16 June 2025

Suite 3, Level 2
280 Keira Street
Wollongong NSW 2500
Phone: 02 4288 4401
Web: www.makereng.com.au
Email: info@makereng.com.au
ABN: 50 628 452 719 ACN: 628 452 719

Southern Regional Planning Panel

Attention: Southern Regional Planning Panel

Dear Sir/Madam

DA-2023/849 – Halcyon Forest Reach Community- Bong Bong Road Huntley

Subject: Updated Water Cycle Management Strategy Outcomes following adoption of the 2023 MCFRMS

Wollongong City Council (Council) have identified that the Water Cycle Management Study (WCMS) prepared for the above development application (DA) for the proposed Halcyon Forest Reach Community (The Site) did not reference Council's latest 2023 Mullet Creek Floodplain Risk Management Study and Plan (FRMS&P).

Maker have been engaged to assess the impact of the revised procedures within the FRMS&P on the WCMS. This report supplements the WCMS by identifying the key changes in the FRMS&P and providing technical analysis of the results achieved using the latest study for the proposed works at the development site. Modelling was undertaken to determine the effect of the FRMS&P on the proposed development.

As set out in this report, the incorporation of the FRMS&P does not have a materially adverse affect on the flood impacts or liability of the proposed development. In some cases, the flood liability of the Site improves as a result of applying the FRMS&P inputs. Therefore, Maker is of the view that the WCMS, when read together with this supplementary report, indicates that there is an acceptable level of flood risk associated with the proposed development and there is no basis to refuse the development due to flooding issues.

BACKGROUND

The Site is subject to multiple previous DA approvals, specifically, DA 673/2020 (masterplanned community to the south), DA 2021/1401 (site wide bulk earthworks) and DA 2023/19 (masterplanned community to the west). The most recent of these approvals is illustrated below in **Figure 1.**

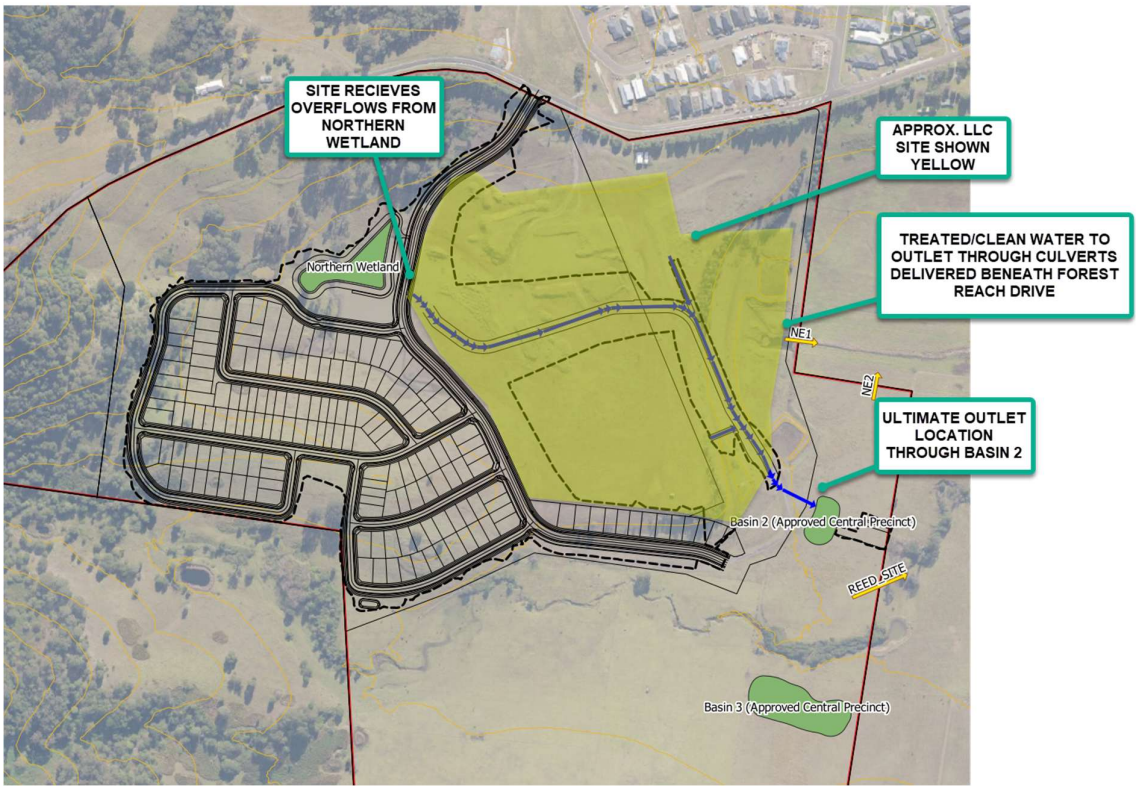

Figure 1 Approved WCMS DA 2023/19 – 8th March 2024

As illustrated in Figure 1**,** these prior approvals by Council deliver most of the flooding infrastructure related to this site, all of which is currently being constructed as part of the precinct bulk earthworks (DA 2021/1401), and civil works (DA 2023/19). Respective WCMS' and flood modelling historically utilised the 2018 Mullet Creek Flood Study. This analysis does not assess the flooding impacts caused by the changed flood model to any existing or approved infrastructure or strategies modelled using the previous 2018 Flood Study.

In addition to the WCMS, Maker provided a written response dated 9 May 2025 to questions raised by Council in relation to flooding matters. This letter was provided to the Panel prior to its meeting on 21 May 2025. The letter foreshadowed the preparation of further information by Maker arising from its detailed review and analysis of the FRMS&P.

The Panel deferred the determination of the proposed development on 21 May 2025, in part to allow this additional flood modelling information to be prepared.

This supplementary report provides that additional flood modelling information.

KEY CHANGES IN FRMS&P COMPARED TO PRIOR COUNCIL STUDIES

The key changes to the FRMS&P from prior Mullet Creek and Brooks Reach catchment studies undertaken by council are:

- The adoption of new hydrological procedures in line with Australian Rainfall and Runoff, which at that time was ARR2019; and
- Adoption and assessment of a Defined Flood Event (DFE), which is no longer considered to be the 1% AEP but is the 1% AEP with 16.3% increased rainfall and 0.9m increase for Sea Level Rise, to include an allowance for the predicted changes due to Climate Change.

The FRMS&P also included updates to the hydraulic component of the flood model, with some updates to the physical characteristics of the wider catchment and the modelling procedures. However, these are minimal with generally no changes in the hydraulic modelling within the vicinity of Forest Reach, including the Site and surrounding areas.

Specific changes are discussed in further detail below.

Hydrologic Modelling

In accordance with the hydrological setup of the FRMS&P, the Watershed Bounded Network Model (Boyd et al, 2019) (WBNM) was adopted for this supplementary assessment in conjunction with Storm Injector (V1.3.5, Catchment Simulation Solutions) for the hydrological modelling of the study area. Hydrological model files were sourced from the SES flood data portal for direct implementation in this assessment.

All modelling parameters and rainfall IFD's adopted within the hydrological model were in accordance with the FRMS&P, as required by the Mullet Creek Flood Model User Guidelines (2024).

Hydraulic Modelling

Hydraulic modelling was undertaken using the FRMS&P TUFLOW model. The base model was updated in a number of ways, to ensure its accurate representation of features that have changed since the release of the FRMS&P, including the following:

- Removal of the 1D network representation of Reed Creek within the Site
- Addition of terrain modifiers including design tins for the Site and adjoining development
- Updated materials files for the existing and proposed developments within the Site
- Inclusion of 1d networks, being the existing and proposed pipes throughout the Forest Reach precinct

Defined Flood Event

The 'Defined Flood Event' under the FRMS&P is a combination of the 1% AEP event, with climate change increases, conduit blockages and increased riparian roughness. Within this analysis, the DFE storm event was modelled in accordance with the FRMS&P by applying a factor of 16.3% increase to the 1% AEP rainfall data to simulate the rainfall increases due to climate change, then creating a matrix of results including an unblocked and blockage policy scenario with a standard roughness material and high riparian roughness scenario. These four scenarios create the DFE.

Complete DFE mapping is included within Appendix A.

Flood Risk Precinct Definition

The Flood Risk Precinct was calculated utilising the definitions shown in Table 1Error! Reference source not found. below. These definitions are as per those outlined within the FRMS&P.

Table 1 Flood Risk Precinct Definition

Hydraulic Category	Definition
High Flood Risk Precinct	Areas greater than H3 hazard in the DFE DFE floodways
Medium Flood Risk Precinct	Land not within the High flood risk precinct that is less than 0.5m above the DFE flood level
Low Flood Risk Precinct	The remainder of the floodplain defined by the PMF extent

ONSITE DETENTION

Onsite Detention (OSD) has historically been assessed as a precinct-wide strategy for Forest Reach, including the northern precinct, central precinct and the Site. As such, the impacts to OSD for the Site have been assessed using the same approach.

The OSD analysis was undertaken using WBNM which included the updated rainfall and loss factors from the FRMS&P, as set out above. Existing OSD is provided within the existing basins, the northern wetland and the central basin. One new local tank structure has been added at the eastern discharge point as a consequence of this supplementary analysis. No updates were required to be made to the northern wetland.

In order to maintain OSD requirements for the additional flows originating from the Site, the Central OSD basin is proposed to be updated with a new outlet configuration that includes: two culverts, one 2.4m x 0.6m culvert at RL38.2mAHD and one 0.9m x 0.6m culvert at RL39mAHD, as well as a reduced weir length to 8m. An outlet configuration sketch is included in Appendix B. It is proposed that these alterations to the current civil plans within the DA, which will have the effect of refining the design of the Central OSD basin as approved under DA 2020/673 and further modified under DA 2023/19, would be required as a condition of consent of the DA (see 'Conclusion' below).

The local structure is proposed as an underground tank requiring a total volume of 165m^3 in the 1% storm event and a 400mm outlet pipe. This structure will be located wholly within the Site and will be privately owned and maintained by the proponent.

The results of the OSD analysis are summarised in Table 2 below.

Table 2 OSD Results Summary

Study location	Event	Existing Flows (m³/s)	Proposed Flows (m³/s)	Difference
East Discharge	20% AEP	0.554	0.408	-0.146
	10% AEP	0.718	0.691	-0.027

	5% AEP	1.27	1.214	-0.056
	2% AEP	2.957	2.09	-0.867
	1% AEP	3.56	2.493	-1.067
Reed Creek discharge	20% AEP	1.691	1.524	-0.167
	10% AEP	2.482	2.284	-0.198
	5% AEP	3.102	3.04	-0.062
	2% AEP	9.273	8.025	-1.248
	1% AEP	12.639	12.032	-0.607

All events demonstrate that lower discharge flows than the existing case can be achieved, effectively maintaining the OSD requirements for the site wide development.

MODELLING RESULTS

The main storm event considered for this assessment was the DFE, as detailed earlier. The complete set of flood mapping results for the DFE storm event are presented within Appendix A. As per the FRMS&P, all results have been filtered to remove depths less than 0.1m. The blockage policy scenario is conducted in accordance with the WCC DCP Chapter E13: Floodplain Management conduit blockage factors (Section 5.2, Table 1, 25/03/2020).

All proposed new roads remain flood free in the DFE storm event, and no lots are flood affected. Velocities within the conveyance swale reach up to 3m/s and thus hazard in the swale also reaches H5.

Floodplain storage was calculated against the site wide existing model due to the existing floodplain storage provided in the central and northern precincts.

The storage for the DFE storm event is presented in **Table 3** below.

Table 3 Floodplain Storage Calculations

Event	Existing (m^3)	Proposed (m^3)
DFE	63,335	66,433

A flood impact assessment was conducted for the proposed development within the Site for the DFE storm event against the existing approved North and Central Precinct development. As can be seen in **Figure 2** below, the proposed development has negligible impact on the flood levels within the boundaries of the Site. Some impact is observed immediately downstream of the Forest Reach Central OSD basin. This change is attributed to the changing outflow configuration of the basin proposed as part of these works. As such, there is a minor reduction in water level within the basin, and a localised area of increased water level at the discharge point. This increase is limited only to the local existing flood plain and does not impact the downstream function of Reed Creek or any existing lots.

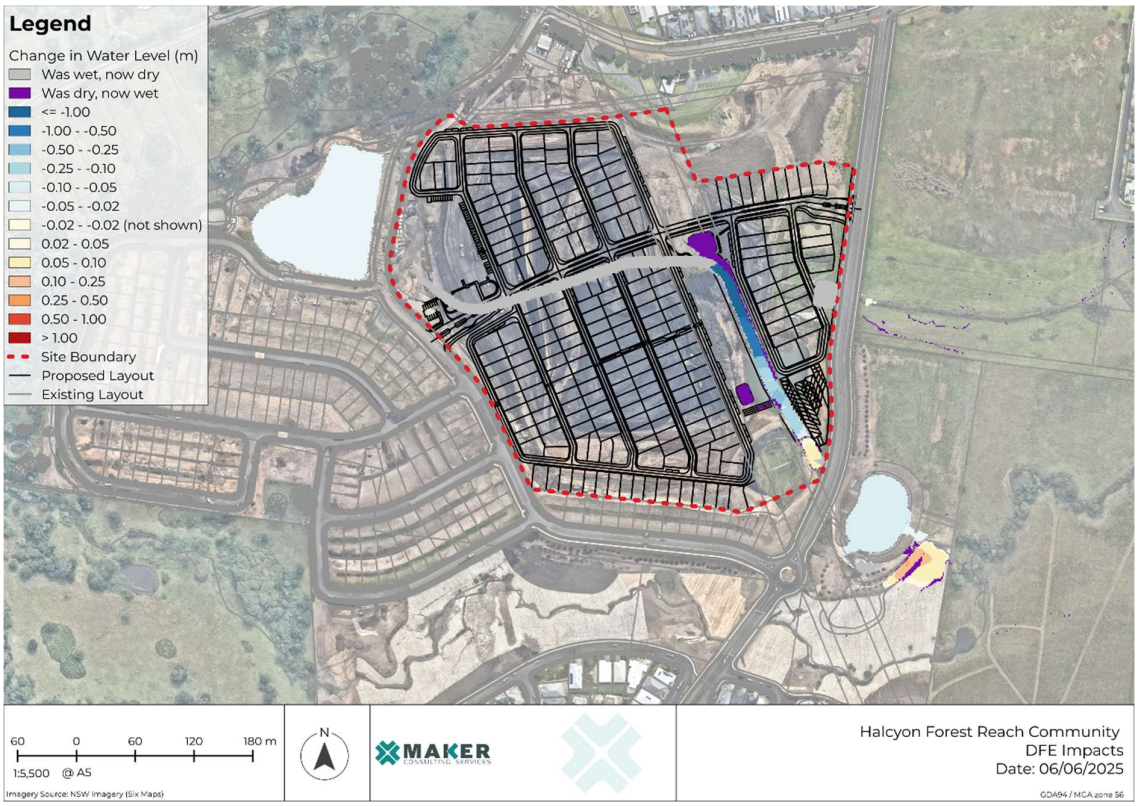

Figure 2 DFE Impacts

The PMF event is understood to be Council's primary concern. It can be seen in **Figure 3** and **Figure 4** that the northern wetland overtops the road, into the high flow swale adjacent to the community facility before continuing down road 01. No lots are inundated in this event. It is noted that the presented results are a matrix of the blocked and unblocked scenarios. During an unblocked scenario, the PMF remains fully within the northern wetland and is conveyed within the culvert, ensuring that all roads remain flood free. The road is only overtopped in the conduit blockage scenario.

It is also noted that the PMF conveyance has improved when compared to the original WCMS, which did not reference the FRMS&P, in which the road experienced greater depths and adjacent lots were experiencing inundation.

The hazard category within Road 01 is now limited to H1 within the actual carriageway, with localised pockets of H2 in the verge. The hazard map is presented in **Figure 4** below. H1 is defined as generally safe for people, vehicles and buildings. Evacuation from the Site is possible under all scenarios, for all residences, via Forest Reach Drive.

The General Controls outlined in the WCC DCP Chapter E13 for the Mullet and Brooks Creek Floodplain requires *Reliable access for pedestrians or vehicles from the building, commencing at a minimum level equal to the lowest habitable flood level to an area of refuge above the PMF level, or a minimum of 20sqm of the dwelling to be above the PMF level.* As lots are no longer inundated during a PMF event in the new modelling, this requirement has been adequately met.

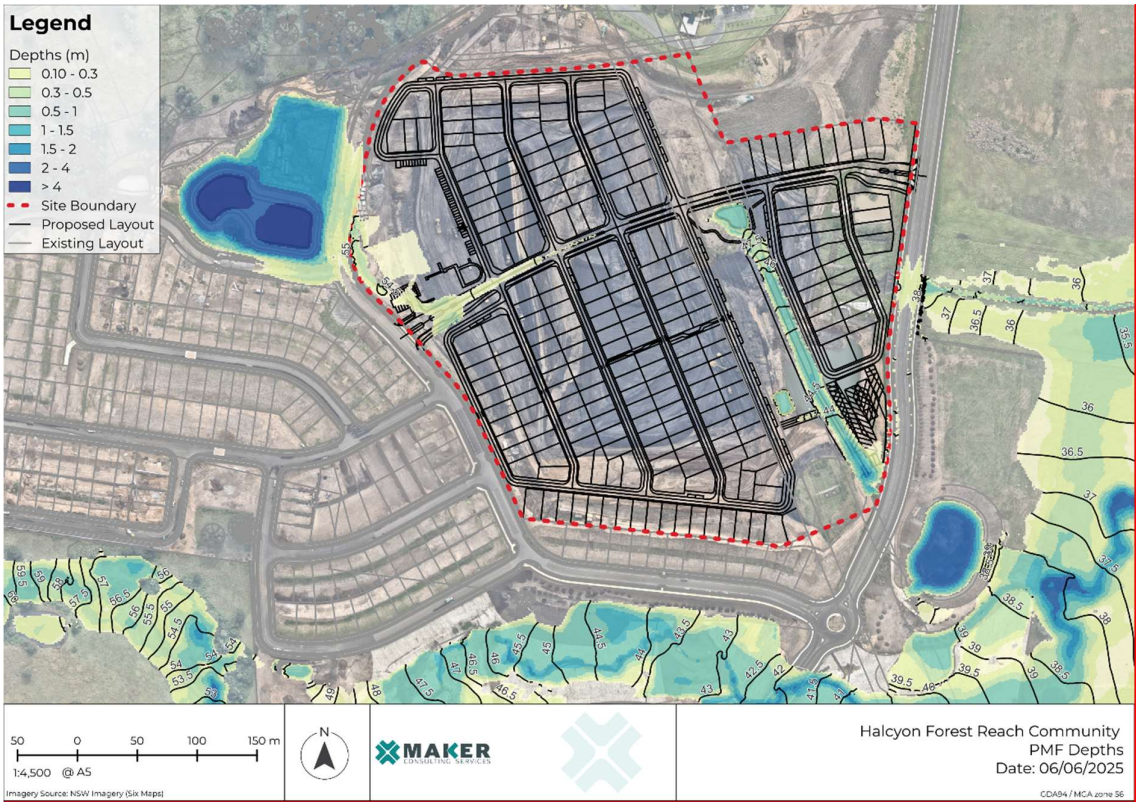

Figure 3 PMF Depths

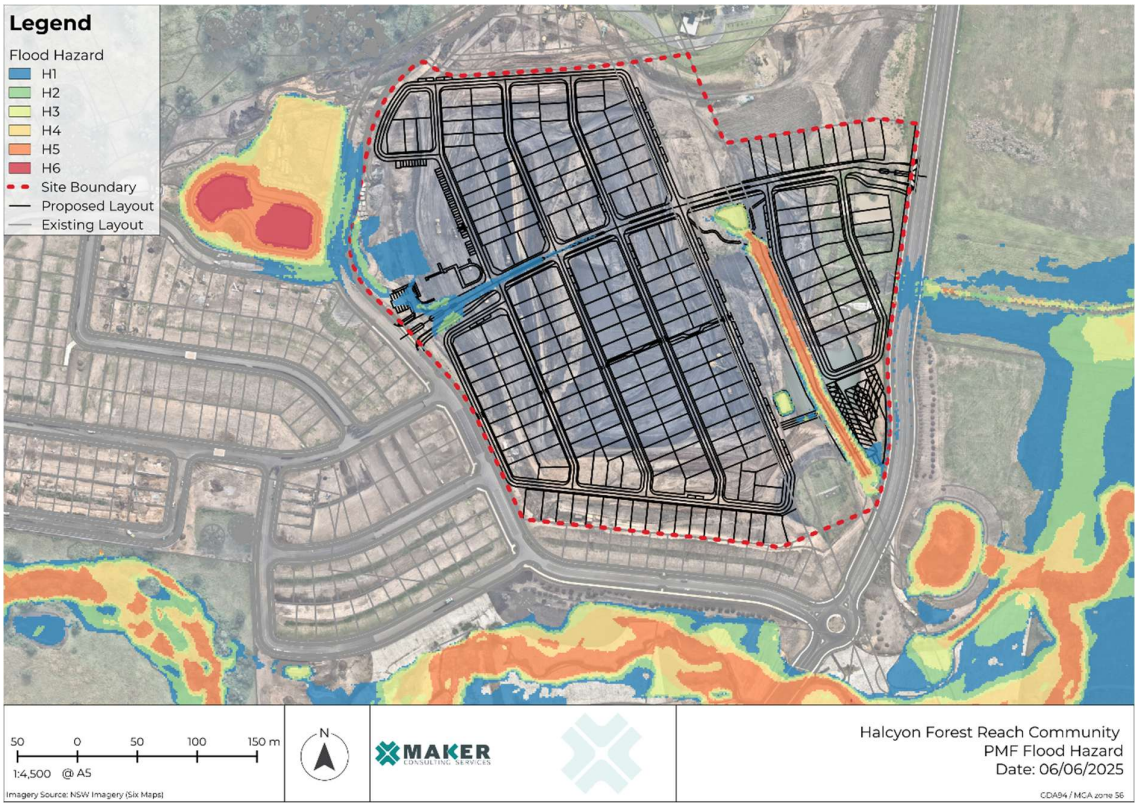

Figure 4 PMF Hazard

LEP CONTROLS

The Wollongong Local Environmental Plan Section 5.21: Flood Planning, sets out the following objectives. These are tabulated against Maker's Response to each applicable objective in **Table 4**

Table 4 Wollongong LEP Objectives Clause 5.21

(1) The objectives of this clause are as follows:	
a) To minimise the flood risk to life associated with the use of land.	The proposed development does not create any flood affected lots. In the blocked PMF scenario, one road is inundated; however, the hazard level is minimal at H1 where adjacent to residential lots ensuring that vehicular egress via Forest Reach Drive remains feasible during this scenario. All lots and roads remain fully flood free in the DFE. Therefore, there is no flood risk to life arising from the proposed development.
b) To allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change.	The FRMS&P incorporates climate change assumptions. The presented results (Appendix A) were undertaken for the DFE under the FRMS&P, which includes the projected changes due to climate change. The results demonstrate that the proposal is consistent with the flood function of the Site.
c) To avoid adverse cumulative impacts on flood behaviour and the environment.	The flood impacts were assessed for the DFE storm event, and the only impacts are limited to localised areas of increased flooding, which does not extend downstream. No adverse impacts on flood behaviour or the environment will occur as part of the development.
d) To enable the safe occupation and efficient evacuation of people in the event of a flood.	All lots remain flood free in storm events up to and including the PMF. Evacuation is possible from the Site Via Forest Reach Drive under all scenarios.
(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development:	
a) is compatible with the flood function and behaviour on the land, and	The proposed development is outside of any floodways and does not encumber the flood function of the Site.
b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and	The impacts presented in this assessment demonstrate that no other developments will be affected by flooding as a result of the proposed development.

c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and	In all events up to and including the PMF, the lots remain flood free. Evacuation is possible from the site via Forest Reach Drive under all scenarios.
d) incorporates appropriate measures to manage risk to life in the event of a flood, and	All residential areas are clear of any modelled flooding extent and roads have been located outside of high hazard areas to manage the risk to life in the event of a flood.
e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses.	The proposed development does not adversely affect the environment. It conforms to the larger approved Forest Reach strategy and does not propose major works to any water courses. The modification of the Central OSD basin results in works in the watercourse, which will be undertaken in accordance with NRAR guidelines and consistent with the existing controlled activity approval for this basin.
(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters:	
a) the impact of the development on projected changes to flood behaviour as a result of climate change,	The assessment has been conducted utilising the DFE, which includes consideration of climate change.
b) the intended design and scale of buildings resulting from the development	The design and scale of the buildings within the Site proposed in the DA, which does not include any residential homes, comply with all relevant planning controls. Residential homes will be approved via a separate planning pathway under the *Local Government Act 1993*, which is not compromised by any matters related to flood risk.
c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood	All lots remain flood free in storm events up to and including the PMF. Evacuation is possible from all lots within the Site via Forest Reach Drive in all storm events.
d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.	The Site has been designed to have a low risk of impact by flooding or coastal erosion. If modification, relocation or removal of buildings is necessary, the roads within the development have been designed to allow this.

CONCLUSION

In response to the Panel's requested further information on flooding, this supplementary report considers the latest Mullet Creek Floodplain Risk Management Study and Plan (2023) and the procedures in this Study were adopted for this assessment. The DFE storm event was simulated within both the hydrologic and hydraulic models and the results are presented within this document.

Minor updates are required to be made to the design of a pre-existing OSD (Central OSD basin) outlet to maintain predevelopment outflows from the proposed development (see Appendix B). This can be achieved by the implementation of a suitable condition of consent. Additionally, a privately owned, underground detention tank is proposed at the eastern discharge point for OSD purposes. A plan identifying the proposed location of this OSD tank is provided at Appendix B**.**

A proposed condition of consent to give effect to the proposed minor design improvements to be made to the approved Central OSD basin (under DA 2020-673, as modified by DA 2023-19) as a consequence of this further study are provided below:

Central OSD Basin

The approved development alters the design of the Central OSD Basin, for which development consent was granted under DA 2020-673 and subsequently modified by DA 2023-19.

This development consent requires the modification of conditions 1 and 38 of DA 2023-19 so that:

a) in respect of condition 1, plan MKR00256-50-C0103 (General Arrangement Plan, Sheet 4 of 4, Maker Eng, 30/04/2024) is to be read consistently with the plan at Appendix B of this document (MKR00256-04-SK050) and, to the extent of any inconsistency, MKR00256-04-SK050 prevails; and

b) in respect of condition 38, the Water Cycle Management Study, Job no. MKR00256-V04, by Maker Eng, Dated 05/05/2023 is to be read consistently with this document dated 16 June 2025 and, to the extent of any inconsistency, this document prevails.

Prior to the issue of a subdivision works certificate, the Applicant must submit a notice pursuant to section 4.17(5) of the *Environmental Planning and Assessment Act 1979* and section 67 of the *Environmental Planning and Assessment Regulation 2021* to Council that seeks to give effect to the above modifications to DA 2023/19.This report presents the additional information requested under the SRPP report and demonstrates that the flooding outcomes as set forth within the Wollongong City Council DCP, Chapters E13 and D16 as well as the Wollongong LEP can be achieved for the proposed development.

Yours faithfully,

Maker ENG

APPENDIX A – DFE FLOOD MAPPING

Proposed DFE Flood Depth
M107

Legend

Depths (m)

- 0.10 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 4
- > 4
- Site Boundary
- Proposed Layout
- Existing Layout

0 50 100 150 m

1:3,000 at A3 Paper Size

M107 - DFE
Proposed

N

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Revision Date: 06-06-2025

Proposed DFE Flood Velocity
M117

Legend

Velocity (m/s)

- <= 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4
- Site Boundary
- Proposed Layout
- Existing Layout

0 50 100 150 m

1:3,000 at A3 Paper Size

M117 - DFE
Proposed

N

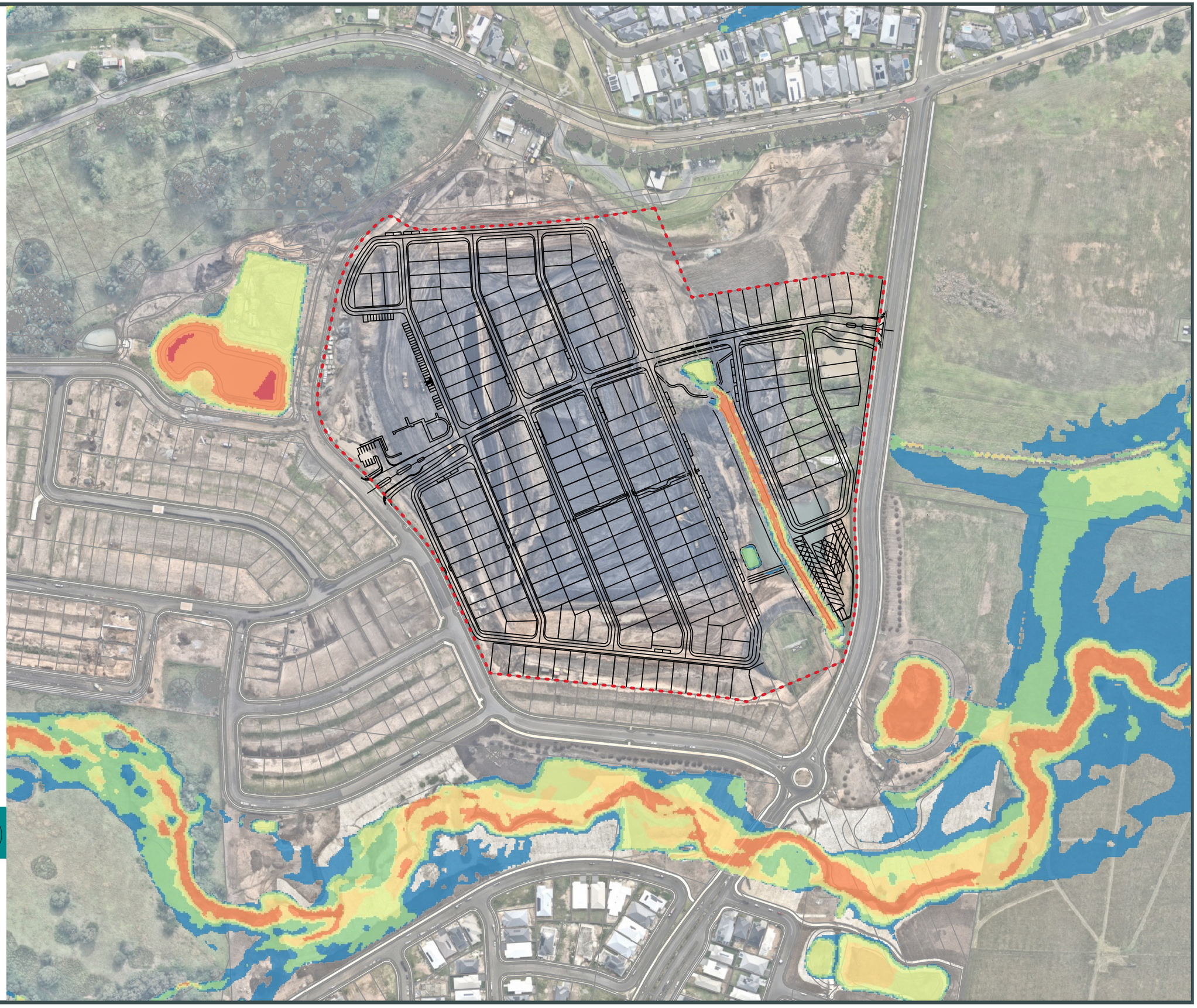
MAKER CONSULTING SERVICES

Revision Date: 06-06-2025

Proposed DFE Flood Hazard
M147

Legend

Flood Hazard
- H1
- H2
- H3
- H4
- H5
- H6
- Site Boundary
- Proposed Layout
- Existing Layout



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M147 - DFE
Proposed

N

MAKER CONSULTING SERVICES

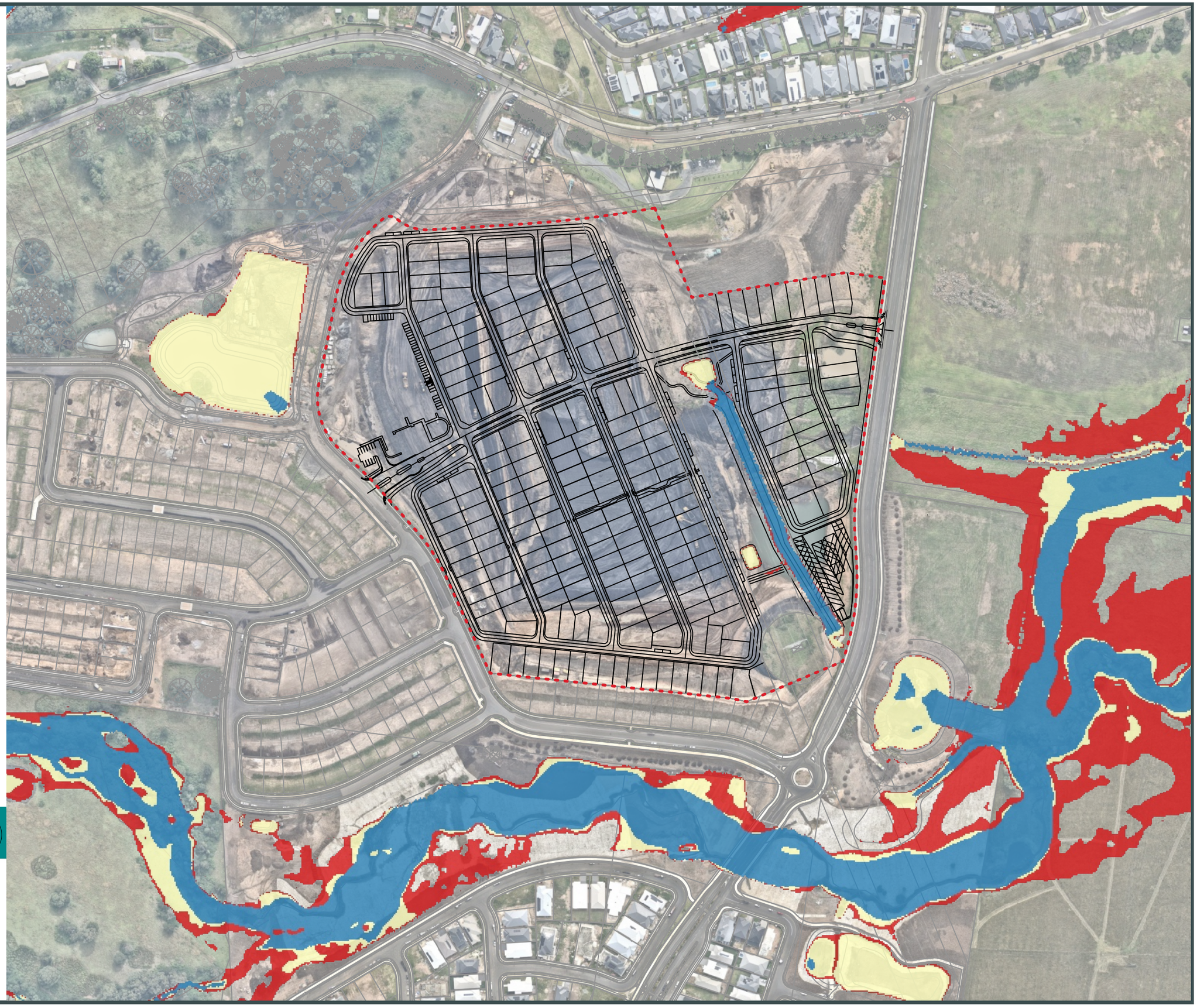
Revision Date: 06-06-2025

Proposed DFE Hydraulic Categorisation
M157

Legend

Hydraulic Categorisation

- Flood Fringe
- Flood Storage
- Floodway
- Site Boundary
- Proposed Layout
- Existing Layout



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M157 - DFE
Proposed

N

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CONSULTING SERVICES

Revision Date: 06-06-2025

Proposed DFE Flood Risk Precinct
M167

Legend

Flood Risk Precinct
- Low
- Medium
- High
- Site Boundary
- Proposed Layout
- Existing Layout

0 50 100 150 m

1:3,000 at A3 Paper Size

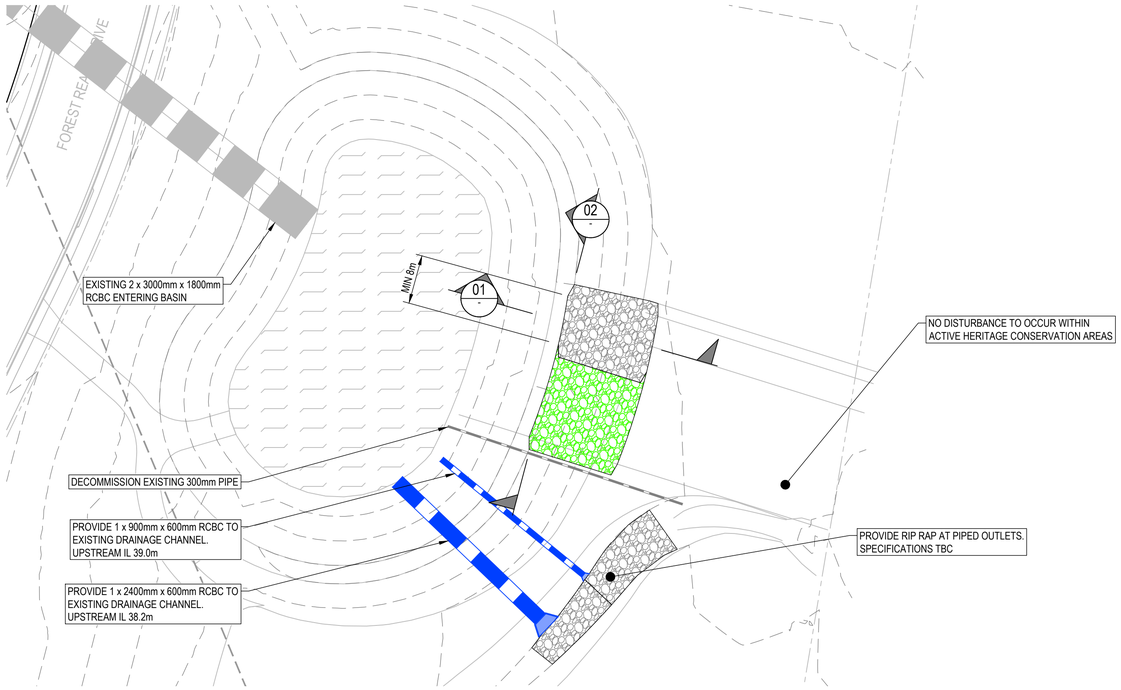
M167 - DFE
Proposed

N

MAKER CONSULTING SERVICES

Revision Date: 06-06-2025

APPENDIX B – OSD TANK AND OSD BASIN OUTLET CONFIGURATION PLAN



BASIN RECONFIGURATION LAYOUT

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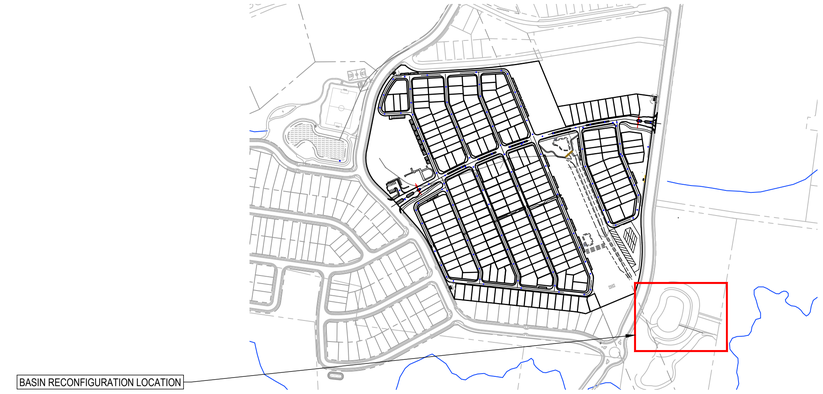


SITE CONTEXT PLAN

SCALE 1:5000

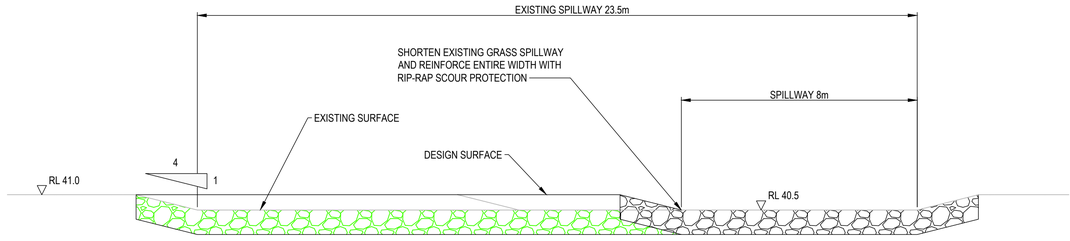
LEGEND

PROPOSED

- SITE BOUNDARY
- STORMWATER PIPES
- RIP RAP
- RIP RAP TO BE REMOVED

EXISTING

- 7.0 CONTOURS (1.0m)
- STORMWATER PIPES
- BASIN



SECTION 02

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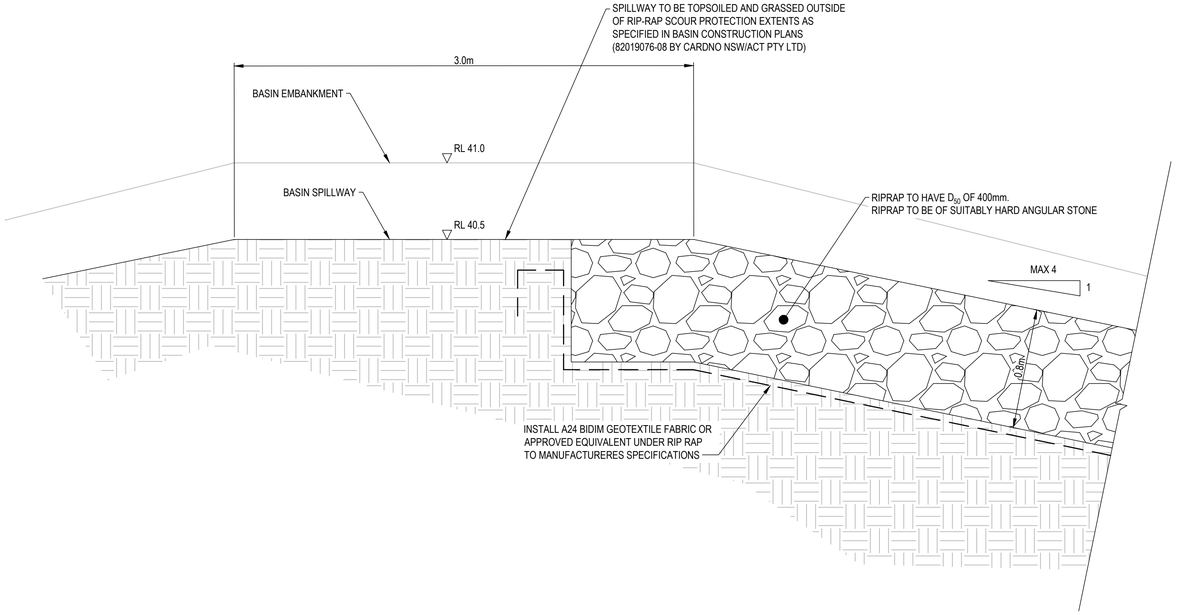

SECTION 01

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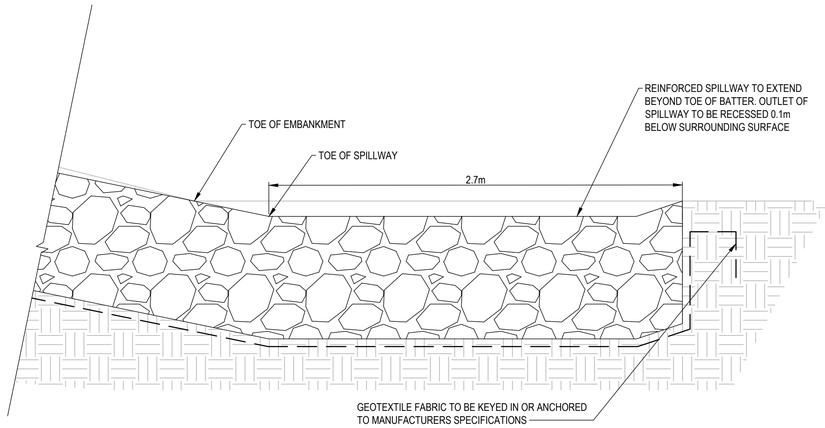

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AVID

MAKER ENG

DRAWN: M.ALLAN	DESIGNED: M.ALLAN
DRAFT CHECK: P.MCGEE	DESIGN CHECK: P.MCGEE
APPROVED: K.MACDONALD	

NOT FOR CONSTRUCTION

AVID
FOREST REACH
SOUTHEASTERN BASIN
RECONFIGURATION

DRAWING NUMBER	SHEET No.	ORIG. SIZE	REVISION
MKR00256-04-SK050		A1	P1

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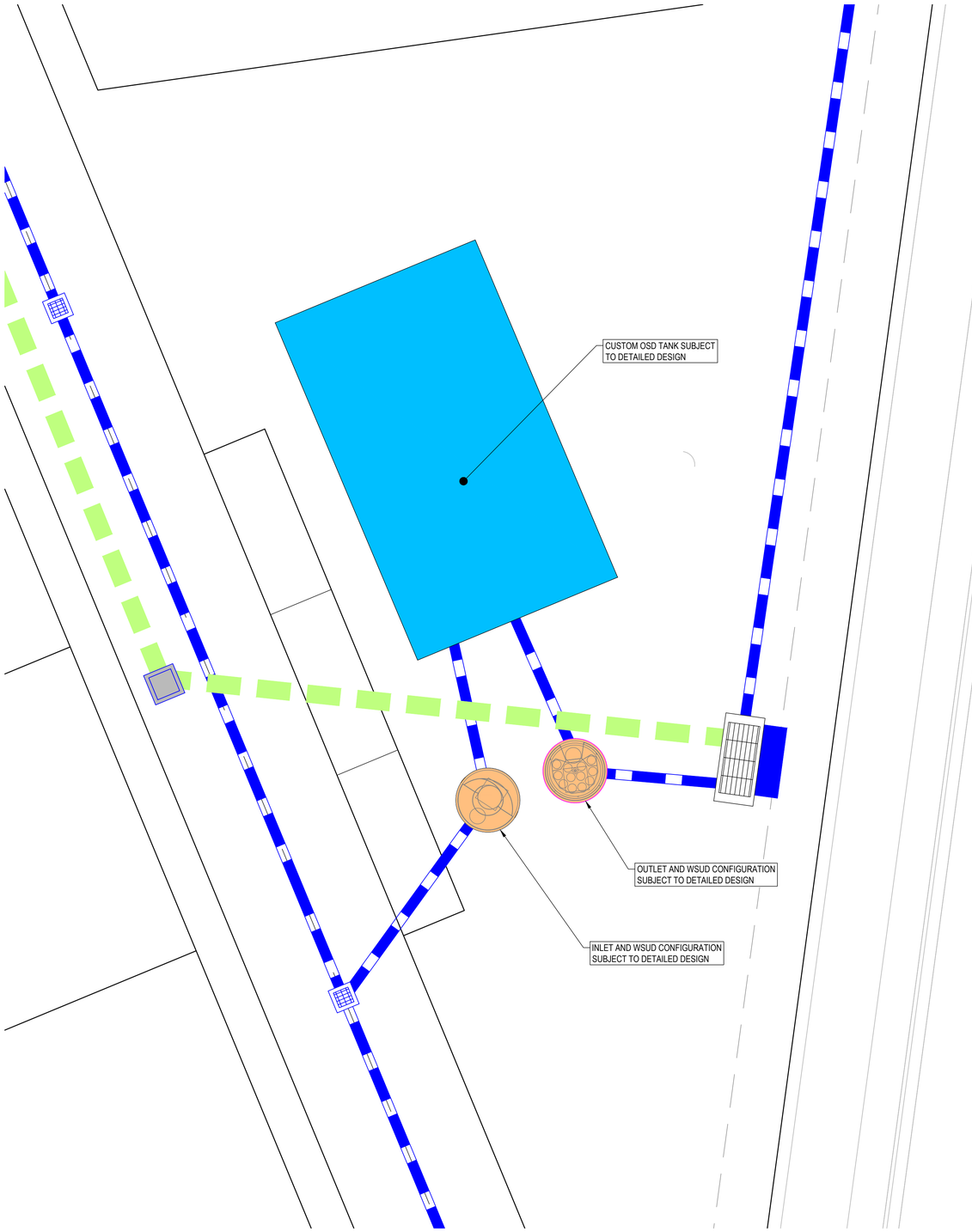
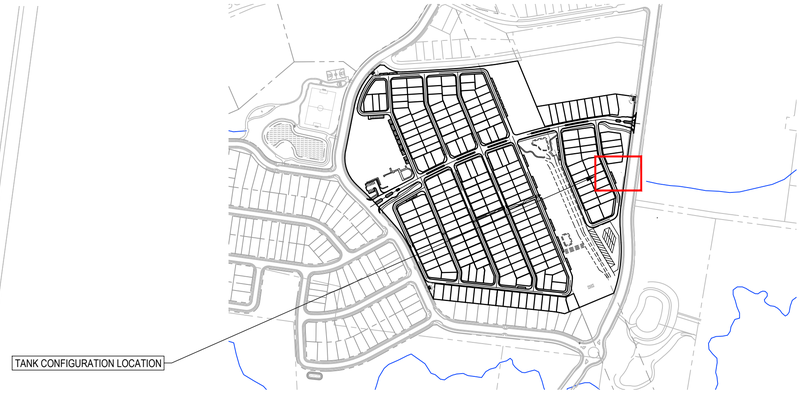


TANK CONFIGURATION LAYOUT

SCALE 1:100



SITE CONTEXT PLAN

SCALE 1:5000

LEGEND

PROPOSED

- SITE BOUNDARY
- STORMWATER PIPES
- STORMWATER STRUCTURES

EXISTING

- STORMWATER PIPES
- NORTHERN PRECINCT LOW-FLOW STORMWATER PIPES
- INDICATIVE OSD TANK EXTENTS

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P1	12.06.25	ISSUED FOR DISCUSSION	MA	KJM

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0 50 100 150 200 250m
SCALE 1:5000 AT ORIGINAL SIZE

DRAWN: M.ALLAN	DESIGNED: M.ALLAN
DRAFT CHECK: P.MCGEE	DESIGN CHECK: P.MCGEE
APPROVED: K.MACDONALD	
NOT FOR CONSTRUCTION	

AVID
FOREST REACH
EASTERN TANK
CONFIGURATION

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MKR00256-04-SK051		A1	P1

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