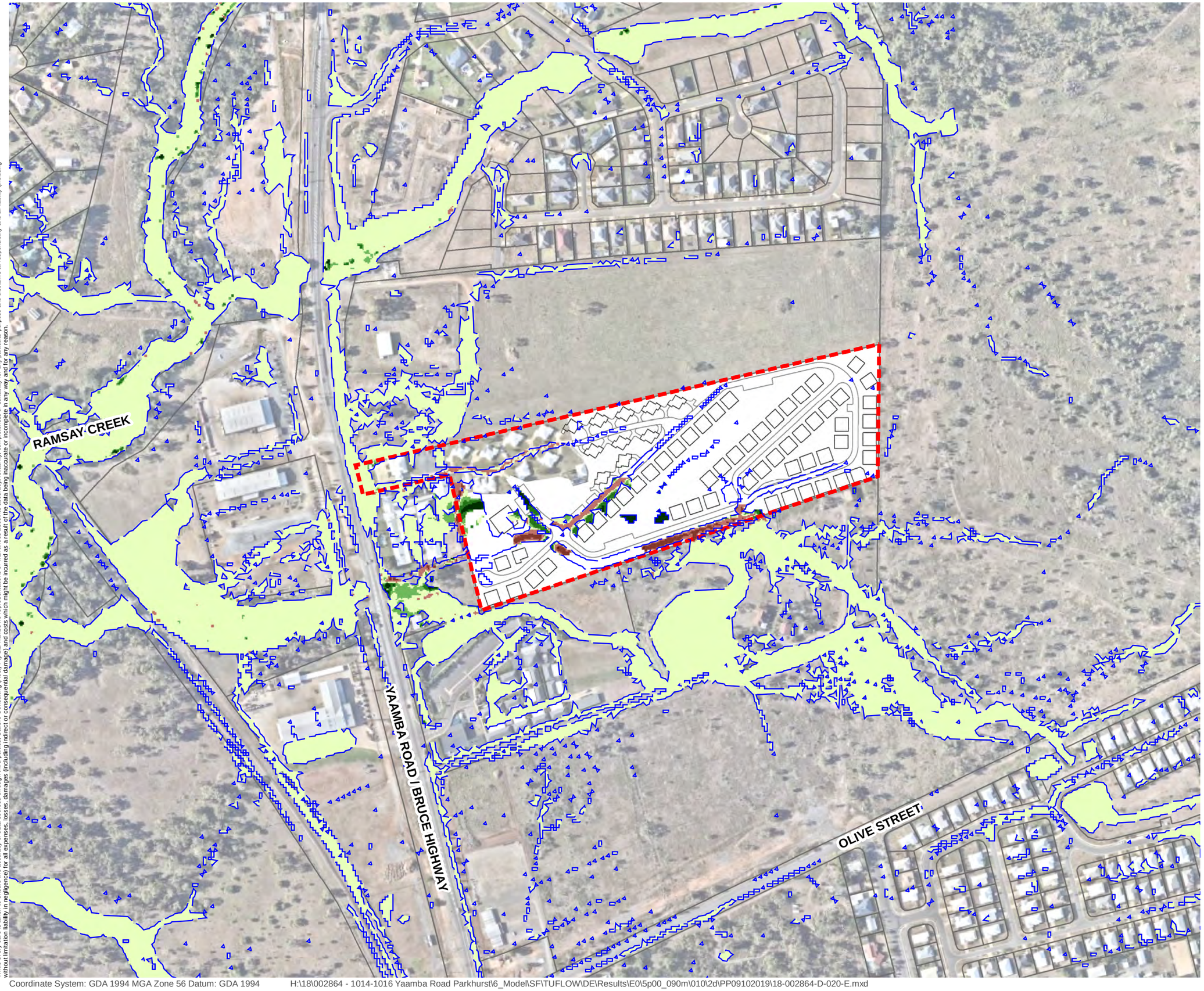
5% AEP STORM EVENT

MAX. FLOOD LEVEL DIFFERENCE PLAN

DRAWING NO: **18-002864-D-020-D**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY DIFFERENCE (m/s)

- < -0.45
- -0.45 to -0.2
- -0.2 to -0.1
- -0.1 to 0.1
- 0.1 to 0.5
- 0.5 to 1
- > 1.0
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

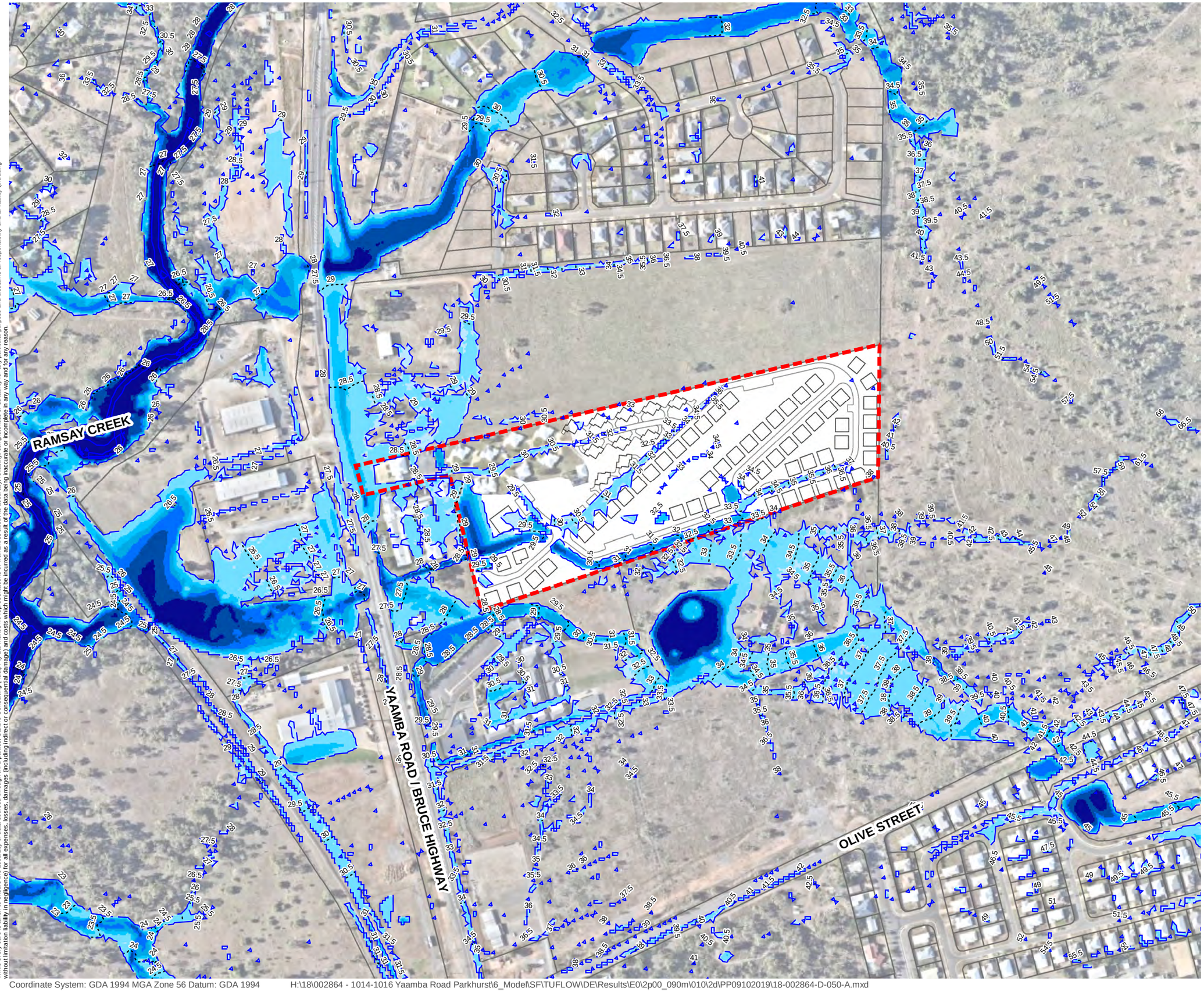
5% AEP STORM EVENT

MAX. FLOOD VELOCITY DIFFERENCE PLAN

DRAWING NO: **18-002864-D-020-E**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOUR (m AHD)
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD DEPTH (m)

- < 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

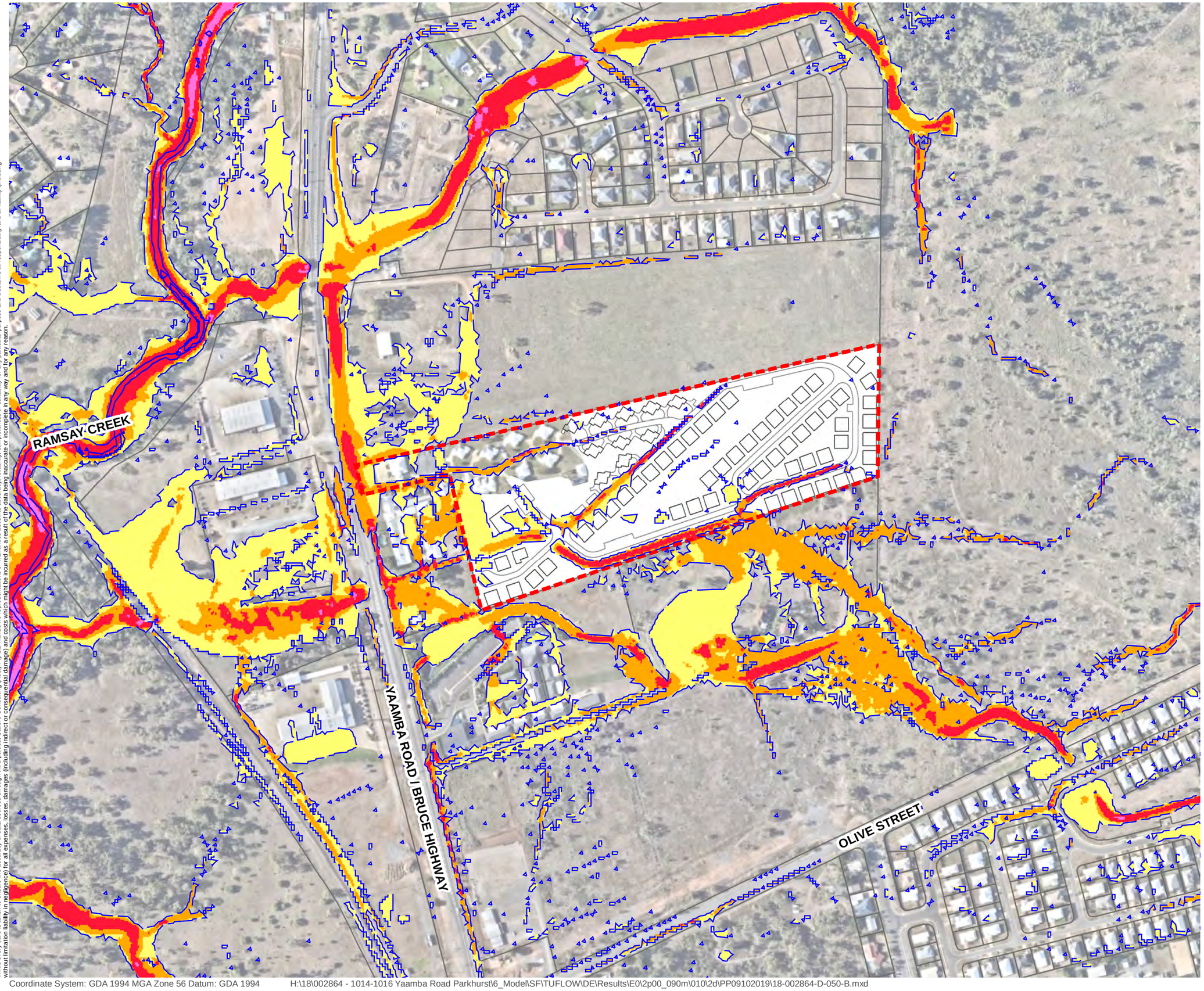
DEVELOPED SCENARIO

2% AEP STORM EVENT

MAX. FLOOD DEPTH PLAN

DRAWING NO: **18-002864-D-050-A** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

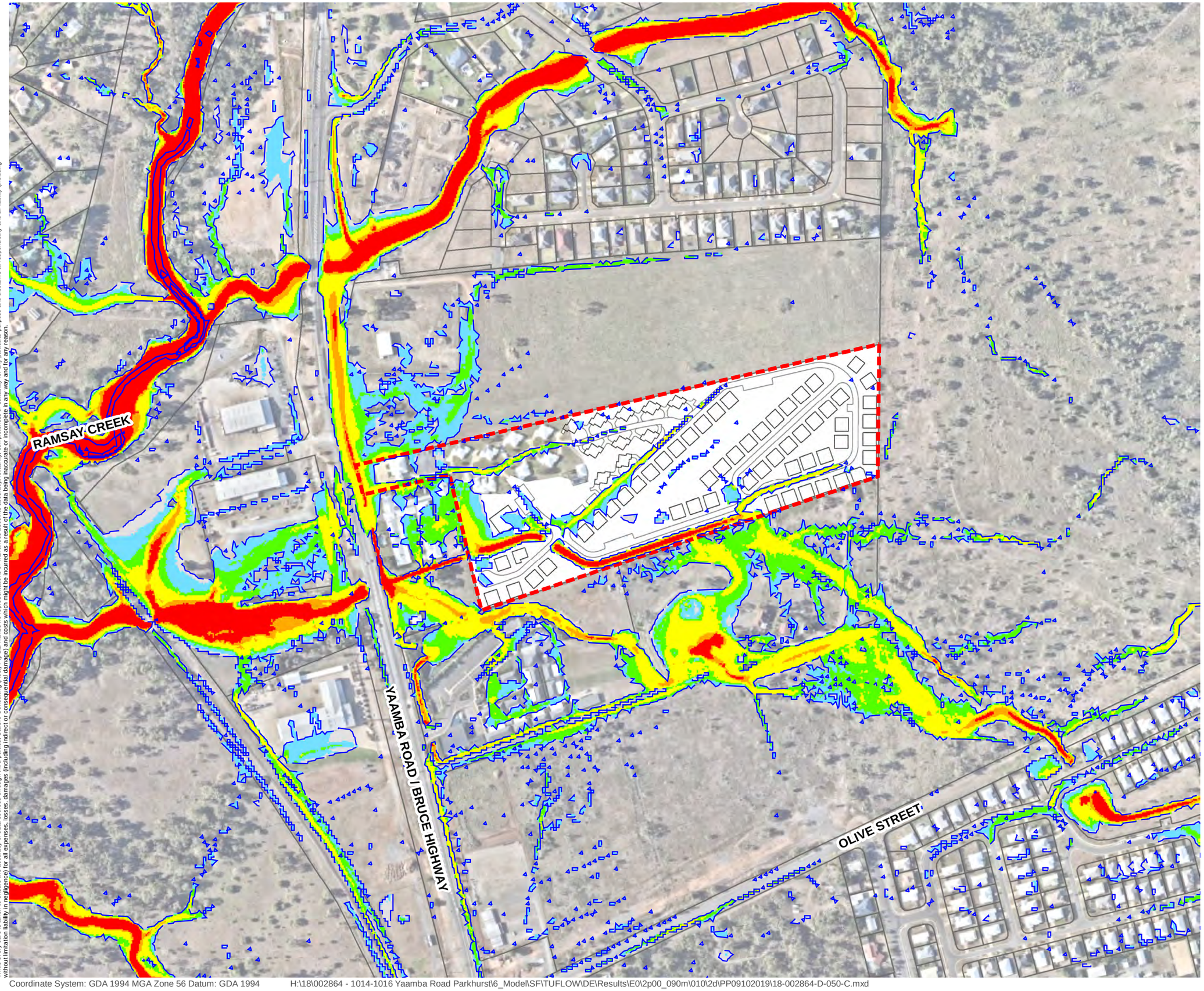
2% AEP STORM EVENT

MAX. FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-D-050-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

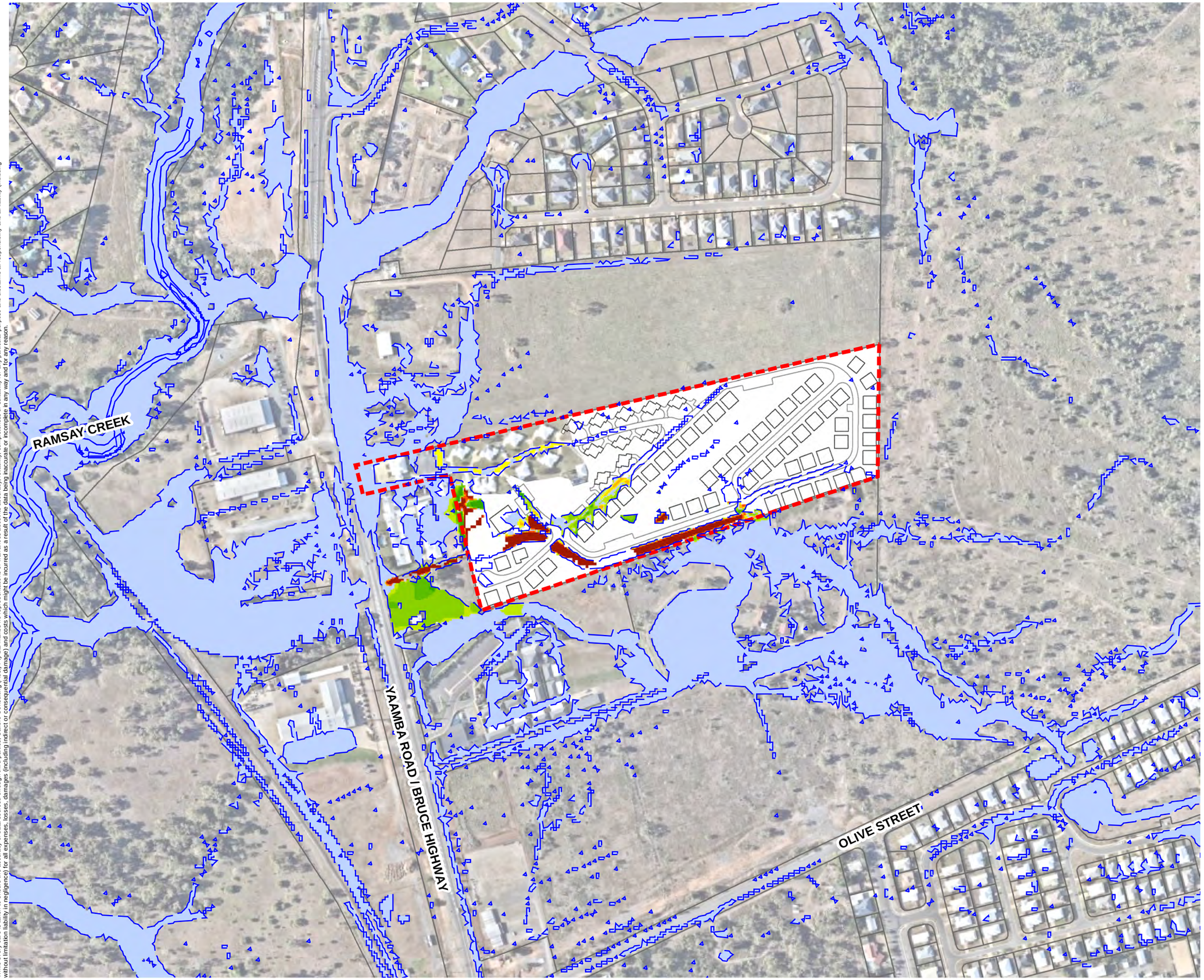
2% AEP STORM EVENT

MAX. FLOOD HAZARD PLAN

DRAWING NO: **18-002864-D-050-C**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD LEVEL DIFFERENCE (m)

- < -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- > 0.2
- CADASTRE

NOTES:
1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m
1:4,000 (A3)
N

PROJECT:
1014-1016 YAAMBA ROAD PARKHURST

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
DEVELOPED SCENARIO
2% AEP STORM EVENT
MAX. FLOOD LEVEL DIFFERENCE PLAN

DRAWING NO: **18-002864-D-050-D** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
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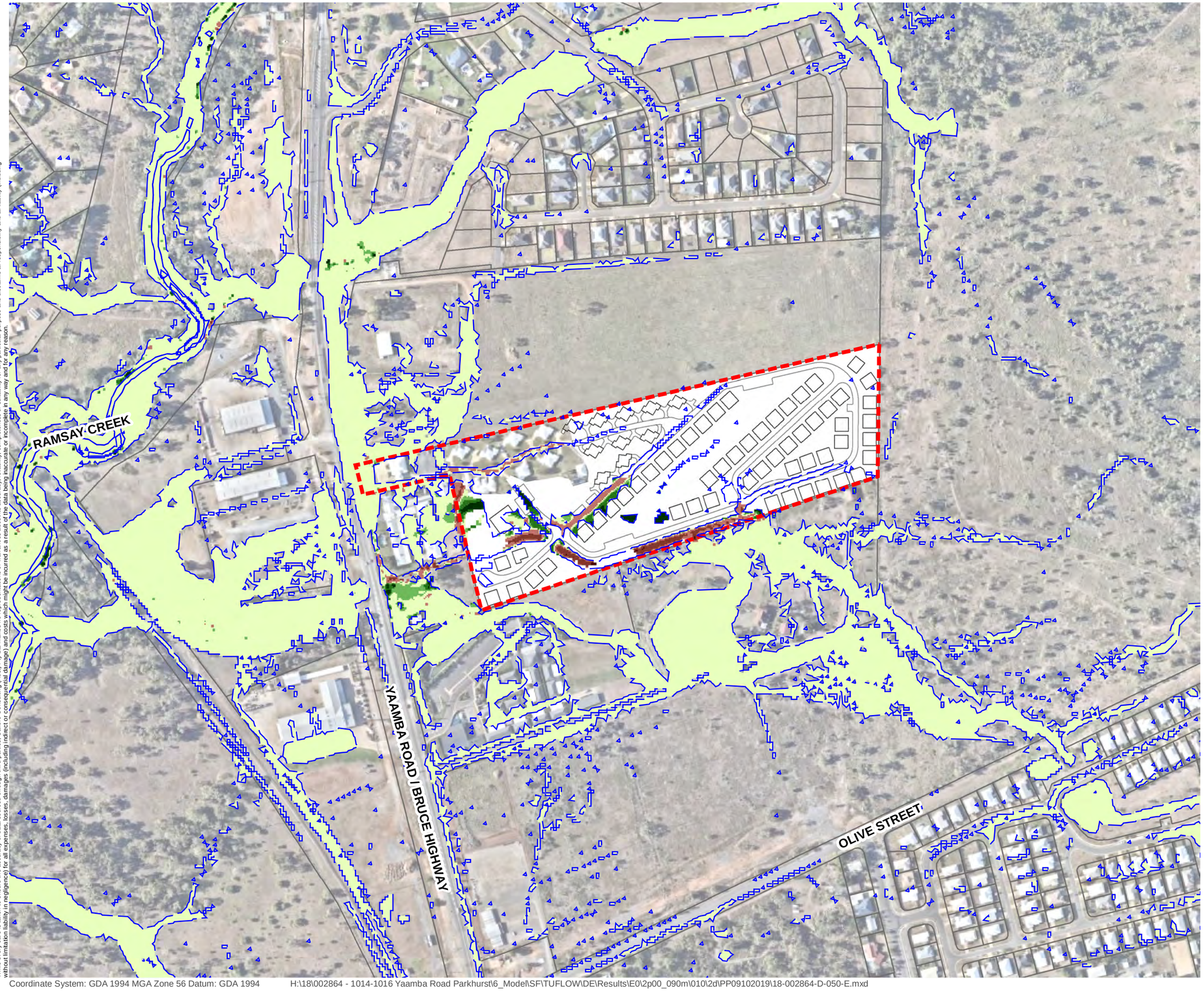

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY DIFFERENCE (m/s)

- < -0.45
- -0.45 to -0.2
- -0.2 to -0.1
- -0.1 to 0.1
- 0.1 to 0.5
- 0.5 to 1
- > 1.0
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

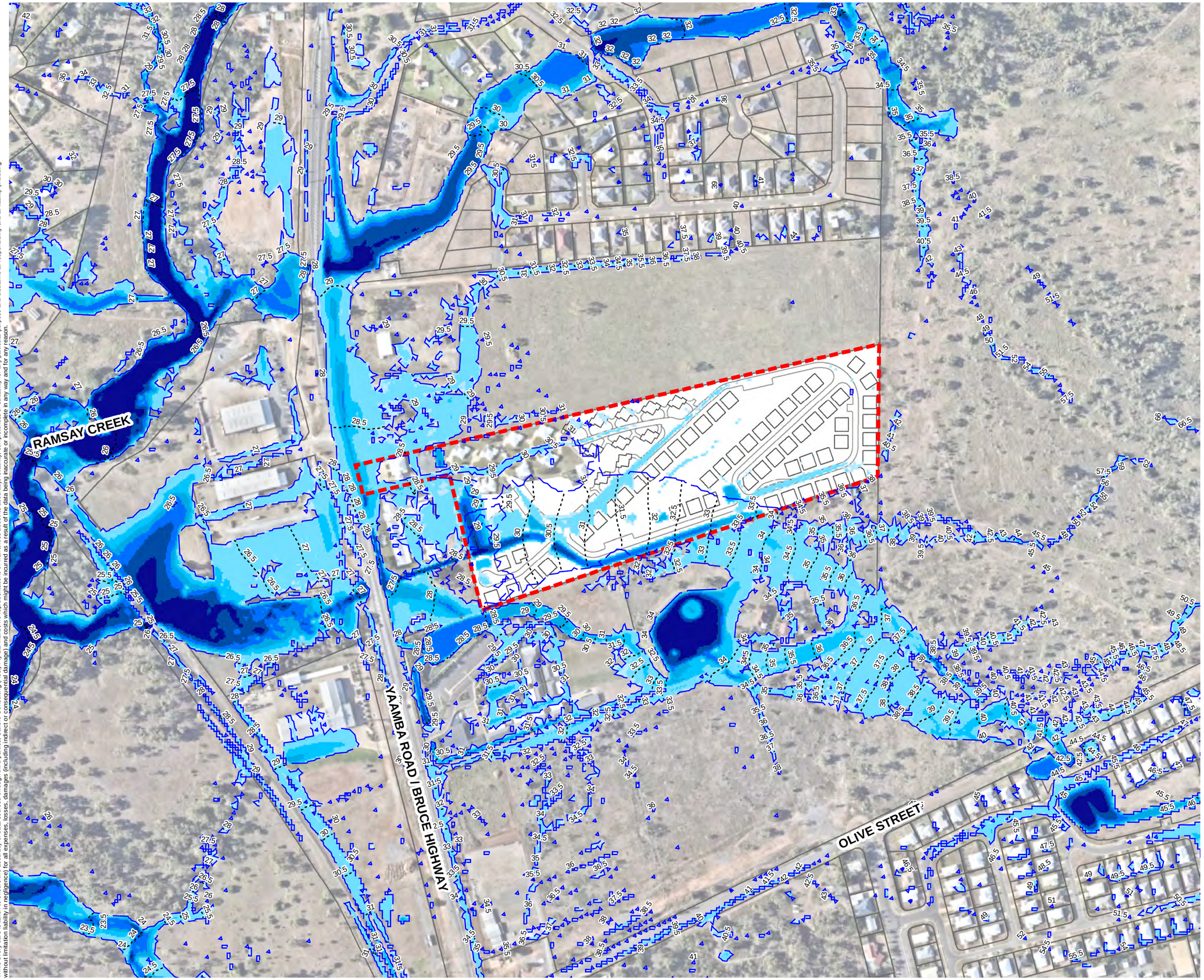
2% AEP STORM EVENT

MAX. FLOOD VELOCITY DIFFERENCE PLAN

DRAWING NO: **18-002864-D-050-E**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



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calibre

LEGEND

- FLOOD EXTENT
- FLOOD HEIGHT CONTOUR (m AHD)
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD DEPTH (m)

- > 0.05
- 0.05 to 0.1
- 0.1 to 0.3
- 0.3 to 0.5
- 0.5 to 0.7
- 0.7 to 1.0
- 1.0 to 1.5
- > 1.5
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

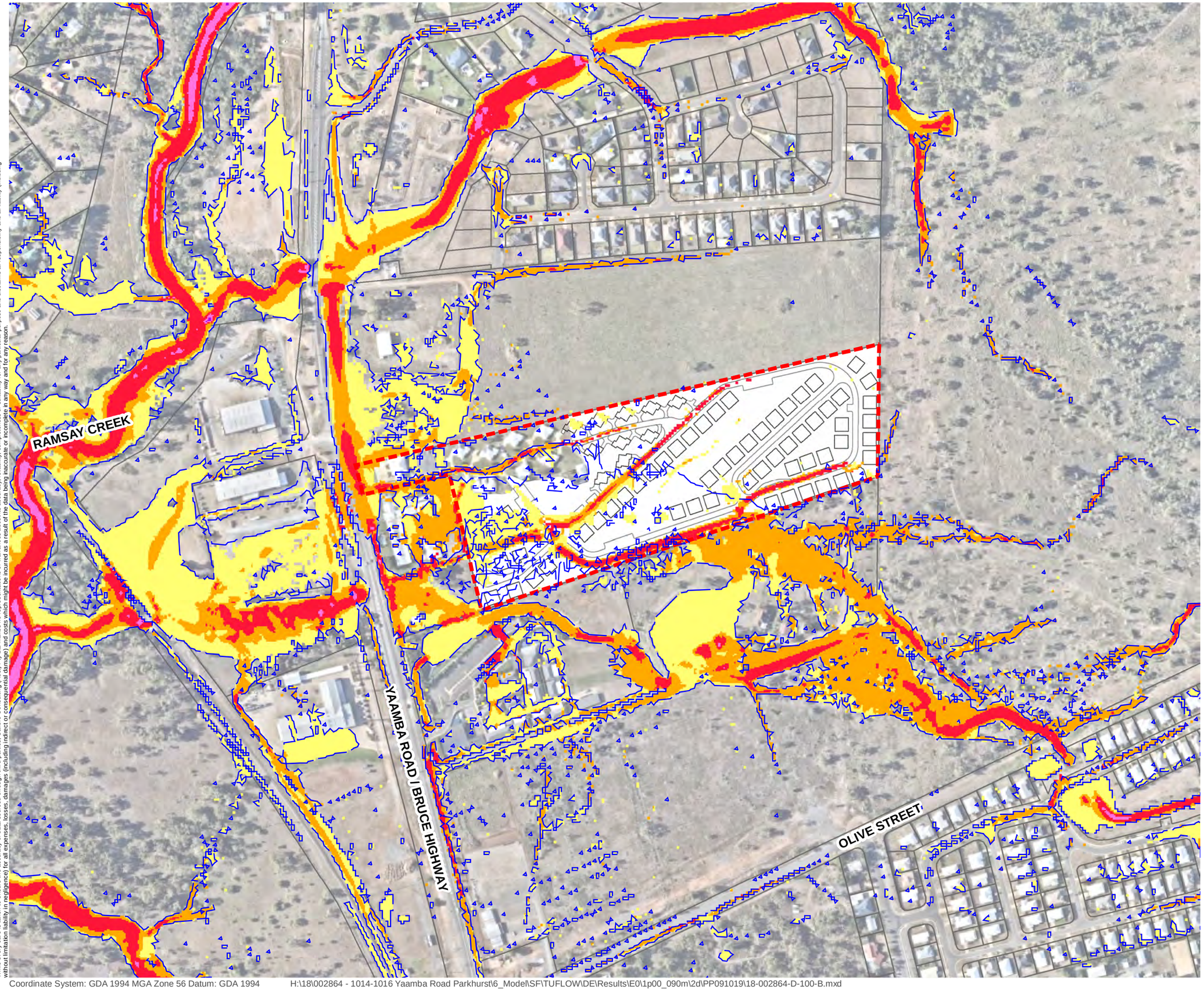
DEVELOPED SCENARIO

1% AEP STORM EVENT

MAX. FLOOD DEPTH PLAN

DRAWING NO: **18-002864-D-100-A** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY (m/s)

- 0 to 0.5
- 0.5 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4
- CADASTRE

NOTES:

1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m

1:4,000 (A3)

N

PROJECT:

1014-1016 YAAMBA ROAD PARKHURST

CLIENT:

G. & M. DEMEDIO

DRAWING TITLE:

DEVELOPED SCENARIO

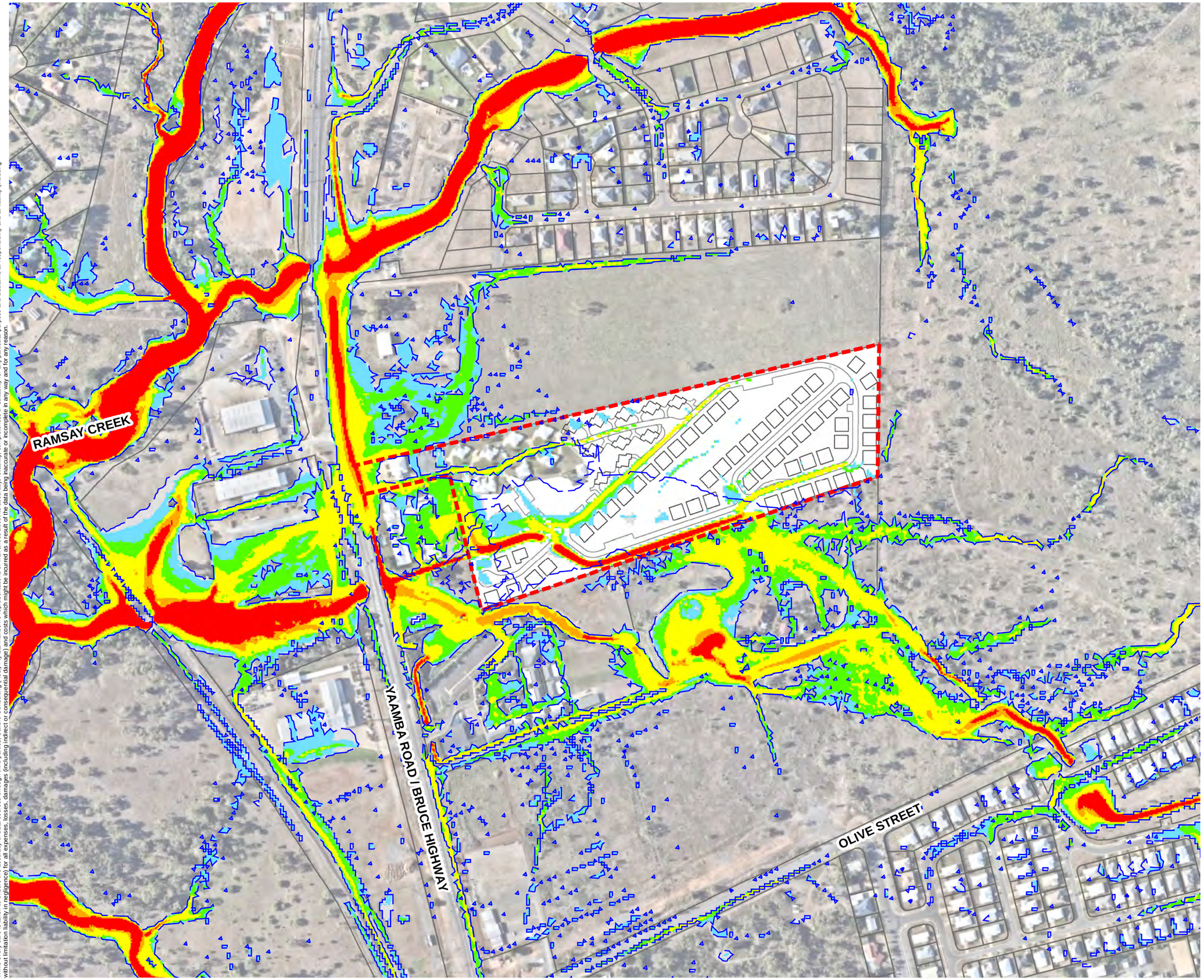
1% AEP STORM EVENT

MAX. FLOOD VELOCITY PLAN

DRAWING NO: **18-002864-D-100-B**

ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE



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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD HAZARD (m²/s)

- < 0.01
- 0.01 to 0.05
- 0.05 to 0.1
- 0.1 to 0.4
- 0.4 to 0.6
- > 0.6
- CADASTRE

NOTES:
1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m
1:4,000 (A3)
N

PROJECT:
1014-1016 YAAMBA ROAD PARKHURST

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
DEVELOPED SCENARIO
1% AEP STORM EVENT
MAX. FLOOD HAZARD PLAN

DRAWING NO: **18-002864-D-100-C** ISSUE: **A**

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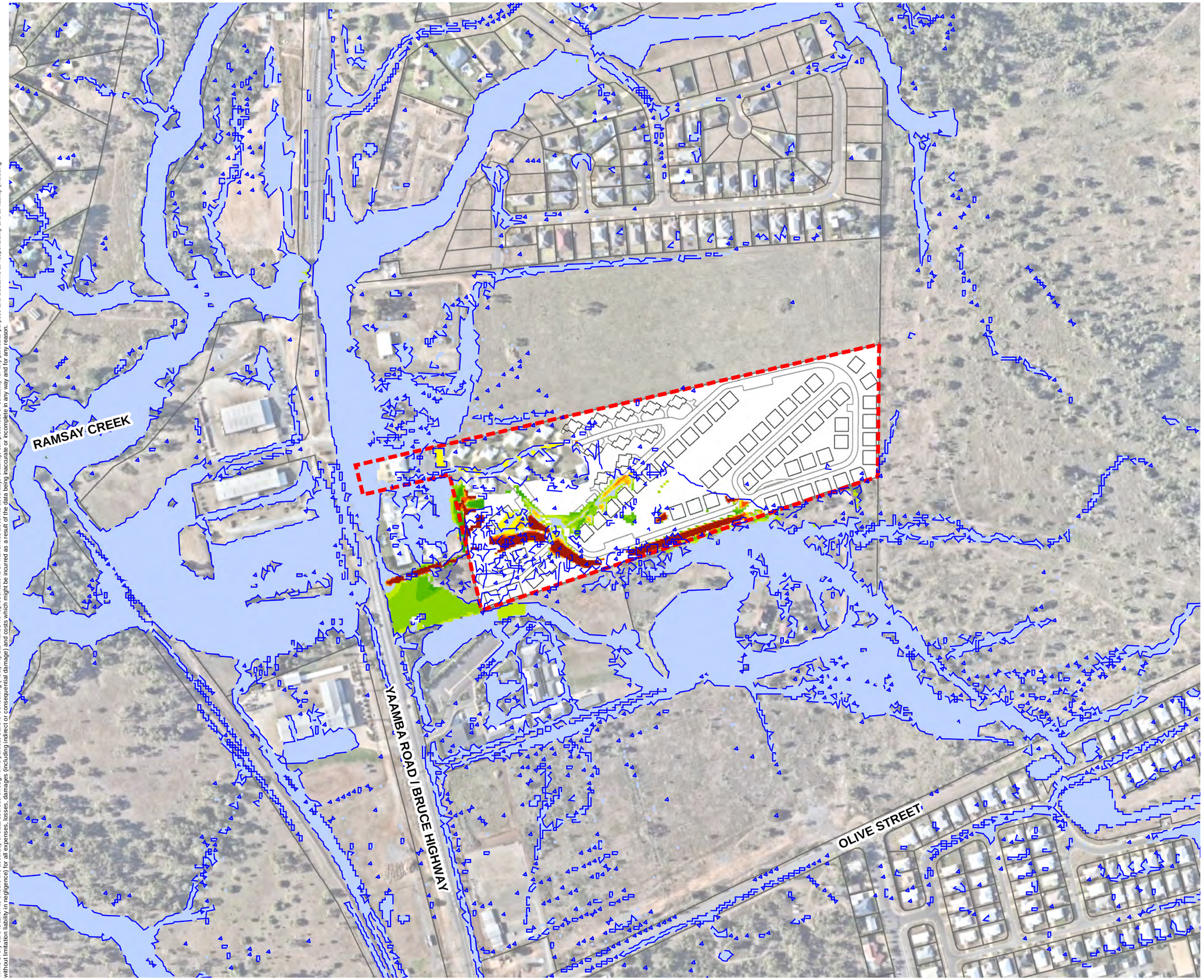

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD LEVEL DIFFERENCE (m)

- < -0.2
- -0.2 to -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- > 0.2
- CADASTRE

NOTES:
1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m
1:4,000 (A3)
N

PROJECT:
1014-1016 YAAMBA ROAD PARKHURST

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
DEVELOPED SCENARIO
1% AEP STORM EVENT
MAX. FLOOD LEVEL DIFFERENCE PLAN

DRAWING NO: **18-002864-D-100-D**
ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
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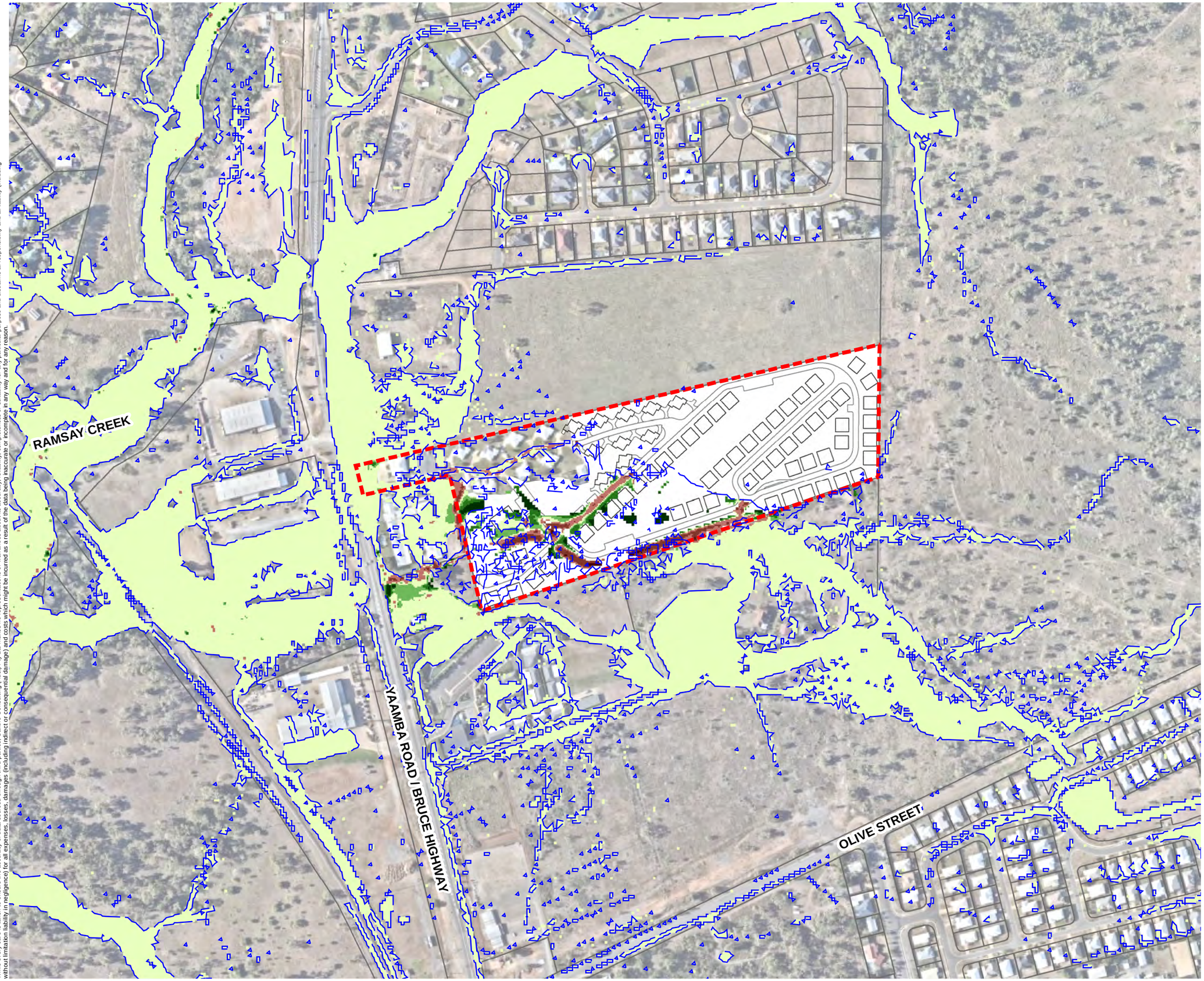

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calibre

LEGEND

- FLOOD EXTENT
- SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT

MAX. FLOOD VELOCITY DIFFERENCE (m/s)

- < -0.45
- -0.45 to -0.2
- -0.2 to -0.1
- -0.1 to 0.1
- 0.1 to 0.5
- 0.5 to 1
- > 1.0
- CADASTRE

NOTES:
1. RESULTS PRESENTED ARE FOR THE MAXIMUM OF THE STANDARD DURATIONS FROM 60MIN TO 180 MIN.

2. REFER TO LATEST VERSION OF CALIBRE CONSULTING REPORT NO. 18-002864-CSMP01A.

0 40 80 160 m
1:4,000 (A3)
N

PROJECT:
1014-1016 YAAMBA ROAD PARKHURST

CLIENT:
G. & M. DEMEDIO

DRAWING TITLE:
DEVELOPED SCENARIO
1% AEP STORM EVENT
MAX. FLOOD VELOCITY DIFFERENCE PLAN

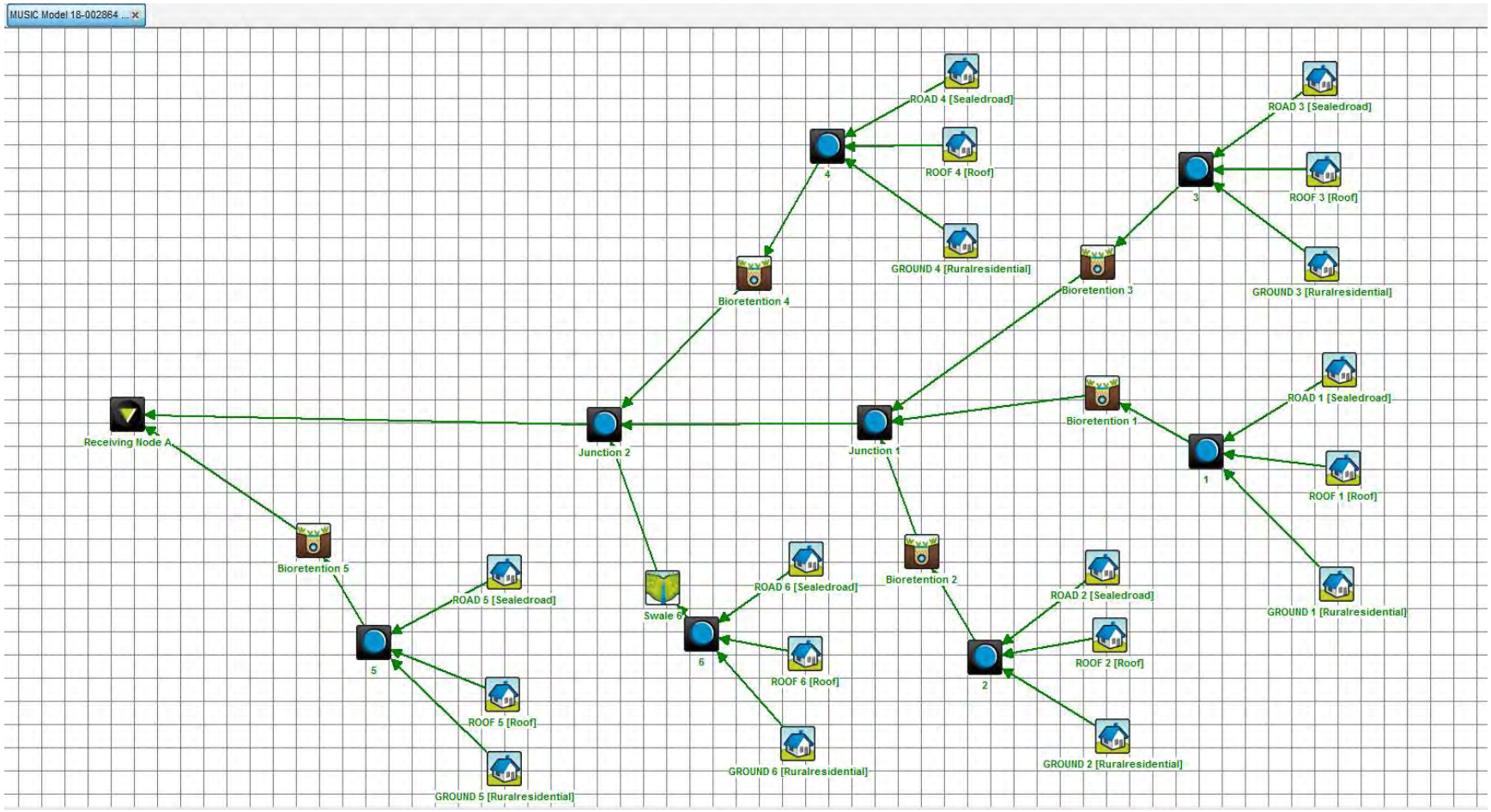
DRAWING NO: **18-002864-D-100-E** ISSUE: **A**

ISS	BY	CHK	DATE	DETAILS
A	AA	MS	09.10.19	INITIAL ISSUE

CONCEPT STORMWATER MANAGEMENT PLAN AND FLOOD IMPACT ASSESSMENT REPORT

Appendix D MUSIC Model and Results

G. & M. DEMEDIO C/- RUFUS DESIGN GROUP



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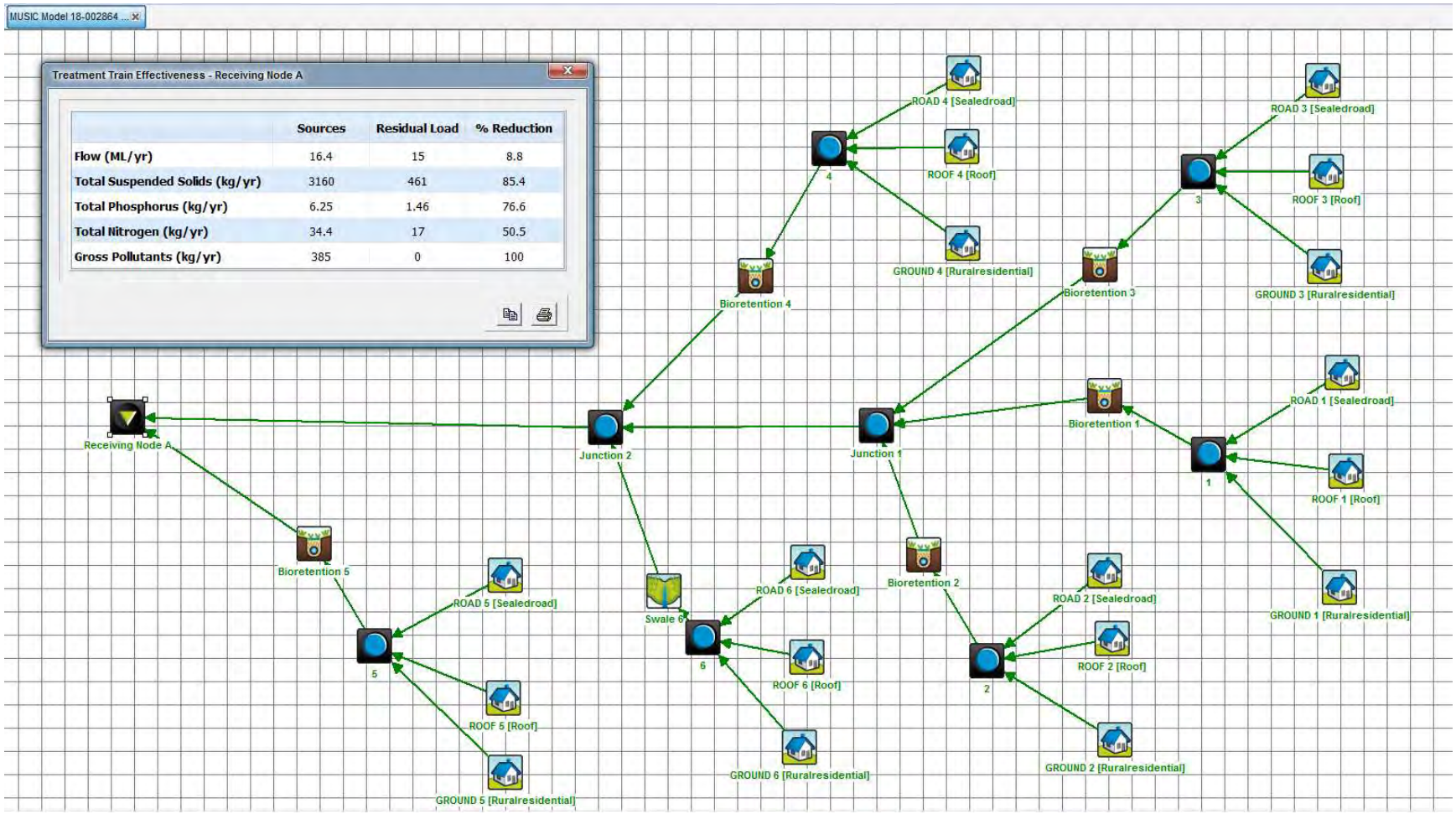
MUSIC Model 18-002864 ...
Treatment Train Effectiveness - Receiving Node A
Sources
Residual Load
% Reduction
Flow (ML/yr) 16.4 15 8.8
Total Suspended Solids (kg/yr) 3160 461 85.4
Total Phosphorus (kg/yr) 6.25 1.46 76.6
Total Nitrogen (kg/yr) 34.4 17 50.5
Gross Pollutants (kg/yr) 385 0 100
ROAD 4 [Sealedroad]
ROOF 4 [Roof]
GROUND 4 [Ruralresidential]
4
Bioretention 4
ROAD 3 [Sealedroad]
ROOF 3 [Roof]
GROUND 3 [Ruralresidential]
3
Bioretention 3
Receiving Node A
Junction 2
Junction 1
Bioretention 1
ROAD 1 [Sealedroad]
ROOF 1 [Roof]
GROUND 1 [Ruralresidential]
1
Bioretention 5
ROAD 5 [Sealedroad]
ROOF 5 [Roof]
GROUND 5 [Ruralresidential]
5
Swale 6
ROAD 6 [Sealedroad]
ROOF 6 [Roof]
GROUND 6 [Ruralresidential]
6
Bioretention 2
ROAD 2 [Sealedroad]
ROOF 2 [Roof]
GROUND 2 [Ruralresidential]
2

CONCEPT STORMWATER MANAGEMENT PLAN AND FLOOD IMPACT ASSESSMENT REPORT

Appendix E Bioretention Maintenance Guidelines and Check List

G. & M. DEMEDIO C/- RUFUS DESIGN GROUP

Bioretention Basin Inspection & Maintenance Requirements

Treatment Device / Property	Inspection	Inspection Frequency	Maintenance
Bioretention Basin			
Litter & Weeds	Visually check for litter, weeds and debris within the Bioretention Basin.	Quarterly for first year then every six months after establishment. Also after significant storm events.*	Remove litter, weeds and debris from the basin and dispose of at approved waste disposal facility.
Inlet and Outlet	Visually check for blockages within the upstream and downstream inlet pits. Check for locked weep holes within the upstream pit.		Remove any blockages or debris within inlet pits or blockages to weep holes.
Sedimentation	Visually check surface of Bioretention Basin for accumulation of sediment.		If sediment build-up is observed, remove accumulated sediment where it is smothering vegetation.
Scour, Erosion and Vehicle Damage	Visually check Bioretention Basin surface for scouring and areas of erosion or vehicle damage.		Repair damage to Bioretention Basin surface and filter media if exposed. Undertake replanting if necessary and maintain watering of area until vegetation has established.
Vegetation	Visually check for any planted vegetation that has died.	Quarterly for first year then every six months after establishment.	Remove dead vegetation and replace with stock of equivalent size and species as detailed in plant schedule. Maintain watering until new vegetation has established.
Filter Media	Check surface of Bioretention Basin for any isolated "boggy" areas.	Every six months.	Increase infiltration rate by tilling the surface of the filter media.
	Visually check and determine time of ponding within basin after a storm event.*	During wetter periods.	If duration of ponding exceeds 48 hours, trial tilling of the surface of the filter media. If no improvement occurs then dispose and replace the top 100 to 150mm layer of filter media (below is the detailed procedure): i. Remove vegetation and store for replanting. ii. Remove top 150mm of filter media and dispose of in an approved manner. iii. Till the remaining filter media to a further depth of 300mm. iv. Place a new layer of appropriate filter media; v. Replant removed vegetation
Subsoil Drainage	Check subsoil drainage for blockages. This is subject to earlier stages of inspection. To discover blockage, flush subsoil drain from the upstream inspection opening. If there is no evidence of a blockage, no further action is required.	Subject to earlier stage of inspection.	If blockage is discovered remove by flushing out the subsoil drainage pipe. Below is an outline of the procedure i. Set up a pump and an appropriate collection device (i.e. a sandbag) at the downstream pipe. ii. Draw outflow through pipe, not allowing any sediment/silt to enter the downstream stormwater drainage system. iii. Collect and dispose flushed material appropriately.

* Significant Rain Event defined as a 24 hour period with rainfall greater than 200mm, or shorter period with an average rainfall intensity greater than 20mm/hour.

BIORETENTION BASIN INSPECTION & MAINTENANCE CHECKLIST

SQID:	
Location:	
Date:	
Time:	
Inspector:	
Weather Conditions	

	Condition Acceptable			
Maintenance Item	**Yes**	**No**	**N/A**	**Comments**
1. Basin Surface				
Clear of sediment build-up				
Check for erosion, scour, vehicle & other damage				
Check for dead or damaged vegetation				
2. Filter Media				
Check for erosion, scour, vehicle & other damage				
Check for isolated boggy patches				
3. Subsoil Drainage				
Visually check subsoil drainage through cleanout inspection openings for build-up of sediment				
Check for blockages to subsoil drainage using other methods (eg. CCTV or flush-out)				
Additional Comments				
Actions to be taken				

GUIDELINES FOR FILTER MEDIA IN BIOFILTRATION SYSTEMS (Version 3.01) June 2009

The following guidelines for filter media in biofiltration systems have been prepared on behalf of the Facility for Advancing Water Biofiltration (FAWB) to assist in the development of biofiltration systems, including the planning, design, construction and operation of those systems.

NOTE: This is a revision of the previous FAWB guideline specifications (published in 2006 (Version 1.01), 2008 (Version 2.01)). It attempts to provide a simpler and more robust guideline for both soil-based and engineered filter media. FAWB acknowledges the contribution of EDAW Inc., Melbourne Water Corporation, Dr Nicholas Somes (Ecodynamics), Alan Hoban (South East Queensland Healthy Waterways Partnership), Shaun Leinster (DesignFlow) and STORM Consulting to the preparation of the revised guidelines.

1 GENERAL DESCRIPTION

The biofiltration filter media guidelines require three layers of media: the filter media itself (400-600 mm deep or as specified in the engineering design), a transition layer (100 mm deep), and a drainage layer (50 mm minimum cover over underdrainage pipe). The biofiltration system will operate so that water will infiltrate into the filter media and move vertically down through the profile.

The filter media is required to support a range of vegetation types (from groundcovers to trees) that are adapted to freely draining soils with occasional wetting. The material should be based on **natural or amended natural soils** or it can be **entirely engineered**; in either case, it can be of siliceous or calcareous origin. In general, the media should have an appropriately high permeability under compaction and should be free of rubbish, deleterious material, toxicants, declared plants and local weeds (as listed in local guidelines/Acts), and should not be hydrophobic. The filter media should contain some organic matter for increased water holding capacity but be low in nutrient content. In the case of natural or amended natural soils, the media should be a **loamy sand**.

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Maintaining an adequate infiltration capacity is crucial in ensuring the long-term treatment efficiency of the system. The ability of a biofiltration system to detain and infiltrate incoming stormwater is a function of the filter surface area, extended detention (ponding) depth, and the hydraulic conductivity of the filter media (Figure 1). Most importantly, design of a biofiltration system should optimize the combination of these three design elements.

For a biofiltration system in a temperate climate with an extended detention depth of 100 – 300 mm and whose surface area is approximately 2% of the connected impervious area of the contributing catchment, the prescribed hydraulic conductivity will generally be between 100 – 300 mm/hr in order to meet best practice targets (Figure 2). This configuration supports plant growth without requiring too much land space. In warm, humid (sub- and dry- tropical) regions the hydraulic conductivity may need to be higher in order to achieve the required treatment performance using the same land space (i.e., ensuring that the proportion of water treated through the media meets requirements).

Where one of these design elements falls outside the recommended range, the infiltration capacity can still be maintained by offsetting another of the design elements. For example, a filter media with a lower hydraulic conductivity may be used, but the surface area or the extended detention depth would need to be increased in order to maintain the treatment capacity. Similarly, if the available land were the limiting design element, the system could still treat the same size storm if a filter media with a higher hydraulic conductivity were installed. Where a hydraulic conductivity greater than 300 mm/hr is prescribed, potential issues such as higher watering requirements during the establishment should be considered. Biofiltration systems with a hydraulic conductivity greater than 600 mm/hr are unlikely to support plant growth due to poor water retention, and may also result in leaching of pollutants. However plant survival might be possible if the outlet pipe were raised to create a permanently submerged zone.

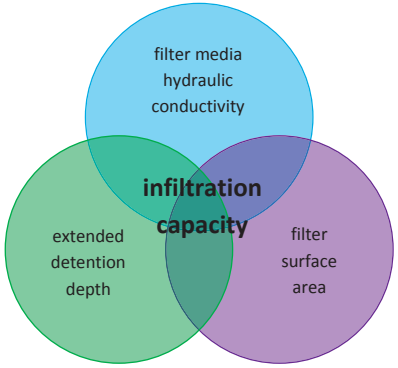

Figure 1. Design elements that influence infiltration capacity.

Biofiltration Filter Media Guidelines (Version 3.01), Prepared by the Facility for Advancing Water Biofiltration (FAWB), June 2009.

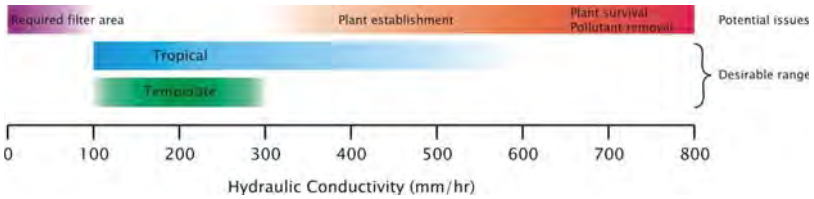

Figure 2. Recommended filter media hydraulic conductivity range and potential issues

The infiltration capacity of the biofiltration system will initially decline during the establishment phase as the filter media settles and compacts, but this will level out and then start to increase as the plant community establishes itself and the rooting depth increases (see Appendix A). In order to ensure that the system functions adequately at its eventual (minimum) hydraulic conductivity, a safety co-efficient of 2 should be used: i.e., **designs should be modelled using half the prescribed hydraulic conductivity**. If a system does not perform adequately with this hydraulic conductivity, then the area and/or ponding depth should be increased. It may also be desirable to report sensitivity to infiltration rate, rather than simply having expected rate. This is important when assessing compliance of constructed systems as systems should ideally meet best practice across a range of infiltration rates.

2 TESTING REQUIREMENTS

2.1 Determination of Hydraulic Conductivity

The hydraulic conductivity of potential filter media should be measured using the ASTM F1815-06 method. This test method uses a compaction method that best represents field conditions and so provides a more realistic assessment of hydraulic conductivity than other test methods.

Note: if a hydraulic conductivity lower than 100 mm/hr is prescribed, the level of compaction associated with this test method may be too severe and so underestimate the actual hydraulic conductivity of the filter media under field conditions. However, FAWB considers this to be an appropriately conservative test, and recommends its use even for low conductivity media.

2.2 Particle Size Distribution

Particle size distribution (PSD) is of secondary importance compared with hydraulic conductivity. A material whose PSD falls within the following recommended range does not preclude the need for hydraulic conductivity testing i.e., it does not guarantee that the material will have a suitable hydraulic conductivity. However, the following composition range (percentage w/w) provides a useful guide for selecting an appropriate material:

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Clay & Silt	<3%	(<0.05 mm)
Very Fine Sand	5-30%	(0.05-0.15 mm)
Fine Sand	10-30%	(0.15-0.25 mm)
Medium to Coarse Sand	40-60%	(0.25-1.0 mm)
Coarse Sand	7-10%	(1.0-2.0 mm)
Fine Gravel	<3%	(2.0-3.4 mm)

Clay and silt are important for water retention and sorption of dissolved pollutants, however they substantially reduce the hydraulic conductivity of the filter media. This size fraction also influences the structural stability of the material (through migration of particles to block small pores and/or slump). It is essential that the total clay and silt mix is **less than 3% (w/w)** to reduce the likelihood of structural collapse of such soils.

The filter media should be well-graded i.e., it should have all particle size ranges present from the 0.075 mm to the 4.75 mm sieve (as defined by AS1289.3.6.1 - 1995). There should be no gap in the particle size grading, and the composition should not be dominated by a small particle size range. This is important for preventing structural collapse due to particle migration.

2.3 Soil-Based Filter Media: Properties

The following specifications are based on results of extensive treatment performance testing conducted by FAWB as well as recommendations made by AS4419 – 2003 (Soils for Landscaping and Garden Use). Filter media must be tested for the following; media that do not meet these specifications should be rejected or amended:

i. Total Nitrogen (TN) Content – <1000 mg/kg.

ii. Orthophosphate (PO_4^{3-}) Content – <80 mg/kg. Soils with total phosphorus concentrations >100 mg/kg should be tested for potential leaching. Where plants with moderate phosphorus sensitivity are to be used, total phosphorus concentrations should be <20 mg/kg.

iii. Organic Matter Content – at least 3% (w/w). An organic content lower than 3% is likely to have too low a water holding capacity to support healthy plant growth. In order to comply with both this and the TN and PO_4^{3-} content requirements, a low nutrient organic matter will be required.

iv. pH – as specified for 'natural soils and soil blends' 5.5 – 7.5 (pH 1:5 in water).

v. Electrical Conductivity (EC) – as specified for 'natural soils and soil blends' <1.2 dS/m.

Optional testing:

vi. Dispersibility – this should be carried out where it is suspected that the soil may be susceptible to structural collapse. If in doubt, then this testing should be undertaken.

Potential filter media should generally be assessed by a horticulturalist to ensure that they are capable of supporting a healthy vegetation community. This assessment should take into

Biofiltration Filter Media Guidelines (Version 3.01), Prepared by the Facility for Advancing Water Biofiltration (FAWB), June 2009.

consideration delivery of nutrients to the system by stormwater. Any component or soil found to contain high levels of salt (as determined by EC measurements), high levels of clay or silt particles (exceeding the particle size limits set above), or any other extremes which may be considered retardant to plant growth should be rejected.

3 ENGINEERED FILTER MEDIA

Where there is not a locally available soil-based material that complies with the properties outlined in Sections 2.1 - 2.3, it is possible to construct an appropriate filter medium. A washed, well-graded sand with an appropriate hydraulic conductivity should be used as the filter medium. Suitable materials include those used for the construction of turf profiles (e.g. golf greens); these materials are processed by washing to remove clay and silt fractions. In large quantities (>20 m^3), they can be obtained directly from sand suppliers, while smaller quantities can be purchased from local garden yards. The **top 100 mm of the filter medium** should then be ameliorated with appropriate organic matter, fertiliser and trace elements (Table 1). This amelioration is required to aid plant establishment and is designed to last four weeks; the rationale being that, beyond this point, the plants receive adequate nutrients via incoming stormwater.

Table 1. Recipe for ameliorating the top 100 mm of sand filter media

Constituent	Quantity (kg/100 m^2 filter area)
Granulated poultry manure fines	50
Superphosphate	2
Magnesium sulphate	3
Potassium sulphate	2
Trace Element Mix	1
Fertilizer NPK (16.4.14)	4
Lime	20

Laboratory testing has shown that biofilters that contain an engineered filter medium will achieve essentially the same hydraulic and treatment performance as those containing a soil-based filter medium (Bratieres *et al.*, 2009). However, it is recommended that a submerged zone be included in biofiltration systems that utilise such a free draining filter medium to provide a water source for vegetation between rainfall events.

4 TRANSITION LAYER

The transition layer prevents filter media from washing into the drainage layer. Transition layer material shall be a clean, well-graded sand material containing <2% fines. To avoid migration of the filter media into the transition layer, the particle size distribution of the sand should be assessed to ensure it meets 'bridging criteria', that is, the smallest 15% of the sand particles bridge with the largest 15% of the filter media particles (Water by Design, 2009; VicRoads, 2004):

D_{15} (transition layer) ≤ 5 x D_{85} (filter media)

where: D_{15} (transition layer) is the 15th percentile particle size in the transition layer material (i.e., 15% of the sand is smaller than D_{15} mm), and
D_{85} (filter media) is the 85th percentile particle size in the filter media.

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A dual-transition layer, where a fine sand overlays a medium-coarse sand, is also possible. While it is acknowledged that this can increase the complexity of the construction process, testing indicates that a dual-transition layer produces consistently lower levels of turbidity and concentrations of suspended solids in treated outflows than a single transition layer. Therefore, it is recommended that this design be specified for stormwater harvesting applications (to enable effective post-treatment disinfection) and where minimising the risk of washout during the establishment period is of particular importance.

The transition layer can be omitted from a biofiltration system provided the filter media and drainage layer meet the following criteria as defined by the Victorian Roads *Drainage of Subsurface Water from Roads - Technical Bulletin No 32* (VicRoads, 2004):

D_{15} (drainage layer) ≤ 5 x D_{85} (filter media)

D_{15} (drainage layer) = 5 to 20 x D_{15} (filter media)

D_{50} (drainage layer < 25 x D_{50} (filter media)

D_{60} (drainage layer) < 20 x D_{10} (drainage layer)

These comparisons are best made by plotting the particle size distributions for the filter media and gravel on the same soil grading graphs and extracting the relevant diameters (Water by Design, 2009).

5 DRAINAGE LAYER

The drainage layer collects treated water at the bottom of the system and converys it to the underdrain pipes. Drainage layer material is to be clean, fine gravel, such as a 2 – 5 mm washed screenings. Bridging criteria should be applied to avoid migration of the transition layer into the drainage layer (Water by Design, 2009; VicRoads, 2004):

D_{15} (drainage layer) ≤ 5 x D_{85} (transition layer)

where: D_{15} (drainage layer) is the 15th percentile particle size in the drainage layer material (i.e., 15% of the gravel is smaller than D_{15} mm), and
D_{85} (transition layer) is the 85th percentile particle size in the transition layer material.

Note: The perforations in the underdrain pipes should be small enough that the drainage layer cannot fall into the pipes. A useful guide is to check to that the D_{85} (drainage layer) is greater than the pipe perforation diameter.

Geotextile fabrics are **not recommended** for use in biofiltration systems due to the risk of clogging. An open-weave shade cloth can be placed between the transition layer and the drainage layer to help reduce the downward migration of smaller particles if required, however this should only be adopted where there is insufficient depth for transition and drainage layers.

6 INSTALLATION

It is recommended that filter media be lightly compacted during installation to prevent migration of fine particles. In small systems, a single pass with a vibrating plate should be used to compact the filter media, while in large systems, a single pass with roller machinery (e.g. a drum lawn roller) should be performed. Under no circumstance should heavy compaction or multiple-passes be made. Filter media should be installed in two lifts unless the depth is less than 500 mm.

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7 FIELD TESTING

It is recommended that field testing of hydraulic conductivity be carried out at least twice: 1. one month following commencement of operation, and 2. in the second year of operation to assess the impact of vegetation on hydraulic conductivity.

The hydraulic conductivity of the filter media should be checked at a minimum of three points within the system. The single ring, constant head infiltration test method (shallow test), as described by Le Coustumer *et al.* (2007), should be used. Given the inherent variability in hydraulic conductivity testing and the heterogeneity of the filter media, the laboratory and field results are considered comparable if they are within 50% of each other. However, even if they differ by more than 50%, the system will still function if both the field and laboratory results are within the relevant recommended range of hydraulic conductivities.

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APPENDIX A

Figure A.1 illustrates the change in hydraulic conductivity during the establishment phase of a Melbourne biofiltration system containing a sandy loam filter media. The hydraulic conductivity initially declines as the filter media is compacted under hydraulic loading, but recovers back to the design value (as indicated by the dashed horizontal line) as plant growth and increased rooting depth counters the effects of compaction and clogging.

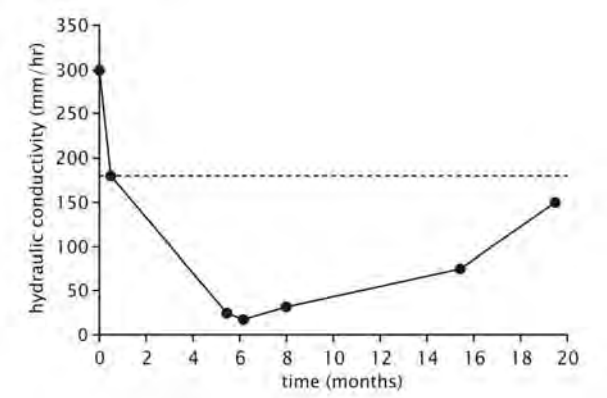

Figure A.1 Evolution of hydraulic conductivity during the first 20 months of a biofiltration system (after Hatt *et al.*, 2009)

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