Concept Flood Assessment and Stormwater Management Plan

Wyatt Road, Kagaru

Welcorp Group Pty Ltd

4 April 2024

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1 INTRODUCTION

Water Technology Pty Ltd (Water Technology) has been commissioned by Welcorp Group Pty Ltd (Welcorp) to prepare a Concept Stormwater Management Plan and Flood Assessment to support the proposed context plan for an area within the southern end of the Flagstone Priority Development Area (PDA). The context plan has been prepared over the area illustrated in Figure 1-1, noting that Welcorp do not control the western most portion of the structure plan extent, however the entirety of the context plan area has generally been considered in this assessment.

The site is located within the Logan City Council (LCC) local government area. However, as the site is also located within the Greater Flagstone PDA, development is administered by Economic Development Queensland (EDQ).

Specific outcomes to be achieved for development proposed within the PDA are outlined in the various guidelines prepared by the Department of State Development, Infrastructure and Planning (DSIP) and administered by EDQ. With respect to flooding and stormwater management for this site, the guidelines of specific interest include:

- "Environmental Values and Sustainable Resource Use – EDQ Guideline 14" dated May 2015 (Guideline 14); and
- "Protection from Flood and Storm Tide Inundation – EDQ Guideline 15" dated May 2015 (Guideline 15).

This Concept SMP and flood assessment has been prepared with the intent of addressing the relevant requirements of the above-mentioned guidelines at a high level to support the context plan, with the understanding that further details will be prepared at a later design stage. The following sections of this report provide the associated detail and results of the technical assessments prepared with respect to stormwater and flood management for the proposed development.

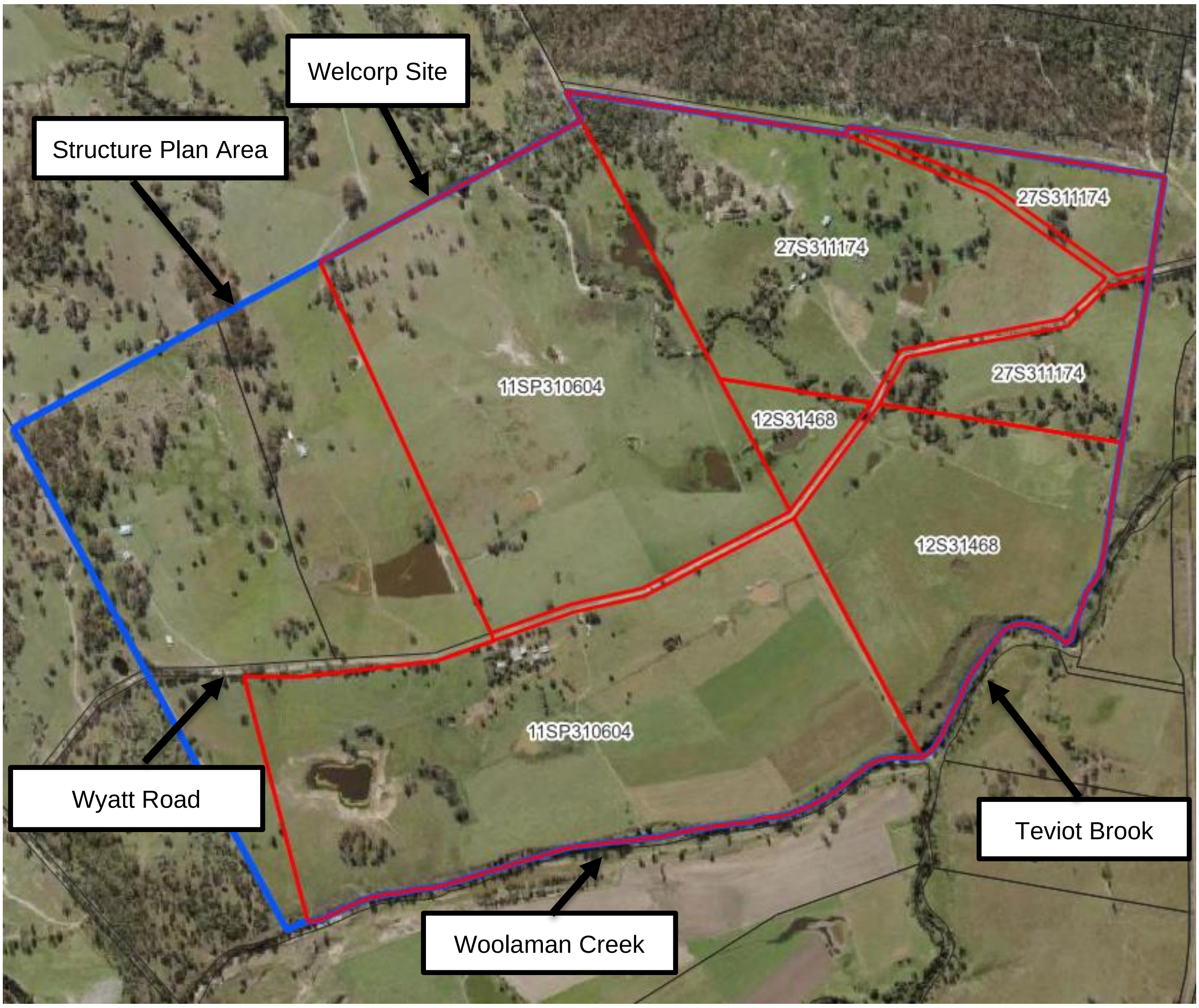


Figure 1-1 Land Parcels Forming the Site

2 SITE DESCRIPTION

2.1 The Site

The site is located in Kagaru within the LCC local government area. Wyatt Road, an unsealed rural road, runs through the centre of the site through the low-lying floodplain of the Logan Albert River system. The total site area, including the Wyatt Road road reserve is approximately 309 ha and consists of the land parcels listed in Table 2-1 and illustrated in Figure 1-1.

The site is predominantly open space / grassland, with some localised areas with stands of trees. A number of dams of varying sizes are located throughout the site and support agricultural / grazing land uses. The southern boundary of the site borders on Woollaman Creek and Teviot Brook, which are part of the larger Logan Albert River system. A smaller unnamed tributary of Teviot Brook passes through the site from the north, with a catchment area of approximately 686 ha upstream of the site.

The site is generally low-lying, consisting of relatively flat floodplains adjacent to the main waterways as illustrated in Figure 2-1. Areas of higher ground associated with rolling hills are located around the fringes of the floodplain.

Table 2-1 Lots within the Site

Lot	Plan	Area (ha)
11	SP310604	90.6
11	SP310604	84
27	S311174	14.5
12	S31468	5.7
27	S311174	56.8
27	S311174	9.7
12	S31468	42.1

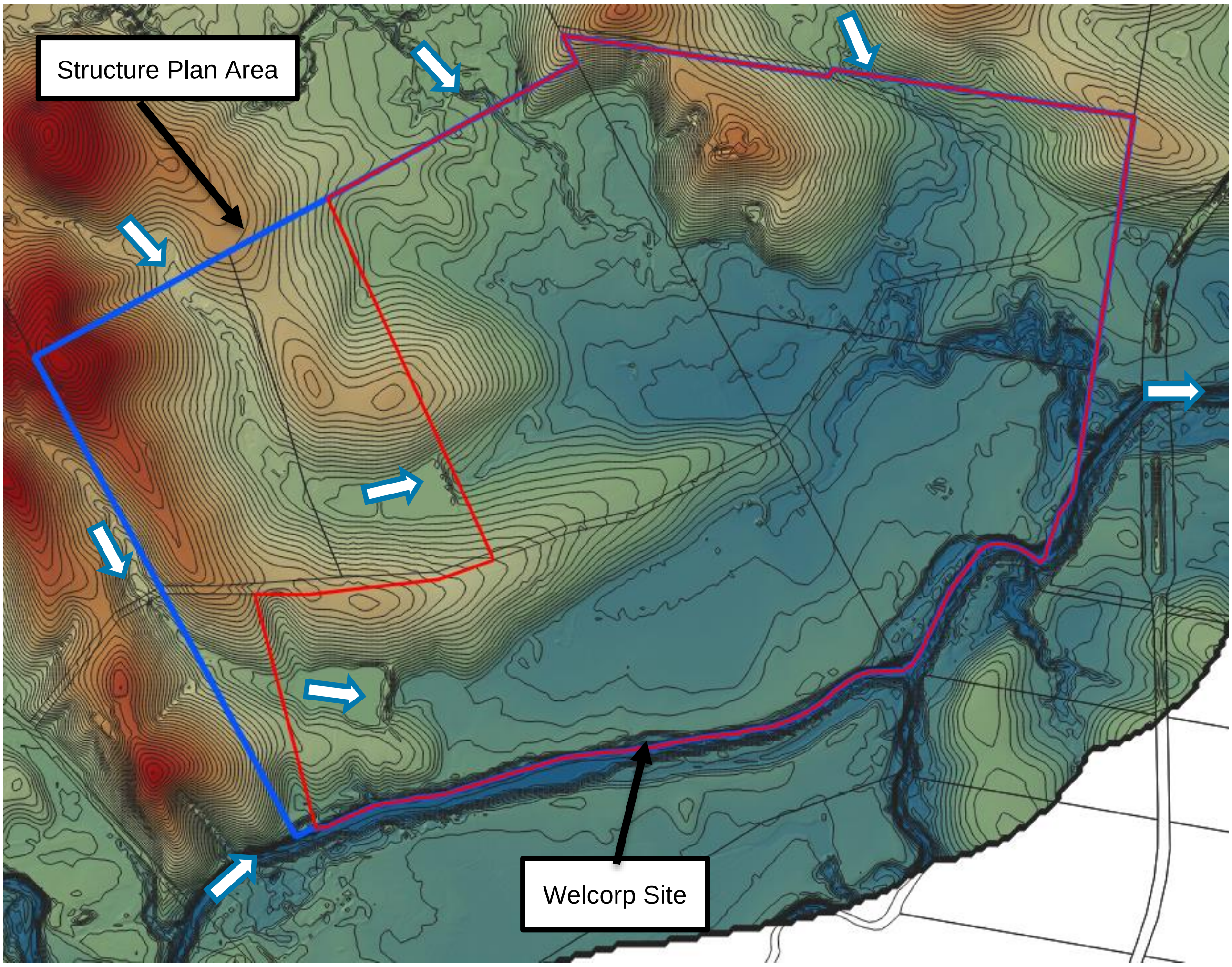


Figure 2-1 Site Topography 2017 LiDAR

2.2 Other Approvals

There is an approved development located immediately to the north of the site, referred to as ‘Flinders Precinct 1’. The development includes a large lake system which discharges onto the site as illustrated in Figure 2-2. The potential for the upstream development to impact on the site was assessed in the report *Flinders Precinct 1: Flood Impact Assessment* by BMT WBM Pty Ltd and dated April 2017 (BMT 2017), which has been stamped approved (reference DEV2017/844 approved 25 October 2017).

The analysis by BMT indicated that the proposed lake will provide sufficient attenuation of runoff from the development to achieve non-worsening in peak discharge at the lake outlet for events up to and including the 1% AEP event. The report did not address other changes to runoff characteristics such as frequency and duration of discharge.

The BMT report indicated that further design works were required to support the preparation of the lake, including preparation of a Dam Failure Impact Assessment to understand the potential risks posed by the lake to downstream areas. The outcomes of any subsequent works is unknown.

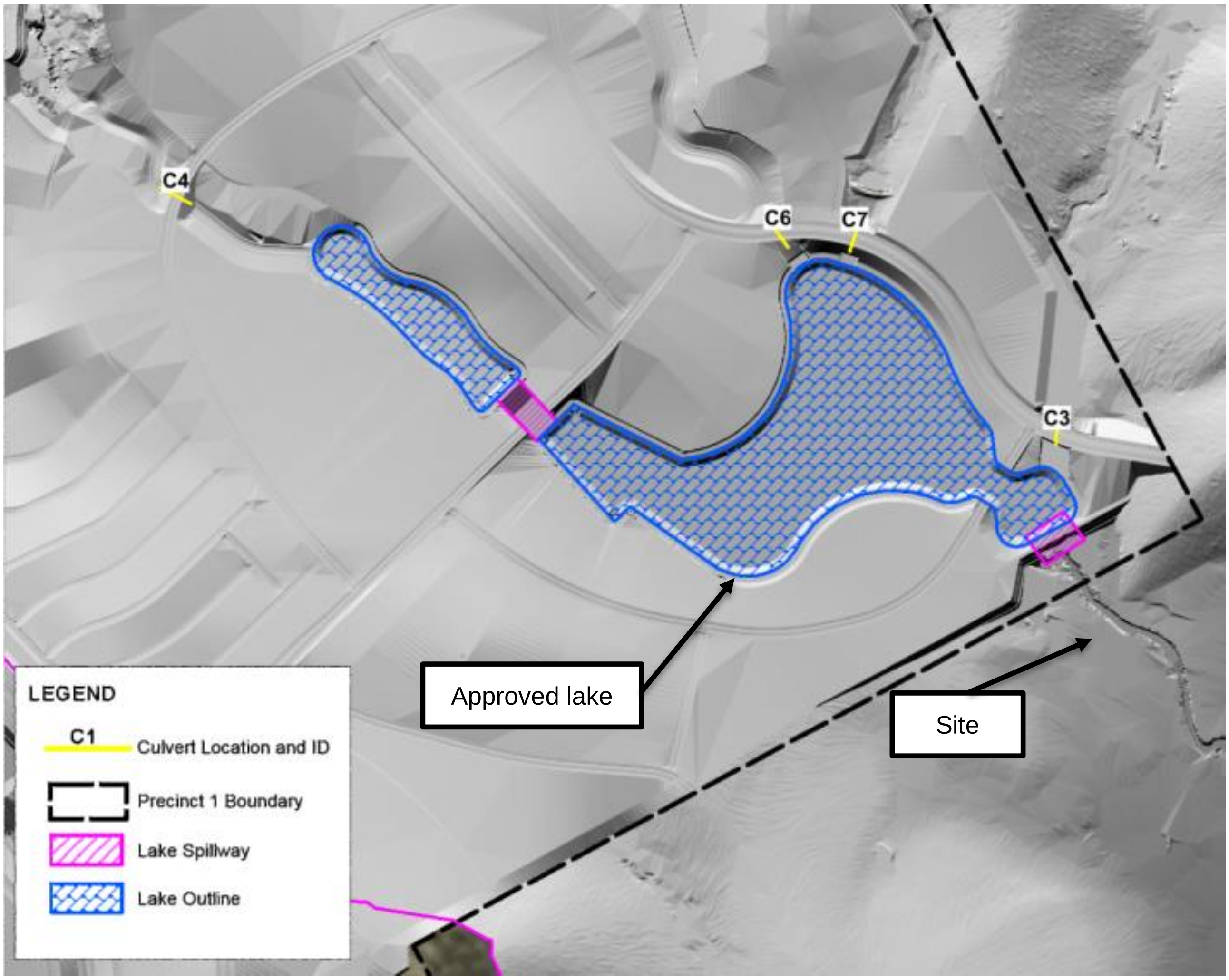


Figure 2-2 Approved Lake to the North of the Site (Source: BMT 2017)

3 PROPOSED DEVELOPMENT

The context plan outlines the extent and style of proposed development, as illustrated in Figure 3-1. The development is generally located outside of the regional flood extent associated with the Logan / Albert River system, which has resulted in vast areas of open space to be incorporated into the development.

For the purposes of the concept flooding and stormwater assessment, all development areas, except for the district recreation park, are proposed to be located above the regional defined flood event (DFE) level which will require localised earthworks / filling in some areas. The district sports park will be located at a minimum of the 5% AEP (20-year ARI) flood level. Stormwater quality infrastructure will generally be located within the open space areas skirting the development areas, noting that these devices have not been indicated on plans at this stage.

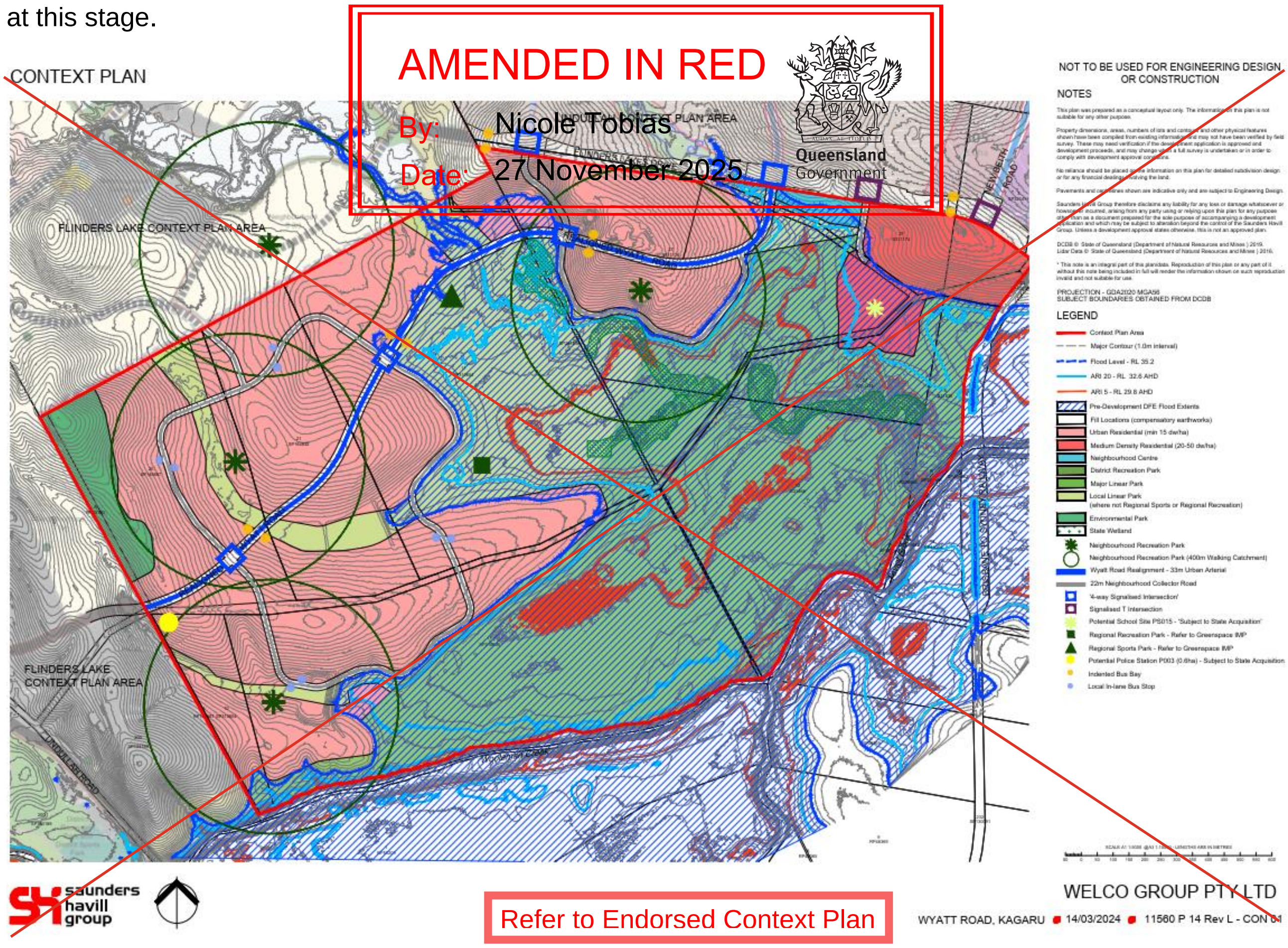


Figure 3-1 Proposed Context Plan (Source: Welcorp, 2024)

4 REGIONAL FLOOD ASSESSMENT

4.1 Overview

The waterways on the southern boundary of the site, being Woollaman Creek and Teviot Brook, are part of the larger Logan Albert River system, flooding from which can result in significantly higher flood levels than local flood events. LCC have recently adopted a revised Logan Albert River flood study, the most recent version of which is dated 2023 and was prepared by WRM (LARFS 2023). This flood study represents the latest available regional flood information for the site and has been adopted in assessing the proposed context plan against modelled flood levels and the proposed filling around fringes of the floodplain.

4.2 Council Flood Certificate

A flood certificate was issued for 325 Wyatt Road, Kagaru (Lot 11 SP 310604) by LCC dated 16 May 2023. The provided flood levels are provided below in Table 4-1. The flood levels provided by LCC were established as part of the LARFS (2021), having recently been superseded by LARFS (2023). The DFE within the LCC local government area is associated with the 1% AEP event with an allowance for climate change, which we understand to be the 4.5% RCP scenario which has subsequently been adopted for this assessment. The supplied levels are applicable to the entirety of the site, as there is very little variation in peak levels in the area upstream of the railway line.

Subsequent to the context plan and associated technical reports being submitted to EDQ, LCC updated the LARFS (LARFS 2023) and associated flood levels at the site. We understand that updates to the flood study include:

- areas with newer LiDAR data;
- further calibration effort in some areas associated with the February 2022 flood event; and
- climate change provisions have been added to all design events (formerly just the 1% AEP or DFE).

A comparison of the LARFS (2021) and LARFS (2023) flood levels at the site is included in Table 4-1. There has been no change in the 1% AEP level at the site, which indicates that there are no fundamental differences in the LARFS models at the site between the 2021 and 2023 versions. All other differences in the supplied flood levels are understood to be associated with the inclusion of climate change provisions in all design events in the LARFS (2023) version of the model.

Table 4-1 Regional Flood Levels Supplied by LCC

Flood Event	Flood Level (mAHD) Obtained May 2023	Updated Flood Levels (mAHD)	Notes
0.5% AEP	35.2	35.7	Updated level includes climate change provisions
1% AEP	35.2	35.2	No change
2% AEP	33.8	34.2	Updated level includes climate change provisions
5% AEP	32.6	33.0	Updated level includes climate change provisions
10% AEP	31.2	31.5	Updated level includes climate change provisions
20% AEP	29.8	30.1	Updated level includes climate change provisions

4.3 As-Received Logan Albert Flood Model

The hydraulic modelling files associated with the LARFS (2021), were obtained under license from LCC for the purposes of undertaking a hydraulic assessment of potential filling within the floodplain associated with the context plan.

WT was not supplied with ‘as received’ model results. Therefore, WT ran the temporal patterns nominated for each duration event in the supplied batch files for the 1% AEP-CC (with climate change) to establish the critical duration event applicable at the site. The results, as illustrated in Figure 4-1 indicate the critical duration at the site is 36 hours and temporal pattern 2.

We understand that the LARFS (2021) was established using TUFLOW version 2018. However, for the purposes of our assessment, the model was run using a more recent version of TUFLOW (2023-03-AC-iSP-w64) with the flag ‘Defaults == Pre 2020-01’. A validation test was undertaken with the resulting peak water surface level found to be within a few millimetres of the TUFLOW version 2018 results. Therefore, the updated TUFLOW version was adopted for this study.

It is acknowledged that the LARFS (2021) model has been superseded by LARFS (2023), however as discussed in Section Figure 4-1, there are no fundamental differences in the models in the vicinity of the site for the 1% AEP event and therefore the updated model has not been sourced from LCC.

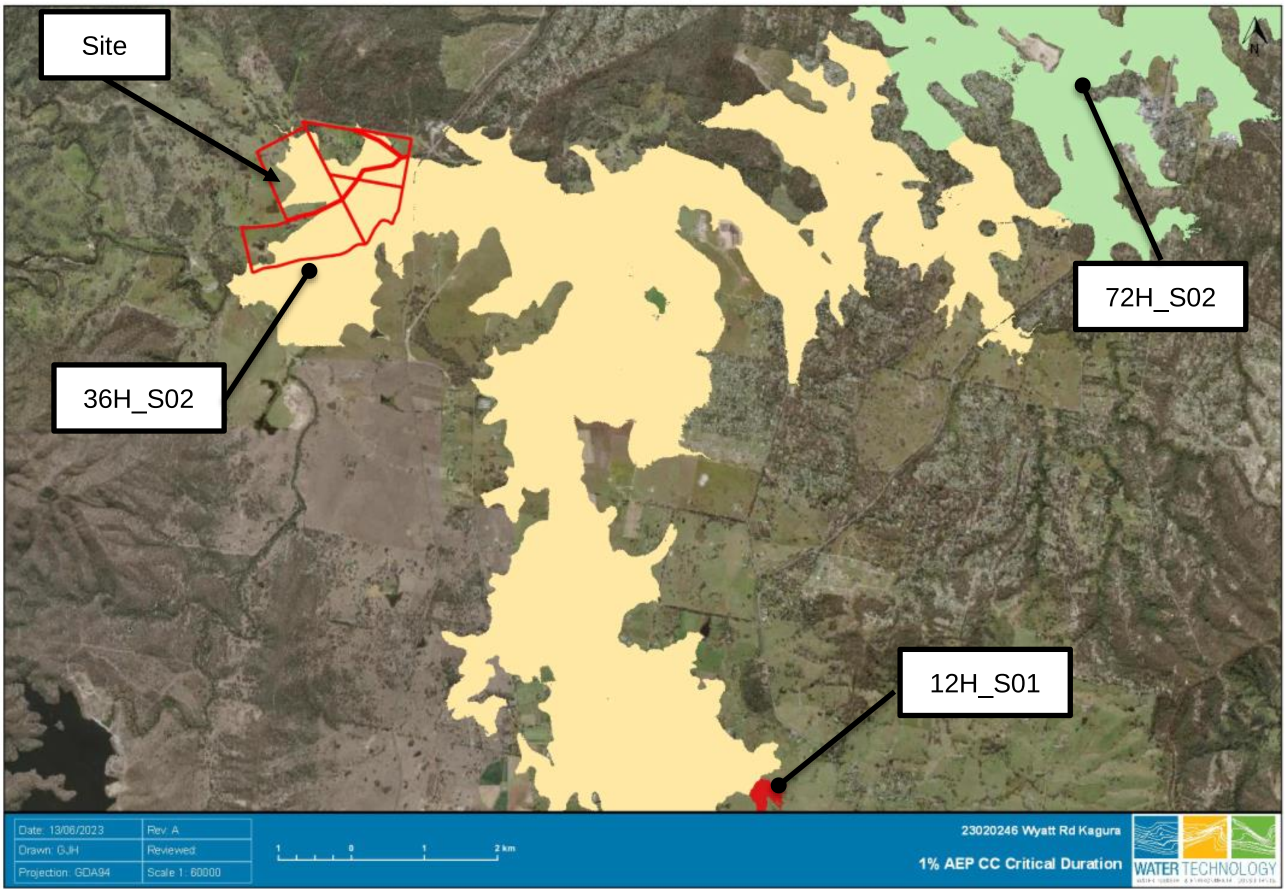


Figure 4-1 As Received Model Critical Duration Mapping – 1% AEP-CC

4.4 Representation of Context Plan Development

The proposed context plan has been represented in the regional TUFLOW model by ensuring that all the development areas meet the minimum flood immunity requirements. This has been achieved by making topographical modifications to the areas illustrated in Figure 4-2 as follows:

- Raising the areas of proposed residential / other development to above the DFE level
  - The areas of proposed fill have been restricted to areas of shallow inundation which outside of main conveyance pathways.
- Raising the realigned Wyatt Road to above the DFE.
- Modifying ground levels for the proposed district recreation park sporting fields to be at or above the 5% AEP flood level of 33.0m AHD, noting that no lowering of areas above the 5% AEP flood level have been applied. There may be scope to achieve balanced earthworks within the district recreation parks.

The above topographical changes resulted in filling within the DFE extent as illustrated in Figure 4-3. This illustrates that the filling is generally restricted to the fringes of the floodplain and is overall limited in depth.

The cross-drainage structures associated with the realigned Wyatt Road have not been assessed at this time. The revised Wyatt Road alignment has been represented in the hydraulic model as filled, with ‘gaps’ in the road at locations where upstream areas are subject to backwater inundation in a regional flood event. Cross-drainage provisions as either culvert structures or bridges can readily be addressed at a later design stage, and will primarily be designed to convey local stormwater runoff flows.

This assessment has also not considered the placement of water quality treatment devices (bioretention basins) around the perimeter of the development as this level of design detail is not yet available. The water quality devices are envisaged to be located within the fringes of the open space areas immediately adjacent to the development area. This may necessitate some minor additional localised filling to accommodate the filter media area and achieve the required flood immunity standard, noting that these devices do not need to be flood immune in the DFE and therefore do not require significant height of fill to construct. Further, this fill can readily be offset by localised compensatory earthworks.

This assessment has conservatively not considered the application of any compensatory earthworks which could be used to offset and otherwise mitigate the loss of floodplain storage available below the DFE level. Compensatory earthworks are envisaged to occur around the fringes of the development, as this will minimise the haulage distances for excavated material.

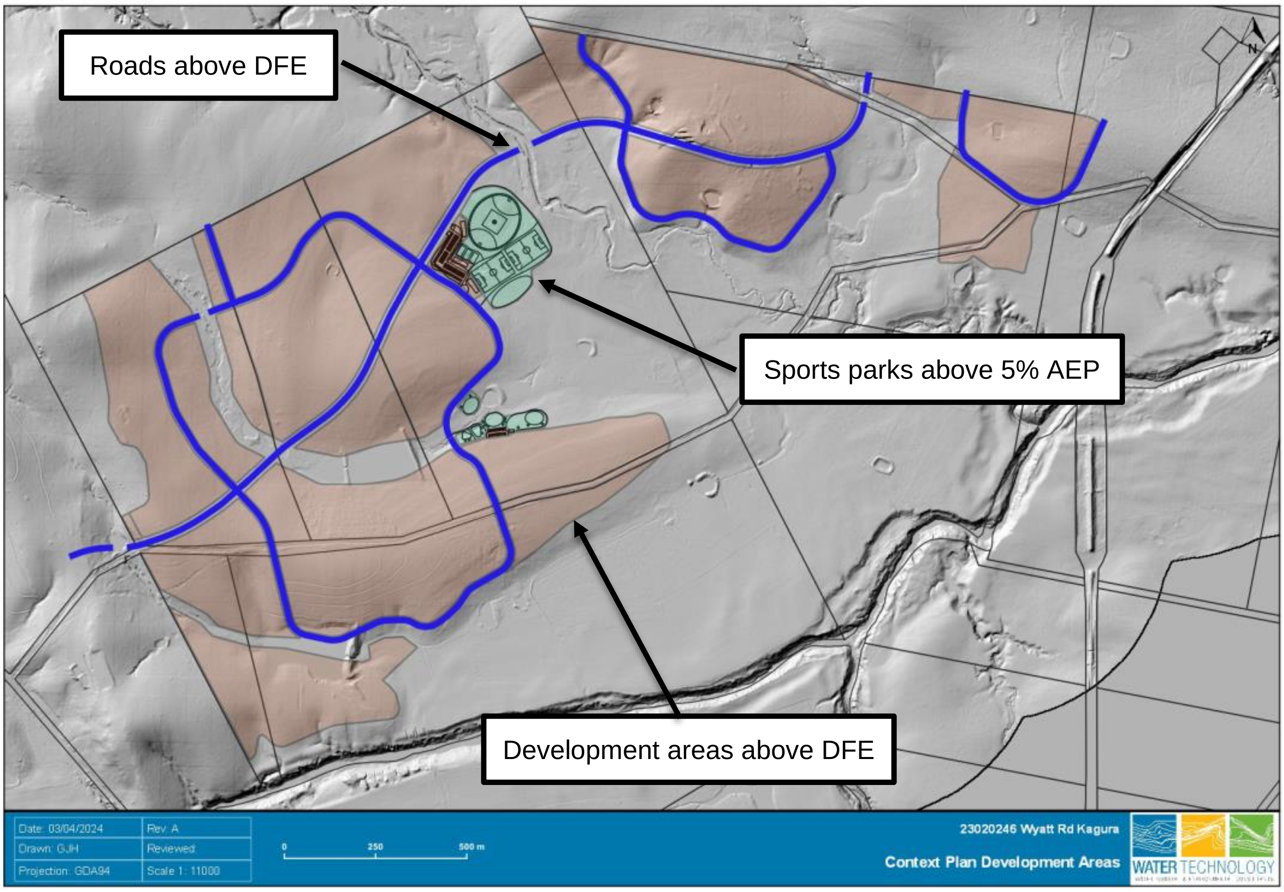


Figure 4-2 Context Plan Representation in Regional TUFLOW Assessment

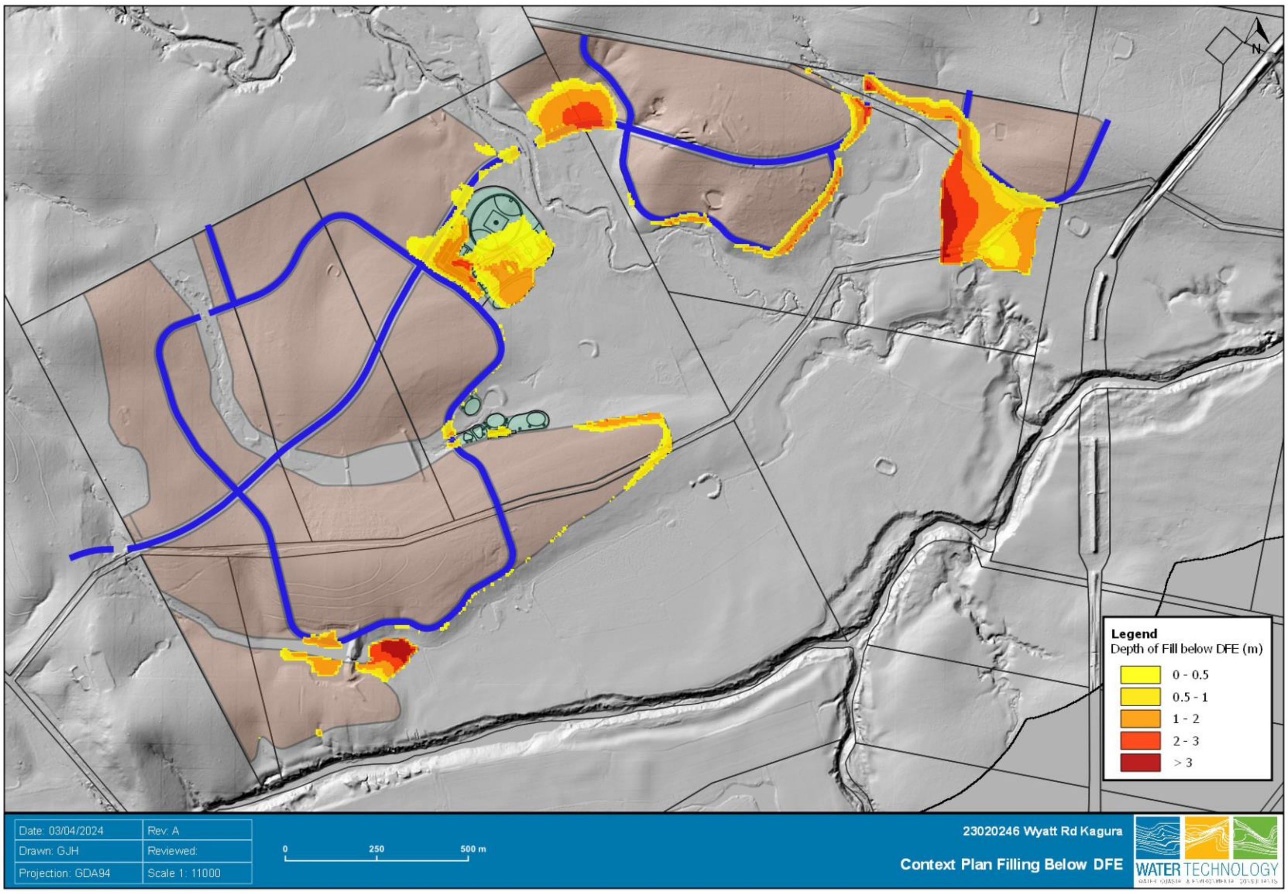


Figure 4-3 Context Plan - Filling Within DFE Extent

4.5 Regional Flood Impact Assessment

The potential for the filling to result in adverse offsite flood impacts has been assessed using the LARFS (2021) TUFLOW model with the inclusion of the above development scenario as topographical modifications for the DFE. The resulting change in peak water surface levels are illustrated in Figure 4-4. High resolution figures associated with the regional flood modelling are also supplied in Appendix A.

The analysis indicated that the targeted filling has resulted in no change in peak water surface levels either within the site or external to the site. This confirms that the limited extent of proposed filling is outside of any high-flow areas consistent with the majority of the floodplain within the site being a 'backwater' area with respect to regional flooding. Further to the above, the lack of adverse flood impacts has occurred without representation of compensatory cut, which is to be specified at a later design stage.

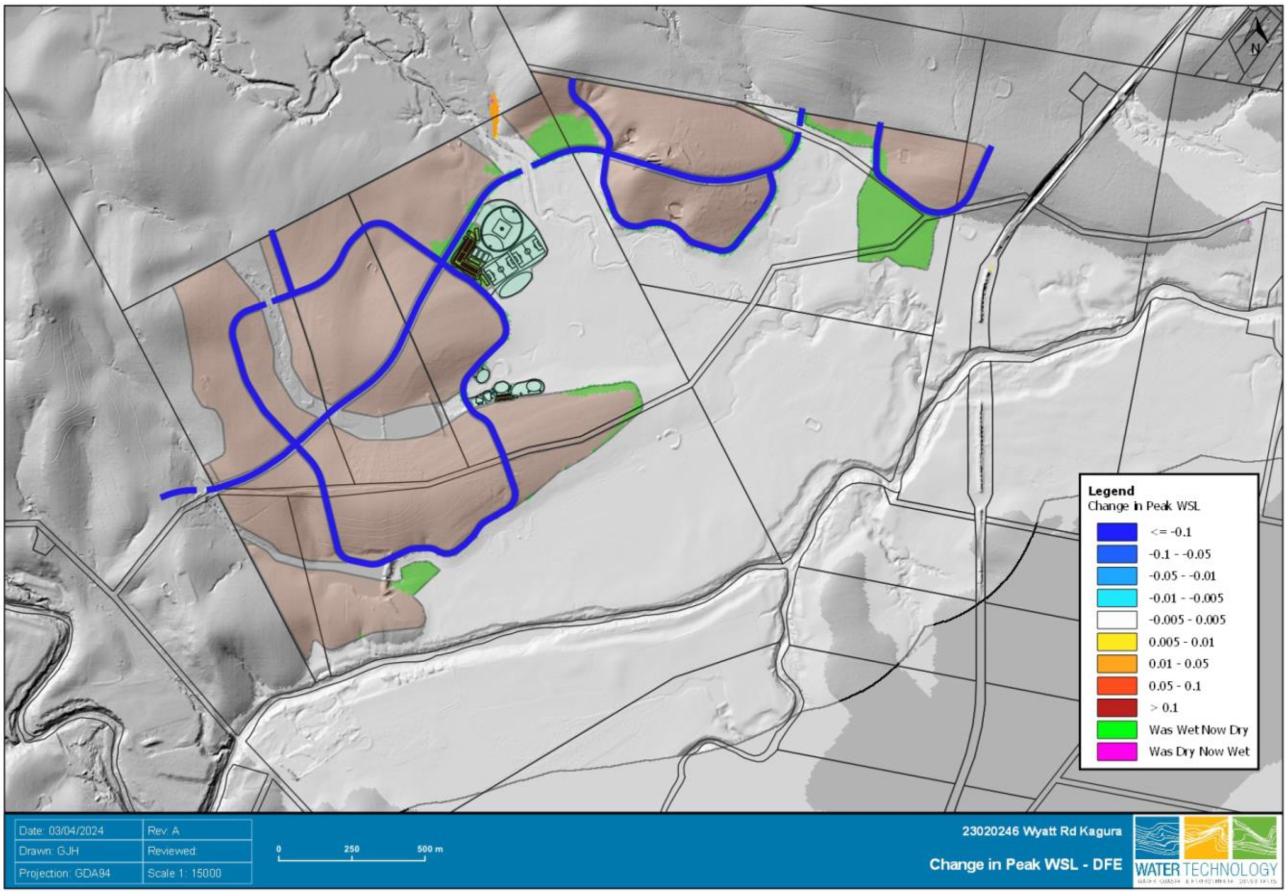


Figure 4-4 Change in DFE Peak Water Surface Levels with Site Fill

4.6 Review of Regional Parks

Each recreation park in the context plan has been reviewed in relation to the post-development 33.0m AHD ground contour (equivalent to the 5% AEP flood level) is illustrated in Figure 4-5 and Figure 4-6. All proposed recreation parks therefore meet the minimum flood immunity standards for a regional flood event. Refer to the discussion in Section 6 for local flooding considerations.

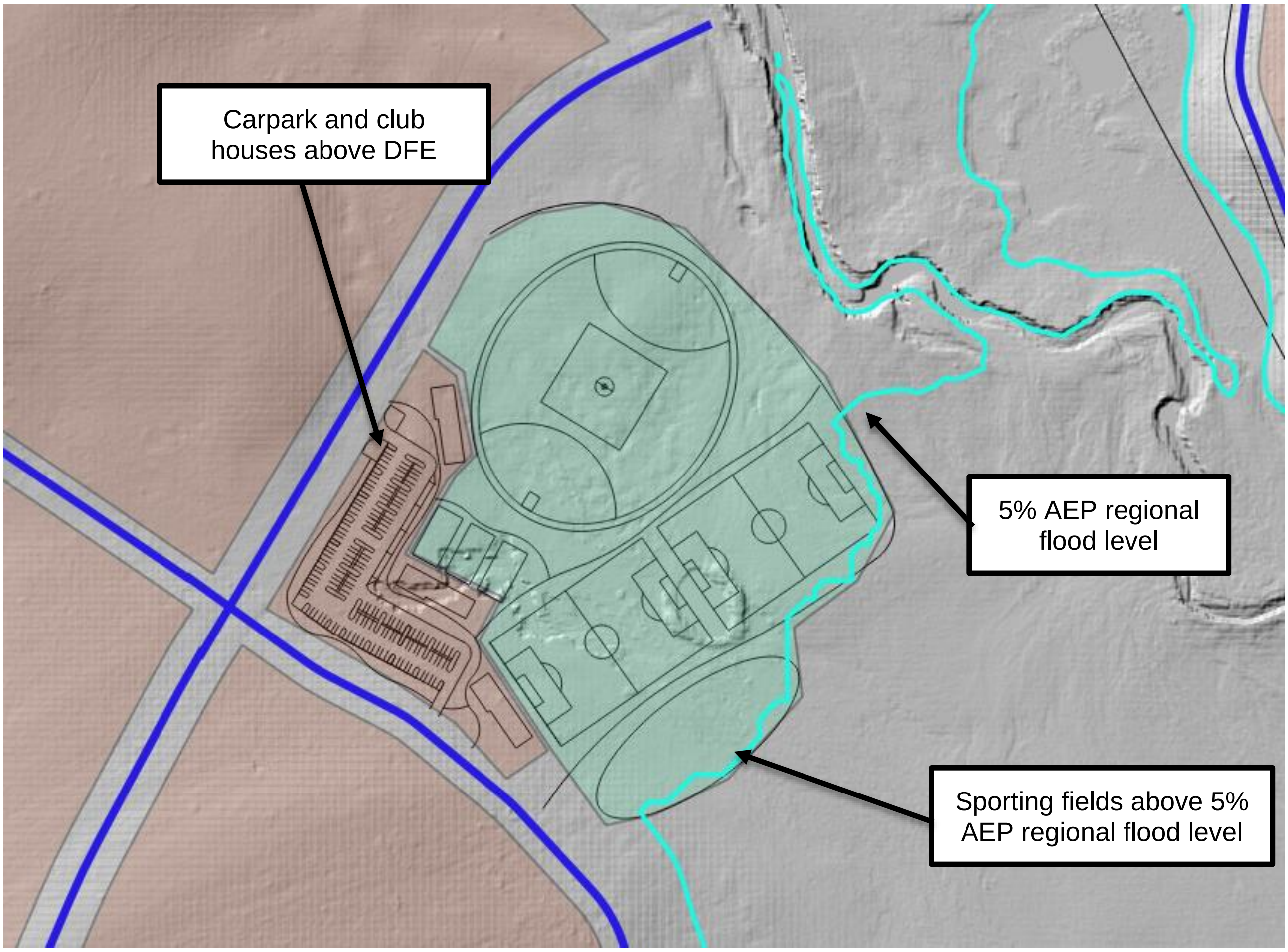


Figure 4-5 Recreation Parks and 33.0m AHD Ground Contour (5% AEP Level)

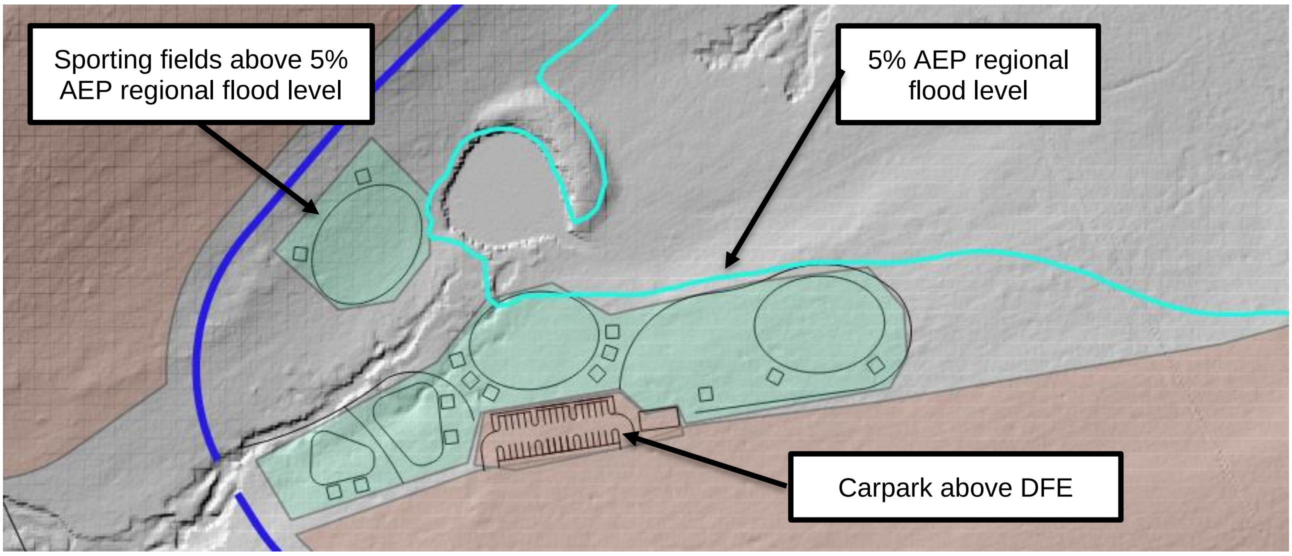


Figure 4-6 Recreation Park and 33.0m AHD Ground Contour (5% AEP Level)

5 SITE DISCHARGE ASSESSMENT

5.1 Overview

A site-specific 'local' hydrological model has been prepared for the purposes of:

- Assessing inflows to the site from upstream areas to ensure adequate waterway corridors are maintained,
- Assessing the potential for the development of the context plan area to result in increases in stormwater runoff, and
- Determine if development of the context plan area would result in a worsening in flows in the receiving waterway.

The local hydrological assessment has been completed using a WBNM hydrologic model and the Australian Rainfall and Runoff 2019 (ARR2019) methodology. The hydrologic models were validated to the Rational Method. Validated model hydrographs were used to inform inflows to a TUFLOW 1D/2D hydraulic model to quantify existing scenario flood extents and confirm that the areas of proposed fill will not result in adverse upstream flood impacts.

5.2 WBNM Model

5.2.1 Catchments

The sub-catchment delineation prepared for the site-specific WBNM model is illustrated in Figure 5-1 and the associated areas are presented in Table 5-1. The fraction imperviousness has been assumed to be zero for the entire local hydrological model in the existing scenario. This is consistent with the rural land use at the site and upper catchments. It is assumed that any subsequent development within the upper catchments will achieve non-worsening in stormwater discharge.

For the post-development scenario, the proposed development footprint has been assumed to have a fraction impervious of 0.8 for general areas, and 1 for the major road corridors. The delineation of impervious areas within the context plan area is illustrated in Figure 5-2 and resulting sub-catchment impervious fractions presented in Table 5-1.

5.2.2 WBNM Model Parameters

A catchment lag parameter of 1.6 was adopted in the WBNM model for the pervious portion of the catchment and 0.1 for the impervious catchment portion. These parameters represent standard values in accordance with the WBNM model guidelines. Stream lag factors of 1.0 have been used for all sub-catchments. Again, these parameters all fall within the recommended parameter guidance ranges for WBNM for undeveloped catchments.

5.2.3 Rainfall Intensity and Losses

The ARR Data Hub was accessed to obtain Intensity-Frequency-Duration (IFD) data and associated loss values for this assessment. We note that the initial loss from the ARR Data Hub was 24mm and the continuing loss was 1.6mm/hr, however this has been modified by StormInjector to account for rainfall pre-burst.

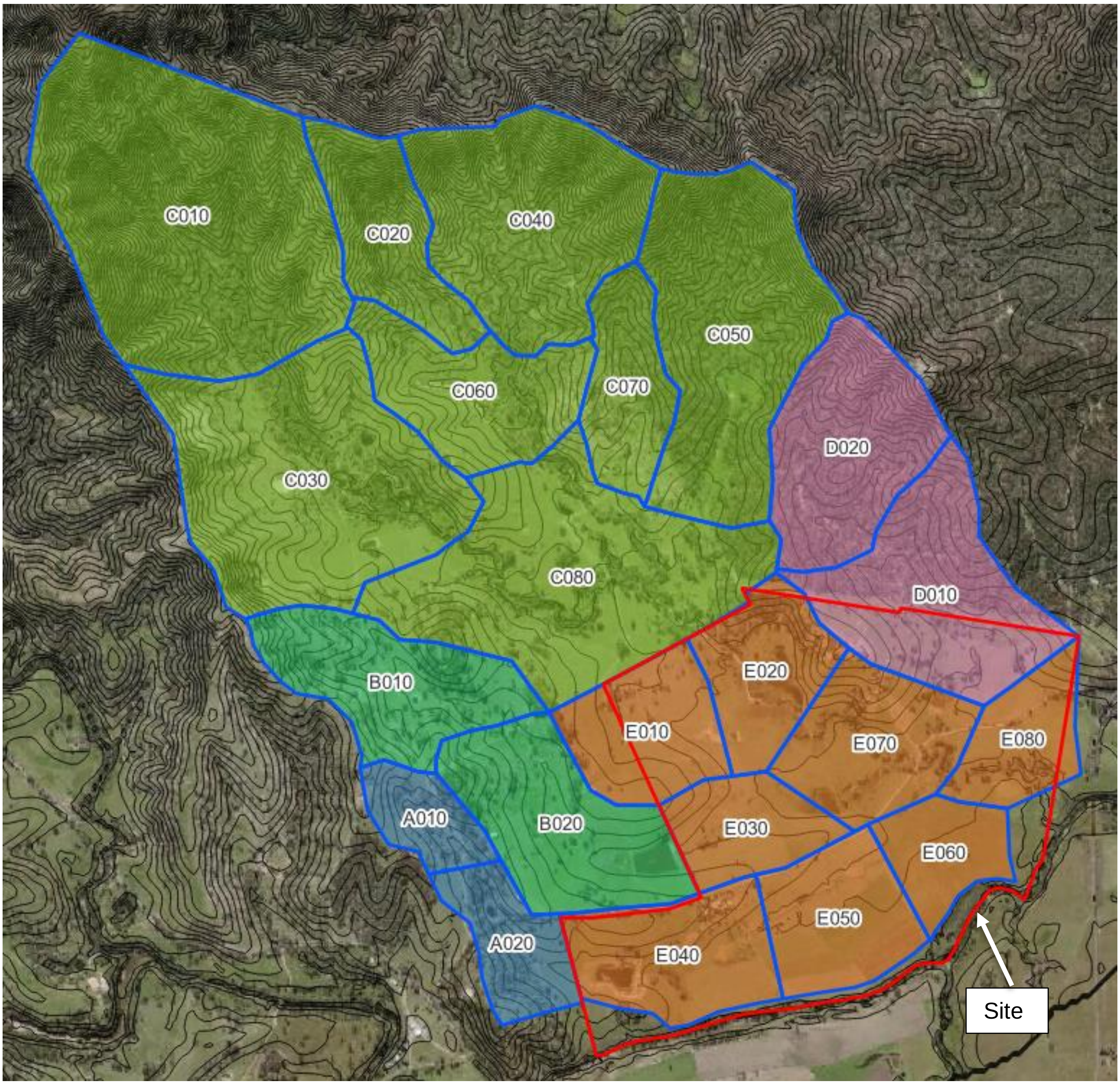


Figure 5-1 Existing Scenario Sub-Catchment Breakdown

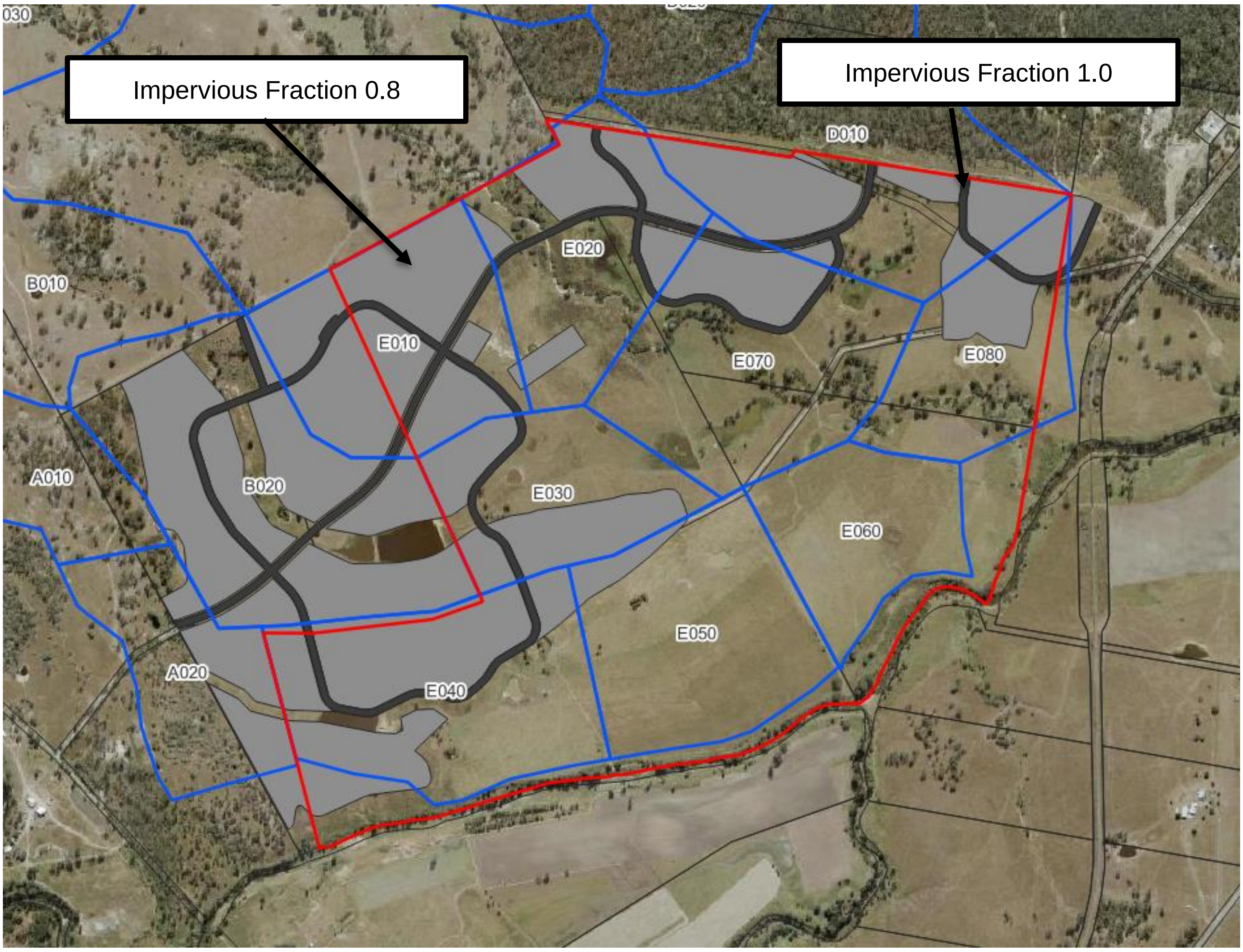


Figure 5-2 Developed Scenario Impervious Areas

Table 5-1 WBNM Sub-Catchments

Sub-Catchment Name	Area (ha)	Fraction Impervious – Exist (%)	Fraction Impervious – Developed (%)	Downstream Sub-Catchment
C010	152.19	0.0	0.0	C030
C030	38.15	0.0	0.0	C080
C020	116.78	0.0	0.0	C060
C040	83.67	0.0	0.0	C060
C060	48.43	0.0	0.0	C080
C070	31.48	0.0	0.0	C080
C050	96.44	0.0	0.0	C080
C080	116.32	0.0	0.1	E020
D020	59.25	0.0	0.0	D010
D010	69.52	0.0	22.7	E070
B010	52.10	0.0	0.0	B020
B020	58.83	0.0	58.9	E030
E030	27.56	0.0	43.9	E070
A010	18.03	0.0	0.3	A020
A020	25.57	0.0	24.4	E040
E040	44.66	0.0	48.0	E050
E050	37.71	0.0	4.9	E060
E060	23.42	0.0	0.0	E080
E010	37.53	0.0	83.7	E020
E020	35.23	0.0	36.0	E070
E070	44.72	0.0	16.9	E080
E080	27.11	0.0	25.0	SINK
Total	1,245			

5.3 WBNM Validation

The existing scenario WBNM models were run for a range of standard design events, durations and temporal patterns for the purposes of identifying the appropriate durations and temporal patterns for use in the hydraulic model as well as for model validation. The WBNM models were operated using StormInjector, which can be used to utilise ARR19 ARR Data Hub specified preburst rainfall and losses.

The WBNM design discharges were utilised for the local hydraulic modelling, as detailed in Section 5.7. For the purposes of validating the estimated flows and establishing the appropriate duration and temporal pattern, the average discharge at the outlet of sub-catchment C080 has been adopted. The outlet of this sub-catchment is located immediately upstream of the site and represents inflows from the largest external catchment to the site. This catchment was also analysed in detail by BMT (2017), allowing a direct comparison of modelling results.

The peak discharges at sub-catchment C080 are included in Table 5-2.

Table 5-2 WBNM Estimated Peak Discharge at C080

Design Event	WBNM – Average Flow (m^3/s)	WBNM Critical Duration	WBNM Median Temporal Pattern	Adopted TP Peak Flow (m^3/s)
1% AEP	79.6	1.50 hour	TP3	79.3
2% AEP	64.0	2 hours	TP8	64.1
5% AEP	46.7	3 hours	TP4	48.0
10% AEP	36.4	3 hours	TP8	37.2
20% AEP	26.0	4.50 hours	TP8	25.9
50% AEP	15.0	9 hours	TP6	15.3
63% AEP	12.1	12 hours	TP4	11.7

5.3.1 Calibration / Validation of Hydrologic Models

Being a site-specific investigation of an ungauged local catchment, there is no site-based data to validate the WBNM modelled discharges from the site. Accordingly, the WBNM hydrologic model has been validated against the Rational Method (RM) as per the Queensland Urban Drainage Manual (QUDM).

The flow comparison was performed at the outlet of sub-catchment C080, being the critical location for establishing potential flowpaths through the site from the largest external catchment. The key parameters used for the RM calculations include:

- Catchment area of 686.5ha;
- C10 of 0.53 (assuming medium cover bushland with medium soil permeability with 10% AEP, 1 hour rainfall intensity of 55.7mm/hr); and
- Time of concentration of 93 minutes (average catchment slope of 4%, assumed average stream velocity of 0.8m/s).

A comparison to the RM is summarised in Table 5-3. The RM closely matched the WBNM estimates for the adopted temporal pattern (TP) for events from the 1% AEP to 10% AEP, being within 10% of the WBNM flow estimates. For more frequent events, the disparity between the flow estimation measures increases, with the WBNM estimate up to approximately 30% less than the RM estimate for the 63% AEP event.

The disparity in results for the smaller, longer duration events is noted, however is not considered to be a concern as these events are not critical for design purposes. The RM is likely under-representing the losses associated with the increasing continuing losses of the longer duration events.

On this basis, the WBNM model is considered suitable for this assessment and has been adopted to inform design inflows to the local hydraulic model and estimate potential differences in peak flows associated with the development of the context plan area.

Table 5-3 Comparison to Rational Method at Sub-Catchment C080

Design Event	RM (m^3/s)	WBNM – Adopted TP (m^3/s)	Difference (%)
1% AEP	76.7	79.3	3.3
2% AEP	65.1	64.1	-1.6
5% AEP	49.8	48.0	-3.6
10% AEP	40.6	37.2	-8.4
20% AEP	32.9	25.9	-21.4
50% AEP	20.8	15.3	-26.4
63% AEP	17.3	11.7	-32.1

5.3.2 Comparison to Upstream Study

The WBNM generated peak discharges from this study have been compared to those reported by BMT (2017) at the respective model outlets, as illustrated in Table 5-4. The comparison indicates a general agreement in the magnitude of peak discharges between the two studies, despite the differences in the studies such as:

- ARR19 IFDs and hydrological methodology Vs the ARR87 IFDs and methodology adopted by BMT:
- Different initial and continuing loss values: and
- Slight disparity in overall model size.

This further indicates that the WBNM generated hydrology is appropriate for the local catchment assessment.

Table 5-4 Comparison of Peak Flows to Previous Studies

Event	BMT Exist (m^3/s)	WT WBNM Exist – Adopted TP (m^3/s)	Difference (m^3/s)	Difference (%)
1% AEP	119.8	135.5	15.7	13.1
2% AEP	101.8	110.6	8.8	8.7
5% AEP	81.5	83.4	1.9	2.4
10% AEP	66.1	64.2	-1.9	-2.8
18% AEP	55.0	45.3	-9.8	-17.7
63.2% AEP	24.0	21.3	-2.7	-11.3

5.4 Change in Peak Discharge – Local Catchment

The WBNM models were used to investigate the potential for the development of the context plan area to result in an increase in peak stormwater runoff to the Teviot Brook, being on the downstream boundary of the model and representing the receiving waterway. This is represented by the peak discharge from sub-catchment node E080.

The analysis has indicated that development of the context area results in a marginal increase in peak discharge across all design events as presented in Table 5-5. The magnitude of increases is minimal and is in the order of 0.3m^3/s to 0.5m^3/s. For context, these increases are generally less than a 0.5% increase in the peak discharge to Teviot Brook for the 1% AEP to 10% AEP events. Proportionally, these increases are slightly higher for the smaller design events such as the 63% AEP.

The relatively minor change in peak flows is due to the larger upstream catchment dominating the magnitude of runoff, and the ability of the development runoff to reach the receiving waterway prior to the peak occurring from the upper local catchment.

The magnitude of the increase in peak discharge across the broad range of design events assessed is not considered to represent a fundamental change from the pre-development scenario.

Table 5-5 Comparison of Site Peak Discharge to Teviot Brook (E080)

Event	Pre-Development Average Discharge (m^3/s)	Post-Development Average Discharge(m^3/s)	Difference (m^3/s)	Difference (%)
1% AEP	135.7	136.1	0.41	0.3
2% AEP	110.5	111.0	0.51	0.5
5% AEP	81.2	81.5	0.35	0.4
10% AEP	62.7	63.0	0.26	0.4
20% AEP	45.1	45.5	0.40	0.9
50% AEP	26.0	26.5	0.50	1.9
63.2% AEP	21.1	21.6	0.52	2.5

5.5 Change in Peak Discharge – Receiving Waterway

The potential for the development of the context plan area to alter peak flow rates in the receiving waterway was also investigated using WBNM. To achieve this, the 'local' WBNM model was expanded to include the full catchments of Woollaman Creek and Teviot Brook. Details for these sub-catchments were adopted as per the LARFS (2023) study, with the sub-catchment mapping included in Figure 5-3 and sub-catchment areas and impervious fractions in Table 5-6.

The expanded WBNM model was re-run using StormInjector with aerial reduction factors applied as per the recommendations in ARR116. The resulting peak flows were not validated to the LARFS (2023) study, however, are considered appropriate for the assessment of comparative flows in the receiving waterway.

Two durations were considered for the assessment of peak flows in the receiving waterway, being:

a. The critical duration of the receiving waterway; and

b. A short duration storm event, nominally selected to be the 1.5 hour duration as per the 1% AEP critical duration for the local catchment.

The results of the critical duration comparison for pre and post-development is included in Table 5-7, which confirms that in the context of the entire catchment for the receiving waterway, the development of the context plan area will not result in any increase in peak flows in the receiving waterway. This is due in part to the critical duration of the entire catchment being in the order of 24 hours, whereas the local site catchment is significantly shorter at 1.5 hours.

The peak flows in the receiving waterway were also analysed for the 1.5 hour duration events as per Table 5-8. This analysis also indicated that there are no increases in peak flows in the receiving waterway for short duration events.

The above analysis indicates that the flows within the receiving waterways are dominated by the large (approximately 68,000 ha) upstream catchment area, and that the proposed development will not result in a worsening in flow conditions within the receiving waterway.

Table 5-6 Additional Upstream WBNM Sub-Catchments from LARFS (2023)

Sub-Catchment	Area (ha)	Impervious (%)	Sub-Catchment	Area (ha)	Impervious (%)
TB019	2,802	4.55	TB008	2,217	7.49
TB018	1,594	5.63	TB007	2,944	7.51
CARN001	2,160	7.08	TB006_OF	2,883	7
TB017	1,709	7.35	CROW002	1,482	5.17
TB016	2,181	6.91	CROW001	1,578	5.93
TB015	2,822	6.02	TB005_WD	1,206	5.88
SAND002	1,422	5.9	TB004	1,178	5.24
SAND001	2,625	6.85	TB003	810	5.5
FLGS001	2,459	6.01	TB002	758	6.83
BRC001	1,832	5.95	WOOL005	1,448	3.24
TB014	2,190	6.74	WOOL004	1,623	6.76
TB013	2,787	6.55	WP001	1,350	6.15
WALL001	1,657	6.74	WOOL003	1,144	12.55
TB012	2,628	7.11	WOOL002	775	29.54
SALT001	2,915	10.05	UND002	1,797	6.81
TB011	3,076	9.46	UND001	1,130	35.72
TB010	2,716	8.03	WOOL001	745	11.22
TB009	2,551	7.41	TB001	1,113	19.26
Total	**68,307**				

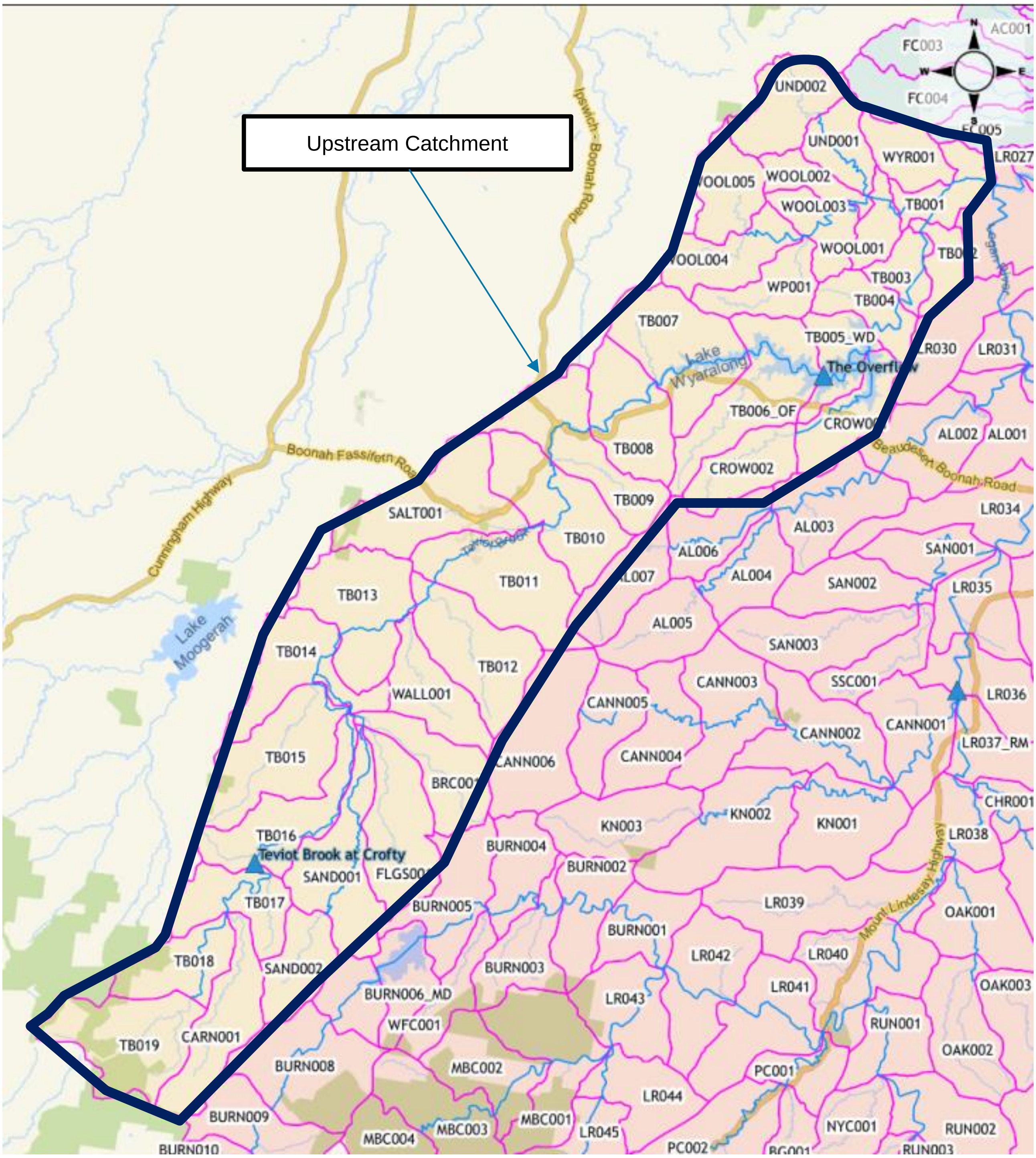


Figure 5-3 Upstream Sub-Catchments from LARFS (2023)

Table 5-7 Comparison of Critical Duration Flows in Receiving Waterway

Event	Critical Duration	Pre-Dev Average Discharge (m^3/s)	Post-Dev Average Discharge(m^3/s)	Difference (m^3/s)	Difference (%)
1% AEP	24 hours	1304.9	1301.0	-3.9	-0.3
2% AEP	18 hours	1059.7	1059.3	-0.4	0.0
5% AEP	18 hours	795.0	794.6	-0.4	0.0
10% AEP	18 hours	583.2	582.9	-0.3	-0.1
20% AEP	24 hours	412.1	411.8	-0.3	-0.1
50% AEP	24 hours	195.9	195.7	-0.2	-0.1
63.2% AEP	24 hours	147.5	147.4	-0.1	0.0

Table 5-8 Comparison of Short Duration Event Flows in Receiving Waterway

Event	Adopted Short Duration	Pre-Dev Average Discharge (m^3/s)	Post-Dev Average Discharge(m^3/s)	Difference (m^3/s)	Difference (%)
1% AEP	1.5 hours	564.0	562.1	-2.0	-0.35
2% AEP		441.0	439.5	-1.5	-0.34
5% AEP		289.4	288.4	-1.0	-0.34
10% AEP		225.0	224.2	-0.7	-0.33
20% AEP		163.6	163.0	-0.5	-0.32
50% AEP		82.5	82.3	-0.2	-0.25
63.2% AEP		60.7	60.6	-0.1	-0.20

5.6 Key Catchment Flowrates

The peak flow rates at a number of key locations within the WBNM model, being inflows from upstream catchments, and at the site discharge location to Teviot Brook, have been indicated in Table 5-9. The flow rates from catchments A to D will be used to inform the future design of stormwater infrastructure to convey stormwater through the site.

Table 5-9 Peak Flows at Key Locations

Location	1% AEP Peak Flow (m^3/s)	Critical Duration
A	7.5	1.50 hour
B	17.4	1.50 hour
C	79.3	1.50 hour
D	17.7	1.50 hour

Location	1% AEP Peak Flow (m^3/s)	Critical Duration
E	135.5	1.50 hour

5.7 Site Discharge Summary

The preparation of site-specific hydrological models has been used to demonstrate that the development of the context plan area would not result in a fundamental increase in peak discharge from the site to the receiving waterway without inclusion of any onsite stormwater mitigation (detention) infrastructure. Further, when considering the entirety of the catchment to the receiving waterway, the analysis has demonstrated no change in peak flow rates in the receiving waterway for both long duration and short duration rainfall events.

On this basis, onsite stormwater mitigation (detention) infrastructure should not be required to support the context plan.

6 LOCAL HYDRAULIC MODELLING

6.1 Overview

2D TUFLOW hydraulic models have been prepared for both the existing scenario and with the proposed context plan for the purposes of establishing the local 1% AEP flood depths and extents within the site and to confirm non-worsening on upstream and downstream areas. This is to provide a high-level assessment of the proposed filling at the site and to inform future design stages of stormwater conveyance requirements.

6.2 TUFLOW Model Details

A brief overview of the establishment of the local existing case 2D hydraulic model is provided below and is illustrated in Figure 6-1.

- The model extends from just upstream of the site boundaries down to Teviot Brook. The proposed lake on the upstream site has not been included in the model, with the upstream inflows applied at the proposed outlet location of the proposed lake.
- Inflow hydrographs have been applied from the local catchment WBNM model as discussed in Section 5. The corresponding upstream flows from Teviot Brook have also been applied.
- Topography is based on the 2017 LiDAR data, noting that the model was run on a 5m grid with sub-grid sampling enabled at 1m resolution.
- A downstream HQ boundary with a slope of 0.5% has been adopted within Teviot Brook. A fixed tailwater level was not adopted as peak flood levels within the site are dominated by a regional Logan Albert River system flood event and the intent was not to address coincidental flooding.
- A global Manning's roughness value of 0.04 to represent open space, which is consistent with the generally cleared nature of the site.
- Initial water levels applied for the larger dams and depressions noted to occur within the model extent for the existing scenario.
- No culverts or cross-drainage structures were included in the model.

The following updates to the TUFLOW were made to represent the proposed context plan area as illustrated in Figure 6-2:

- Adopt the post-development inflows, noting that inflow 'E010' was shifted south-east to immediately downstream of the recreation park.
- Apply filling at the site as per the regional flood assessment.
- Formalise the waterways through the site with conceptual width of 20m.
- Removal of the dams from the context plan area.
- Addition of some minor bunding to prevent shallow overland flow over the recreation park and development areas. The bunding may not be required once a formal earthworks plan is prepared for the site.

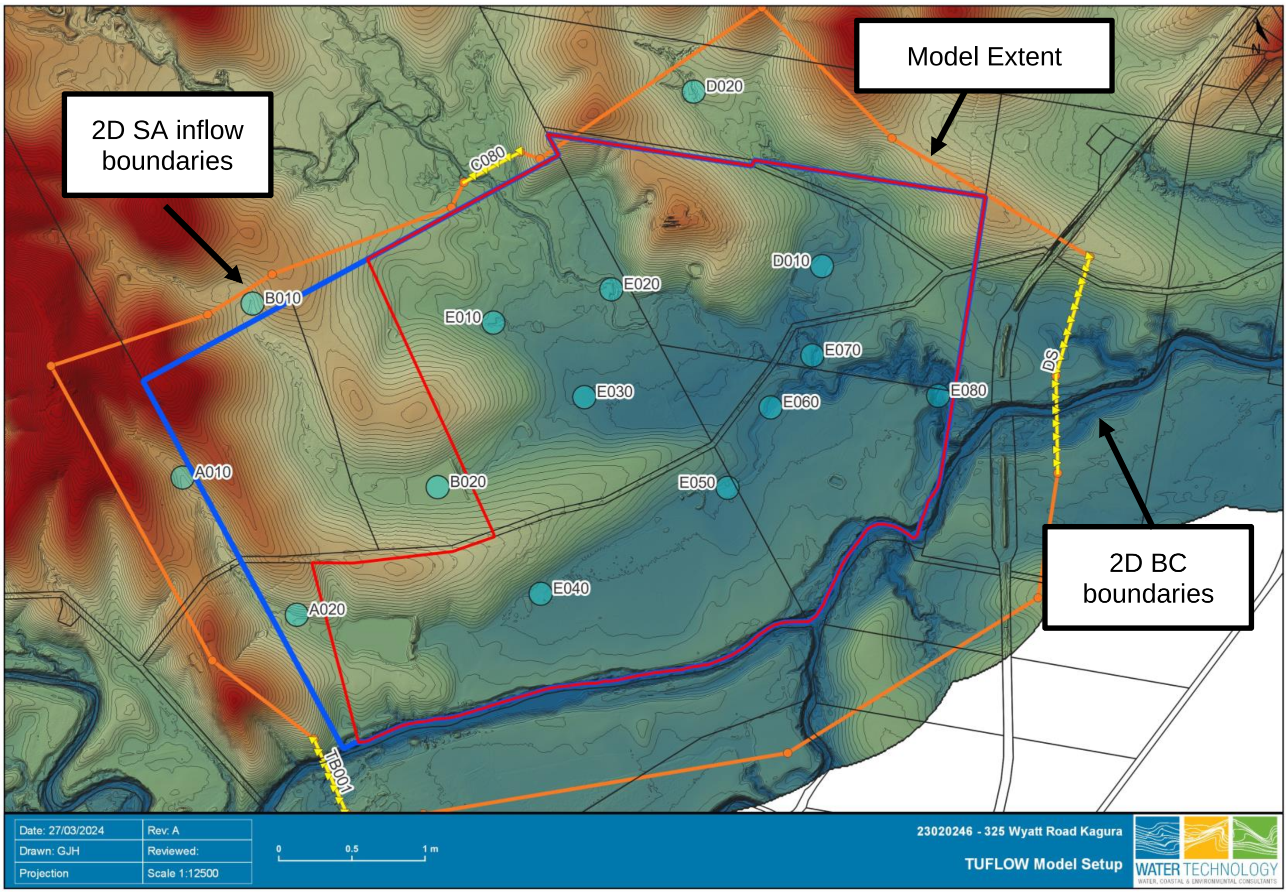


Figure 6-1 TUFLOW Model Setup

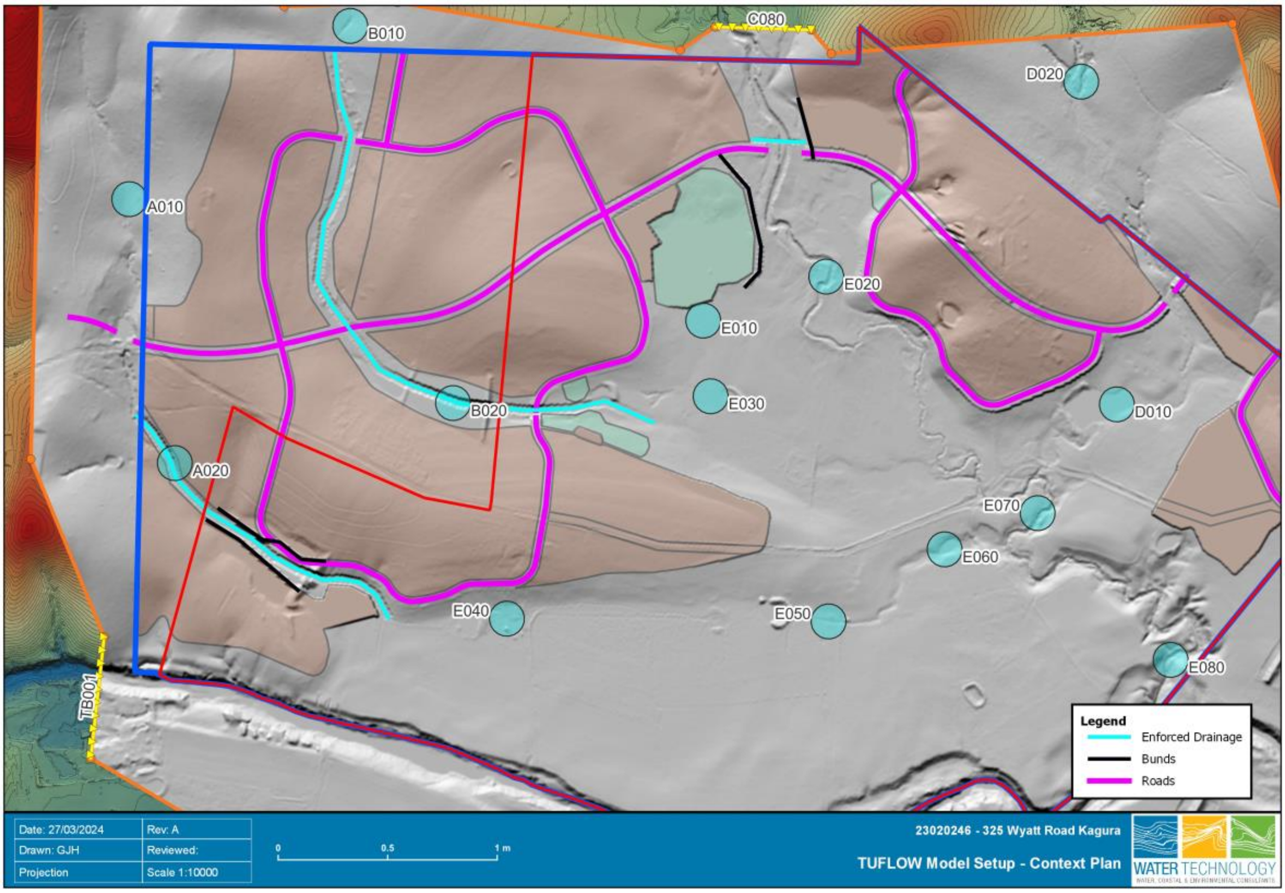


Figure 6-2 Developed Scenario TUFLOW Model Setup

6.3 Hydraulic Model Results

The local TUFLOW model was simulated for both the existing and developed scenarios. Existing and developed scenario flood depth results for the 1% AEP design event are illustrated in Figure 6-3 and Figure 6-4 respectively. High resolution local hydraulic model figures are also supplied in Appendix B. The difference in peak water levels is shown in Figure 6-5. The results confirm that the flood depths associated with a local 1% AEP event are significantly less than that of a regional flood event.

The following is a summary of the local TUFLOW model results:

- Some filling of the development area and/or formalisation of the waterways associated with waterways 'A' and 'B' in Figure 6-3 and Figure 6-4 will be required to achieve flood free areas for development. The modelling has indicated that a formalised channel can be accommodated within the waterway corridor.
- Removal of the existing dams in waterways 'A' and 'B' will significantly reduce the extent of inundation within the waterway corridors.
- The recreational park areas adjacent to waterway 'B' are not inundated in the local 1% AEP event with the formalisation of this waterway.
- The main inflows from the upper catchments, being waterway 'C' will require substantial cross-drainage capacity to be provided under the proposed road. This could be in the form of banks of reinforced concrete box culverts (RCBCs) or a bridge. Assessment of specific crossing types has not been undertaken at this stage.

- The recreation park area adjacent to waterway 'C' required provision of small bunds on the eastern side to prevent shallow overland flow breakout out across this area. This may be a product of not having a bulk earthworks surface available for this assessment. A small bund along the eastern perimeter of the recreational park would be preferable to filling the recreation park area to preserve the available floodplain storage volume.
- There were no issues observed with waterway 'D', again noting that cross-drainage structures have not been assessed at this stage.
- The change in peak water surface levels indicated that within the site there are localised areas with increased flood depths. However, these do not extend to the receiving waterway nor to upstream properties. On this basis, the increases are not considered a worsening in flooding conditions.
- The 2D hydraulic modelling has also indicated that the proposed development will result in non-worsening in flooding in the receiving waterway. Reference is also made to the hydrographs extracted from the TUFLOW model in Figure 6-6, which indicates that in the developed scenario the peak site runoff occurs sooner than in the existing case. However, with the influence of the upstream catchments, this does not coincide with the wider catchment runoff and therefore results in an overall reduction in peak discharge.

The above has confirmed that the development of the context area is compatible with the local flooding conditions.

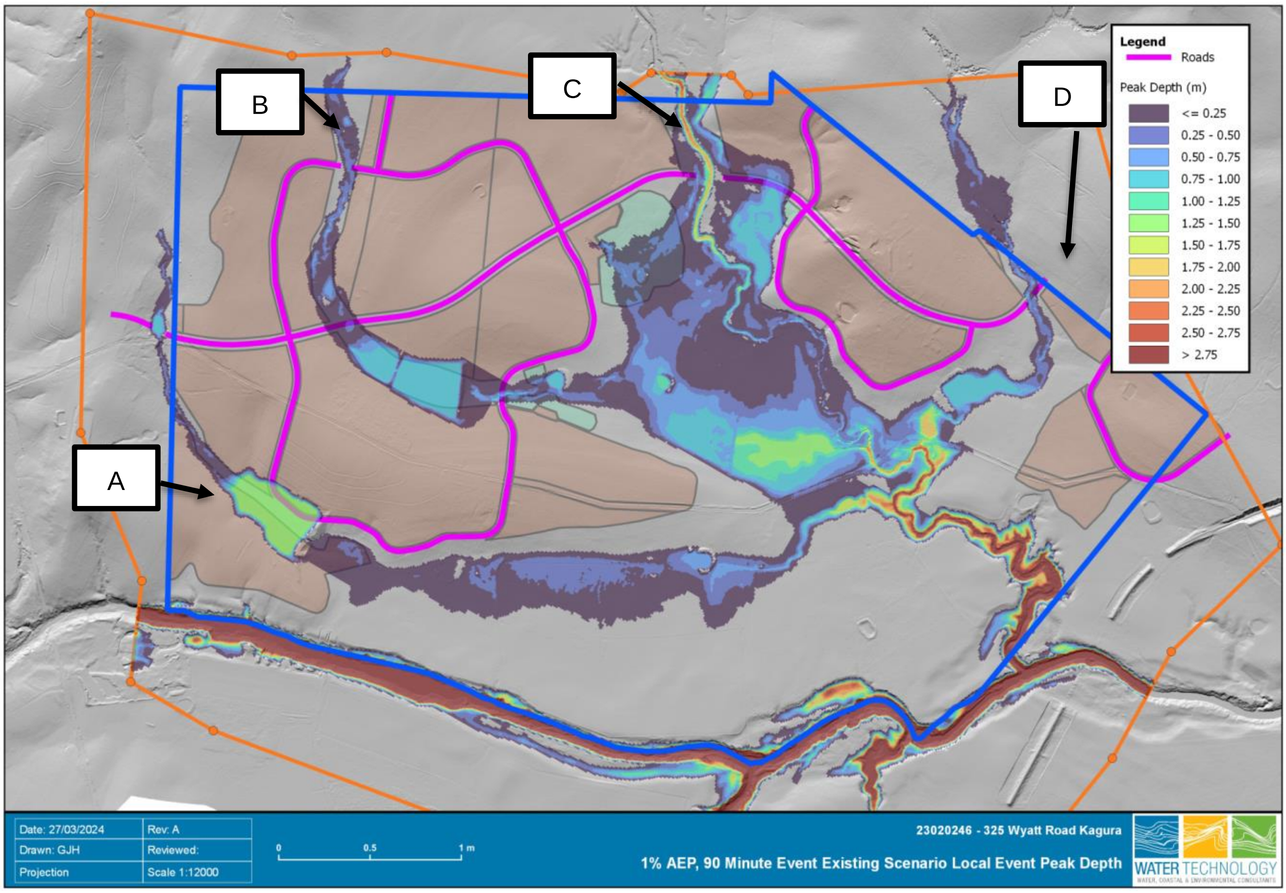


Figure 6-3 Local 1% AEP Existing Peak Depths with Context Plan Overlayed

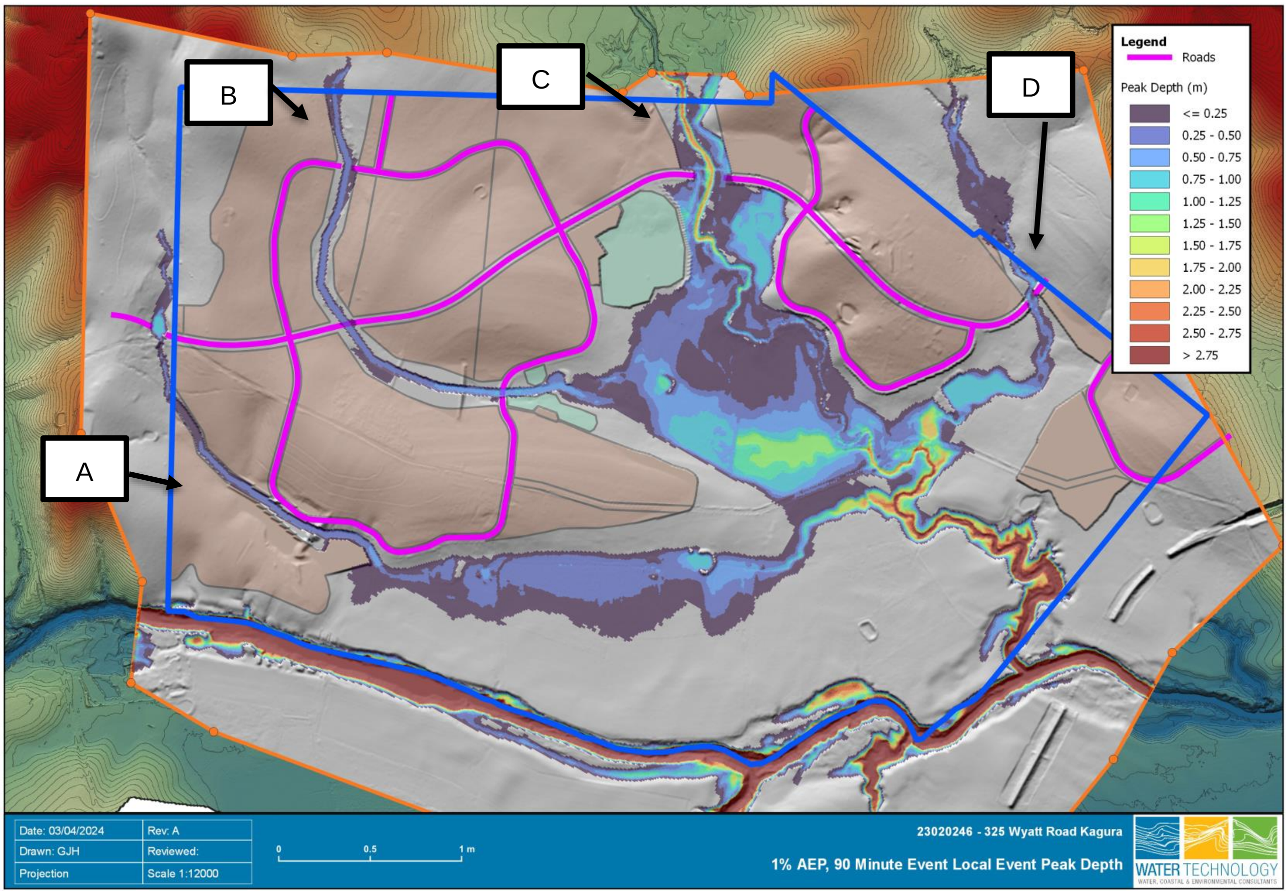


Figure 6-4 Local 1% AEP Developed Peak Depths with Context Plan Overlayed

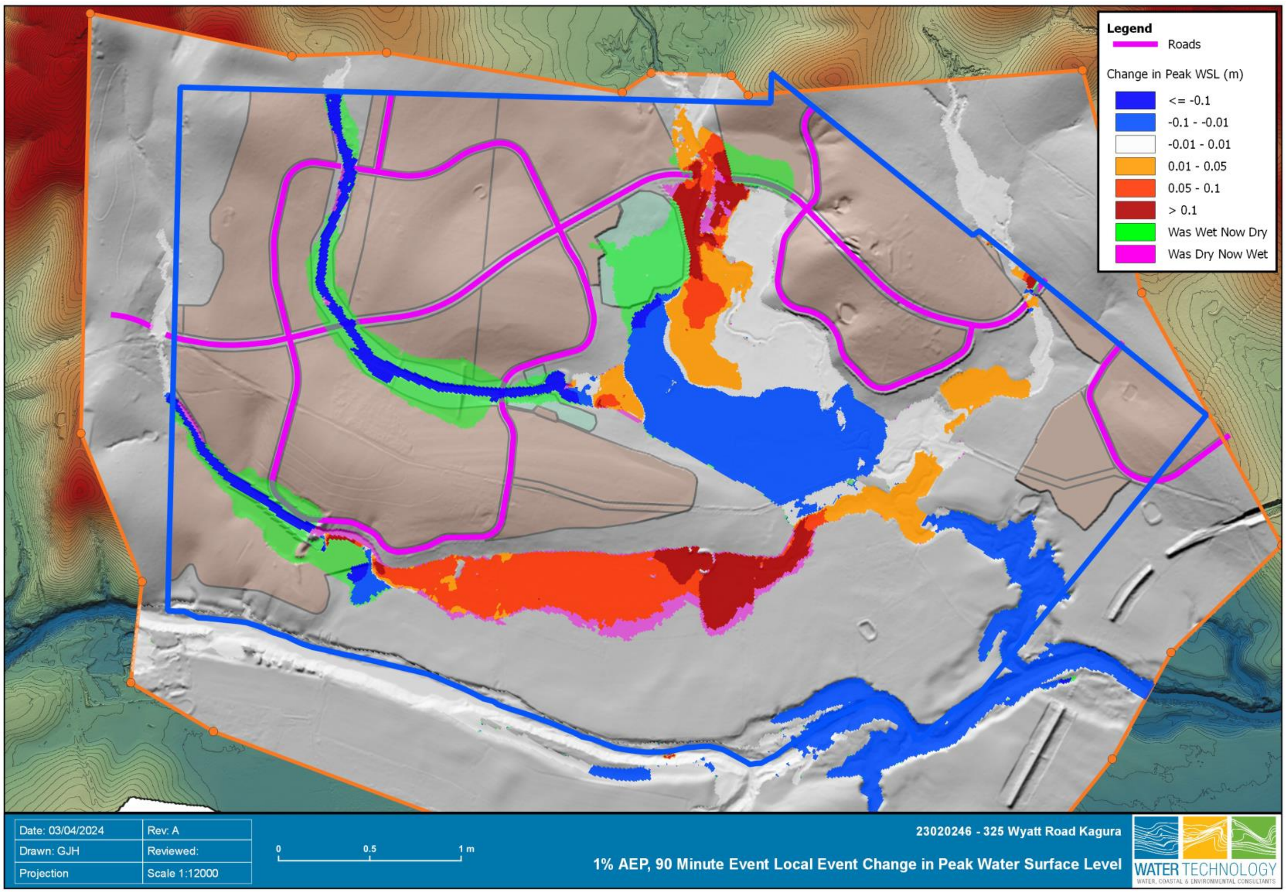


Figure 6-5 Change in Peak Water Surface Levels – Local 1% AEP Event

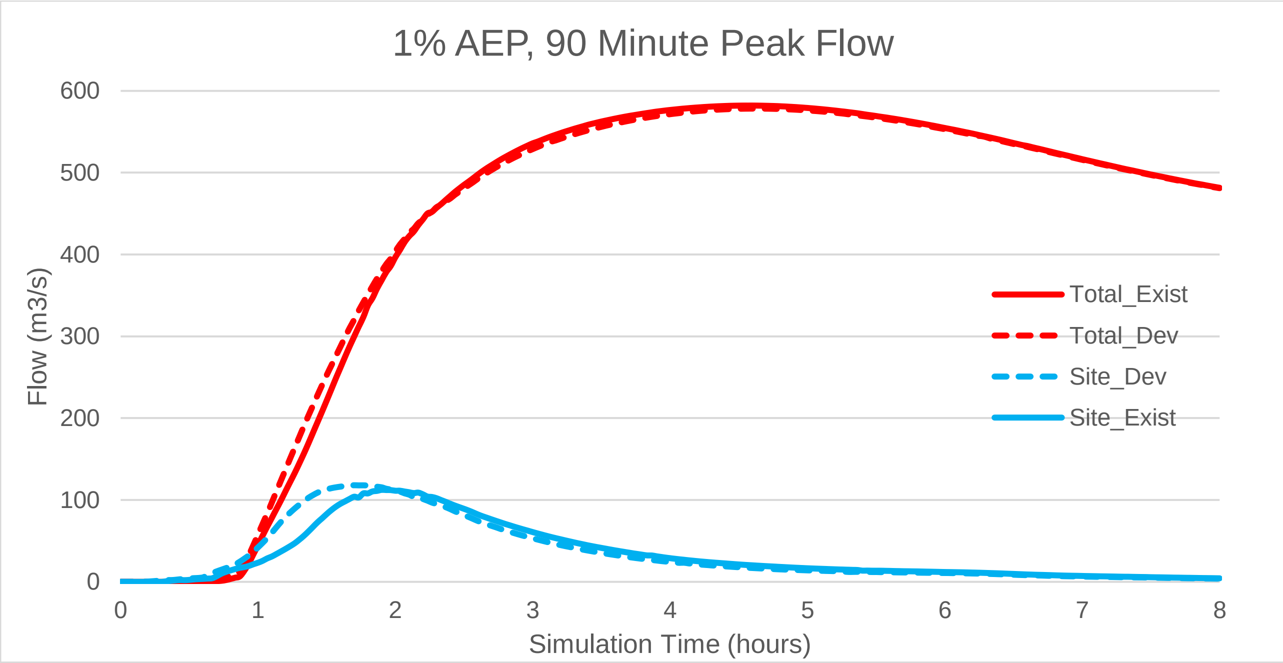


Figure 6-6 TUFLOW Extracted Hydrographs – Site Discharge and Model Discharge

6.4 Local Hydraulic Analysis Summary

The local hydraulic analysis has confirmed that the peak flood levels and depths at the site are dominated by the larger regional system. The flow paths which pass through the development are generally well defined and can readily be accommodated within future development at the site, noting that the cross-drainage structures will be subject to further detailed analysis at a later design stage.

7 STORMWATER MANAGEMENT STRATEGY

7.1 Overview

The proposed stormwater management strategy for the context plan area, specifically within the site boundary, is outlined in the following sections.

7.2 Stormwater Quantity Management

The strategy for stormwater quantity management for the proposed development generally consists of discharging stormwater from the entire site, inclusive of the external catchment areas, to Teviot Brook via the existing overland flow pathways which lead to the unnamed tributary of Teviot Brook as illustrated in Figure 7-1. No site-specific stormwater quantity mitigation infrastructure, such as detention basins, is proposed as flooding conditions within Teviot Brook are dominated by the larger regional watercourses rending onsite infrastructure ineffective and unnecessary. As has been documented in Section 5.4 and Section 5.5, non-worsening in peak discharge in the receiving waterway can be achieved without onsite detention basins.

Stormwater discharge rights are protected in perpetuity by virtue of both the unnamed tributary and Teviot Brook being defined watercourses under the Water Act 2000. Further, the short distance between the downstream site boundary and Teviot Brook is encumbered with an easement.

The above indicates that the site can satisfy the requirements for Lawful Point of Discharge without provision of dedicated onsite stormwater quantity mitigation infrastructure.

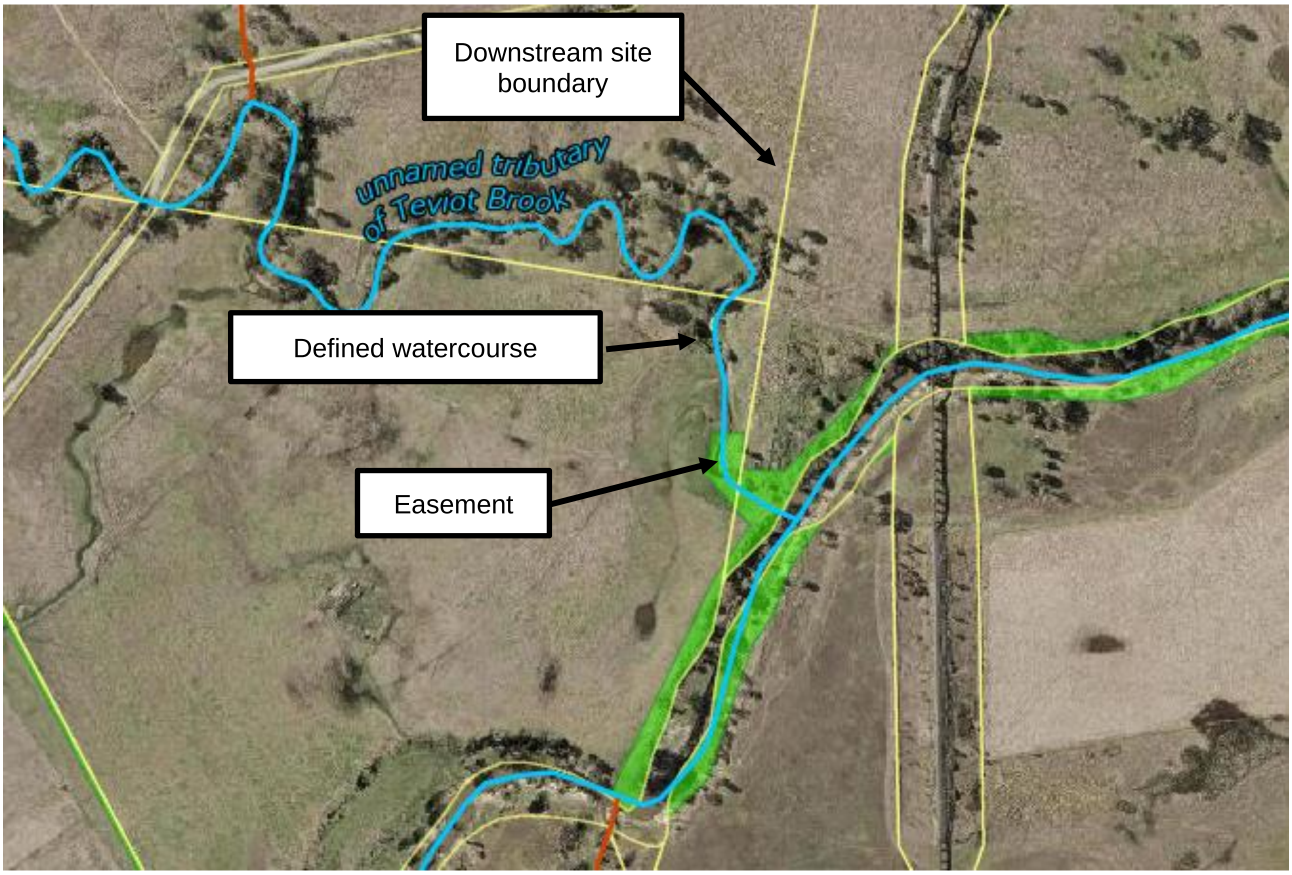


Figure 7-1 Downstream Site Boundary

7.3 Stormwater Quality Management

The strategy for stormwater quality management will be to locate bioretention basins within the open space areas around the fringes of the development area. The context plan lacks sufficient detail to provide detailed calculations regarding the location and sizing of individual treatment measures. However, a preliminary water quality analysis using MUSIC has been completed to establish the likely land-take requirements for water quality treatment.

A summary of the input parameters adopted for the water quality analysis is as follows:

- A nominal 10ha urban residential catchment has been adopted based on a density of 15 dwellings per hectare.
- The split catchment approach, assuming 25% as road, 32.5% as roof and 42.5% as ground level.
- Pollutant export parameters as per the MUSIC by Design Guidelines (2010) for urban residential.
- Climate data from the Bureau of Meteorology (BoM) for Logan City Council (west) representative gauges, being Greenbank Thompson Rd (Station Number 40659) and covered the period from the 1st January 1980 to the 31st December 1989.
- Bioretention basin parameters as follows:
  - No low-flow bypass or high-flow bypass;
  - Extended detention depth of 0.3m;
  - Saturated hydraulic conductivity of 200 mm/hr;
  - Filter depth of 0.6m;
  - TN Content of Filter Media of 400 mg/kg;
  - Orthophosphate Content of Filter Media of 30 mg/kg;
  - Vegetated with effective nutrient removal plants;
  - Basin lined with underdrain present;
  - Equal area (surface area and filter media area); and
  - Weir as 1/10th of surface area.
- MUSIC model schematic as illustrated in Figure 7-2.

The high-level analysis indicated that 700m^2 of bioretention filter media area was sufficient to treat stormwater runoff to achieve the State Planning Policy (SPP) 2017 pollutant load reduction targets from a nominal 10ha catchment. This represents 0.7% of the contributing development area.

The site can readily accommodate water quality devices within the open space area adjacent to the development. In the absence of specific flood immunity requirements for water quality devices in Guideline 12, it is proposed to adopt the stormwater quality device flood immunity standard required by LCC in the Flood Hazard Overlay Code (with TLPI) A026. The acceptable outcome for stormwater quality devices is to locate the high flow outlet (spillway) above the 5% AEP flood event by local or regional flooding. This means that the filter media will need to be located at or above 32.7m AHD to comply with this outcome when considering regional flood levels.

Further details regarding the specific location, sizing, orientation etc of bioretention basins will be completed at a later design stage.

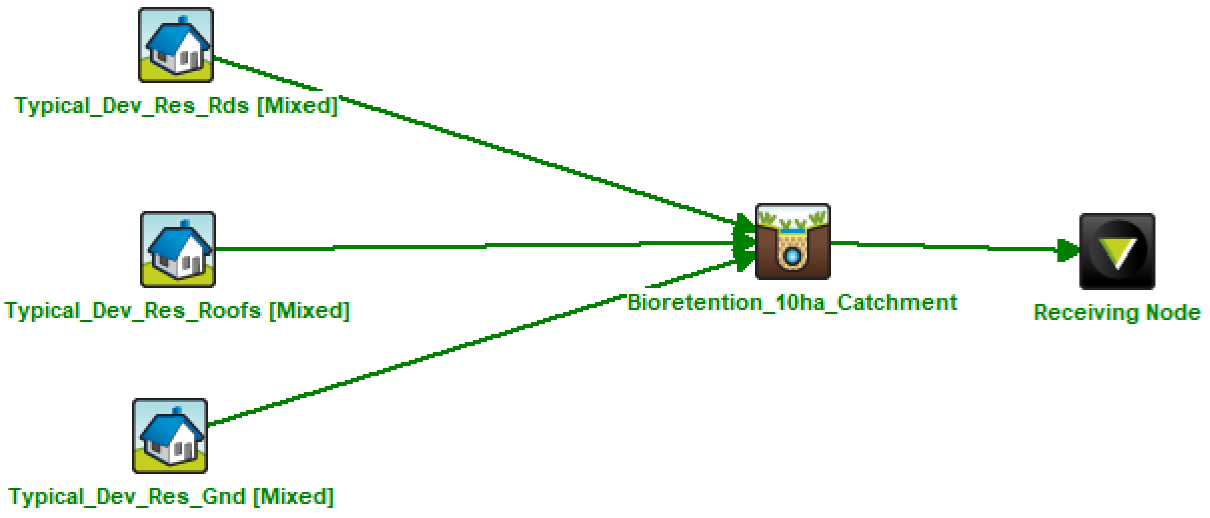


Figure 7-2 MUSIC Model Schematic

8 RESPONSE TO INFORMATION REQUEST

Formal Further Issues letters have been received in relation to the context plan previously submitted to EDQ. The following sections provide detailed responses to the items raised.

8.1 Further Issues Letter – 8 February 2024

Further Issues Item

12. Flooding

Provide additional information regarding the flood immunity of all parks. Upon review of the proposed plans it appears that the District Recreation park is heavily flood affected and while the open space is located above the 5% AEP as required by Guideline 12 it is noted that the Temporary Local Planning Instrument 1/2023 – Risk-based flood mapping and policy for the City of Logan and Framework for the Integration of Flood and Stormwater Management into Open Space have not been taken into account in the design. In addition it is noted that while the application material states that flood immunity can be achieved no specific information has been provided.

WT Response

The TLPI 1/2023 lists recreation and open space as compatible with the high-risk flood area providing it does not include an accommodation land use. Refer to Section 8.2.5.2 (Purpose) item 2.C. The TLPI and supporting documentation does not appear to include a minimum flood immunity standard for recreation parks and open space. On this basis, the 5% AEP flood immunity standard for the District Recreation Park as per Guideline 12 is the most conservative value, with no flood immunity standard applicable to the balance of the open space area.

Carparking associated with the park areas is however required to be above the DFE as per the TLPI unless proposing a risk-based management approach. The risk-based management approach detailed in the Planning Scheme Policy 10 appears to apply a maximum inundation depth of 300mm to carparks. For the context plan, there is very little difference in ultimate design levels by lowering the carpark 300mm below the DFE. For this reason, the carparks have been indicated above the DFE in the context plan.

Note that at a later design stage, further investigation of risk-based management approaches to parking for the parks areas may indicate a lower flood immunity standard could be adopted. This would be subject to further assessment and approvals by EDQ and is not being pursued at this time.

8.2 Further Issues Letter – 27 February 2024

Further Issues Item

4. Provide an updated stormwater management plan that clarifies and addresses the following:

    i. The need or otherwise to detain stormwater. If detention is required, provide indicative size/location of basins.
    ii. The requirement of compensatory earthworks.
    iii. That the stormwater management devices should generally be outside the extent of the 1% AEP flood.
    iv. That the development will maintain flood storage balance for all events up to and including 1% AEP flood.

WT Responses

i. The technical assessment of the local stormwater runoff has been expanded to include an assessment of the post-development stormwater discharge from the site, which has indicated peak flows from the site to the receiving waterway are fundamentally unchanged without inclusion of any onsite stormwater detention infrastructure, as per Section 5.4.

   Further, stormwater runoff from the site has been analysed in relation to the overall Teviot Brook waterway upstream of the site as detailed in and Section 5.5. This analysis has further confirmed that the proposed development would not result in any fundamental changes to the flow regime in Teviot Brook without inclusion of onsite mitigation measures.

   Based on the above technical analysis demonstrating non-worsening in the receiving waterway and the stormwater discharge rights being protected in perpetuity by virtue of both the unnamed tributary and Teviot Brook being defined watercourses under the Water Act 2000, the proposed context plan can be supported without inclusion of onsite detention infrastructure.

   The above has been detailed in Section 7.2.

ii. The TUFLOW model has been used to assess the full extent of proposed filling below the DFE level, which has demonstrated no adverse offsite flood impacts to a tolerance of 5mm <u>without</u> consideration of compensatory earthworks. Note that the PSP10 states that a 10mm tolerance for flood impacts is acceptable. This suggest that even without compensatory earthworks, no adverse offsite flood impacts shall occur as a result of the development of the context plan area.

   Notwithstanding this, the proposal is to provide compensatory earthworks however detailed bulk earthworks models have not yet been prepared at this stage. It is envisaged that the compensatory earthworks will occur generally above 31.0m AHD in the areas adjacent to the development footprint. This will minimise the haulage distances and maintain buffer areas to the existing waterways through the site.

   Due to the lack of offsite flood impacts as demonstrated in the regional TUFLOW model, the specific location of the compensatory earthworks is not critical for their function to preserve floodplain storage.

iii. The stormwater management devices required to support the development of the context plan area consists of water quality devices, most likely bioretention. Bioretention basins are designed to be frequently inundated with stormwater as part of their function. Therefore, there is little benefit to be gained from locating these devices outside of the DFE extent.

We propose to adopt the flood immunity standard required by LCC in the Flood Hazard Overlay Code (with TLPI) A026. The acceptable outcome for stormwater quality devices is to locate the high flow outlet (spillway) above the 5% AEP flood event by local or regional flooding. Adopting the LCC standard is considered appropriate as LCC will ultimately take ownership of the water quality assets. Provision of these basins at this level may require some localised filling in discrete locations around the perimeter of the development.

iv. The regional TUFLOW model has been completed without consideration of compensatory earthworks. It is envisaged that the development of the context plan area will be conditioned to achieve no loss in floodplain storage up to the DFE level. There are extensive areas of open space available in which to undertake compensatory earthworks.

Due to the lack of offsite flood impacts as demonstrated in the regional TUFLOW model, the specific location of the compensatory earthworks is not critical for their function to preserve floodplain storage. The compensatory earthworks can be detailed at a later design stage.

9 SUMMARY

Water Technology Pty Ltd (Water Technology) has been commissioned by Welcorp Group Pty Ltd (Welcorp) to prepare a Concept Stormwater Management Plan and Flood Assessment to support the proposed context plan for an area within the southern end of the Flagstone Priority Development Area (PDA). The context plan has been prepared over the area illustrated in Figure 1-1, noting that Welcorp do not control the western most portion of the structure plan extent which is otherwise excluded from this assessment.

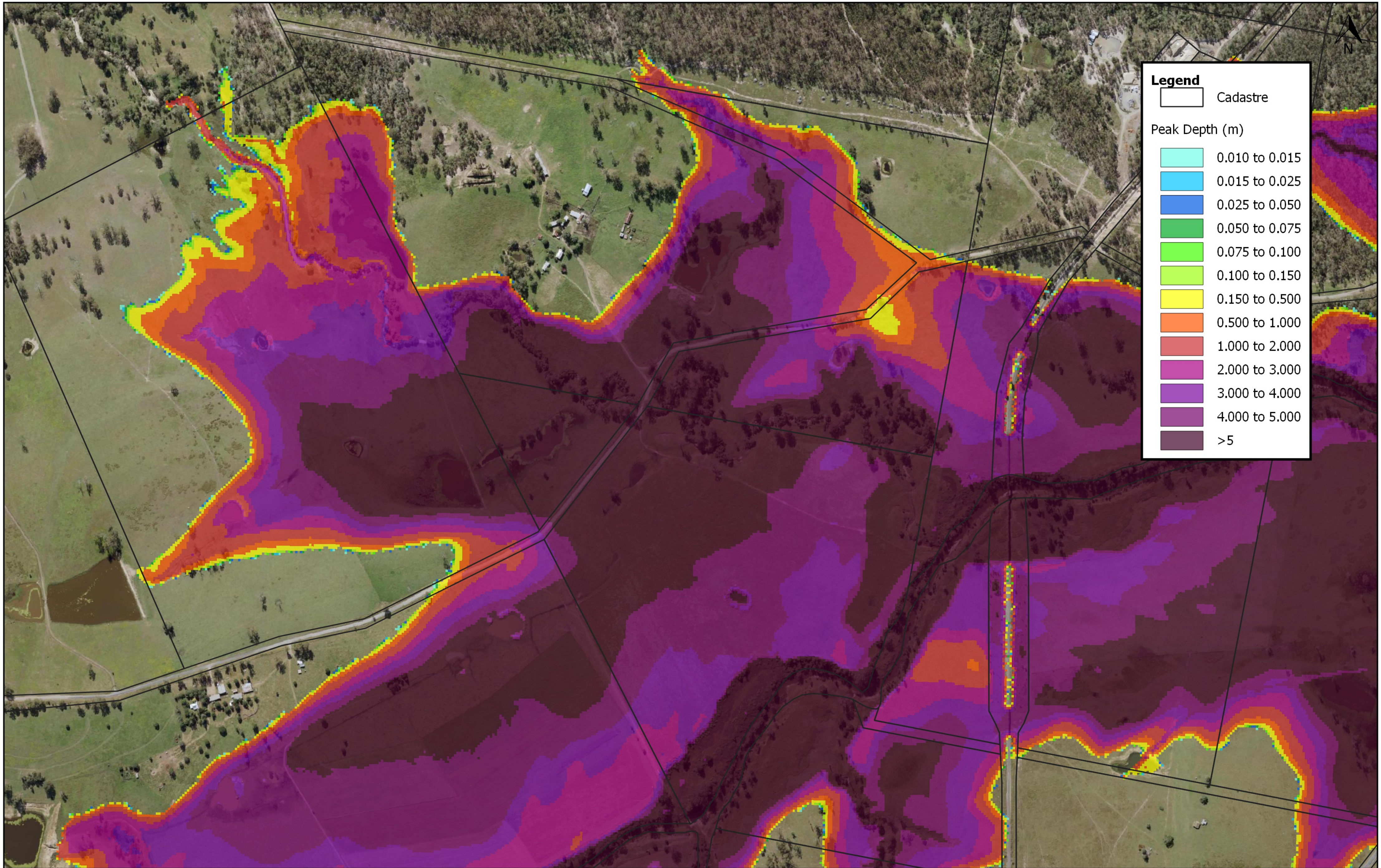
The site is located within the Logan City Council (LCC) local government area. However, as the site is also located within the Greater Flagstone PDA, development is administered by Economic Development Queensland (EDQ).

The key aspects of the flooding and stormwater management strategy relevant to the proposed context plan include:

- Development is to be provided above the DFE, as determined by the latest LCC flood study. Some relatively small areas of fill are proposed to rationalise the edges of the development and provide some additional developable area. A preliminary regional flood impact assessment has confirmed that this strategy will not result in adverse offsite flood impacts even conservatively excluding any potential mitigation effects of compensatory earthworks.
- Conveyance of stormwater runoff generated from external and upstream catchment areas will be conveyed through the site to Teviot Brook. This may be achieved through preservation of overland flow corridors, potentially with some formalisation and associated stabilisation. This will be determined at a later design stage.
- Stormwater runoff from the development will be discharged to Teviot Brook without provision of onsite detention. Flow rates in the receiving waterway are dominated by the larger regional system, with any onsite detention likely to be ineffective. Further, discharge rights to this waterway are protected in perpetuity as they are directly to mapped watercourses as defined by the Water Act 2000. This satisfies lawful point of discharge requirements.
- Stormwater quality treatment will be provided via bioretention systems located on the fringes of the open space area adjacent to the development footprint. A preliminary analysis has indicated that provision of bioretention filter media area equivalent to 0.7% of the contributing development area would be sufficient to achieve the SPP (2017) pollutant load reduction targets.

Based on the above, it is contended that the proposed context plan can be readily supported by EDQ, with further technical analysis and design to be undertaken at a later design stage.

APPENDIX A
HIGH RESOLUTION GIS FIGURES – REGIONAL TUFLOW MODELLING



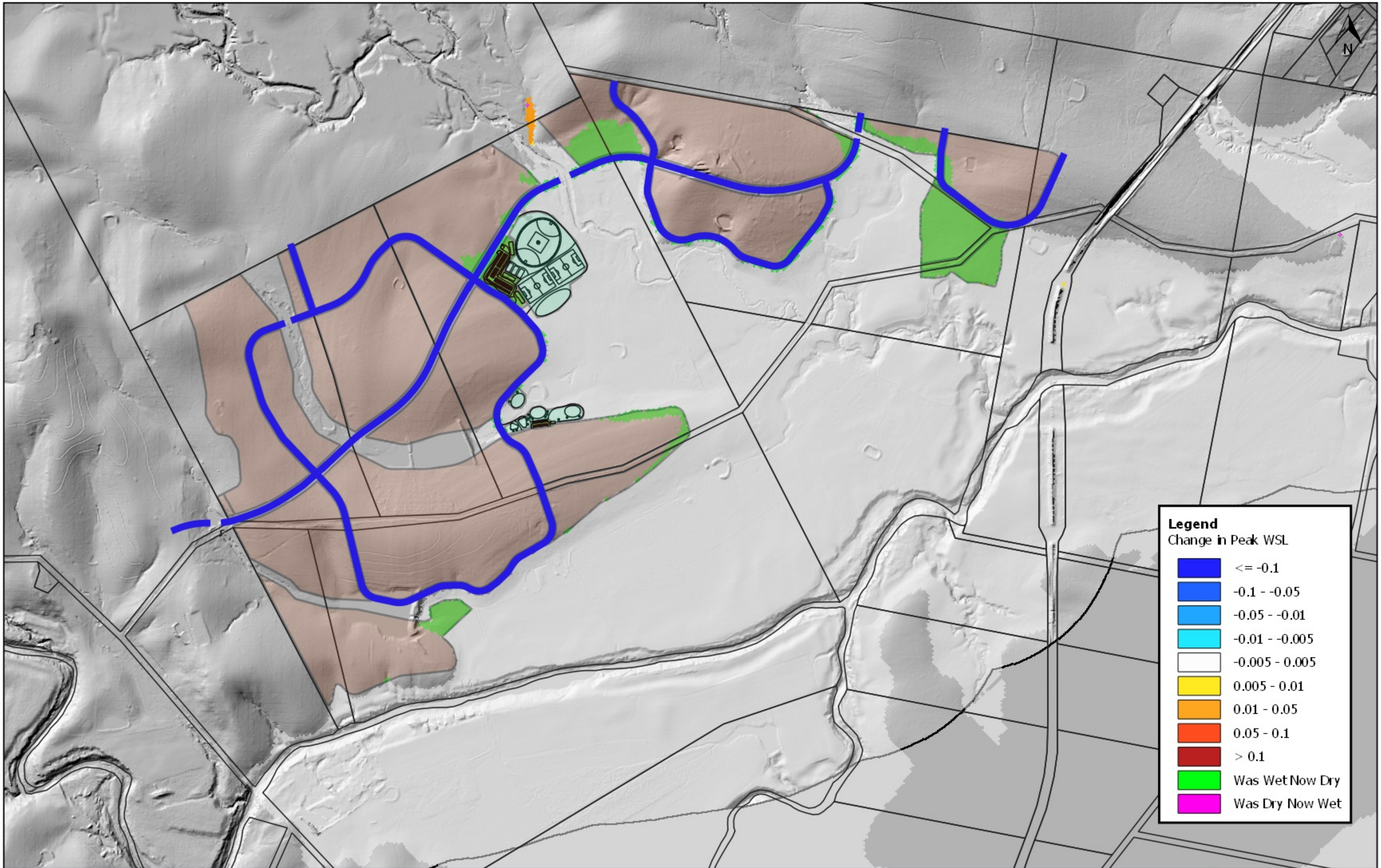
Date: 06/06/2023	Rev: A
Drawn: GJH	Reviewed:
Projection	Scale 1:12500

0 0.5 1 m

23020246 - 325 Wyatt Road Kagura

Indicative 1% AEP (climate change) Depth

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS



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0 250 500 m

23020246 Wyatt Rd Kagura

Change in Peak WSL - DFE

WATER TECHNOLOGY

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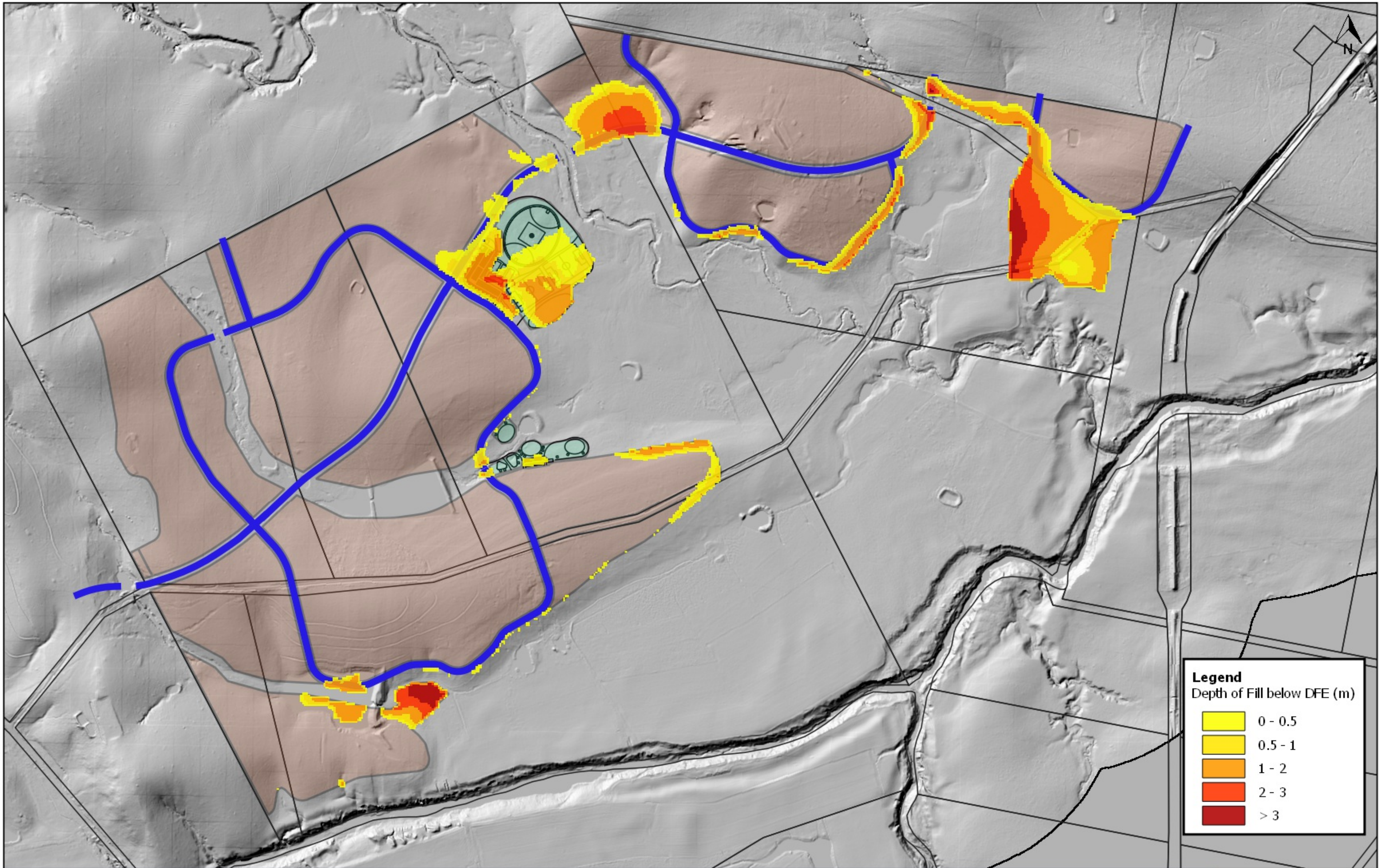

Date: 03/04/2024	Rev: A
Drawn: GJH	Reviewed:
Projection: GDA94	Scale 1: 11000

23020246 Wyatt Rd Kagura

Context Plan Filling Below DFE

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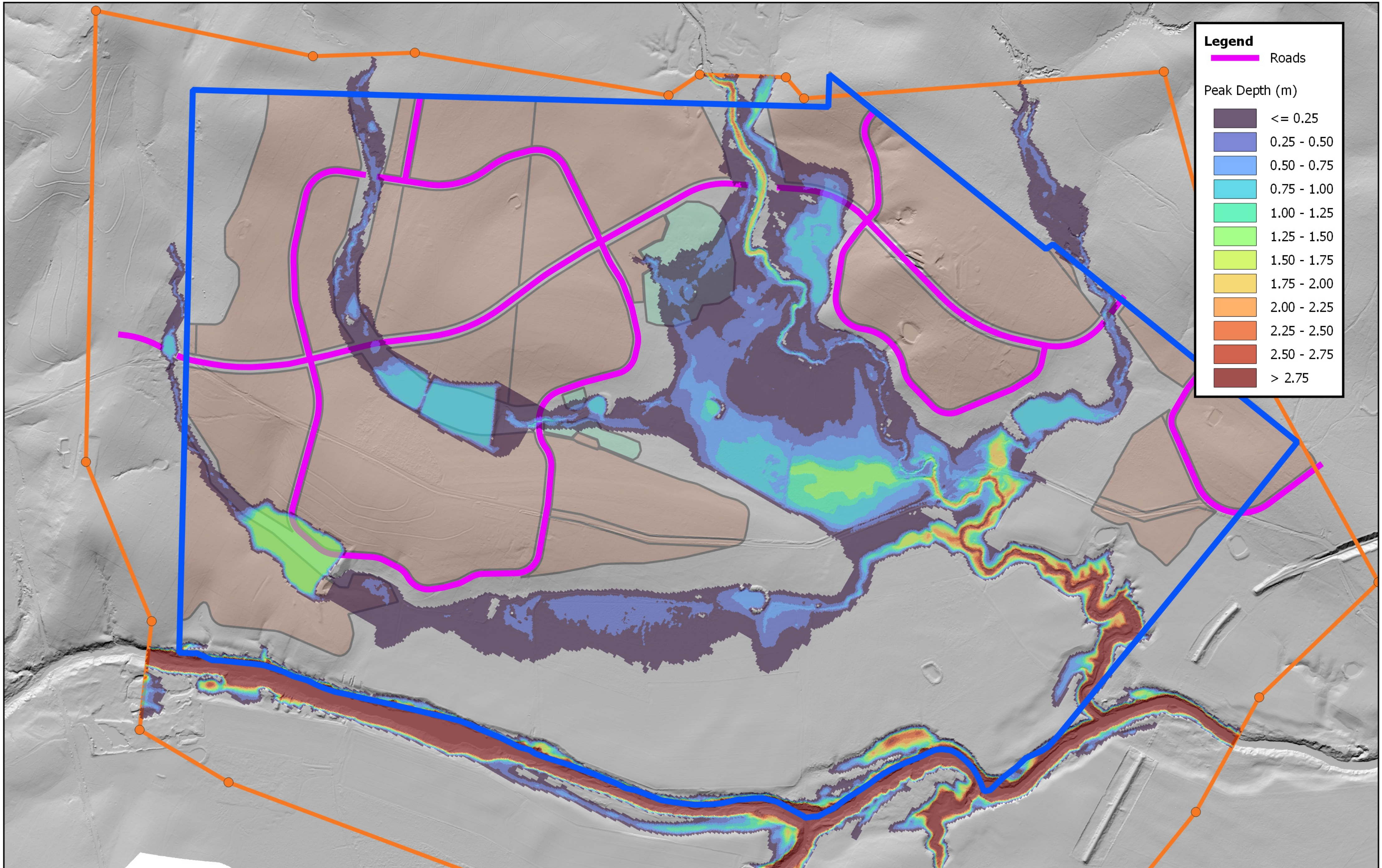
APPENDIX B
HIGH RESOLUTION GIS FIGURES – LOCAL TUFLOW MODELLING



Date: 03/04/2024	Rev: A
Drawn: GJH	Reviewed:
Projection	Scale 1:12000

0 0.5 1 m

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1% AEP, 90 Minute Event Existing Scenario Local Event Peak Depth

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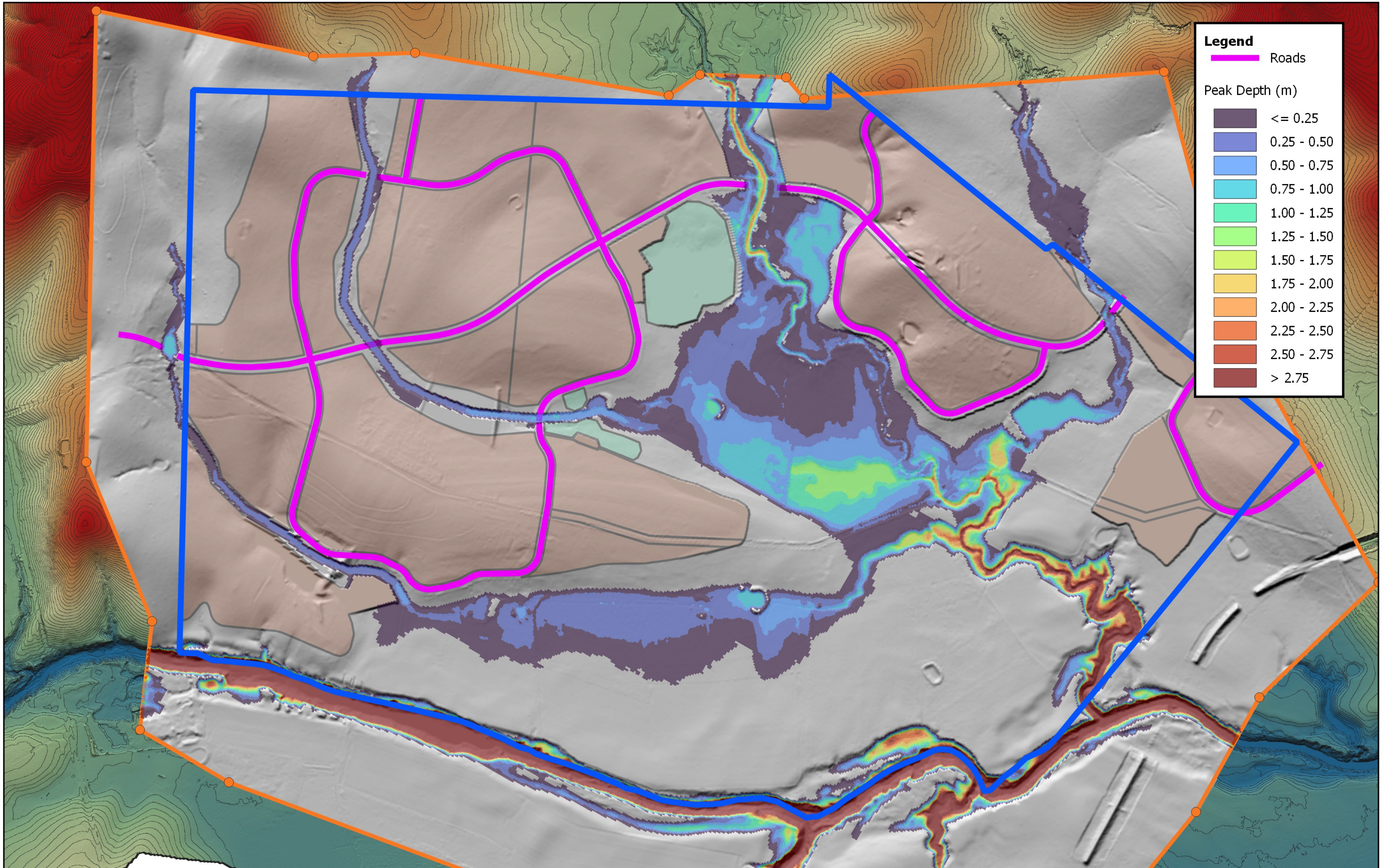

Date: 03/04/2024	Rev: A
Drawn: GJH	Reviewed:
Projection	Scale 1:12000

0 0.5 1 m

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1% AEP, 90 Minute Event Local Event Peak Depth

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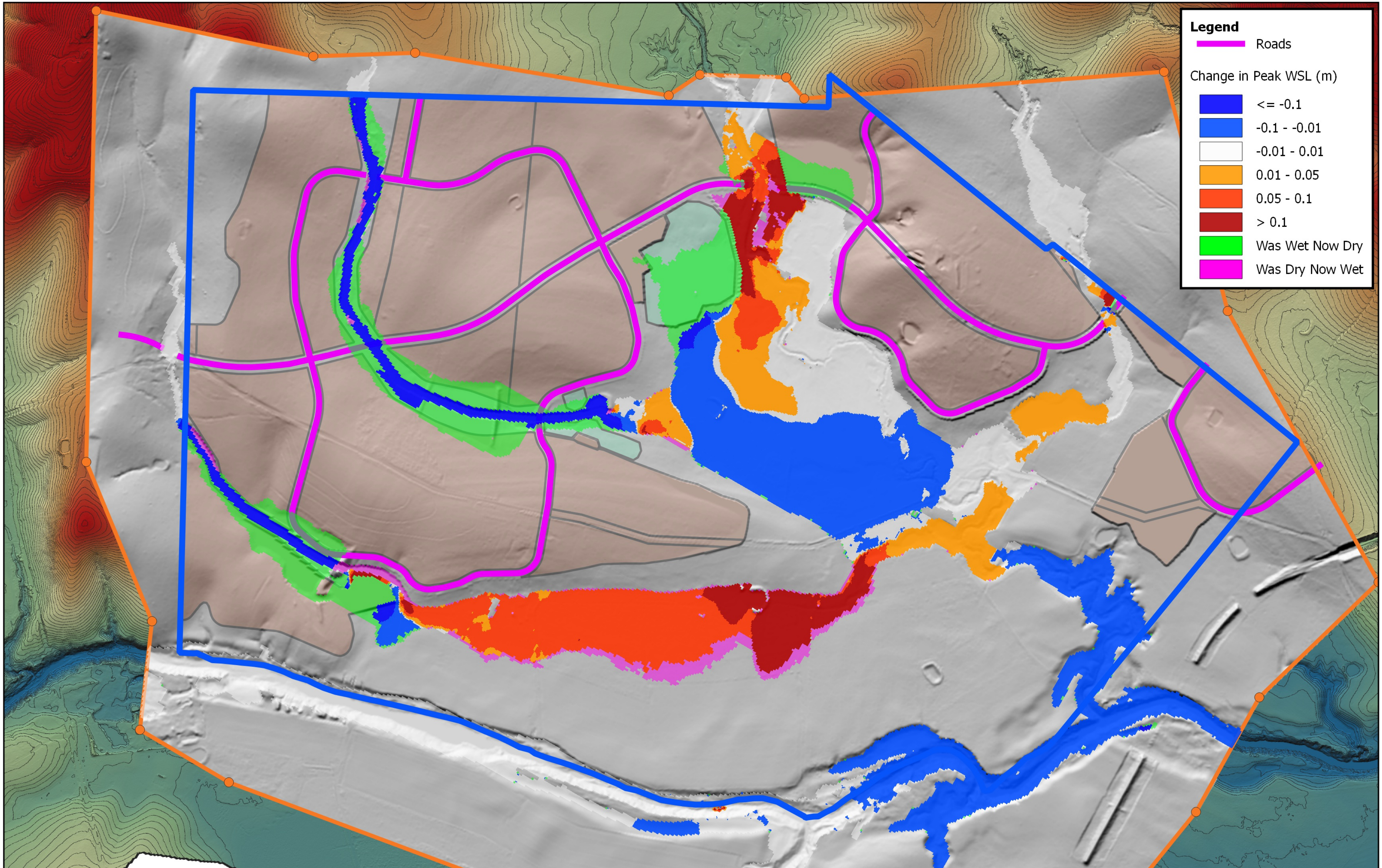

Date: 03/04/2024	Rev: A
Drawn: GJH	Reviewed:
Projection	Scale 1:12000

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1% AEP, 90 Minute Event Local Event Change in Peak Water Surface Level

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