ENGENY

LOGAN CITY COUNCIL

Windaroo Creek Flood Study

Flood Study and Floodplain Management Report

M9000_082-REP-704-1

15 MARCH 2024

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0	4/03/2024	Draft for Review	Kelsey Mundt	Mark Page	Kelsey Mundt	Mark Page
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1. INTRODUCTION

1.1 Background

Engeny was engaged by Logan City Council (LCC or Council) to undertake the Windaroo Creek Flood Study. The intent of the study is to develop and calibrate hydrologic and hydraulic models of the Windaroo Creek catchment and the adjacent smaller Belivah Creek catchment. For simplicity, this report will refer to the study area as the Windaroo Creek catchment. The intended use of these models by Council is to provide accurate planning scheme flood mapping, or more specifically, estimates of flood levels, depths, velocities, and flood hazard of design events along the Windaroo Creek waterways and tributaries, where they fall within Council's Waterway Corridors Overlay.

1.2 Catchment Description

Windaroo Creek and Belivah Creek flow in a mostly easterly direction before discharging to the Albert River, with the catchment located on the western side of the Pacific Motorway. The catchment includes the suburbs of Windaroo, Bahrs Scrub, and Belivah. Beaudesert Beenleigh Road forms a significant hydraulic control through the lower portion of the catchment.

The catchment area of Windaroo Creek upstream of the Albert River is approximately 12.0 sqkm and the catchment area of Belivah Creek upstream of the Albert River is approximately 5.3 sqkm. The Windaroo lakes system is located in the lower portion of the catchment.

At the time of writing this report (2024), the land use in the catchment comprises residential development in the lower portion of the catchment, de-densifying in the upper catchment to a rural residential land use and Environmental Management and Conservation areas with isolated higher density residential developments under construction. The Council planning scheme indicates broad areas of Emerging Community throughout the catchment, suggesting that significant residential development will continue to occur in the catchment.

It should be noted that the flood behaviour shown in this report accurately reflects catchment conditions at the time that the aerial and LiDAR was captured for the project; in 2021. With continual development occurring in the upper catchment, flood behaviour and extents are expected to change into the future.

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1	Final Issue	13-03-2024

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Figure 1.1

Windaroo Creek Flood Study
Windaroo Creek Flood Study Catchment
As of 2022

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2. STUDY METHODOLOGY

2.1 Hydrologic Model Development

A WBNM (2019) runoff-routing model was developed for the Windaroo Creek Flood Study catchment upstream of the junction with the Albert River. The WBNM model was calibrated using the May 2015, February 2020, and March 2022 events. The intent of the calibration was to ensure the model produced similar peak level and catchment response at the Bahrs Scrub Alert flood level gauge (the location of which is previously shown on Figure 1.1). As no rating curve information is available for this gauge, a rating curve was developed at the gauge utilising the TUFLOW hydraulic model to also compare flood discharge.

2.2 Hydraulic Model Development

A 1D/2D TUFLOW hydraulic model (BMT WBM, 2020) was developed for the waterways of the Windaroo Creek catchment. The hydraulic model included 1D elements such as culverts and key trunk drainage lines. The hydraulic model covers all waterways of Windaroo Creek and Belivah Creek upstream of their junction with the Albert River. The hydraulic model does not include representation of minor overland flow paths.

2.3 Joint Model Calibration

Local inflow hydrographs for all catchments for the February 2020 and March 2022 events were applied to the hydraulic model, with the May 2015 event retained as a hydrologic calibration only due to the expected differences in land use and topography at the time of this event in comparison to the other two calibration events. The resulting water level and flood discharge time series results from the hydraulic model were compared with recorded water levels at the Bahrs Scrub Alert water level gauge for the February 2020 and March 2022 events.

3. AVAILABLE DATA

The following sections provide a summary of the data supplied for the project.

3.1 Previous Studies

No formal previously adopted Council flood study is available for the catchment.

3.1.1 Bahrs Scrub Local Development Area Stage 2 Investigations Stormwater Management Strategy (DesignFlow & Worley Parsons, 2012)

The Bahrs Scrub Local Development Area Stage 2 Investigations Stormwater Management Strategy (DesignFlow & Worley Parsons, 2012) was developed in order to establish a stormwater strategy for the development set to occur through Bahrs Scrub Local Development Area (located within the Windaroo Creek catchment). The study involved development of an XPRAFTS hydrologic model for the Windaroo Creek catchment, a waterway ecologic assessment, stormwater management strategy, flood & waterway stability modelling utilising TUFLOW, stormwater quality modelling, and costs.

The XPRAFTS model and catchment delineation from this study was utilised as a starting point for the WBNM model development for the Windaroo Creek Flood Study.

3.1.2 Logan Albert Rivers Flood Study (WRM, 2021)

WRM undertook updates to the *Logan Albert River Flood Study* in 2021. This study utilised XPRAFTS hydrologic modelling and TUFLOW hydraulic modelling. The flood level results from this study were utilised in determining the downstream tailwater levels for the design event hydraulic model and the flood velocities and hydraulic grade line from this study were utilised to inform the vertical and temporal translation of the Wolffdene Alert gauge to the Windaroo Creek catchment outlet.

3.2 Topographic Data

1m LiDAR topographical data captured in 2014 and 2021 was made available for use in this study. The 2014 capture was utilised to delineate catchments for the May 2015 calibration, whereas the 2021 capture was utilised for the February 2020 and March 2022 calibration hydrologic and hydraulic models, and for the design event models.

3.3 Aerial Photography

Aerial photography captured in 2017 and 2021 of the Windaroo Creek catchment was supplied by Council for use in this Study. The 2017 capture was utilised to inform land use for the May 2015 calibration, whereas the 2021 capture was utilised for the February 2020 and March 2022 calibration land use, and for the design even models.

3.4 Council's GIS Database

Council supplied Engeny with a complete database of vector files (dated 2022) relevant to the Study in shapefile format. The files supplied included:

- Stormwater network; pits, pipes, box culverts: with diameters and inverts for adoption in the hydraulic model.
- Waterways.
- Waterway Corridors.
- Bridges.
- Building footprints.
- Cadastre.

- Easements.
- Flood survey markers.
- Telemetry water level sensor locations.
- Planning Scheme 2015 Flood Hazard Overlay.
- Planning Scheme 2015 Zoning Overlay.
- Roads.
- Stormwater GPTs, headwalls, open drains.

3.5 Hydraulic Structure Review and survey

Council undertook an in-house review of their stormwater GIS layers in 2021. This information was provided in an excel spreadsheet format for Engeny to reflect and update dimensions or invert information as required. Engeny also provided a list of hydraulic structures to Council to undertake further survey, and the provided survey was in-turn reflected in the stormwater network setup in the hydraulic model.

3.6 Site Inspection

A site inspection was undertaken by Engeny on 3 August 2022. This site inspection was utilised to confirm any remaining stormwater network or bridge dimensions not covered in Council's original GIS layers, hydraulic structure review or survey in order for the structures to be incorporated in the TUFLOW hydraulic model as accurately as possible.

3.7 As Constructed Drawings

Limited as-constructed drawings were required and supplied for the Study. The data supplied to Engeny for the project included:

- Bannockburn Road Stage 2 Drainage Improvements.

3.8 Rainfall Data

Historic pluviographic rainfall records from the Bahrs Scrub Alert (station number 540598) were provided by Council, for the period from 2012 to 2022. This data was used as an input to the hydrologic model for the May 2015, February 2020, and March 2022 historical calibration events. Pluviographic information at the Beenleigh Alert (station number 540644), Waterford Alert (station number 40878), Wolffdene Alert (station number 40761) and Lower Quinzeh Alert (station number 540688), was also supplied but as these stations are located outside the Study catchment they have not been utilised. The location of these stations are shown on Figure 1.1.

3.9 Water Level Gauges

Historical water level series records from the Bahrs Scrub Alert (station number 540598) and Wolffdene Alert (station number 40761) were provided by Council for the period of 2012 to 2021 and 2006 to 2022, respectively. No rating curve information was available for these gauges. This data was used to calibrate and to provide a downstream tailwater condition to the hydraulic model for the February 2020 and March 2022 historical calibration events. Water level series at the Beenleigh Alert (station number 540644) was also supplied but as this station is located outside the Study catchment it has not been utilised. The location of these stations are shown on Figure 1.1.

3.10 Surveyed Peak Flood Levels

Limited flood debris survey for historical events was available from Council, however two survey points were provided for the February 2020 event in the Study catchment.

4. HYDROLOGIC MODEL DEVELOPMENT

4.1 Overview

A WBNM runoff-routing model (WBNM, 2019) was developed for the Windaroo Creek catchment (including Belivah Creek). Two different models have been developed:

- Land use and delineation matching 2015 conditions for the May 2015 historical calibration event.
- Land use and delineation matching 2022 conditions for the February 2020 and March 2022 historical calibration events, and design event modelling.

4.2 WBNM Model Configuration

4.2.1 Spatial Configuration

Figure 4.1 shows the catchment delineation of the Windaroo Creek WBNM model for the May 2015 calibration event and Figure 4.2 shows the catchment delineation of the model for the February 2020 and March 2022 calibration event and design flood events. The hydrologic model consists of a total of 179 sub-catchments and 181 sub-catchments, respectively for the two model variants. The differences occur due to the 2014 LiDAR topographical data capture being utilised for the May 2015 calibration event model, and the 2021 LiDAR topographical capture being utilised for the February 2020 and March 2022 calibration event and design flood event model. The delineation has been undertaken to ensure that no catchments exceed 30 hectares.

4.2.2 Sub-catchment Parameters

The WBNM model adopts a split-catchment approach (pervious and impervious catchments) and utilises the following parameters:

- Catchment area.
- Impervious fraction.

For the May 2015 calibration event, impervious fractions were based upon the observed development present in the catchment in the 2017 aerial and Nearmap imagery around 2015. For the February 2020 and March 2022 historical calibration events, impervious fractions were based upon the 2021 aerial capture. Impervious fractions for the design event modelling were based on the Council's ultimate land use zoning. The list of catchment parameters is provided in Appendix A.

The percentage impervious values that were assigned to various land use types are summarised in Table 4.1.

TABLE 4.1: ADOPTED FRACTION IMPERVIOUS VALUES BY LAND USE TYPE

Land Use Type	Fraction Impervious
Roads	90%
Special Purpose (Road)	90%
Recreation and Open Space	20%
Rural Residential	10%

Land Use Type	Fraction Impervious
Rural	2%
Community Facilities	70%
Environmental Management and Conservation/Dense Bush	0%
Low Density Residential	55%
Emerging Community	70%
Low-Medium Density Residential	55%
Centre/Industrial	90%
Mixed Use	90%
Waterway in channel - lightly vegetated	0%
Waterway in channel - moderately vegetated	0%
Waterway in channel - highly vegetated	0%
Upper Catchment Watercourse	0%
Waterway corridor	0%

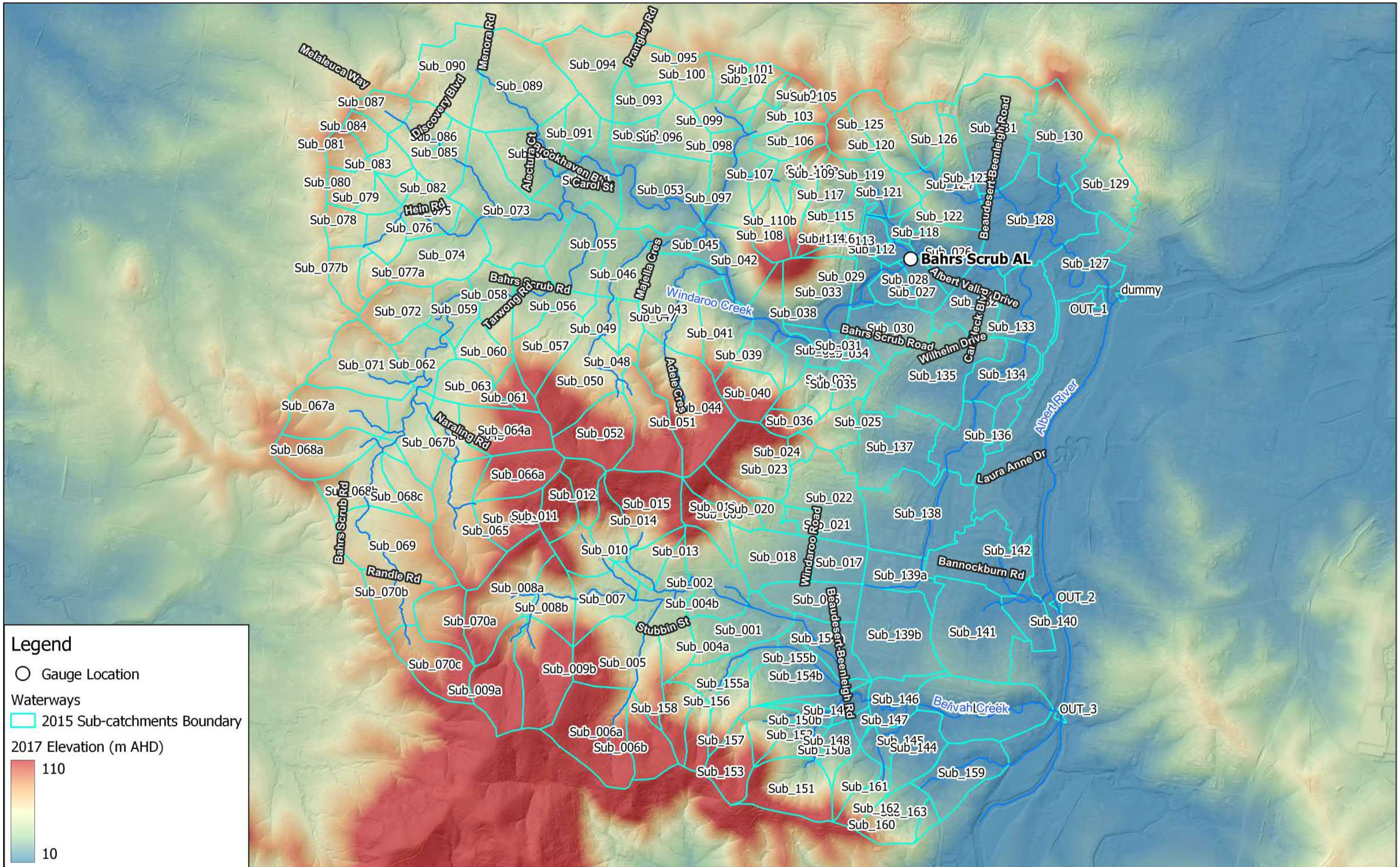

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Figure 4.1

Windaroo Creek Flood Study
WBNM Sub-catchment Delineation
May 2015 Calibration

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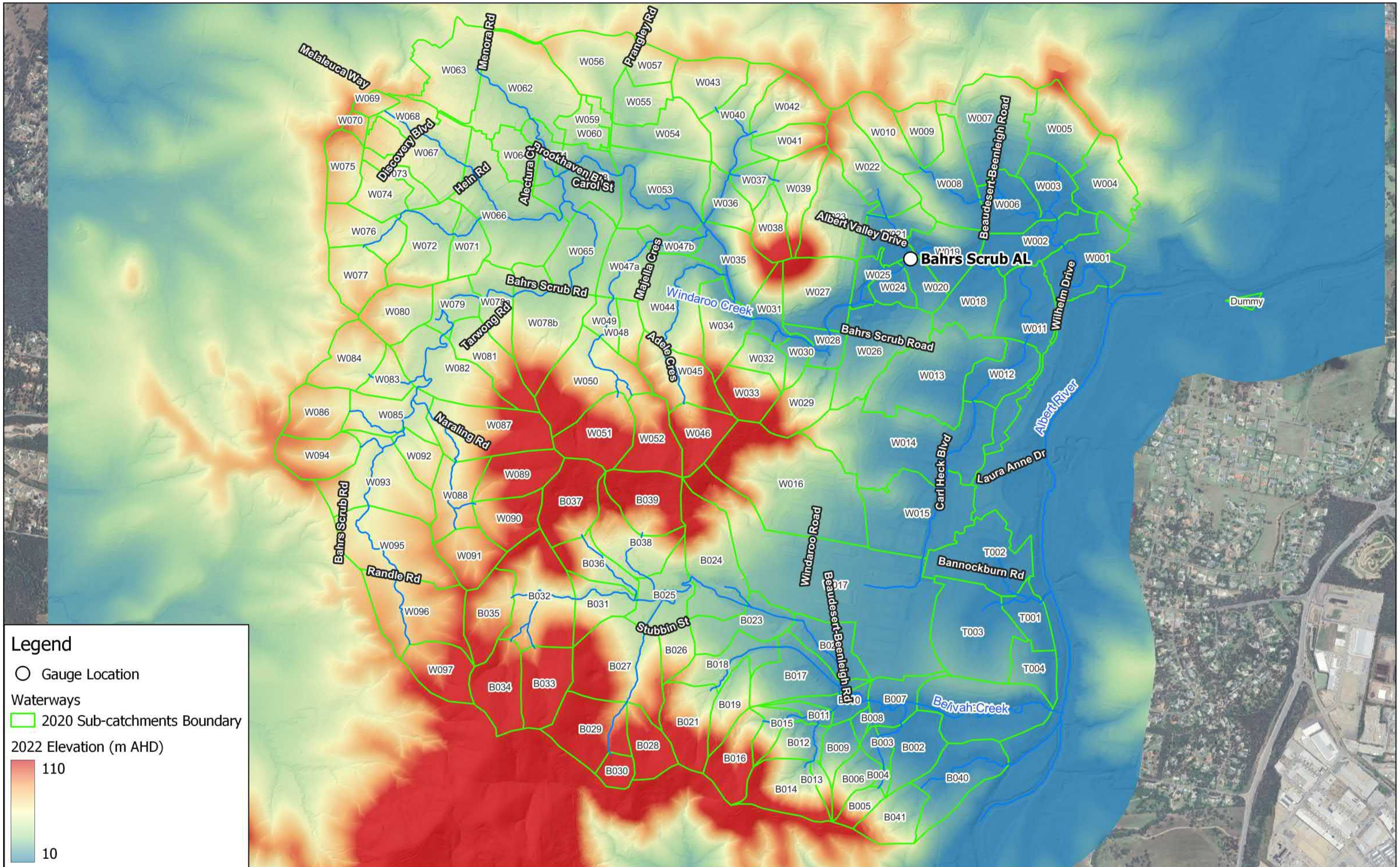

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Figure 4.2

Windaroo Creek Flood Study
WBNM Sub-catchment Delineation
February 2020 and March 2022 Calibration and Design Flood Events

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4.2.2.1 Additional Parameters

The following remaining WBNM parameters have been specified:

- Impervious lag factor of 0.1.
- Stream lag factor of 1.0.
- Catchment lag factor has been adjusted to achieve as close as possible representation of the calibration events as discussed in Section 5.4.2.

5. HYDROLOGIC MODEL CALIBRATION

5.1 Methodology

The objective of the calibration was to achieve the best possible fit between the hydraulically modelled and the recorded water level series at the Bahrs Scrub Alert. Emphasis was placed on timing and achieving a similar catchment discharge response between the hydrologic model and the hydraulic model.

5.2 Calibration Events

5.2.1 Selection of Events

A review of the supplied water level records, pluviographic rainfall series and debris survey was undertaken to determine the three flood events suitable for calibration. From the data supplied, the following events were considered for calibration based on the period of water level and pluviographic record supplied:

- May 2015 (hydrologic calibration only).
- February 2020 (joint hydrologic and hydraulic calibration).
- March 2022 (joint hydrologic and hydraulic calibration).

Events prior to 2013 were immediately discounted due to there being no pluviographic data available, and remaining significant events were discounted due to significant regional backwater affects observed from the Albert River. A summary of considerations undertaken to determine the flood events to model are provided in Table 5.1.

TABLE 5.1: HISTORICAL EVENT SELECTION DISCUSSION

Event	Approximate Event Magnitude	Influence of the Albert River on the Bahrs Scrub Alert	Availability of Debris Survey	Commentary
January 2013	Minor flood event	Not impacted by Albert River.	Some available	Calibration possible, but not undertaken as hydraulic model required is significantly different to the design event model and other selected events.
May 2015	Major flood event	Not impacted by Albert River.	None	Hydrologic calibration undertaken. Hydraulic calibration possible, but not undertaken as hydraulic model required is significantly different to the design event model and other selected events.
June 2016	Below minor flood event	Not impacted by Albert River.	None	Excluded from historical calibration due to size of event being too small to provide value.
April 2017	Major flood event	Heavily impacted by Albert River.	Some available	Excluded from calibration due to the water level record at Bahrs Scrub being entirely driven by the Albert River.

Event	Approximate Event Magnitude	Influence of the Albert River on the Bahrs Scrub Alert	Availability of Debris Survey	Commentary
February 2020	Moderate flood event	Not impacted by Albert River.	Three points available.	Joint hydrologic and hydraulic calibration.
March 2021	Moderate flood event	Potential error in recorded series.	None	Excluded from calibration due to the water level record at Bahrs Scrub being irregular in shape.
February 2022	Major flood event	Heavily impacted by Albert River.	None	Excluded from calibration due to the water level record at Bahrs Scrub being entirely driven by the Albert River.
March 2022	Minor flood event	Not impacted by Albert River.	None	Joint hydrologic and hydraulic calibration.

Therefore, the adopted events for calibration were the May 2015, February 2020, and March 2022 flood events.

5.2.2 Summary of Events

The key details regarding the calibration events modelled are provided in Table 5.2.

TABLE 5.2: SUMMARY OF CALIBRATION EVENTS

Event	Simulation Start Time	Simulation End Time	Cumulative Rainfall	Recorded Peak Level
May 2015	30th April 2015 1:00 am	1st May 2015 11:55 pm	211 mm	8.55 m AHD
February 2020	12th February 2020 8:15 am	14th February 2020 8:15 am	193 mm	8.23 m AHD
March 2022	28th March 20222 12:00 am	30th March 2022 12:00 am	138 mm	7.67 m AHD

5.3 Assignment of Total Rainfalls and Temporal Patterns

Total rainfall and temporal patterns for the historical events were taken from the pluviographic rainfall record at the Bahrs Scrub Alert (station number 540598) and were applied to all sub catchments as it was the only gauge within the catchment.

The cumulative rainfall recording from the Bahrs Scrub Alert applied to the WBNM model is shown in Figure 5.1, Figure 5.2 and Figure 5.3 for the May 2015, February 2020 and March 2022 flood events, respectively.

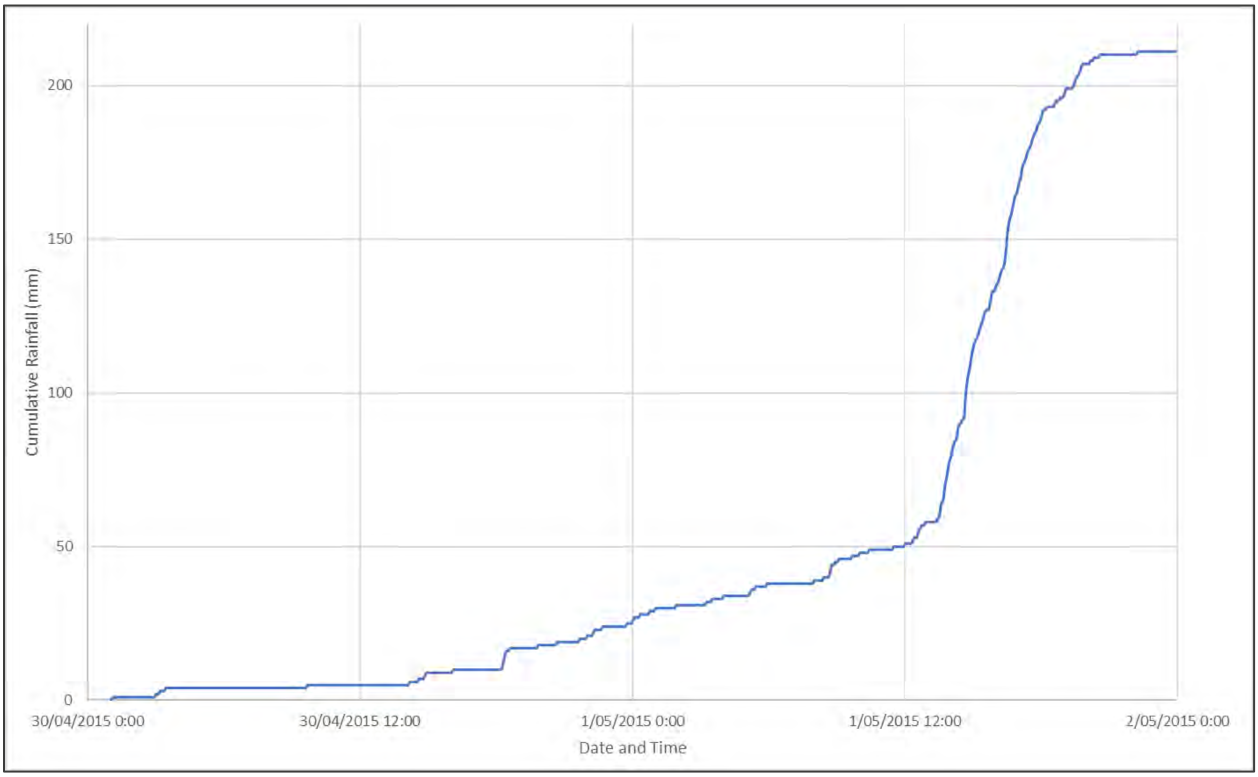

Figure 5.1: May 2015 Cumulative Rainfall

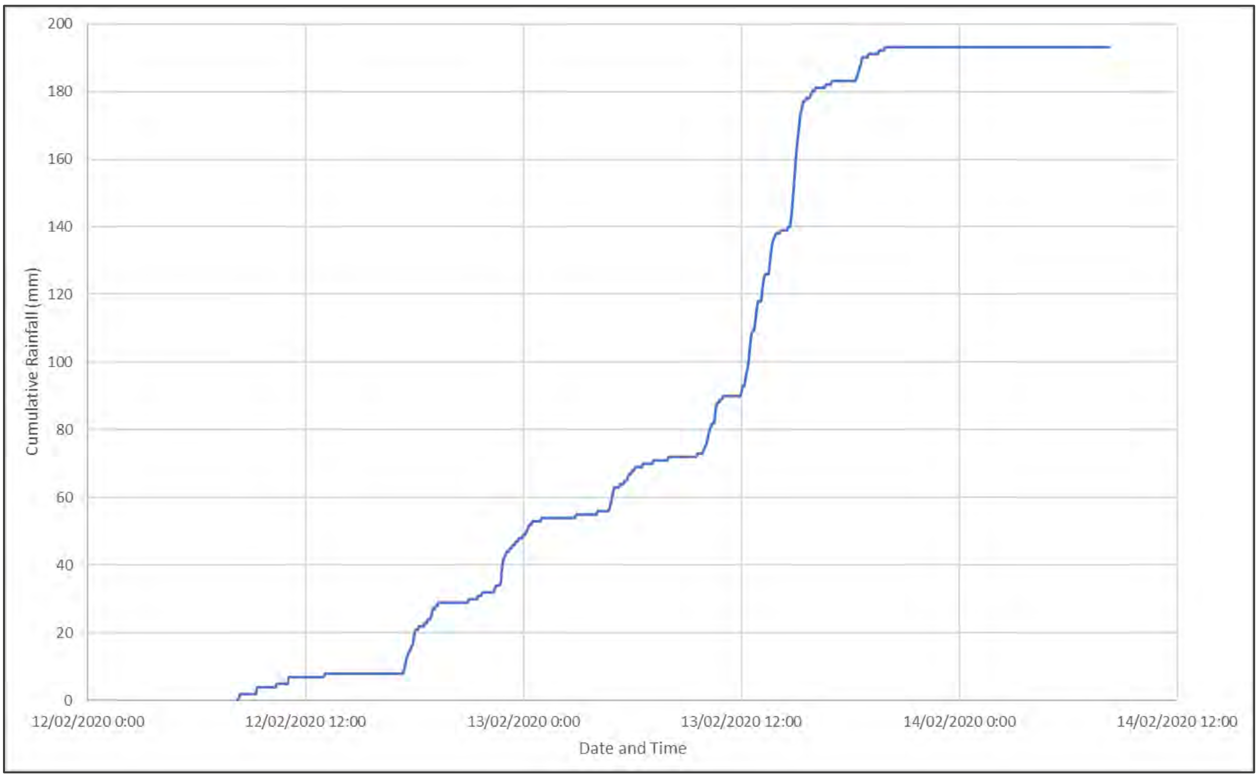

Figure 5.2: February 2020 Cumulative Rainfall

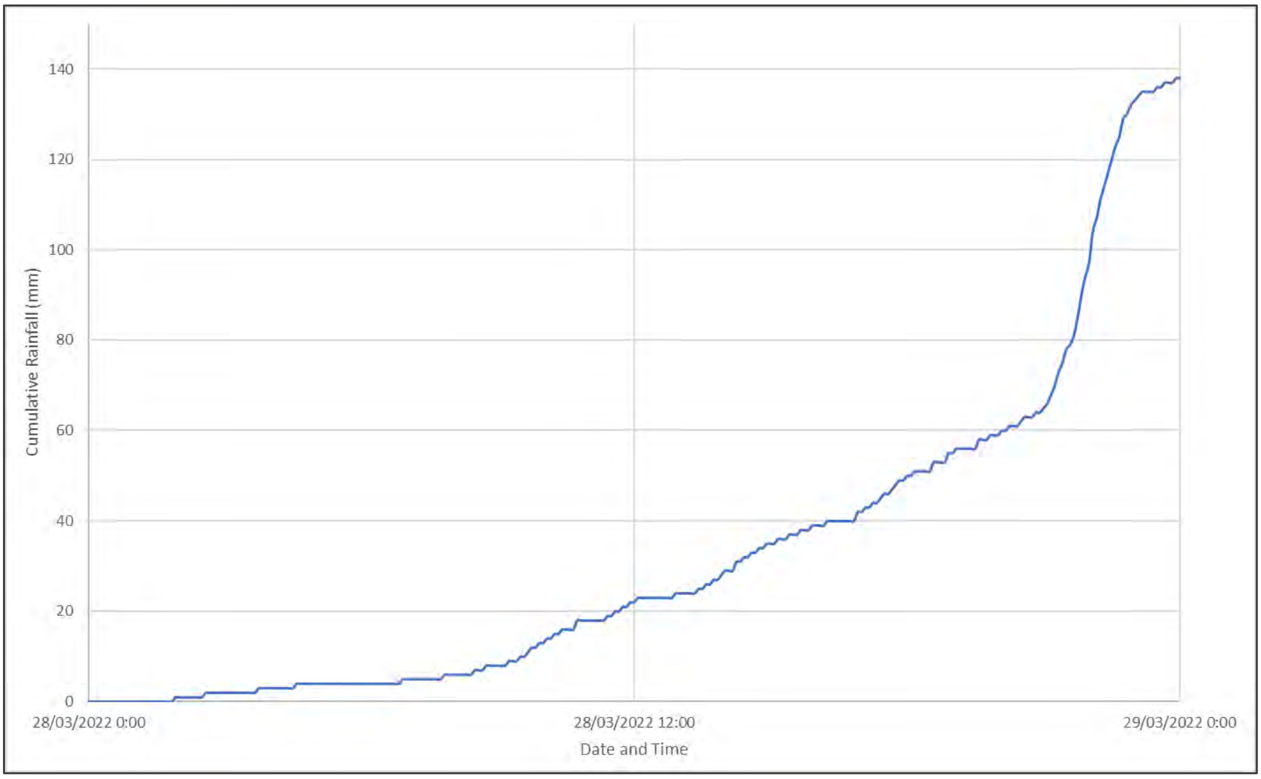

Figure 5.3: March 2022 Cumulative Rainfall

5.4 Adjustment to Model Parameters

Adjustment to the WBNM hydrologic model parameters (in addition to those outlaid in Section 4.2) were made in order to replicate the catchment response of the historical events.

5.4.1 Initial and Continuing Losses

Initial (IL) and continuing losses (CL) were adjusted for each event and are summarised in Table 5.3. These adopted losses are similar to those adopted for the same calibration events for other LCC catchments.

TABLE 5.3: INITIAL (IL) AND CONTINUING LOSSES (CL) ADOPTED FOR HISTORICAL EVENTS

Event	IL (mm)	CL (mm/h)
May 2015	150	3.1
February 2020	150	3.1
March 2022	125	3.1

5.4.2 C Value and Routing

The stream lag parameter (1.0) and impervious lag parameter (0.1) remained constant for all three calibration events as per Section 4.2.

The catchment lag parameter was specified at 1.3 for all three calibration events.

6. HYDRAULIC MODEL DEVELOPMENT

6.1 Overview

A TUFLOW 1D/2D hydraulic model was used to model flood behaviour for the Windaroo Creek catchment. The Heavily Parallelised Compute (HPC) solution scheme coupled with a Graphical Processing Unit (GPU). The TUFLOW build adopted for was the 2023-03-AB-iSP-w64 solver.

The discharges estimated using the WBNM hydrologic model were adopted as inflows to the TUFLOW hydraulic model. Almost all inflows to the model were local inflows, except where catchments are located over residential areas and the resultant flow is overland rather than creek flows, and total flows were adopted instead.

6.2 Spatial Configuration and Grid Cell Size

The extent of the TUFLOW model, as shown in Figure 6.1, has been determined in order to model flood behaviour in the main waterways of both Windaroo Creek and Belivah Creek down to their confluences with the Albert River. The total model area is 19.7 sq km. The adopted grid cell size is 3 m, which provides suitable definition for small drains and waterways in the upper catchment, without resulting in unreasonable simulation durations.

6.3 Topography

6.3.1 Base Model Topography

The topography adopted in the hydraulic model is the 1 m LiDAR captured in 2021. Therefore, the flood behaviour represents catchment conditions as at 2021, with further development expected to occur in the future, but not able to be reflected in the model.

6.3.2 Topographical Alterations

The 2021 LiDAR data set has been inspected to ascertain where there are locations where 2D z-shape topographical alterations should be included in the TUFLOW model to accurately provide suitable model performance. Types of locations that benefit from topographical alteration include:

- Where road embankments over waterways with culvert crossings have been removed. These road embankments are reinstated in the hydraulic model.
- Where road embankments over waterways with bridges have been retained. These road embankments are removed in the hydraulic model to allow accurate modelling using a layered flow constriction (see Section 6.6.3).

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Figure 6.1

Windaroo Creek Flood Study
TUFLOW Model Layout

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6.4 Inflow and Outflow Boundaries

6.4.1 Inflow Boundaries

The majority of the inflow boundaries in the TUFLOW model were applied as local flow 2d source-area (SA) polygons, where flows are applied to the lowest point in the polygon initially, before spreading to a larger area. For areas where the contributing catchment are highly urbanised with no formalised waterways, flows are applied downstream at the waterway corridor. The location of the SA polygons is shown on Figure 6.1.

6.4.2 Outflow Boundaries

The hydraulic model has two outflow locations to the Albert River: from Windaroo Creek and from Belivah Creek. The location of these outflow boundaries is shown on Figure 6.1.

6.4.2.1 Design Events

The adopted tailwater levels for the design flood events were determined using the "Quick Intensity Frequency Duration (IFD)" method as outlined in Section BN8.3.4 of the *Queensland Urban Drainage Manual (QUDM)* (IPWEAQ, 2017). This method compares the IFD for the mainstream (Albert River) time of concentration to the equivalent IFD for the side stream (Windaroo Creek) time of concentration, in order to determine the appropriate design AEP flood level for the mainstream to use as the model tailwater conditions. The method is shown visually in Figure 6.2, and a summary of the applied for all design event AEPs is listed in Table 6.1. Due to the relatively small size of the Windaroo Creek catchment to the Albert River catchment, the proposed corresponding AEP of the Albert River to apply as a tailwater condition falls below the 39% AEP flood event for below the 2% AEP flood event. For these events, a normal slope boundary has been applied.

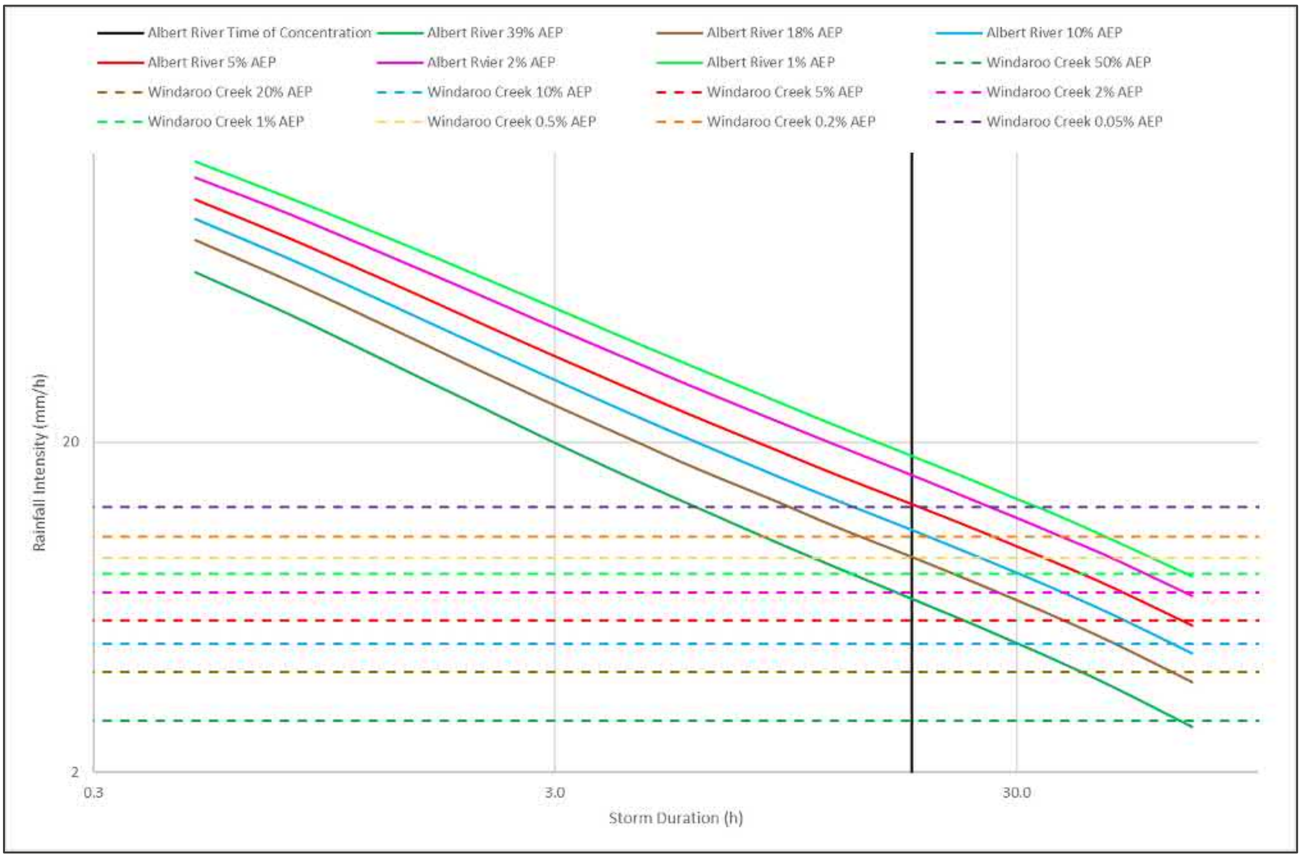

Figure 6.2: QUDM IFD Assessment

TABLE 6.1: DESIGN AEP DOWNSTREAM BOUNDARY CONDITIONS

Design Flood Event	Tailwater Configuration*	Tailwater Level (m AHD)
50% AEP	Normal Depth	-
20% AEP	Normal Depth	-
10% AEP	Normal Depth	-
5% AEP	Normal Depth	-
2% AEP	50% AEP Albert River	3.94
1% AEP	50% AEP Albert River	3.94
0.5% AEP	18% AEP Albert River	6.25
0.2% AEP	10% AEP Albert River	7.56
0.05% AEP	10% AEP Albert River	7.56
PMF	5% AEP Albert River	8.77

*Albert River flood levels taken from *Logan Albert River Flood Study* (WRM, 2021).

6.4.2.2 Calibration Events

For the two calibration events, the recorded tailwater level series in the Albert River at the Wolffdene Alert (station number 40761), translated to the study area location were used. The methodology adopted to translate the recorded water level series was:

- Recorded elevations were translated vertically by observing the vertical drop in hydraulic grade from the Wolffdene Alert location to the study area for a corresponding similar sized design event result as the historical event from the *Logan Albert River Flood Study* (WRM, 2021).
- The time stamp on the recorded water level series were translated by using a calculated travel time from the Wolffdene Alert location to the study area, utilising the distance from the study area to the alert and the flood velocities for a corresponding similar sized design event result as the historical event from the *Logan Albert River Flood Study* (WRM, 2021).

The translated water level recording from the Wolffdene Alert applied as a tailwater level condition to the hydraulic model is shown in Figure 6.3 and Figure 6.4 for the February 2020 and March 2022 flood events, respectively. The resulting translation was a 3.3 m reduction of the Wolffdene Alert recorded levels.

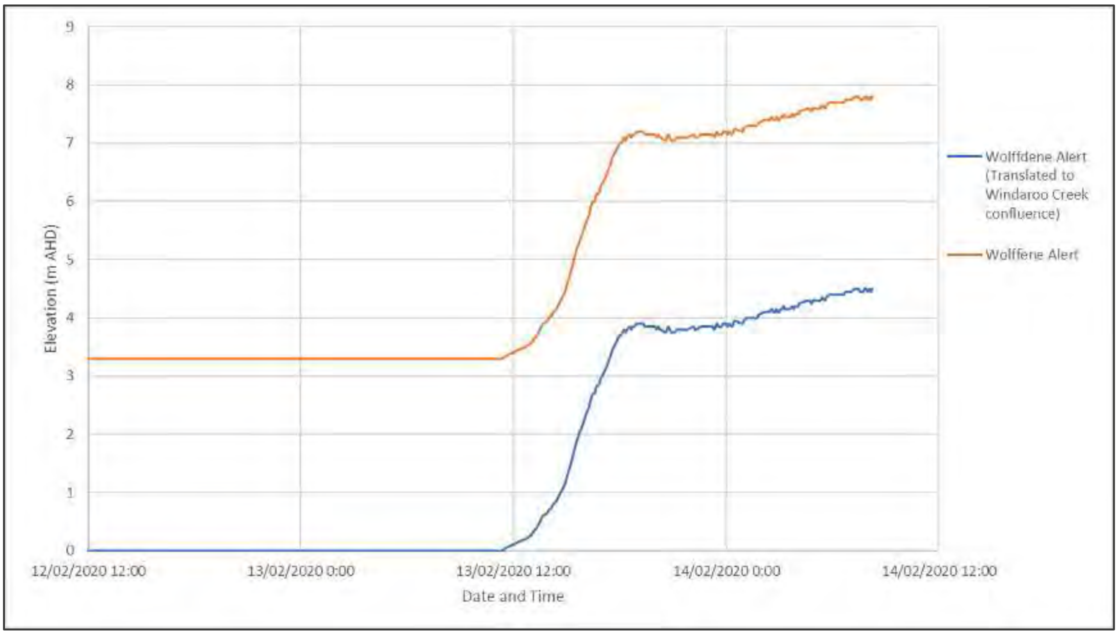

Figure 6.3: February 2020 Translated Wolffdene Alert Tailwater Level Series

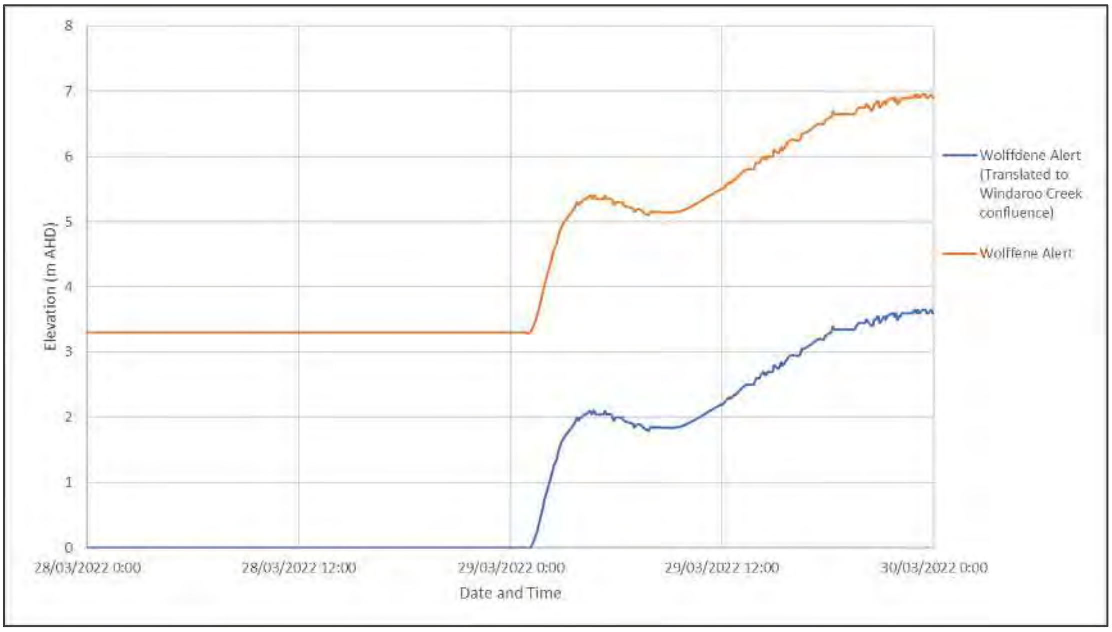

Figure 6.4: March 2022 Translated Wolffdene Alert Tailwater Level Series

6.5 Hydraulic Roughness

Hydraulic roughness in the TUFLOW model is represented by delineation of the Manning's "n" roughness coefficients. Determination of applicable roughness coefficients for the study area were undertaken using the planning scheme GIS layer and the 2021 aerial photography supplied by Council.

The adopted Manning's "n" roughness coefficients adopted per land use are provided in Table 6.2, with the delineation of the various land uses provided in Figure 6.5 for the February 2020 and March 2022 calibration events and in Figure 6.6 for the design events.

TABLE 6.2: ADOPTED HYDRAULIC ROUGHNESS COEFFICIENTS

Description	Manning's "n" Roughness Coefficient
Road Reserve	0.025
Special Purpose	0.025
Recreation and Open Space	0.045
Rural Residential	0.055
Rural	0.055
Community Facilities	0.06
Environmental Management and Conservation/Dense Bush	0.09
Low Density Residential	0.2
Low-Medium Density Residential	0.25
Emerging Community	0.25
Centre/Industrial	0.3
Mixed Use	0.3
Waterway in Channel (lightly vegetated)	0.05
Waterway in Channel (moderately vegetated)	0.06
Waterway in Channel (highly vegetated)	0.08
Waterway bed (centreline)	0.04
Waterbody	0.025

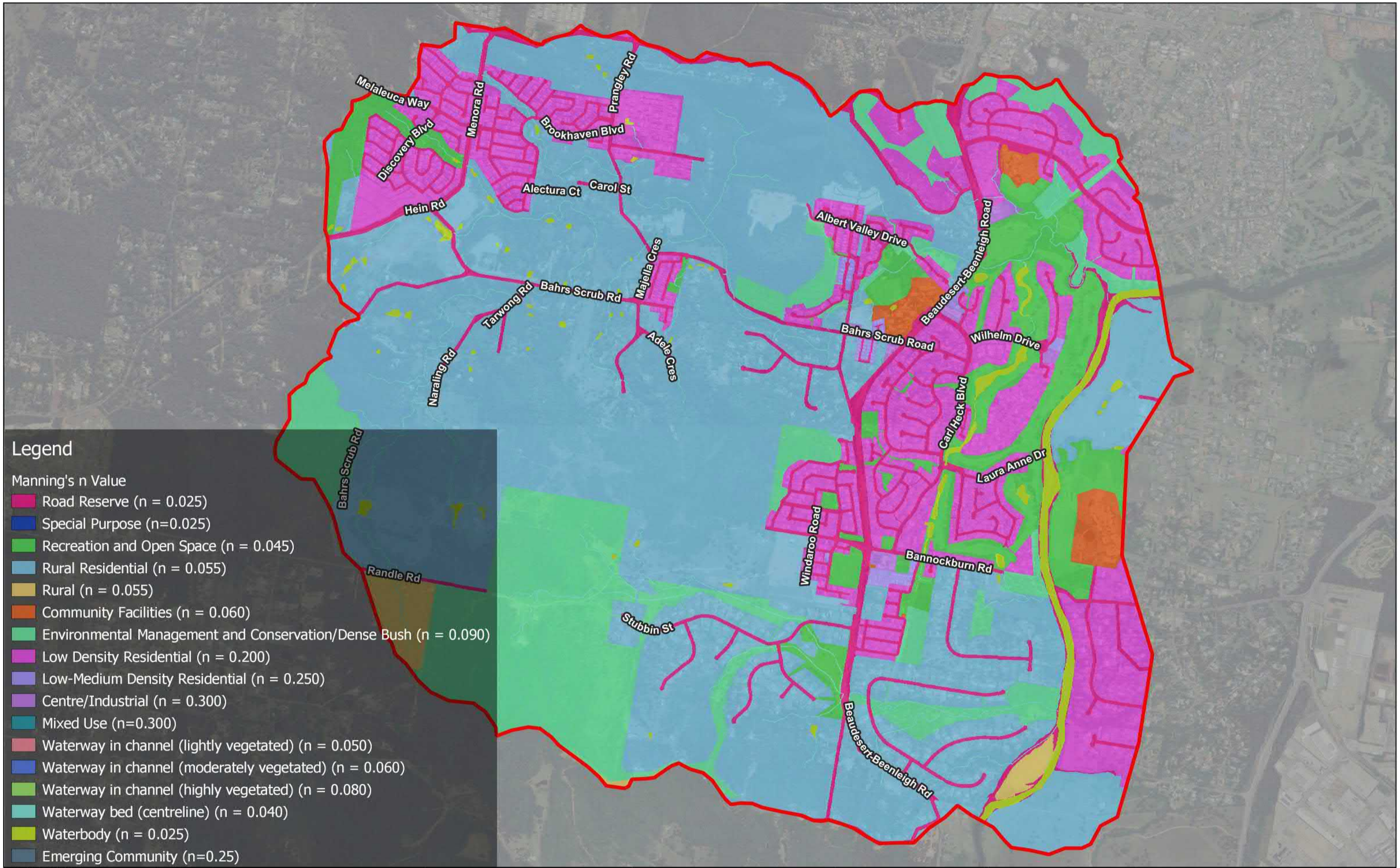

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Figure 6.5

Windaroo Creek Flood Study
TUFLOW Hydraulic Roughness - February 2020 and March 2022 Flood Events

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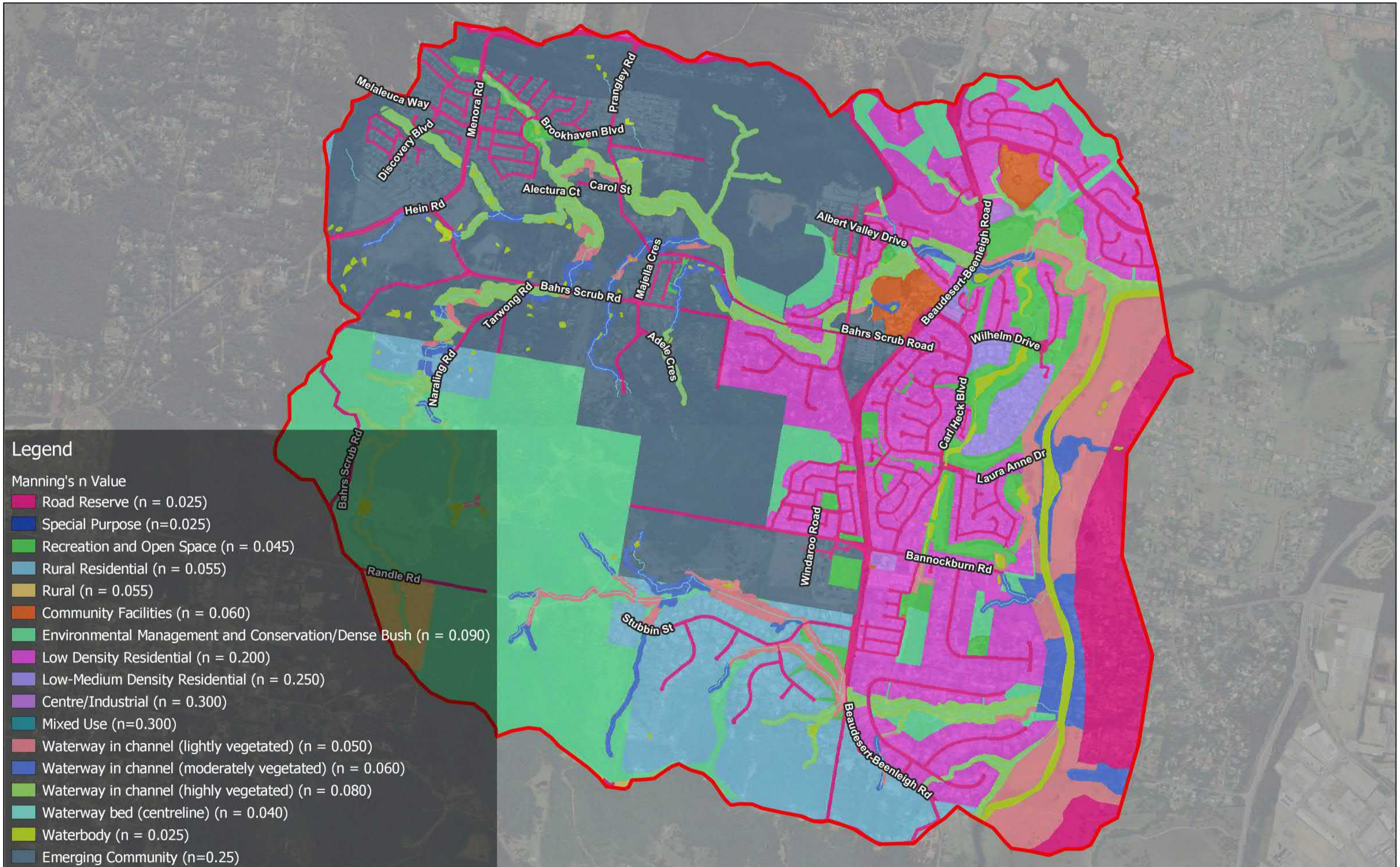

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Figure 6.6

Windaroo Creek Flood Study
TUFLOW Hydraulic Roughness - Design Events

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6.6 Hydraulic Structures

6.6.1 Overview

A summary of all hydraulic structures included in the hydraulic model are provided below:

- 10 box culverts.
- 51 pipe culverts.
- 3 bridges.

6.6.2 Stormwater Culverts and Trunk Stormwater Pipes

Culverts and trunk stormwater network pipes within the TUFLOW model were modelled as 1D elements. The parametrisation of the culverts were based on multiple sources of information, inclusive of:

- Council's stormwater network GIS layers.
- Council's hydraulic structure review database.
- Council's supplied culvert survey.
- Site visit.
- Interpolation of missing inverts through inspection of the topography.

Trunk stormwater network pipes were only included where the pipes form the dominant conveyance path for an upstream waterway through built over / developed areas. A summary of all included stormwater network elements in the TUFLOW model is provided in Appendix B.

6.6.2.1 Blockage

No blockages were applied to the culverts for the historical event calibration. For the design event modelling, the procedures outlined in Book 6 – Chapter 6 of ARR 2019 (Ball et. al.) were followed. Blockage factors were applied depending on AEP and structure size. A summary of the key assumptions regarding the blockage methodology are provided in Table 6.3.

TABLE 6.3: ARR2019 DEBRIS BLOCKAGE ASSUMPTIONS

Parameter	Windaroo Creek Catchment	Belivah Creek Catchment
Debris Availability Classification	Medium Majority of catchment will be urbanised based on land use zoning; however, a portion of upper catchment will be retained as nature reserve.	Medium Majority of catchment will be urbanised based on land use zoning; however, a portion of upper catchment will be retained as nature reserve.
Debris Mobility Classification	Medium Significant debris observed during site visit and thick veg around waterways indicates a high debris mobility, however future development will reduce this.	Medium Significant debris observed during site visit and thick veg around waterways indicates a high debris mobility, however future development will reduce this.
Debris Transportability	Low Equal Area slope of 0.6% for catchment indicates low transportability.	Medium Equal Area slope of 1.8% for catchment indicates medium transportability
1% AEP Debris Potential	Low	Medium
<5% AEP Debris Potential	Low	Low
5%-0.5% AEP Debris Potential	Low	Medium
>0.5% AEP Debris Potential	Medium	High

Parameter	Windaroo Creek Catchment	Belivah Creek Catchment
Average Length of Longest 10% of Debris (L10)	10 m	10 m

The resultant applied design event blockage is summarised in Table 6.4.

TABLE 6.4: APPLIED DESIGN EVENT BLOCKAGE

Design Event	Windaroo Creek			Belivah Creek		
	Blockage (%) Inlet Clear Width <10m	Blockage (%) Inlet Clear Width 10-30m	Blockage (%) Inlet Clear Width >30m	Blockage (%) Inlet Clear Width <10m	Blockage (%) Inlet Clear Width 10-30m	Blockage (%) Inlet Clear Width >30m
50% AEP	25	0	0	25	0	0
20% AEP	25	0	0	25	0	0
10% AEP	25	0	0	25	0	0
5% AEP	25	0	0	50	10	0
2% AEP	25	0	0	50	10	0
1% AEP	25	0	0	50	10	0
0.5% AEP	25	0	0	50	10	0
0.2% AEP	50	10	0	100	20	10
0.05% AEP	50	10	0	100	20	10
PMF	50	10	0	100	20	10

6.6.3 Bridges

Bridges in the TUFLOW model were represented using 2D layered flow constrictions. This input allows the area underneath the bridge, the deck, and the rails to be modelled with carrying blockages and form loss coefficients. Bridge details were determined from the site visit and aerial photography.

Layer 1 blockages were determined as per Section 6.6.2, blockage for Layer 2 was 100% as this layer represents the bridge deck, and Layer 3 represents the guard rails and were generally between 20-50%. Form loss coefficients were specified in accordance with the *Hydraulics of Bridge Waterways* (Bradley, 1978) or the TUFLOW manual specification.

7. MODELLING CALIBRATION AND VALIDATION

7.1 Calibration

7.1.1 Methodology

Calibration of the May 2015 flood event was only completed from a hydrologic perspective. The February 2020 and March 2022 calibration events were jointly calibrated in the hydrologic and hydraulic model. Inflow hydrographs for the February 2020 and March 2022 calibrations events were exported from WBNM and applied as input to the TUFLOW hydraulic model. The hydraulic model results were then compared to the recorded water level series at the Bahr Scrub Alert in terms of the recorded timing and peak of the flood event and the limited debris survey markers available also to determine whether and hydrologic or hydraulic model adjustments were required. In addition, the estimated hydrographs in the hydrologic model and hydraulic model at the Bahrs Scrub Alert were compared to ensure the routing and flood event discharge of both models were performing similarly.

7.1.2 Development of Rating Curve for Bahrs Scrub Alert

The TUFLOW hydraulic model as discussed above was utilised for development of a rating curve for the Bahrs Scrub Alert River gauge. No current rating curve exists for the gauge, and the rating curve is necessary to translate the recorded water levels to discharge for calibration of the May 2015 event, and to support the assessment of similar catchment response between the hydrologic and hydraulic models for the February 2020 and March 2022 calibration events.

A synthetic hydrograph with a peak discharge beyond that expected in any of the calibration events was simulated through the TUFLOW model, and a time series of creek discharge and water level was extracted at the gauge location. From this time series, a rating curve was ascertained. The location of the flow and level reporting location is shown on Figure 7.1, and the rating curve is shown on Figure 7.2.

It is expected that the rating curve is limited in accuracy due to the dense vegetation present at the gauging location, as seen on Figure 7.1. It is expected that vegetation could be impacting on the accuracy of the curve at elevations of less than 7.5 m AHD. An inspection of cross-sections through the 2021 LiDAR (with the 2017 LiDAR showing similar topography) shows that it is highly likely that the creek base elevations have not been accurately captured, with influence of the vegetation seen in the fluctuations of the topographical elevations. This results in an underestimation of discharge for responding water level elevations throughout the entire range of the rating curve. This will present severe limitations of the attempted calibration and could be considered for rectification through capture of bathymetry or detailed survey in the proximity of the gauge.

Figure 7.1: Bahrs Scrub Alert Rating Curve Extraction Location

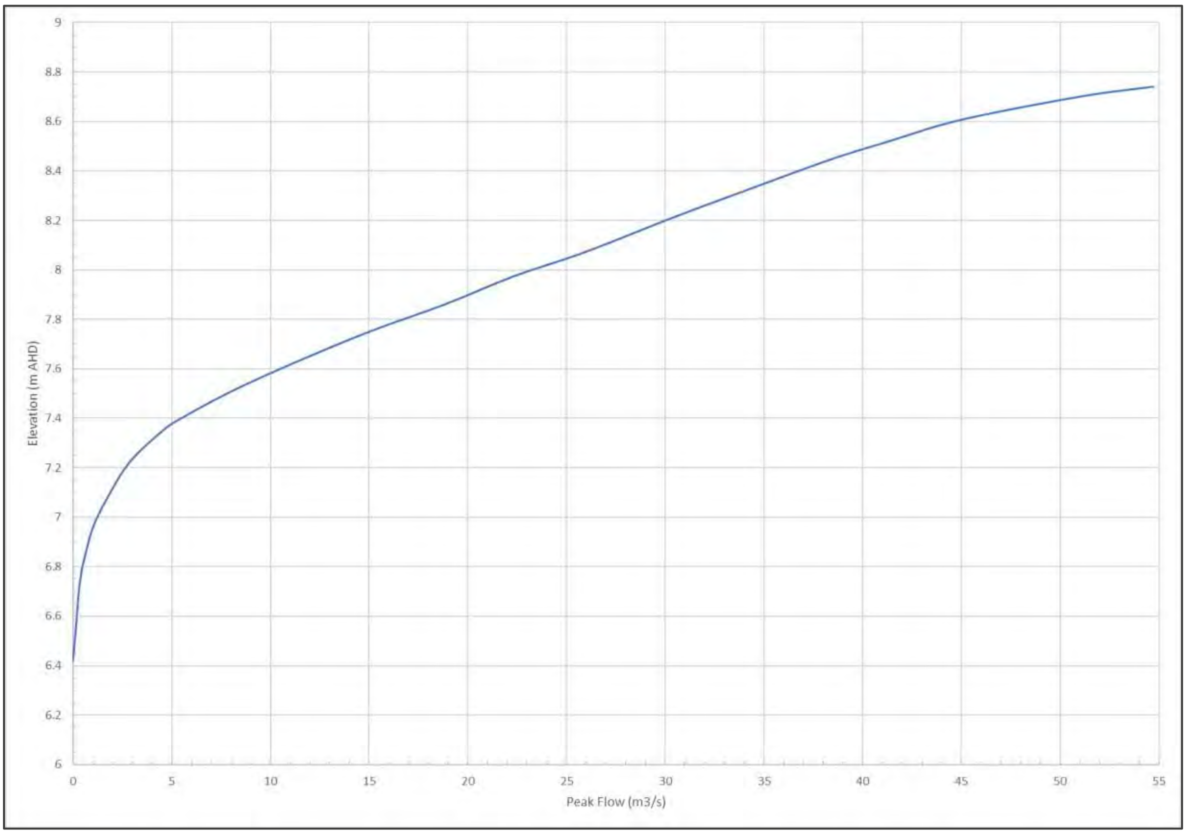

Figure 7.2: Bahrs Scrub Alert Rating Curve

7.1.3 May 2015 Calibration Event

7.1.3.1 Comparison of Hydrologic Model Response

The May 2015 calibration event was simulated in the WBNM hydrologic model. A comparison of the model hydrograph to the WBNM hydrograph is provided in Figure 7.3. The results show that the magnitude of the modelled flows are similar to the translated water level to flow utilising the developed rating curve. However, the general shape of the hydrograph and the timing of the peak are slightly delayed in the modelled datasets, with slightly less volume.

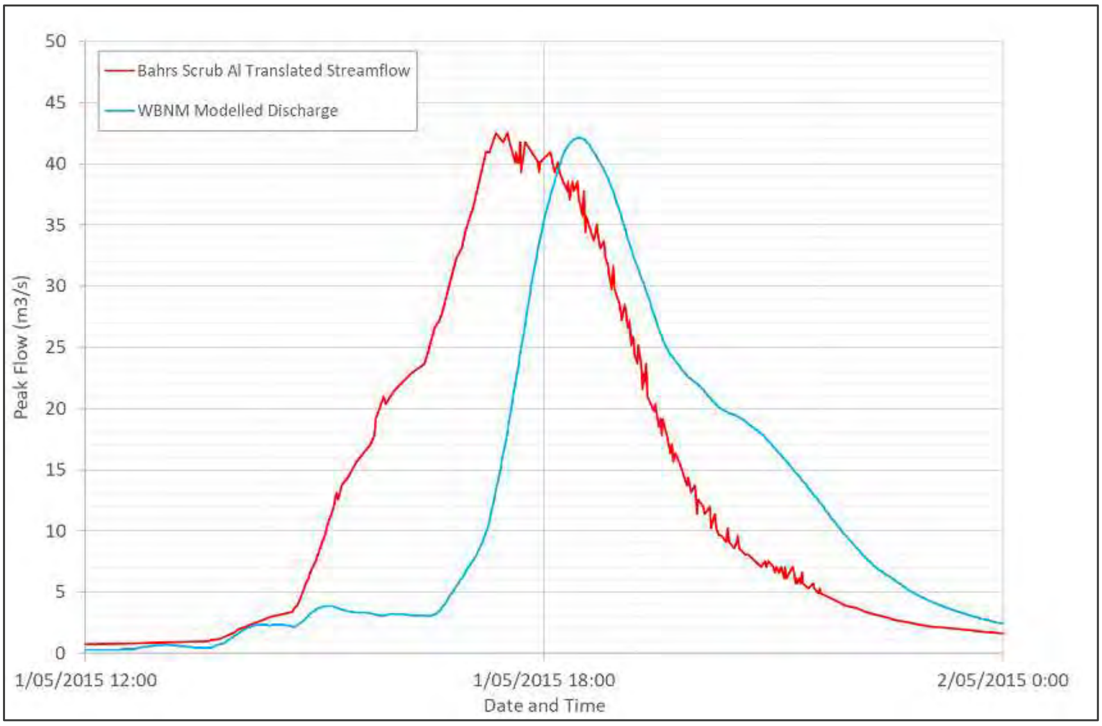

Figure 7.3: Comparison of Recorded and Modelled Discharge – May 2015

TABLE 7.1: MAY 2015 RECORDED VERSUS MODELLED DISCHARGE AT BAHRS SCRUB ALERT

Location and Event	Peak Flow Comparison			Timing		
	Recorded Peak Flow (m^3/s)	Modelled Peak Flow (m^3/s)	Difference to Recorded (m^3/s)	Recorded Time of Peak	Modelled Time of Peak	Difference to Recorded
Bahrs Scrub Alert – May 2015	43	42	-1	1st May 2015 17:31	1st May 2015 18:26	55 minutes

7.1.4 February 2020

7.1.4.1 Comparison of Predicted and Recorded Peak Flood Levels at Bahrs Scrub Alert

The hydraulic model level results for the February 2020 event were compared to the recorded water level series at the Bahrs Scrub Alert. Similar to the hydrologic analysis of the May 2015 event, the modelled flood level result generally sits higher than the recorded flood level result through the peak, however, for the start of the event the modelled result is lower. General catchment response shape and timing is similar. Flood level mapping for the event, and the location of the debris markers are provided in Figure 7.6. Flood depth mapping is provided in Figure 7.7.

A summary of the peak flood event level and date/time stamp for the February 2020 event is provided in Table 7.2. The modeled versus recorded water level series is provided in Figure 7.4. In addition, to support the validation of the calibrated 'fast' model utilised to select the Representative Design Storms (as outlined in Section 8.3), the modelled water level series from this model have also been included in the calibration result reporting.

TABLE 7.2: FEBRUARY 2020 RECORDED VERSUS MODELLED PEAK FLOOD LEVEL AT BAHRS SCRUB ALERT

Location and Event	Water Level Comparison			Timing			Volume	
	Recorded Water Level (m AHD)	Modelled Water Level (m AHD)	Difference (m)	Recorded Time of Peak	Modelled Time of Peak	Difference	Recorded Volume (ML)	Modelled Volume (ML)
Bahrs Scrub Alert – February 2020 (3m)	8.23	8.22	-0.01	13th February 14:20	13th February 16:30	2 hour 10 minutes	426.5	433.9
Bahrs Scrub Alert – February 2020 (10m)	8.23	8.17	-0.06	13th February 14:20	13th February 16:05	1 hour 45 minutes	426.5	363.7

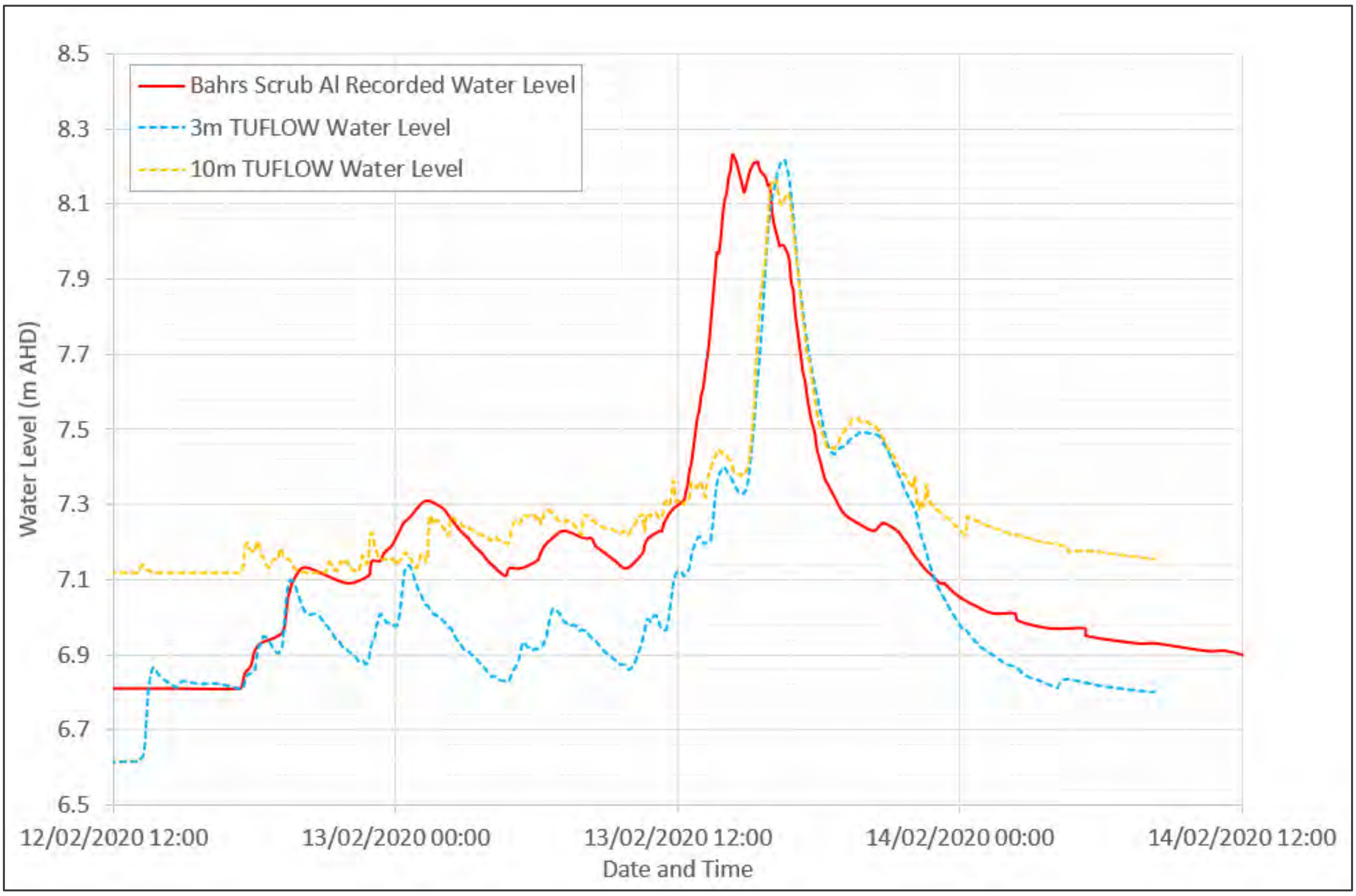

Figure 7.4: Modelled versus Recorded Water Level Series - February 2020

7.1.4.2 Comparison of Predicted Flood Levels with Survey Debris Marks

Two debris survey markers were provided by Council for the February 2020 event. These have been utilised as a secondary source of calibration. A summary of the modelled peak flood level versus the level provided on the debris survey is provided in Table 7.3. The results indicate a reasonable calibration between the modelled results and the debris markers, considering the inherent uncertainty in the accuracy of the exact peak event water level and the location of the debris surveyed post-event.

TABLE 7.3: MODELLED FLOOD HEIGHT VS DEBRIS MARKERS – FEBRUARY 2020 EVENT

Location	Debris Marker Elevation (m AHD)	Model Elevation (m AHD)	Difference (m)
Beaudesert-Beenleigh Road – Upstream	6.83	6.41	-0.42
Beaudesert-Beenleigh Road – Downstream	6.66	6.43	-0.23

7.1.4.3 Comparison of Hydrologic and Hydraulic Model Response

Adjustments were made to hydrologic and hydraulic model parameters to ensure that both models show a similar catchment response. The water level series recorded at the Bahrs Scrub Alert was translated to peak discharge using the rating curve developed by Engeny from the TUFLOW hydraulic model. This resultant translated hydrograph is compared to the WBNM hydrologic hydrograph and the TUFLOW hydraulic flood hydrograph in Figure 7.5. The peak flow discharges from the Bahrs Scrub Alert and the models are summarised in Table 7.4.

As per the result from the water level comparison, the peak discharge modelled both hydrologically and hydraulically is higher than the translated recorded streamflow at the Bahrs Scrub Alert, however the general timing and shape of the catchment response is similar between the recorded and modelled datasets. As per previous discussion, there is concern for the accuracy of the translated recorded streamflow due to dense vegetation and likely underestimation of flow conveyance at low water level elevations. The hydrologic and hydraulic models are seen to behaving similar in terms of routing, with slight dampening in the TUFLOW hydraulic model compared to that seen in the WBNM model likely from additional hydraulic controls and storage not able to be accurately represented in WBNM. In addition, to support the validation of the calibrated 'fast' model utilised to select the Representative Design Storms (as outlined in Section 8.3), the modelled peak flow from this model has also been included in the calibration result reporting.

TABLE 7.4: FEBRUARY 2020 RECORDED VERSUS MODELLED DISCHARGE AT BAHRS SCRUB ALERT

Location and Event	Peak Flow Comparison				
	Translated Recorded Peak Flow (m^3/s)	TUFLOW Peak Flow (m^3/s)	Difference to Recorded (m^3/s)	WBNM Peak Flow (m^3/s)	Difference to Recorded (m^3/s)
Bahrs Scrub Alert – February 2020 (3m)	31.0	32.0	1.0	35.4	4.4
Bahrs Scrub Alert – February 2020 (10m)	31.0	26.0	-5.0		

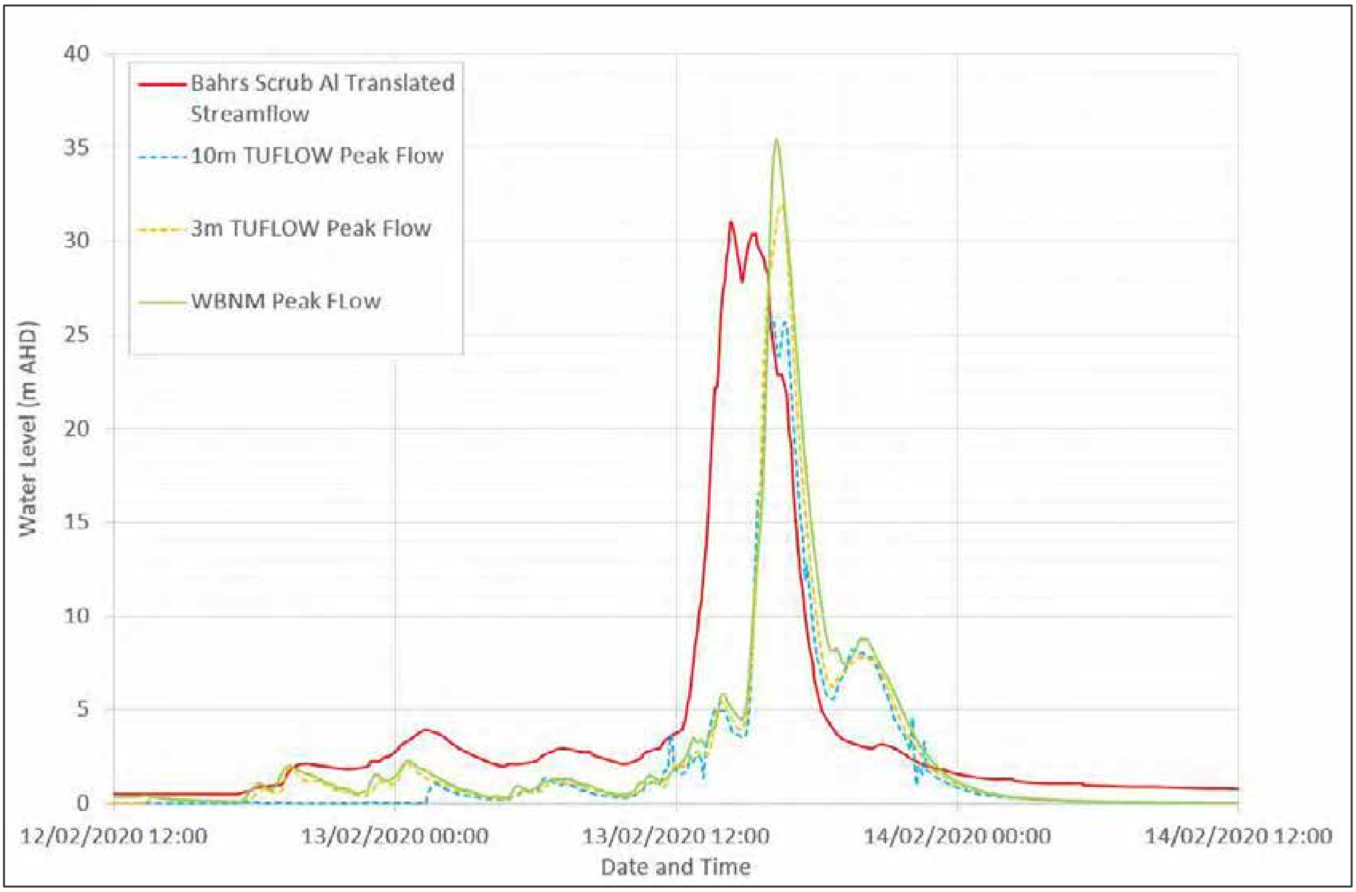

Figure 7.5: February 2020 Hydrologic and Hydraulic Discharge Comparison

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Figure 7.6

Windaroo Creek Flood Study
February 2020 Flood Level

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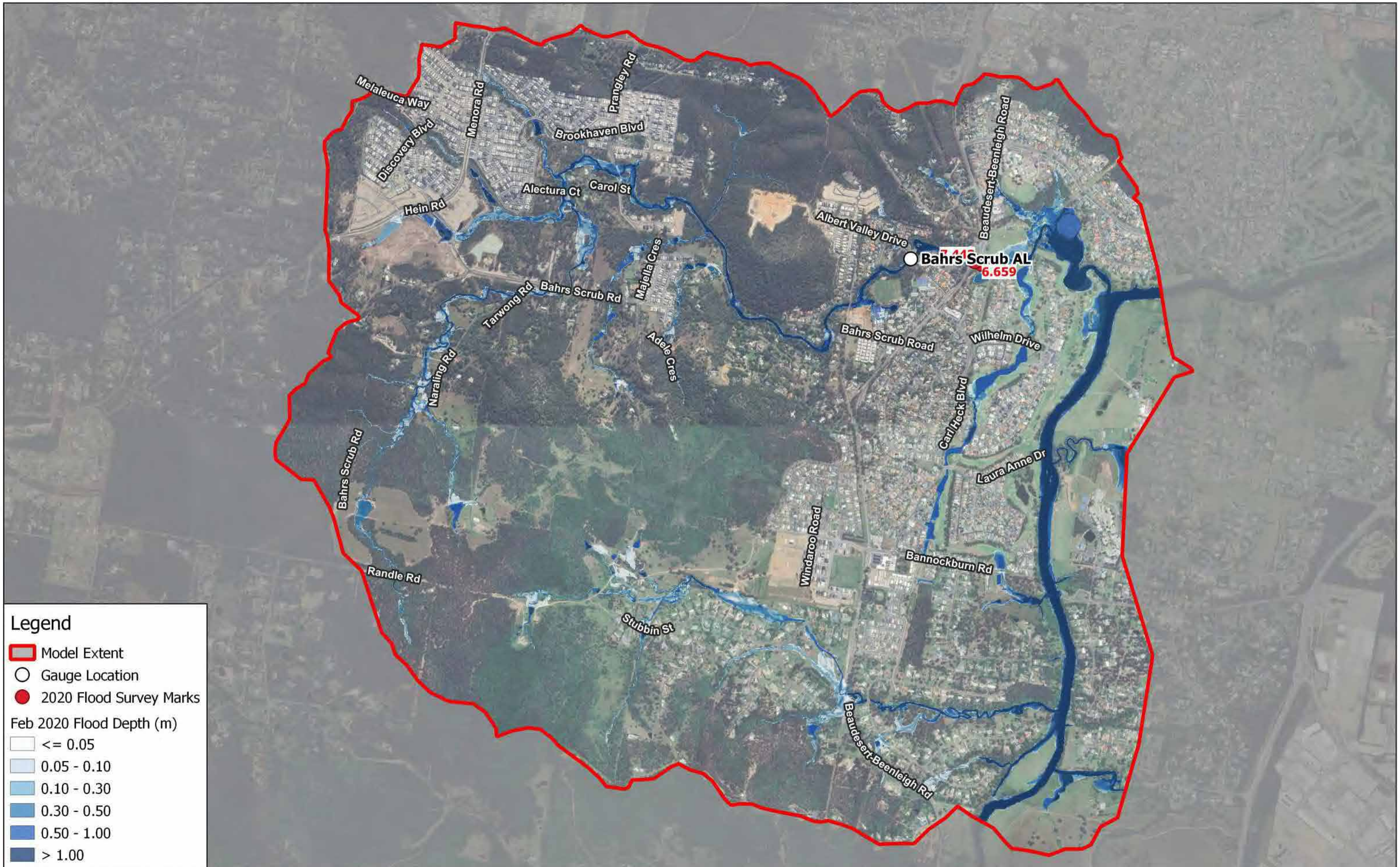

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Figure 7.7

Windaroo Creek Flood Study
February 2020 Flood Depth

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7.1.5 March 2022

7.1.5.1 Comparison of Predicted and Recorded Peak Flood Levels at Bahrs Scrub Alert

The hydraulic model level results for the March 2022 event were compared to the recorded water level series at the Bahrs Scrub Alert. Similar to the May 2015 and February 2020 events, the modelled flood level result generally sits higher than the recorded flood level result through the peak, however, for the start of the event the modelled result is lower. General catchment response shape and timing is similar.

Flood level mapping for the event is provided in Figure 7.10. Flood depth mapping is provided in Figure 7.11.

A summary of the peak flood event level and date/time stamp for the March 2022 event is provided in Table 7.5. The modelled versus recorded water level series is provided in Figure 7.8. In addition, to support the validation of the calibrated 'fast' model utilised to select the Representative Design Storms (as outlined in Section 8.3), the modelled water level series from this model have also been included in the calibration result reporting.

TABLE 7.5: MARCH 2022 RECORDED VERSUS MODELLED PEAK FLOOD LEVEL AT BAHRS SCRUB ALERT

Location and Event	Water Level Comparison			Timing			Volume	
	Recorded Water Level (m AHD)	Modelled Water Level (m AHD)	Difference (m)	Recorded Time of Peak	Modelled Time of Peak	Difference	Recorded Volume (ML)	Modelled Volume (ML)
Bahrs Scrub Alert – March 2022 (3m)	7.67	7.62	-0.05	28th March 2022 23:00	28th March 2022 23:40	40 minutes	154.2	290.6
Bahrs Scrub Alert – March 2022 (10m)	7.67	7.61	-0.06	28th March 2022 23:00	28th March 2022 23:25	25 minutes	154.2	220.8

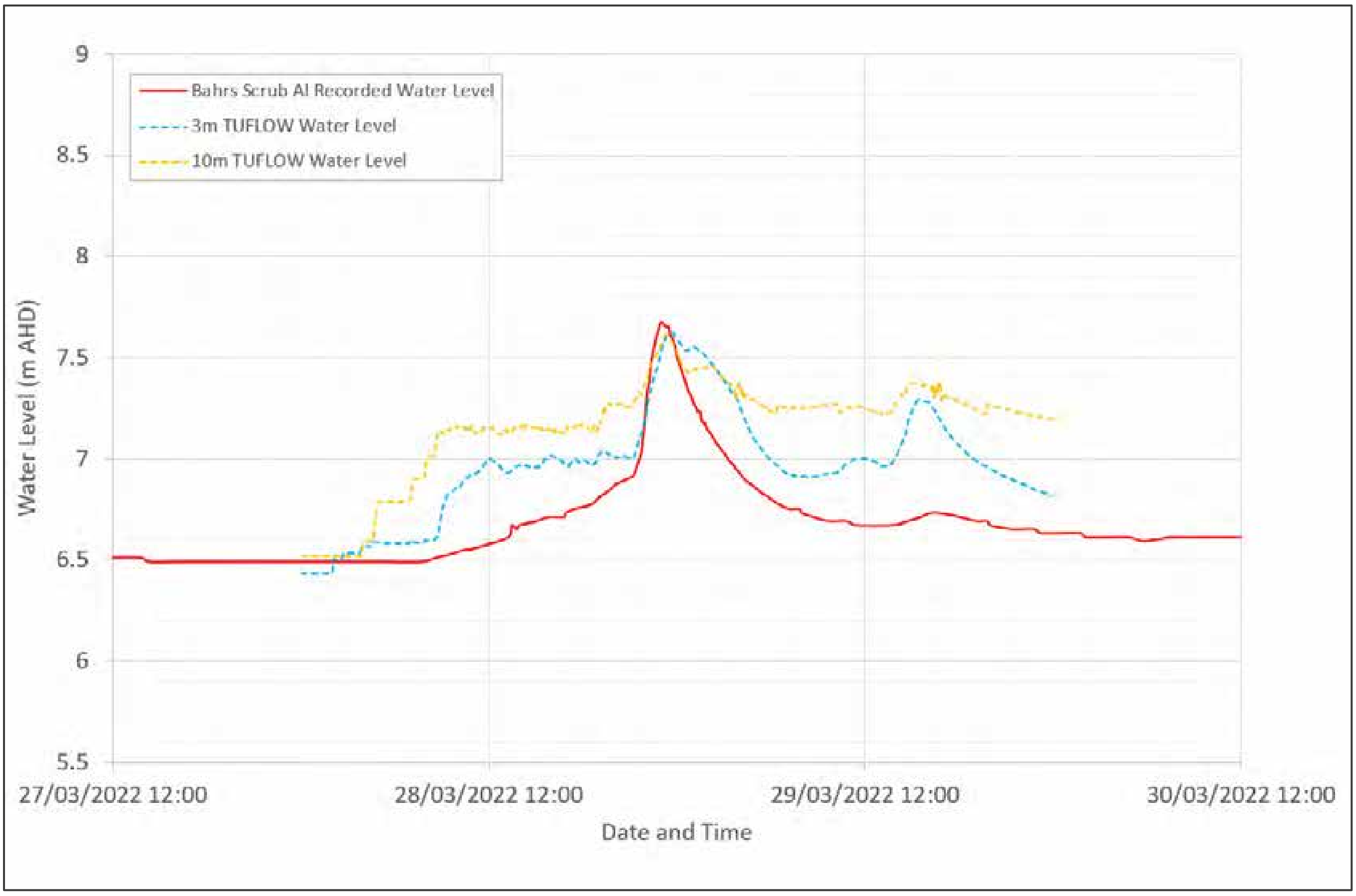

Figure 7.8: Modelled versus Recorded Water Level Series – March 2022

7.1.5.2 Comparison of Hydrologic and Hydraulic Model Response

Adjustments were made to hydrologic and hydraulic model parameters to ensure that both models show a similar catchment response. The water level series recorded at the Bahrs Scrub Alert was translated to peak discharge using the rating curve developed by Engeny from the TUFLOW hydraulic model. This resultant translated hydrograph is compared to the WBNM hydrologic hydrograph and the TUFLOW hydraulic flood hydrograph in Figure 7.9**.** The peak flow discharges from the Bahrs Scrub Alert and the models are summarised in Table 7.6.

As per the result from the water level comparison, the peak discharge modelled both hydrologically and hydraulically is higher than the translated recorded streamflow at the Bahrs Scrub Alert, however the general timing and shape of the catchment response is similar between the recorded and modelled datasets.

TABLE 7.6: MARCH 2022 RECORDED VERSUS MODELLED DISCHARGE AT BAHRS SCRUB ALERT

Location and Event	Peak Flow Comparison				
	Translated Recorded Peak Flow (m^3/s)	TUFLOW Peak Flow (m^3/s)	Difference to Recorded (m^3/s)	WBNM Peak Flow (m^3/s)	Difference to Recorded (m^3/s)
Bahrs Scrub Alert – March 2022 (3m)	12.5	11.8	-0.7	12.8	0.3
Bahrs Scrub Alert – March 2022 (10m)	12.5	10.3	-2.2		

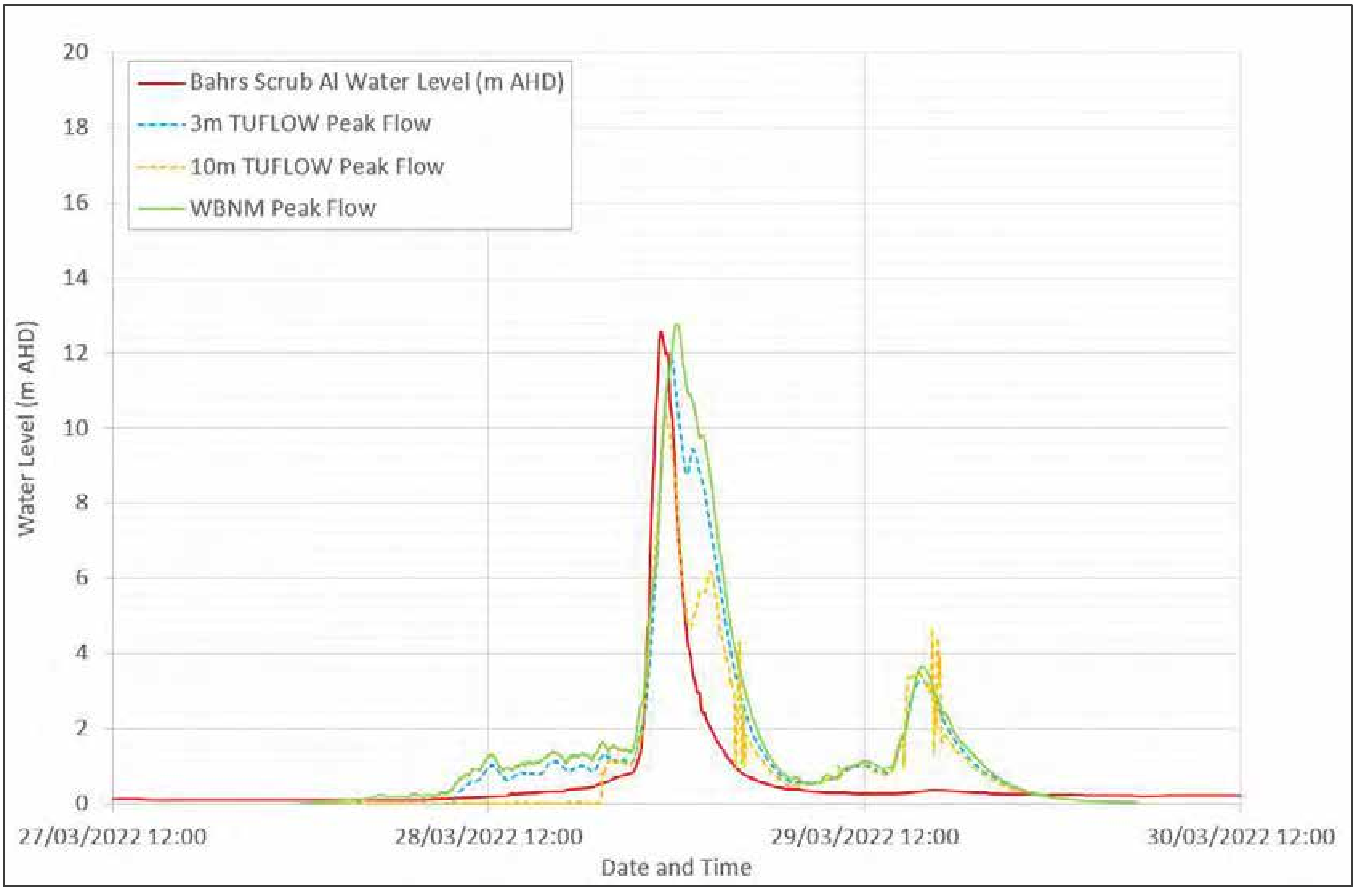

Figure 7.9: March 2022 Hydrologic and Hydraulic Discharge Comparison

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Figure 7.10
Windaroo Creek Flood Study
March 2022 Flood Level

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Figure 7.11

Windaroo Creek Flood Study
March 2022 Flood Depth

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7.1.6 Summary of Model Calibration

The key limitations and assumptions from the calibration process are:

- The Windaroo Creek catchment (inclusive of Belivah Creek) has been represented in a WBNM hydrologic model and a TUFLOW hydraulic model. The following events were selected for calibration:
  - May 2015: hydrologic calibration only (estimated between a 50% and 20% AEP flood event).
  - February 2020: hydrologic and hydraulic calibration (estimated at around a 50% AEP flood event).
  - March 2022: hydrologic and hydraulic calibration (estimated at less than a 50% AEP flood event).
- Only one streamflow gauge exists in the Study catchment for use in the calibration – the Bahrs Scrub Alert (station number 540598). Levels from this gauge have been compared to the TUFLOW modelled water level series and translated to discharge for WBNM hydrologic calibration.
- Only one pluviographic rainfall station exists in the Study catchment for use in the calibration – also the Bahrs Scrub Alert. The rainfall series from this gauge has been applied to the WBNM hydrologic model in order to simulate the calibration events.
- No rating curve exists for the Bahrs Scrub Alert and therefore one was developed from the level-discharge series observed in the TUFLOW hydraulic model. Given the dense vegetation likely captured in the LiDAR topographical dataset at this location, there is likely to be limited accuracy to the translating of observed gauge levels to peak discharge. This could be improved by capture of bathymetric survey at the vicinity of the gauge.
- The Wolffdene Alert (station number 40761) water level record was required to be translated to the Study catchment outlet location utilising the Logan Albert River Flood Study (WRM, 2021) design event result hydraulic grades in order to form the downstream boundary condition for the hydraulic model simulations.

A summary of the calibration outcomes was:

- May 2015 hydrologic calibration:
  - The WBNM modelled discharge aligns with the translated water level to discharge record at Bahrs Scrub Alert. This translation is dependent on a rating curve developed from the TUFLOW hydraulic model that may be influenced by topography showing higher levels than in reality due to the presence of dense vegetation.
  - Hydrograph shape and timing to peak is slightly delayed in the modelled result at the gauge, however, no adjustment of catchment and stream lag parameterisation can be made without influencing the magnitude of the peak flow.
- February 2020 and March 2022 joint calibration:
  - The hydrologic model shows consistent behaviour to the May 2015 event, with higher peak discharge, but similar hydrograph shape and timing in the WBNM model compared to the translated discharge record at Bahrs Scrub Alert.
  - The TUFLOW hydraulic model results indicate that the WBNM stream routing is similar to the hydraulic routing, with consistent hydrograph peak, shape, and timing between the hydrologic and hydraulic models.
  - There should be limited weight provided to the calibration, with uncertainty associated with the accuracy of the rating curve and capture of the creek bed elevations in the vicinity of the gauge due to dense vegetation.

7.1.7 Adoption of Parameters for Design Event Modelling

The WBNM hydrologic and TUFLOW hydraulic models developed for the February 2020 and March 2022 calibration events have been broadly utilised to inform the design event modelling of the Windaroo Creek catchment. Due to limitations in the confidence of the calibration rating curve, and the high calibration initial losses, adoption of the ARR 2019 Data Hub recommended initial and continuing losses was selected. Adjustments to the hydrologic model for design event modelling included:

- Adoption of the initial and continuing losses as recommended by the ARR 2019 Data Hub (Ball et. al., 2019).
- Catchment lag, stream lag and impervious lag factors retained from the calibration models.
- The impervious fractions were updated to reflect LCC's ultimate Planning Scheme (2015) zoning.

Adjustments to the hydraulic model for design event modelling included:

- Update to the Manning's "n" roughness values to reflect LCC's ultimate Planning Scheme (2015) zoning.
- Update to hydraulic structure blockage to match ARR 2019 (Ball et. al., 2019) design event blockage recommendations.

7.2 Model Validation

Peak design event flows adopted for this study have been considered for validation against the following sources of design flood flow estimates:

- Flood Frequency Analysis (FFA).
- The Rational Method as documented in QUDM (IPWEA, 2017).
- Regional Flood Frequency Estimation Model (RFFE) (Ball et. al., 2019).
- Quantile Regression Technique (QRT) (Palmen and Weeks, 2011).
- Validation of hydrologic and hydraulic model catchment response.

7.2.1 Flood Frequency Analysis

The appropriateness of a Flood Frequency Analysis (FFA) for validation of the peak flows for the catchment was considered. Applicable gauges nearby the catchment for consideration included:

- Albert River at Wolffdene Alert (40761).
- Albert River at Beenleigh Alert (540644).
- Bahrs Scrub Alert (operated by Logan City Council) (540598).

The Albert River gauges were not considered a suitable gauge for a FFA analysis due to the difference in magnitude of catchment size and topographical and flood behaviour characteristics between Windaroo Creek and the Albert River. The Bahrs Scrub Alert was also discarded as a gauge suitable for FFA analysis due to a limited period of record and lack of rating curve information.

7.2.2 Rational Method

Peak design flood flows from both WBNM and TUFLOW for various catchment areas have been validated against peak flow estimates generated using the Rational Method. Table 7.7 summarises peak flows at five (5) locations. These catchment locations can be viewed on Figure 4.2. The 1:10 AEP and 1:100 AEP events only have been validated as they are representative of a minor and major flood event and combined with the calibration results are sufficient to indicate that the models are producing suitable peak flow estimates. Details of the Rational Method calculations are presented in Appendix C.

TABLE 7.7: COMPARISON OF PEAK FLOWS WITH RATIONAL METHOD

Sub-Catchment Outlet	Catchment Area (ha)	Rational Method T_c (min)	AEP	Rational Method Peak Flow (m^3/s)	WBNM Peak Flow (m^3/s)	Difference (WBNM – Rational Method)
W001	1,272	142	1:10	116	129	11%
			1:100	228	210	-8%
B001	402	90	1:10	38	40	5%
			1:100	67	67	0%
W016	43	39	1:10	8	10	25%
			1:100	16	16	0%

Sub-Catchment Outlet	Catchment Area (ha)	Rational Method T_c (min)	AEP	Rational Method Peak Flow (m³/s)	WBNM Peak Flow (m³/s)	Difference (WBNM – Rational Method)
T001	57	53	1:10	9	10	11%
			1:100	17	17	0%
B021	13	21	1:10	2	2	0%
			1:100	4	4	0%

8. DESIGN FLOOD MODELLING

8.1 Overview

Two versions of the hydraulic model were developed as below:

- A 10m "fast" model:
  - This model is simulated for all events, durations, and the full ensemble of ten ARR 2019 temporal patterns.
  - Post-processing is completed to extract the median flood depth for each cell in the model for each duration, for each AEP.
  - Zonal statistical analysis is then completed to determine, of the ten ensemble temporal patterns, which one results in the minimal amount of difference to the median flood depth.
  - The resultant singular temporal pattern is referred to as the "representative design storm" for each duration and AEP.
- A 3m "detailed" model:
  - simulated for the "representative design storm" for each duration and AEP as identified from the "fast" model.

This section summarises the development of the design event parameters, "fast" model analysis and key findings from the modelling results.

8.2 Design Event Rainfall Inputs

8.2.1 Methodology

A summary of the adopted design hydrology methodology for this study is provided in Table 8.1. This approach is consistent with previous flood studies completed for the Council, and specific project direction.

TABLE 8.1: SUMMARY OF DESIGN EVENT METHODOLOGY

Parameter	AEP	Source/Method	Comment
Rainfall Depth	≤ 0.05% AEP	ARR 2019	Industry standard.
	PMP	BoM GSDM	Industry standard approach for durations ≤ 6 hours. Adopted in this study for durations up to and including 12 hours, through interpolation with GTSMR method for durations ≥ 24 hours.
Areal Reduction Factor	≤ 0.05% AEP	ARR 2019	Conservative adoption of ARF 1.0.
	PMP	BoM GSDM	Industry standard.
Temporal Pattern	≤ 0.05% AEP	ARR2019 Ensemble	Adopted in this study for consistency with other Council studies.
	PMP	BoM GSDM	Industry standard approach for durations ≤ 6 hours. Adopted in this study for durations up to and including 12 hours.
Spatial Distribution	≤ 0.05% AEP	ARR2019	Inspection of the BoM IFD grids identified four grids covering the Windaroo Creek catchment which have been applied as spatially varying input in WBNM.

Parameter	AEP	Source/Method	Comment
	PMP	BoM GSDM	Industry standard.
Rainfall Losses	≤ 0.05% AEP	ARR2019	Adopted initial and continuing losses were based on estimates given in ARR 2019 and adopted for median pre-burst rainfalls and sub-catchment fraction impervious.
	PMP	Adopt Minimum Losses	Adopt 0 mm initial loss and 0 mm/h continuing losses.

8.2.2 Design IFD Data

Design rainfall data for the Windaroo Creek catchment was derived for rainfall events between the 50% AEP event and the Probable Maximum Precipitation (PMP) event. The design rainfall data was derived using the following methods:

- Rainfall totals in the AEP range 50% AEP to 0.05% AEP were generated for four locations within the catchment using the BoM IFD tool (www.bom.gov.au/water/designRainfalls/revised-ifd/).
- PMP rainfall estimates were calculated using the GSDM method (BOM, 2003) for durations less than 6 hours.

Design rainfall totals (point values) for the nearest grid to the central IFD location at the Bahrs Scrub Alert (latitude of -27.7375, longitude of 153.875) are summarised in Table 8.2.

TABLE 8.2: WINDAROO CREEK DESIGN RAINFALL TOTALS (MM) – BAHRS SCRUB ALERT

Duration	Flood Event								
	50% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP	0.5% AEP	0.02% AEP	0.05% AEP
30 minutes	29.4	40.1	47.4	54.5	63.7	70.8	79	91.7	155
1 hour	37.8	52.2	62.4	72.5	86.3	97.2	109	126	184
1.5 hours	43	60	72.2	84.5	102	115	129	150	207
2 hours	47.1	66.2	79.9	94.1	114	130	145	169	243
3 hours	53.8	76.2	92.6	110	134	153	171	198	284
4.5 hours	62	88.5	108	128	157	181	201	232	319
6 hours	69	99	121	144	177	203	226	261	155

8.2.3 Design Temporal Patterns

The ensemble temporal patterns approach was adopted for design event simulations. Design point patterns from the 'East Coast North' region were used for design events up to the 0.05% AEP event. The Generalised Short-Duration Method (GSDM) (BoM, 2003) were adopted for the PMP flood event.

8.2.4 Areal Reduction Factor

A conservative approach of adopting an ARF of 1.0 was adopted for all durations and AEPs up to the 0.05% AEP flood event. For the PMP event, the BoM (2003) GSDM guidelines were used.

8.2.5 Design Event Loss Parameters

Pervious Sub-catchment

Design storm rainfall losses (Initial Loss = 27 mm and Continuing Loss = 1.6 mm/h) were sourced from the ARR 2019 Data Hub (http://data.arr-software.org) for storm events up to 1% AEP. Median pre-burst rainfall depths were also sourced from the ARR 2019 Data Hub (http://data.arr-software.org) for storm events up to 1%AEP. The WBNM software applies median pre-burst rainfall depths over four (4) routing increments prior to the design burst temporal patterns.

Zero initial and one mm/hr continuing loss values have been adopted for the PMP event. Initial loss values were interpolated for storm events between the 1% AEP and PMF events using a log-normal interpolation method as recommended in ARR 2019 Section 4.3.2.2. The initial and continuing loss values adopted for the various design events are summarised in Table 8.3.

TABLE 8.3: ADOPTED DESIGN EVENT INITIAL AND CONTINUING LOSSES

Flood Event	Initial Loss (mm)	Continuing Loss (mm/h)
≤ 1% AEP	27.0	1.6
0.5% AEP	22.0	1.0
0.2% AEP	17.0	1.0
0.05% AEP	11.0	1.0
PMF	0.0	1.0

Impervious Sub-catchment

An initial loss of 1 mm and 0 mm /hr continuing loss were applied to impervious sub-catchments in WBNM across all modelled flood events.

8.2.6 Climate Change

The following 2090 climate change RCP scenarios have been simulated in the hydraulic model:

- RCP4.5 for 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2% and 0.05% AEP flood events.
- RCP6.0 and RCP8.5 for the 1% AEP flood event.

The applicable increase in rainfall intensity is summarised in Table 8.4.

TABLE 8.4: 2090 CLIMATE CHANGE SCENARIO RAINFALL INTENSITIES

Climate Change Representative Concentration Pathway	Increase to Rainfall Intensity
RCP4.5	9.5%
RCP6.0	11.5%
RCP8.5	19.7%

8.2.7 Probable Maximum Precipitation (PMP)

Based on the critical duration of the design storms in this study, the Generalised Short-Duration Method (GSDM) (BoM, 2003) was applied to Probable Maximum Precipitation (PMP) generation. The parameters in generating the PMP estimate are given in Table 8.5.

TABLE 8.5: PROBABLE MAXIMUM PRECIPITATION PARAMETERS

PMP Parameter	Windaroo Creek	Belivah Creek
Catchment Area (km2)	12.7	4.0
Elevation Adjustment Factor	1.0	1.0
Moisture Adjustment Factor	0.8	0.8

The derived PMP depths used in the study are summarised in Table 8.6.

TABLE 8.6: DERIVED PROBABLE MAXIMUM PRECIPITATION DEPTHS

Duration (hrs)	Windaroo Creek PMP Depth (mm)	Belivah Creek PMP Depth (mm)
1	360	390
1.5	470	500
2	540	580
3	660	700
4.5	790	850
6	880	940

8.3 Critical Duration and Temporal Pattern Analyses

It was considered that the simulation of the full ensemble of temporal patterns for all durations and flood event AEPs in the calibrated 'fine' hydraulic model is too time intensive and not appropriate for the purposes of this study. Therefore, a process to determine a single representative temporal pattern for each storm duration for each AEP has been undertaken. The selected temporal patterns were chosen to represent the best estimate of flood levels without simulation of the full ensemble, and was undertaken in accordance with the below methodology:

- Initially, a suitably large envelope of critical durations for each flood event AEP was determined in the hydrologic model.
- A calibrated 'fast' hydraulic model with a grid cell resolution of 10m was then developed.
- Simulation of the full ensemble of temporal patterns through the calibrated 'fast' hydraulic model for all storm AEPs and the envelope of critical durations identified in the hydrologic model was then undertaken.
- The statistical median flood level at every cell for each storm AEP and duration was then calculated from the calibrated 'fast' hydraulic model flood height results.
- The flood level difference between each temporal pattern and the statistical median flood level at every cell for each storm AEP and duration was calculated.
- The mean flood level difference between each temporal pattern and the statistical median flood level at every cell for each individual storm AEP and duration was calculated.
- Determination and selection of the temporal pattern which produces the lowest mean flood level difference between each temporal pattern and the statistical median flood level for each individual storm AEP and duration at each cell. These are the "Representative Design Storms".
- Simulation of the selected temporal pattern in the final calibrated 'fine' model with a 3 m grid cell resolution for each storm AEP and duration.

The selected "Representative Design Storms" are included in Appendix D. Critical duration mapping is provided in Appendix E.

8.3.1 1% AEP Flood Event

An exception to the critical duration and temporal pattern analysis outlined in Section 8.3 is the 1% AEP flood event. Initially, a suitably large envelope of critical durations for the 1% AEP flood event was determined in the hydrologic model. However, the calibrated 'fast' hydraulic model was not utilised to reduce the number of temporal patterns simulated. The full ensemble of ten ARR2019 temporal patterns was simulated for the 1% AEP flood event, to add further rigour to the peak flood results given the importance of this flood event in the context of planning and flood risk management.

All sensitivity assessments (including climate change) performed on the 1% AEP flood event (as summarised in Section 9) were also simulated with the full ensemble of ten ARR2019 temporal patterns.

The selected "Representative Design Storms" for the 1% AEP flood event have still been included in Appendix D, to enable simulation of a single temporal pattern if desired in alternative applications of the hydraulic model.

8.4 Interpretation of Results

As discussed previously, a full range of critical durations and "representative" design storms were simulated. The resulting peak flows and levels throughout this report relate to the storm duration with the highest value from the median of the ten temporal patterns. The maps provided are "max-max" results, also showing the highest value from the median of the ten temporal patterns.

Peak flood levels, depths and mapping are provided in the following sections.

8.4.1 Summary of Design Peak Flows

Peak flows for the simulated design events have been summarized at 15 locations throughout the catchment. The peak flows are summarized in Table 8.7 and the locations are shown on Figure 8.1. The peak flow analysis at the catchment outlet is provided in Appendix F.

TABLE 8.7: DESIGN EVENT PEAK FLOW SUMMARY (M^3/S)

Location ID	Location Description	50%	20%	10%	5%	2%	1%	0.5%	0.2%	0.05%	PMF
PO_005	Windaroo Valley State High	35	62	78	99	117	139	163	188	223	462

Location ID	Location Description	50%	20%	10%	5%	2%	1%	0.5%	0.2%	0.05%	PMF
PO_009	Windaroo Road	334	61	78	97	115	135	161	193	247	753
PO_011	Beaudesert-Beenleigh Road 1	36	63	81	101	120	140	168	203	263	820
PO_025	Bahrs Scrub Road 2	29	53	70	89	105	122	145	172	221	625
PO_042	Prangley Road	20	36	49	64	74	84	103	123	163	448
PO_064	Azure Street	6	13	20	20	24	26	30	31	38	126
PO_070	Bahrs Scrub Road 1	11	22	29	36	42	48	58	71	97	291
PO_154	Windaroo Creek Outlet	46	75	94	118	143	160	204	253	338	1114
PO_161	Prenzlau Crescent	9	14	16	17	18	18	20	51	51	174
PO_171	Laura Anne Drive	0	0	3	3	5	7	11	20	31	117
PO_183	Stubbin Reserve	10	21	28	31	35	40	49	61	80	288
PO_233	Belivah Creek Outlet	18	34	44	54	62	70	85	105	143	418
PO_245	Bahrs Scrub Road 3	34	61	79	97	114	136	161	192	244	704
PO_163	Beaudesert-Beenleigh Road 2	8	14	16	16	17	18	19	26	39	152
BahrsScrubAl	Albert Valley Drive	35	61	71	84	95	109	126	143	180	478

8.4.2 Summary of Design Peak Flood Levels

Peak levels for the simulated design events have been summarised at 33 locations throughout the catchment. The peak levels are summarised in Table 8.8 and the locations are shown on Figure 8.1.

TABLE 8.8: DESIGN EVENT PEAK LEVEL SUMMARY (M AHD)

Location ID	Location Description	50%	20%	10%	5%	2%	1%	0.5%	0.2%	0.05%	PMF
PO_H_25	Albert Valley Drive 1	0.0	0.0	10.7	10.7	10.7	10.8	11.0	11.3	11.6	13.2
PO_H_26	Albert Valley Drive 2	0.0	0.0	0.0	0.0	10.3	10.5	10.6	10.9	11.0	12.2
PO_H_19	Bahrs Scrub 1	0.0	19.5	19.6	19.6	19.6	19.6	19.7	19.7	19.9	22.0
PO_H_20	Bahrs Scrub 2	16.5	17.1	17.4	17.6	17.8	18.0	18.2	18.5	18.8	21.0
PO_H_22	Bahrs Scrub 3	12.2	12.9	13.2	13.5	13.7	13.8	14.0	14.2	14.5	16.1
PO_H_7	Bahrs Scrub 4	34.3	34.6	34.8	34.9	35.0	35.1	35.2	35.4	35.6	36.7
PO_H_65	Bannockburn Road	0.0	7.5	7.6	7.6	7.6	7.6	7.6	7.7	7.7	9.0
PO_H_28	Beaudesert-Beenleigh Road 1	6.8	7.1	7.3	7.5	7.8	7.9	8.1	8.5	8.8	10.1
PO_H_63	Beaudesert-Beenleigh Road 2	0.0	0.0	11.3	11.3	11.3	11.3	11.3	11.4	11.4	11.7
PO_H_40	Beaudesert-Beenleigh Road 3	10.9	11.3	11.5	11.6	11.8	11.9	12.1	12.3	12.6	14.1
PO_H_43	Beaudesert-Beenleigh Road 4	0.0	0.0	11.6	11.7	11.7	11.8	12.0	12.3	12.6	14.1
PO_H_29	Beaudesert-Beenleigh Road Pedestrian Bridge	6.6	7.0	7.1	7.3	7.4	7.5	7.6	8.0	8.1	9.5
PO_H_31	Carl Heck Boulevard	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.4	11.6	12.6
BahrsScrub_Al	Gauge Station	8.3	9.0	9.4	9.9	10.4	10.6	10.9	11.2	11.5	13.0

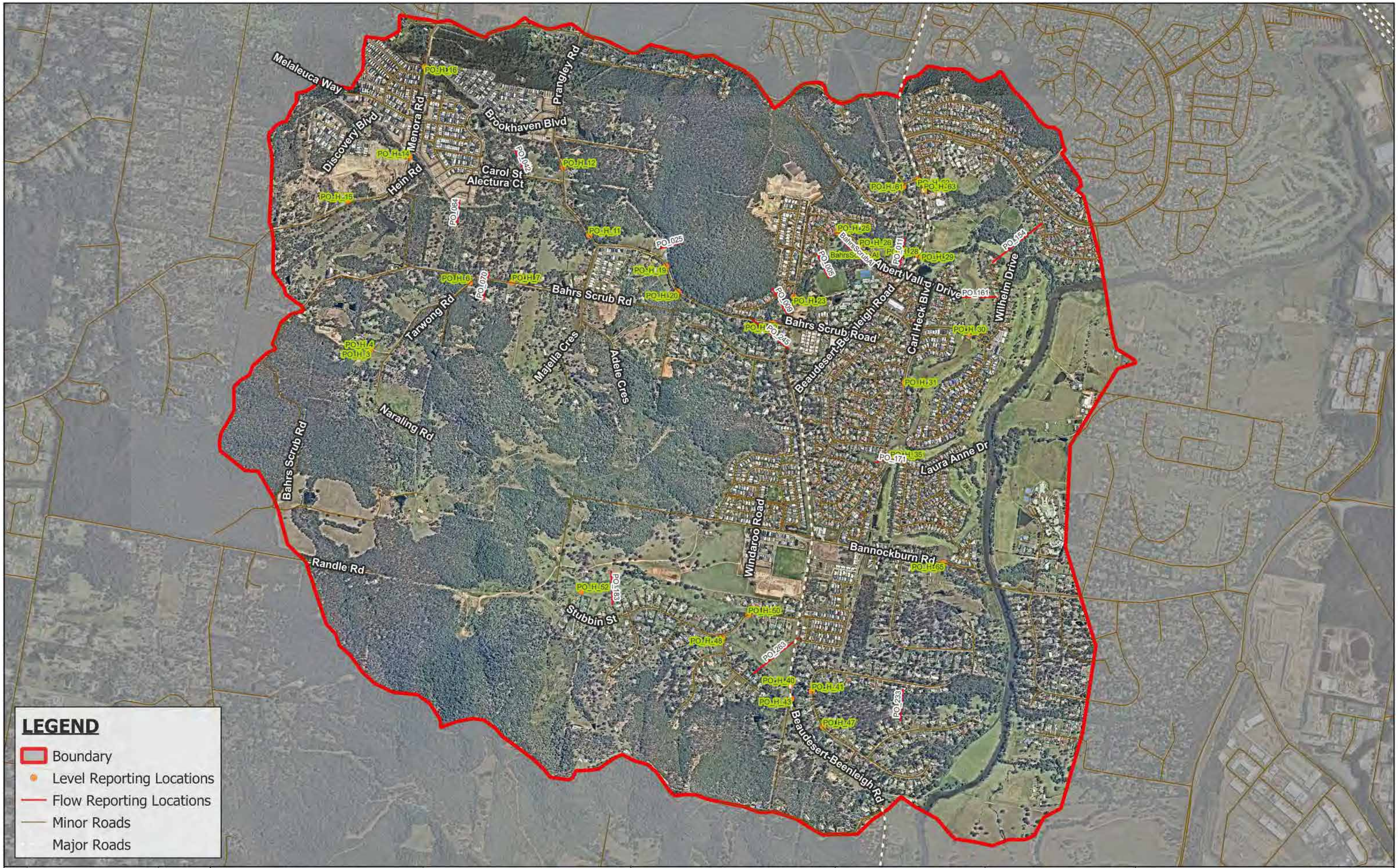
Location ID	Location Description	50%	20%	10%	5%	2%	1%	0.5%	0.2%	0.05%	PMF
PO_H_15	Hein Road	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6
PO_H_62	Janine Drive 1	0.0	0.0	13.7	13.7	13.7	13.7	13.8	13.8	13.8	13.9
PO_H_61	Janine Drive 2	0.0	0.0	14.2	14.2	14.2	14.2	14.3	14.3	14.3	14.5
PO_H_14	Menora Road 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.5	41.7	42.1
PO_H_16	Menora Road 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.8
PO_H_3	Neraling Road Driveway 1	44.9	45.1	45.2	45.2	45.3	45.3	45.4	45.5	45.7	46.5
PO_H_4	Neraling Road Driveway 2	44.8	44.9	45.0	45.0	45.1	45.1	45.2	45.3	45.5	46.3
PO_H_48	Osborne Court	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.6
PO_H_12	Prangley Road 1	24.6	24.7	24.8	24.9	25.0	25.1	25.2	25.3	25.6	27.2
PO_H_11	Prangley Road 2	0.0	29.9	30.0	29.9	30.0	30.0	30.1	30.1	30.2	30.7
PO_H_41	Richland Drive 1	0.0	10.9	11.2	11.4	11.5	11.6	11.7	11.9	12.1	13.2
PO_H_47	Richland Drive 2	11.7	11.7	11.8	11.8	11.8	11.8	11.8	11.9	11.9	12.3
PO_H_50	Stubbin Street	0.0	0.0	19.3	19.3	19.4	19.5	19.6	19.8	19.9	20.4
PO_H_52	Stubbin Street Driveway	0.0	0.0	0.0	0.0	0.0	39.6	39.7	39.8	39.9	40.4
PO_H_35	Susan Godfrey Drive	0.0	0.0	11.6	11.6	11.6	11.6	11.6	11.7	11.8	12.9
PO_H_6	Tarwonga Road	36.1	36.4	36.5	36.5	36.6	36.6	36.7	36.9	37.1	38.1
PO_H_30	Wilhelm Drive	0.0	0.0	0.0	0.0	0.0	0.0	11.1	11.3	11.5	12.1

Location ID	Location Description	50%	20%	10%	5%	2%	1%	0.5%	0.2%	0.05%	PMF
PO_H_23	Windaroo Road	0.0	11.4	11.6	11.7	11.9	12.0	12.2	12.3	12.5	13.9

8.4.3 Flood Mapping

Flood mapping for the design flood events is provided in Appendix G of this report. These maps are “max-max” results and have been provided for the following results:

- Level.
- Depth.
- Velocity.
- Hazard – Depth x Velocity Product.
- Hazard – AIDR Classifications.
- Hazard – QRA Classifications.



R	DETAILS	DATE
1	Final Issue	15-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	15-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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Figure 8.1

Windaroo Creek Flood Study

Flood Hotspot Areas

M9000_082

8.4.4 Climate Change

In order to visually illustrate the expected flood level increases, an afflux map showing the expected increase in flood level between the current climate 1% AEP flood event and the 2090 horizon Representative Concentration Pathway (RCP) 4.5 1% AEP event are provided in Figure 8.2. Mapping for all simulated 2090 horizon RCP 4.5 flood events are provided in Appendix H.

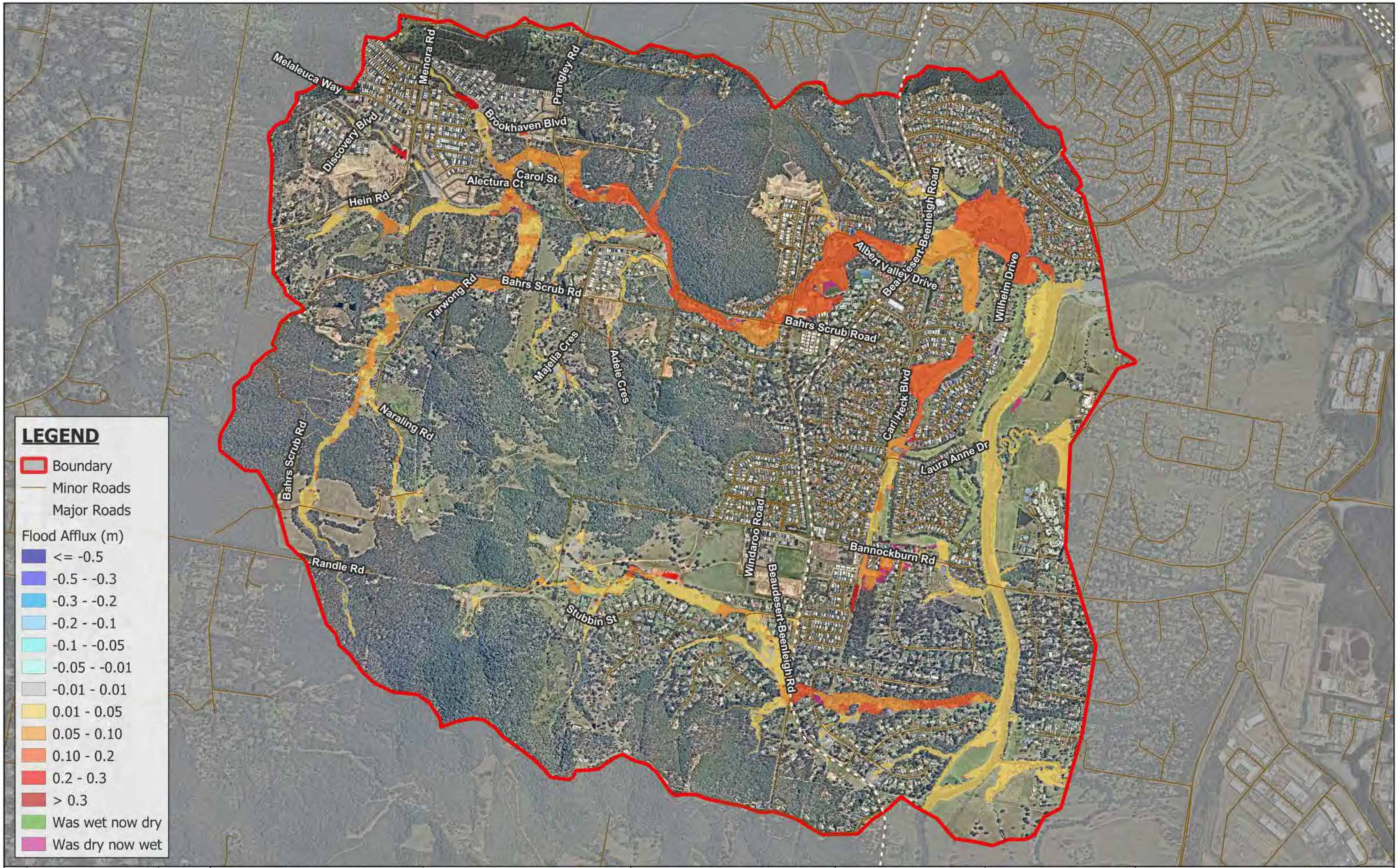
The mapping shows that flood levels are expected to increase in the future climate, with greater increase expected in the higher order streams and towards the catchment outlet. On average, increases in the range of 20 to 260 mm are expected.

The peak flows for the various Climate Change scenarios are summarised in Table 8.9, and the locations are shown on Figure 8.1.

TABLE 8.9: DESIGN EVENT PEAK FLOW SUMMARY – CLIMATE CHANGE RCP4.5 2090 SCENARIO (M^3/S)

Location ID	Location Description	50%	20%	10%	5%	2%	1%	0.5%	0.2%	0.05%
PO_005	Windaroo Valley State High	40.0	69.0	86.3	110.1	130.5	155.1	178.7	202.7	236.9
PO_009	Windaroo Road	38.5	68.2	85.7	108.4	128.7	151.7	178.9	214.2	273.6
PO_011	Beaudesert -Beenleigh Road 1	41.2	69.5	88.9	111.0	133.7	157.4	187.3	226.0	292.7
PO_025	Bahrs Scrub Road 2	33.2	59.6	76.9	100.3	116.9	135.8	160.9	189.4	244.5
PO_042	Prangley Road	22.0	41.2	55.8	70.7	82.9	94.1	114.4	137.8	182.0
PO_064	Azure Street	7.0	15.1	22.4	21.7	26.2	27.9	32.1	33.6	42.9
PO_070	Bahrs Scrub Road 1	12.8	25.5	34.0	40.2	47.0	53.4	64.7	81.2	107.7
PO_154	Windaroo Creek Outlet	51.1	82.2	102.4	129.5	157.5	175.7	227.1	284.3	378.8
PO_161	Prenzlau Crescent	9.9	14.8	16.4	17.5	18.2	18.8	22.7	51.0	51.0
PO_171	Laura Anne Drive	0.0	0.1	4.6	4.2	7.3	9.7	13.9	24.0	36.4
PO_183	Stubbin Reserve	11.1	23.0	33.9	35.3	41.1	45.8	54.5	68.6	89.0
PO_233	Bolivah Creek Outlet	19.9	38.6	50.1	60.2	70.5	78.3	95.5	118.5	159.2
PO_245	Bahrs Scrub Road 3	38.6	68.2	87.3	108.2	127.8	152.0	178.7	212.6	270.5

Location ID	Location Description	50%	20%	10%	5%	2%	1%	0.5%	0.2%	0.05%
PO_163	Beaudesert -Beenleigh Road 2	9.3	14.3	16.4	16.9	18.3	19.0	21.6	31.3	45.5
BahrsScrubAl	Albert Valley Drive	40.2	66.2	75.9	90.7	104.5	119.5	137.2	156.4	197.6



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NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Figure 8.2

Windaroo Creek Flood Study
1% AEP RCP4.5 Climate Chnage Afflux

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9. SENSITIVITY ANALYSES

9.1 Overview

Three sensitivity scenarios were simulated for the 1% AEP flood event to assess the impact of the following changes to modelling parameters:

- Increase to hydraulic roughness (20%).
- Severe blockage of culverts and bridges, in accordance with ARR 2019 guidelines.
- Zero blockage of culverts and bridges.
- Increase in waterway roughness to reflect revegetation.

9.2 Methodology

For the 1% AEP simulations of the sensitivity analysis scenarios, all durations with the full ensemble of ten temporal patterns as per the design event methodology were simulated and compared against the baseline model maximum flood level result.

The following methodology was adopted for modelling of the sensitivity analysis scenarios.

9.2.1 Increased Hydraulic Roughness

The hydraulic roughness Manning's "n" values were increased for all land uses (as shown in Figure 6.6) by a consistent value of 20%. A comparison of the base versus sensitivity analysis roughness values are provided in Table 9.1.

TABLE 9.1: LAND USE AND MANNING'S "N" VALUES

Land Use Type	Manning's "n" – Design Case	Manning's "n"- Increased Roughness Sensitivity Analysis
Roads	0.025	0.03
Special Purpose (Road)	0.025	0.03
Recreation and Open Space	0.045	0.054
Rural Residential	0.055	0.066
Rural	0.055	0.066
Community Facilities	0.06	0.072
Environmental Management and Conservation/Dense Bush	0.09	0.108
Low Density Residential	0.2	0.24
Emerging Community	0.25	0.3
Low-Medium Density Residential	0.25	0.3
Centre/Industrial	0.3	0.36

Land Use Type	Manning's "n" – Design Case	Manning's "n"- Increased Roughness Sensitivity Analysis
Mixed Use	0.3	0.36
Waterway in channel - lightly vegetated	0.035	0.042
Waterway in channel - moderately vegetated	0.05	0.06
Waterway in channel - highly vegetated	0.08	0.096
Upper Catchment Watercourse	0.065	0.078
Waterway corridor	0.1	0.12

9.2.2 Severe Blockage of Culverts and Bridges

For the severe blockage of culverts and bridges scenario, 100% blockage has been applied to all hydraulic structures in the model.

9.2.3 No Blockage of Culverts and Bridges

For this scenario, zero blockage was applied to culverts and no debris blockage applied to guard rails on bridges.

9.2.4 Increase in Waterway Roughness

A review into the current condition of the waterways through the Windaroo Creek catchment was undertaken. The intent of this sensitivity is to represent revegetation of any waterways that are considered currently engineered with concrete inverts or grass lined or are in a state of degradation so that they reflect rehabilitation back to natural waterway conditions. Areas were identified where the waterway vegetation could be improved, and these areas were updated to a Manning's "n" roughness of 0.08 to reflect the fully vegetated waterway conditions.

9.3 Results

9.3.1 Increased Hydraulic Roughness

The flood afflux mapping for the scenario where the hydraulic roughness was increased is shown in Figure 9.1. The mapping indicates that the model is sensitive to this parameter and increasing the hydraulic roughness will result in higher flood depths and elevation. The results from this assessment shows that increases in modelled flood depth are relatively consistent across the model extent, averaging approximately 20 mm to 170 mm.

9.3.2 Severe Blockage of Culverts and Bridges

The flood afflux mapping for the scenario where the blockage of hydraulic structures was increased is shown in Figure 9.2. The mapping indicates that blockage of key hydraulic structures results in localized increases in flood levels upstream of the crossings and reductions in flood levels downstream of the crossings. Key crossings that influence the flood height mapping the most in the catchment include Menora Road, Brookhaven Boulevard, Albert Valley Drive, Bannockburn Road, and Beaudesert-Beenleigh Road.

9.3.3 No Blockage of Culverts and Bridges

The flood afflux mapping for the scenario where structures are unblocked are shown in Figure 9.3. As expected, the mapping indicates that eliminating culvert blockage has less impact on modelled flood levels and depths than the other sensitivity analyses. This is due to majority of structures in the catchment having only a 20% blockage for design events, meaning there is minimal difference between the design and sensitivity events. Additionally, in larger magnitude flood events the culvert capacities are already exceeded under the design blockage scenario, with large amounts of flow overtopping the road embankments, meaning that eliminating culvert blockage has minimal impact on flood behaviour. Areas where changes in flood level are more prominent are:

- Flood level reductions of up to 40 mm were observed in the residential areas adjacent Bannockburn Road.
- A large extent of reduction is observed upstream of Albert Vallet Drive through the waterway from 20 to 150 mm.
- Significant local flood level reductions are observed upstream of Menora road and Brookhaven Boulevard up to 400mm, with localised increases in flood levels downstream of around 20 mm.
- Balanced decreases in flood level upstream of Beenleigh-Beaudesert Road and increases downstream are observed at Janine Drive.

9.3.4 Increase in Waterway Roughness

The flood afflux mapping for the scenario where waterways are revegetated to a consistent manning's "n" roughness are shown in Figure 9.4. Localised increases in flood level from 20 to 130 mm are observed through the areas where the waterway roughness has been increased to represent revegetation. Where these areas discharge to waterway areas that are not proposed to increase in roughness, reductions in flood levels in the region of 20 mm are observed of a result in reduction in conveyance resultant from the upstream revegetated areas.

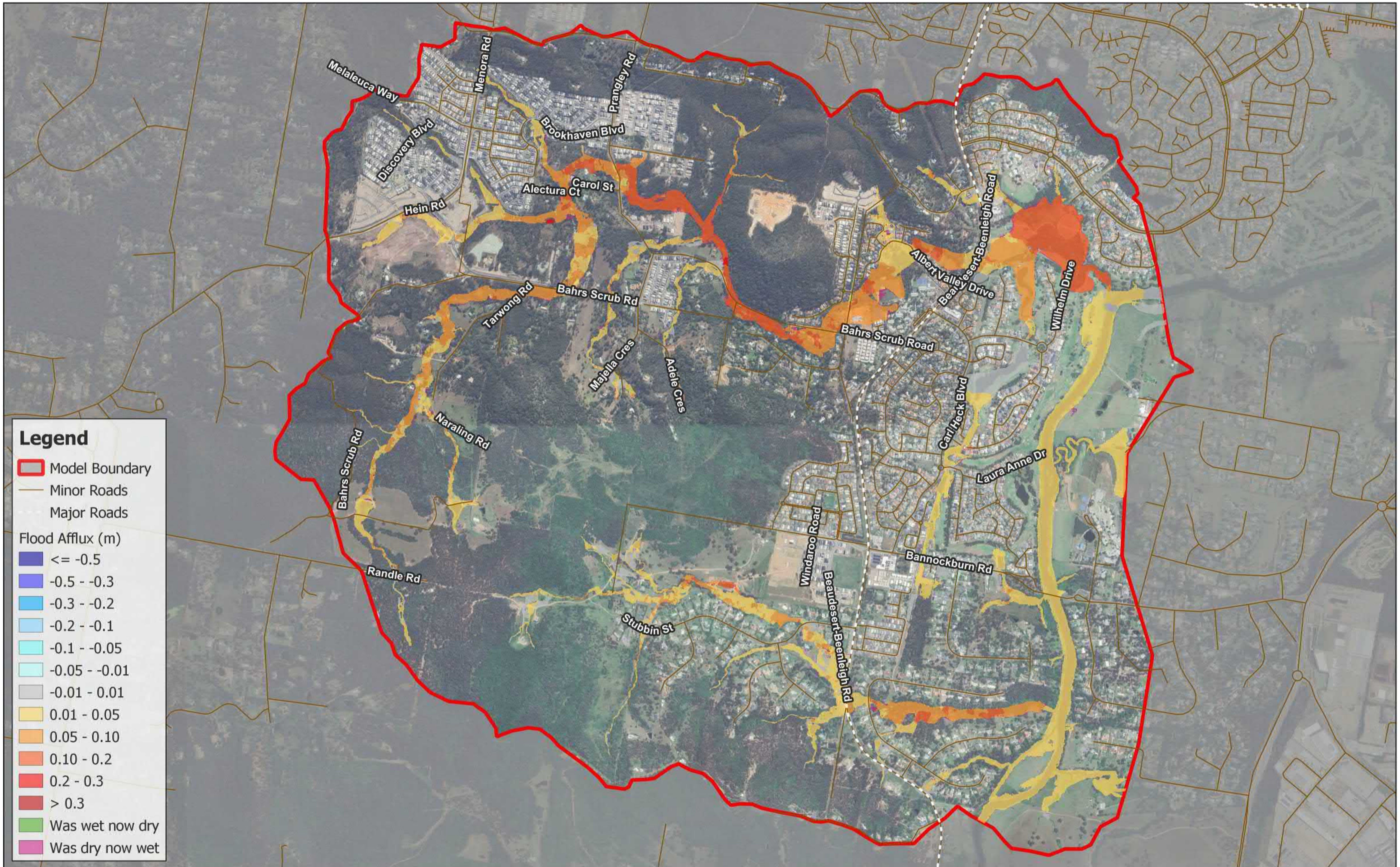

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Figure 9.1

Windaroo Creek Flood Study
20% Increase in Manning's Roughness
Sensitivity Afflux

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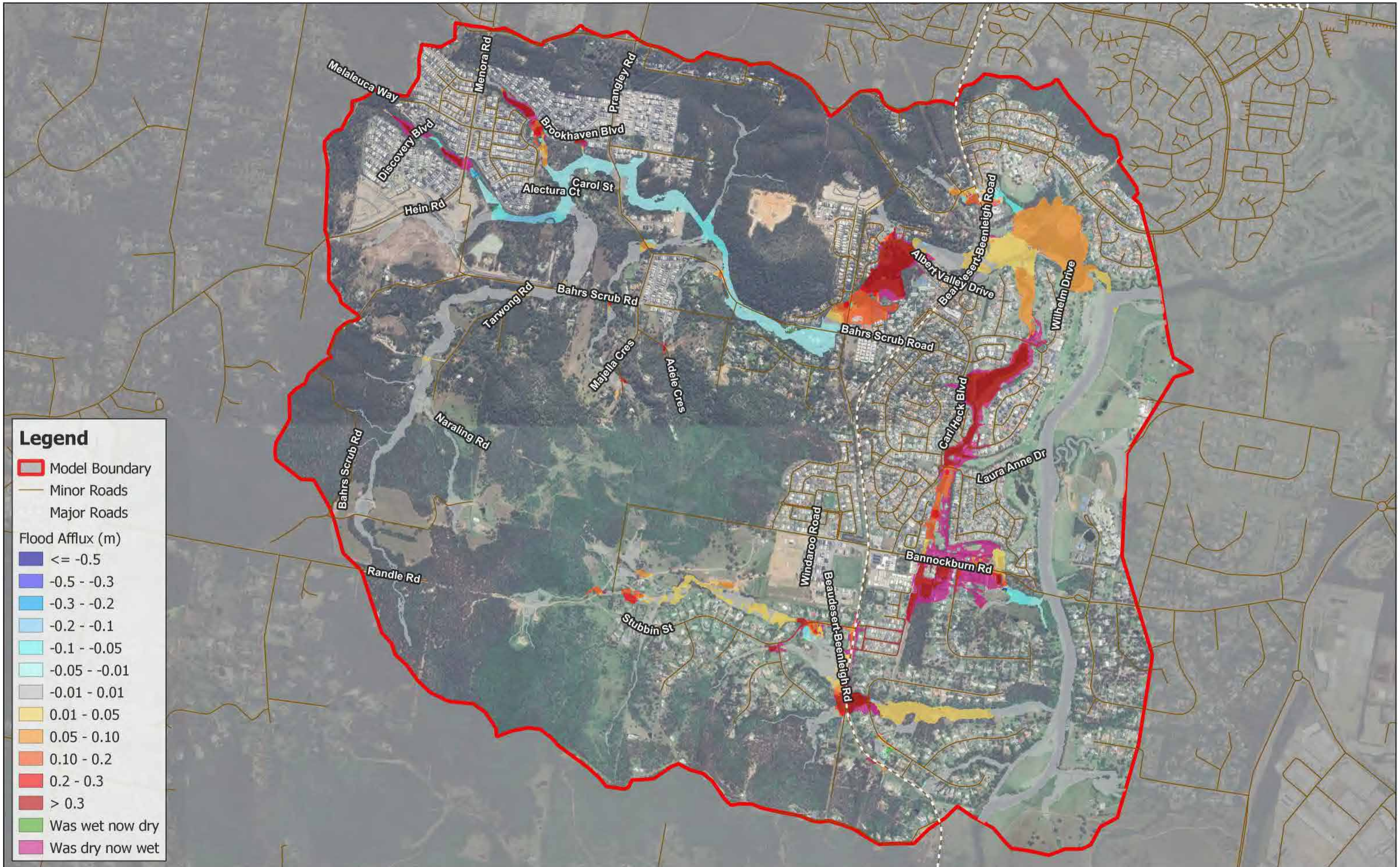

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Figure 9.2

Windaroo Creek Flood Study
Full Hydraulic Structure Blockage Sensitivity
Afflux

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Figure 9.3

Windaroo Creek Flood Study
No Hydraulic Structure Blockage Sensitivity
Afflux

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Figure 9.4

Windaroo Creek Flood Study
Increase in Waterway Roughness Sensitivity
Afflux

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10. FLOOD STUDY SUMMARY

10.1 Overview

WBNM hydrologic and TUFLOW hydraulic models were developed for the Windaroo Creek and Belivah Creek catchments in accordance with ARR 2019 guidelines. The models were calibrated against the May 2015 (hydrologic model only), February 2020 (joint hydrologic and hydraulic calibration), and March 2022 (joint hydrologic and hydraulic calibration) historical events and were validated for deign events.

Flood behaviour was determined for the 50%, 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.5%, 0.05% and PMF flood events, and climate change. A brief summary of the flood study update is provided in the below sections.

10.2 Hydrologic Model Development

The following is a summary of the key parameters of the WBNM hydrologic model.

- Sub-catchment delineation was undertaken to ensure that catchment sizes are generally no larger than 30 hectares.
- Catchment parametrisation was undertaken utilising the 2021 1 m LiDAR and the ultimate planning scheme.
- Spatially varied rainfall from four locations across the catchment were applied to the model.
- Rainfall losses in accordance with ARR 2019 were applied.
- The catchment lag parameter was amended to achieve validation of hydrograph shape between the hydrologic and hydraulic model.

The model was simulated for all design events and calibration events to produce local inflows to the hydraulic model.

10.3 Hydraulic Model Development

The following is a summary of the key parameters of the TUFLOW hydraulic model:

- The TUFLOW model was simulated using the latest TUFLOW build at the time (2023-03-AB) and the GPU hardware and the HPC solver.
- The model was built utilising the 2021 1m LiDAR capture.
- A coarse resolution, 10 m cell size model (referred to as the calibrated 'fast' model) was run for a full envelope of durations with the complete ensemble of 10 ARR 2019 temporal patterns in order to select one temporal pattern per duration. The validity of the calibrated 'fast' model was confirmed through comparison of modelled water level series from this model to that of the calibrated 'fine' model, for the historical calibration events. The exception to this methodology, however, is the 1% AEP flood event where the full ensemble of ARR2019 temporal patterns have been simulated.
- A finer resolution model (referred to as the calibrated 'fine' model) with a 3 m cell size was utilised for the final adopted runs.
- Representation of hydraulic structures (bridges and culverts) throughout the model were undertaken using 2d layered flow constrictions and 1D network elements. Standard blockage factors were applied in accordance with ARR 2019 guidance.
- Local inflow locations have been specified to match the catchment delineation.
- The model discharges to the Albert River, and constant water levels informed by the *Logan Albert Rivers Flood Study* (WRM, 2021) were applied for design events and the Wolffdene Alert stream gauge for the calibration events.
- Roughness values to match current conditions were utilised for simulation of the calibration events, with amendment to reflect ultimate planning scheme for the design event modelling.

10.4 Modelling Calibration and Validation

The hydrologic model was calibrated for May 2015 (estimated at between as 50% and 20% AEP flood event), February 2020 (estimated at around a 50% AEP flood event) and March 2022 (estimated at less than a 50% AEP flood event). A joint hydrologic and hydraulic calibration was completed for the February 2020 and March 2022 flood event. This was achieved through application of pluviographic rainfall data from the Bahrs Scrub Alert (station number 540598) and tailwater levels from the Wolffdene Alert gauge, with calibration of water level time series recorded and modelled at the Bahrs Scrub Alert gauge. There were uncertainties associated with the accuracy of the Bahrs Scrub gauge, and a rating curve to translate recorded water levels to flows in order to complete the hydrologic calibration.

The hydrologic calibration of the May 2015 event showed that the WBNM model was able to replicate the peak flow, with some discrepancy with the hydrograph shape and timing. The joint calibration of the February 2020 and March 2022 flood events showed a close match for peak water level (10 mm and 40 mm) respectively, but a variance in the volume and hydrograph shape. Therefore, the hydrologic model catchment parameters from the calibration were adopted for the design event modelling, but the recommended loss values as recommended by ARR 2019 were adopted in the design event modelling.

For design event validation, the Rational Method was utilised on smaller sub-catchments for the 10% AEP and 1% AEP flood events indicate that the peak flow estimates were within a range of +/- 15% of the validation estimates for all locations considered.

10.5 Modelling Results

Peak flood levels and flows for the critical duration and temporal pattern throughout the Windaroo Creek catchment have been extracted and summarised in this report. Flood behaviour in the Windaroo Creek catchment features defined waterways in the upper catchment, with some broadening of the flood extent through the lower catchment at broadening out to wider floodplains through the lakes area.

PDF "max-max" mapping for the design flood events have been provided with this report.

10.6 Sensitivity Analyses

Four sensitivity analyses were undertaken for the 1% AEP flood event (simulation of the full ensemble of ARR2019 temporal patterns):

- Increased hydraulic roughness – results in consistent increases in flood level across the model extent.
- Full hydraulic blockage of culverts and bridges – results in localised increases of flood level upstream of culvert crossings and reductions downstream of culvert crossings.
- No blockage of culverts and bridges – minimal impact on modelling results, with local reductions upstream of Menora Road, Brookhaven Boulevard, and Bannockburn Road, accompanied by flood level increases downstream.
- Sensitivity on waterway revegetation – localised increases in flood levels where revegetation is proposed accompany by reductions downstream where revegetation is not proposed due to reduced conveyance through the higher roughness areas.

11. FLOODPLAIN MANAGEMENT PLANNING

Floodplain management planning and assessment of the Windaroo Creek catchment has been completed in accordance with Council specifications utilising the flood model outputs from the flood study. The key components of the scope included:

- Provision of additional mapped output, inclusive of:
  – Hydraulic risk classification.
  – Identification of high and low flood islands.
  – Time to inundation mapping.
  – Duration of inundation mapping.
  – Hydraulic function specification.
- Assessment of road immunity and evacuation capability.
- Structural mitigation option assessment.
- Flood damages assessment.

11.1 Flood Risk Mapping Outputs

11.1.1 Hydraulic Risk Classification

Hydraulic risk mapping was developed utilizing the flood hazard results and the matrix shown in Figure 11.1. The flood hazard classification scheme is discussed in Guideline 7.3 of the *Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia (*AIDR, 2017).

The AIDR flood hazard vulnerability curves associated with this classification are provided in Figure 11.2. The flood events considered in development of this mapping are as per Figure 11.1, and included:

- 1:10 AEP RCP4.5 2090 climate change
- 1:20 AEP RCP4.5 2090 climate change
- 1:50 AEP RCP4.5 2090 climate change
- 1:100 AEP RCP4.5 2090 climate change
- 1:200 AEP RCP4.5 2090 climate change
- 1:500 AEP RCP4.5 2090 climate change
- 1:2,000 AEP
- PMF.

A final hydraulic risk map which shows the maximum classification at each grid cell across the model extent is provided in Figure 11.3.

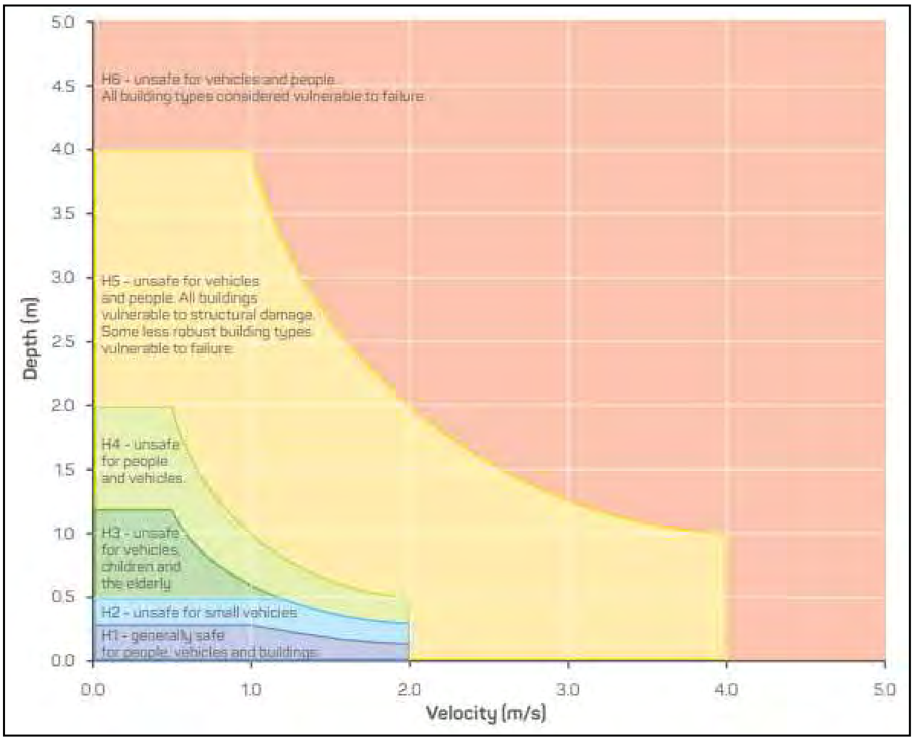

Figure 11.1: AIDR Flood Hazard Vulnerability Curves

AEP Event (%)	Hazard Level (Australian Emergency Management Institute)					
	H1	H2	H3	H4	H5	H6
PMF	HR5	HR5	HR5	HR5	HR5	HR5
0.05	HR5	HR5	HR4	HR4	HR4	HR4
0.2+CC	HR5	HR4	HR4	HR3	HR3	HR3
1+CC	HR4	HR4	HR3	HR2	HR2	HR2
2+CC	HR4	HR3	HR2	HR2	HR1	HR1
5+CC	HR3	HR2	HR2	HR1	HR1	HR1
10+CC	HR2	HR1	HR1	HR1	HR1	HR1

Figure 11.2: Hydraulic Risk Classification Matrix

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Figure 11.3

Windaroo Creek Flood Study

Hydraulic Risk Map

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11.1.2 Hydraulic Function Specification

Hydraulic function mapping has been completed utilising the categorisation from the hydraulic risk mapping as summarised in Table 11.1. The hydraulic function map is provided in Figure 11.4. The hydraulic risk categorisation is explained further in Section 11.1.1, and is a function of the AIDR hazard classification of flood events ranging from the 1:10 AEP to PMF flood events.

TABLE 11.1: HYDRAULIC FUNCTION CLASSIFICATION

Hydraulic Function	Hydraulic Risk Categorisation (as per Figure 11.2)
Conveyance	HR1 and HR2
Storage	HR3 and HR4
Fringe	HR5

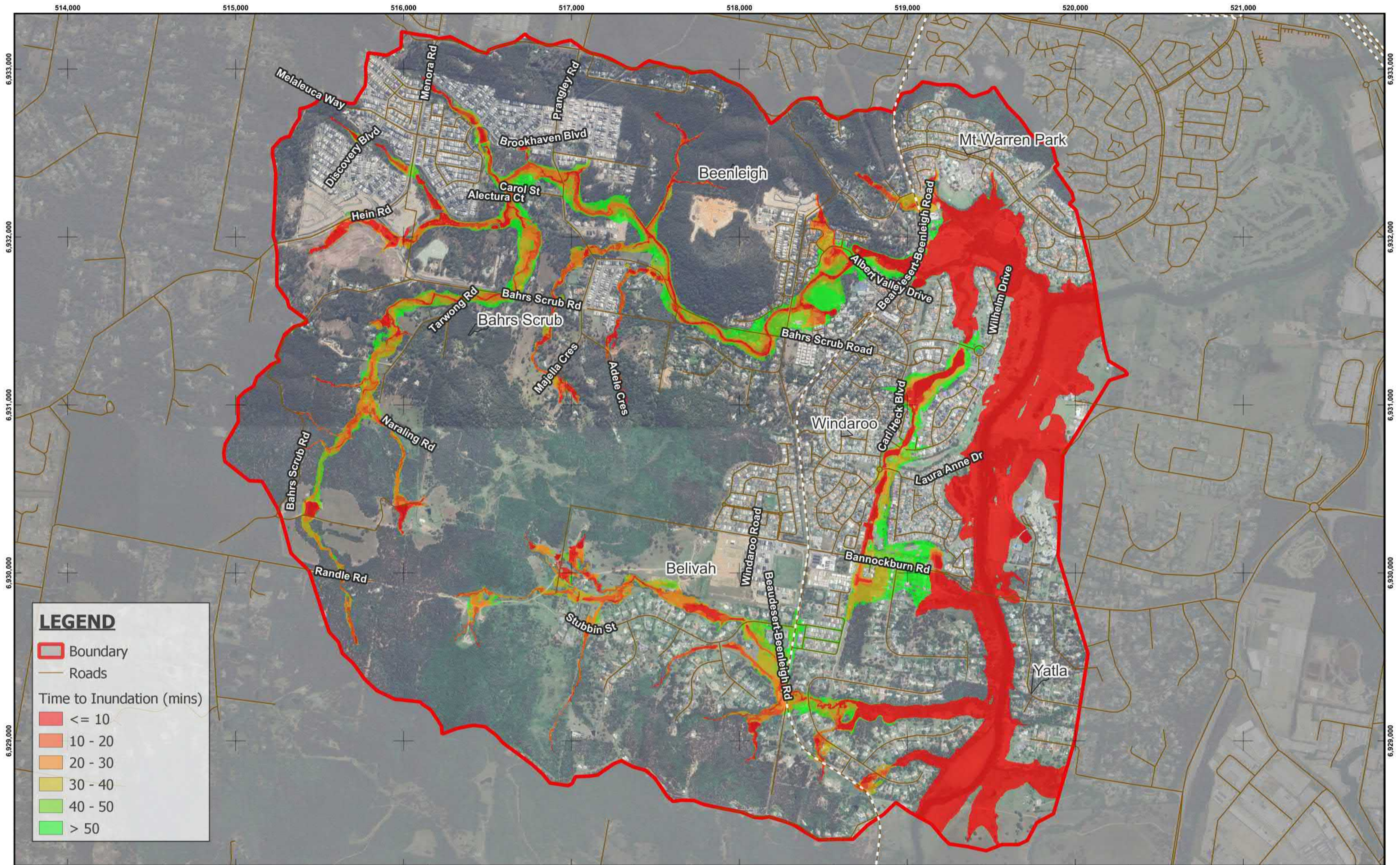

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Figure 11.4

Windaroo Creek Flood Study

0.05% AEP Time to Inundation Map

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11.1.3 Time to Inundation and Duration of Inundation Mapping

Time to inundation and duration of inundation mapping has been produced for the 0.05% AEP event utilising TUFLOW's automatically generated grids. For time to inundation, the time until each model cell in the floodplain is flooded (>0.01 m) is shown in Figure 11.5. For duration of inundation, the total time cells in the floodplain are submerged (>0.01 m) is shown in Figure 11.6.

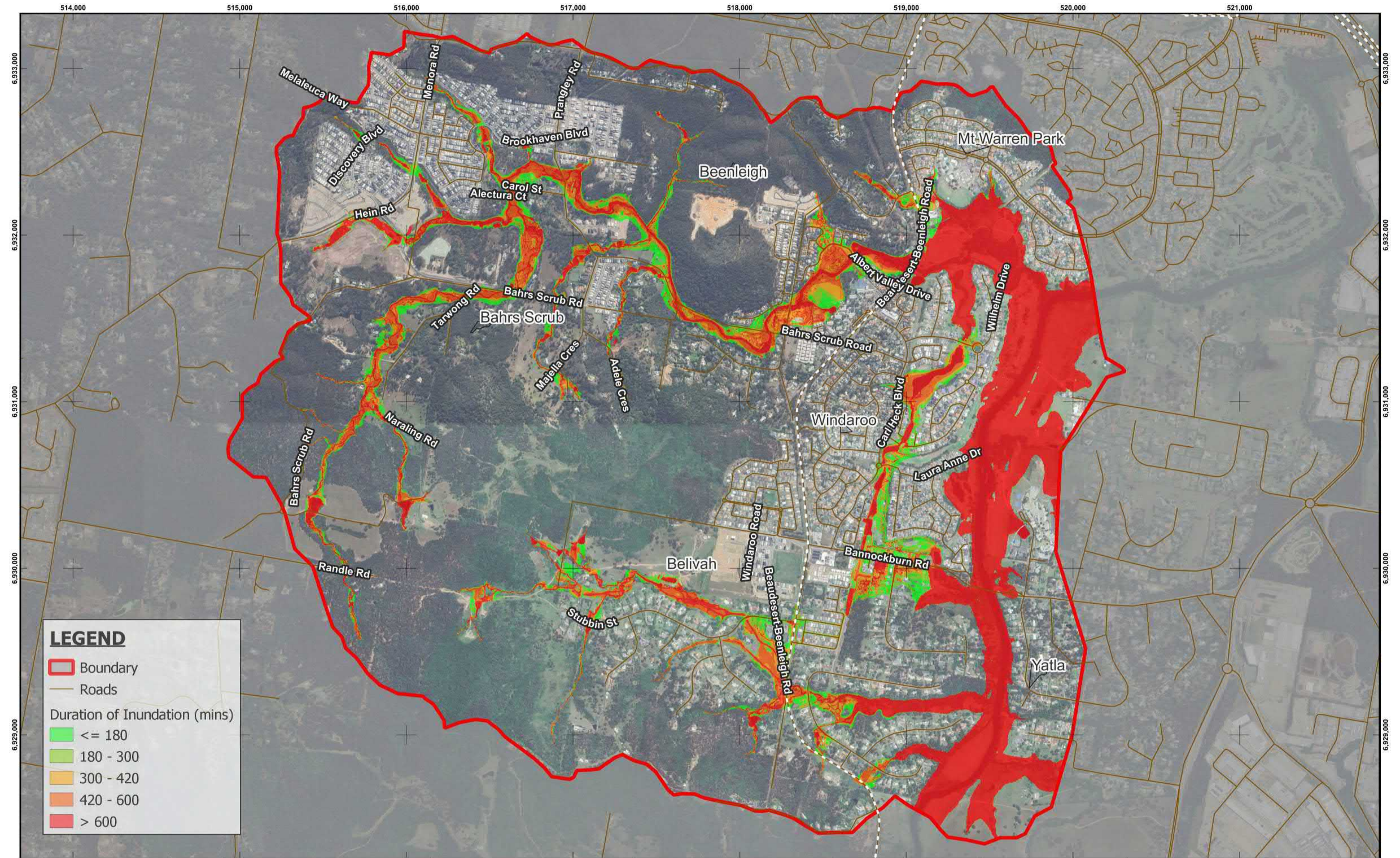

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Figure 11.5

Windaroo Creek Flood Study

0.05% AEP Duration of Inundation Map

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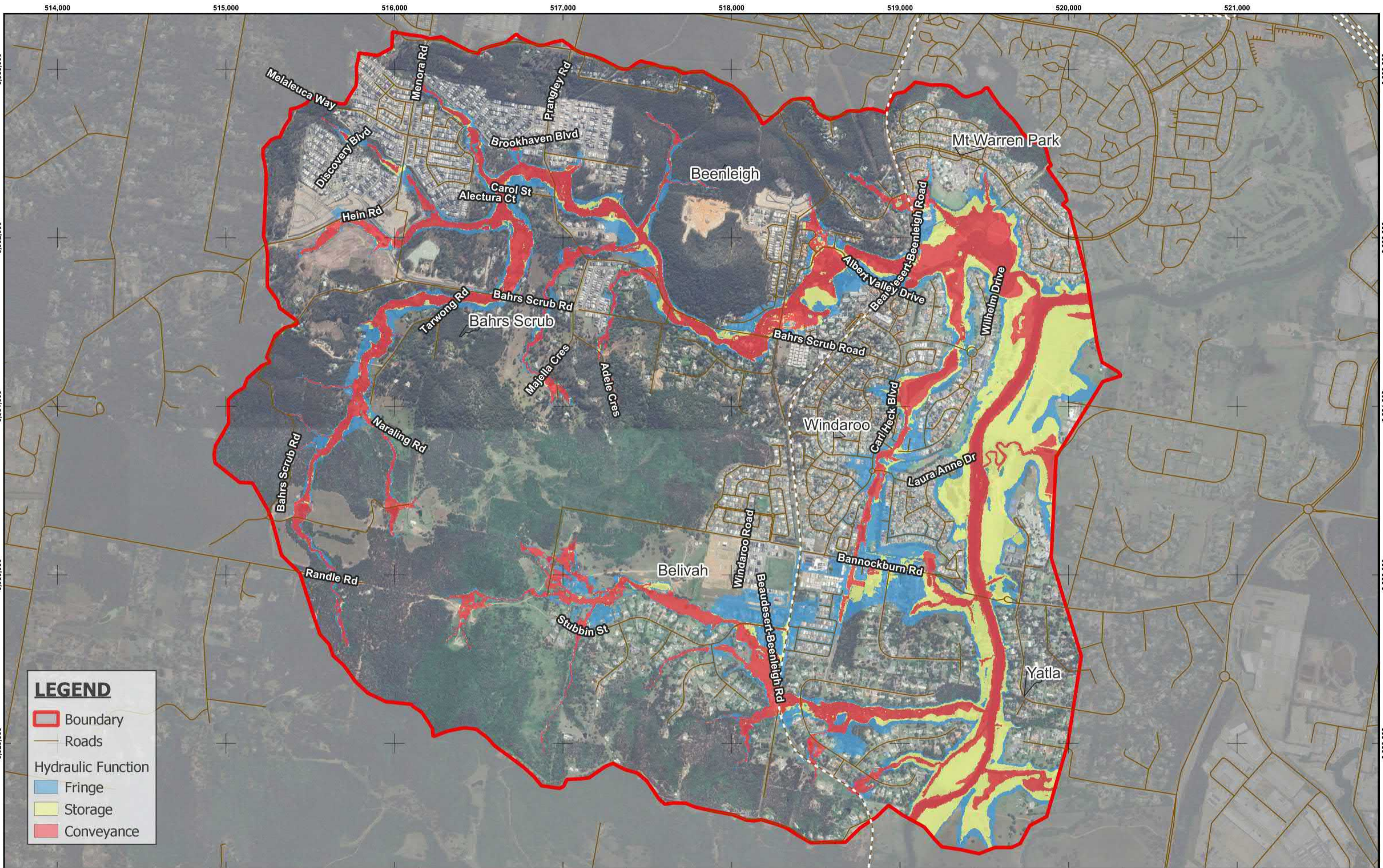

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Figure 11.6

Windaroo Creek Flood Study

Hydraulic Funcion Map

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11.1.4 Identification of High and Low Flood Islands

Identification of high and low flood islands has been informed in accordance with *Flood Emergency Response Classification of the Floodplain* (AIDR, 2017). The following definitions in Table 11.2 have been applied to the Windaroo Creek catchment floodplain. The corresponding map is shown in Figure 11.7.

TABLE 11.2: DEFINITION OF HIGH AND LOW FLOOD ISLANDS

Classification	AIDR Descriptor	Guiding Description
Low Flood Islands	Submerged	Where all the land in the isolated area will be fully submerged in a PMF after becoming isolated.
High Flood Islands	Elevated	Where there is a substantial amount of land in isolated areas elevated above the PMF.

Flood islands have been identified in accordance with the approach provided by Council. Flood islands were determined utilising flood extents from the following flood grids:

- 1:5 AEP RCP4.5 2090 climate change.
- 1:10 AEP RCP4.5 2090 climate change.
- 1:20 AEP RCP4.5 2090 climate change.
- 1:50 AEP RCP4.5 2090 climate change.
- 1:100 AEP RCP4.5 2090 climate change.
- 1:200 AEP RCP4.5 2090 climate change.
- 1:500 AEP RCP4.5 2090 climate change.
- 1:2,000 AEP
- PMF.

Low and high flood islands were spatially determined and classified as per the definition provided in Table 11.2. The flood event at which island become isolated was determined by when depth of flooding across access roads exceeds 300 mm and is noted on the digital data. The flood event at which each island becomes inundated is also noted on the digital data. Flood islands with an area less than 1 ha were excluded.

The isolation duration for the high flood islands in a Windaroo Creek flood event is likely to be relatively short (i.e., less than 6 hours) due to the relatively short catchment response time. Isolation due to Albert River flooding in the lower parts of the catchment may be more severe however was not the focus of this study.

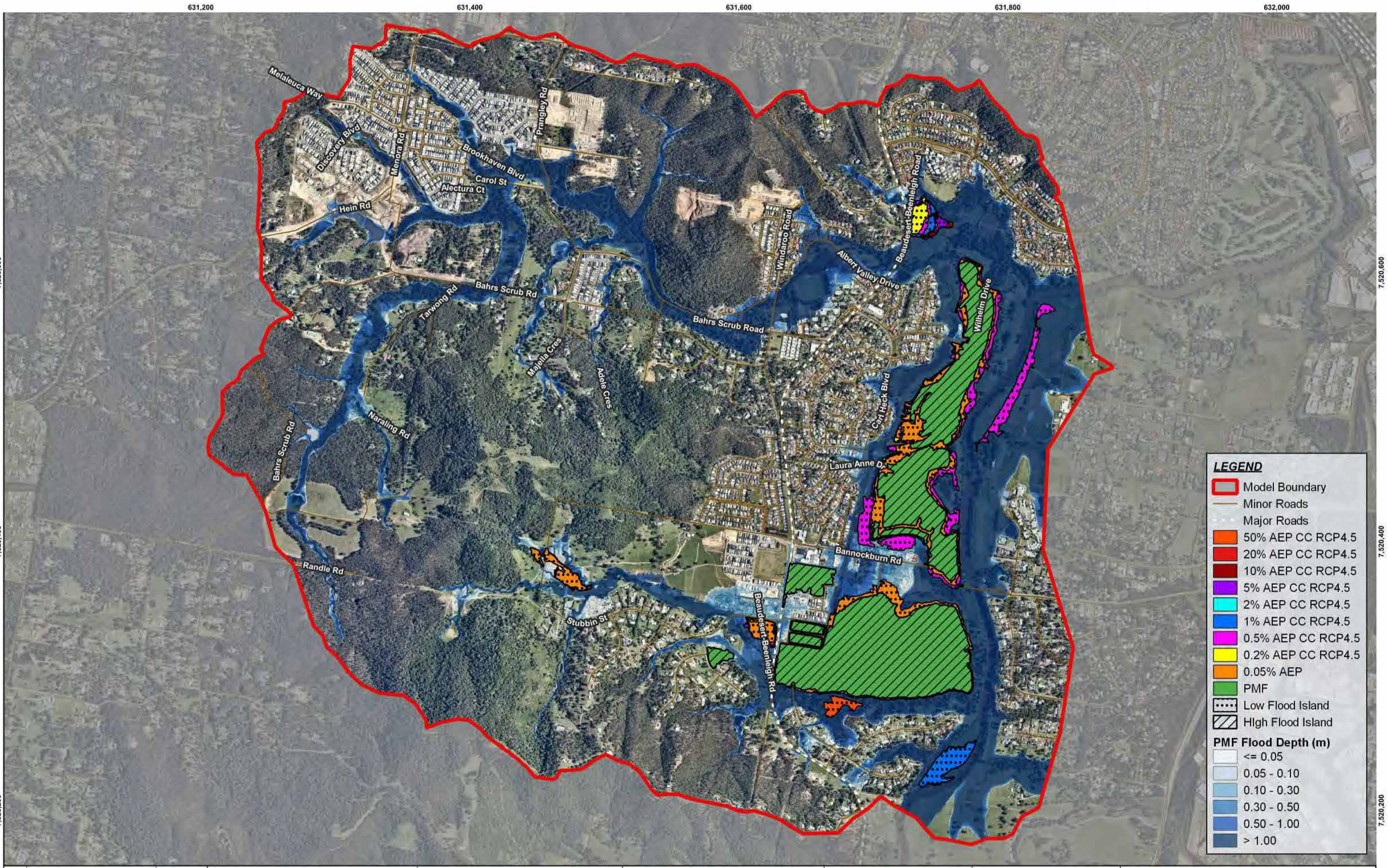

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Figure 11.7

Windaroo Creek Flood Study

Low and High Flood Islands

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11.2 Road Immunity and Evacuation Capability

11.2.1 Road Immunity

A flood immunity and trafficability assessment has been completed for road crossings within the Windaroo Creek catchment. Analysis of road crossings was undertaken for all flood events analysed and the identified flood immunity is shown in Figure 11.8. Numerous local roads have flood immunity less than the 50% AEP flood event.

Trafficability at road crossings was also assessed by identifying the most frequent flood event which inundates the road crossing segment to a depth of greater than 300 mm. The road trafficability mapping is presented in Figure 11.9.

The flood immunity and trafficability of road crossings within the catchment is generally considered to be low and is likely to restrict access and evacuation during flood events, however the duration of inundation is also low and therefore the greatest risk to the community is considered to relate to road safety and flood warning during flood events.

It should be noted that TMR is currently upgrading Beaudesert-Beenleigh Road between Armstrong Road and Stubbin Street. Advice provided by Council was that the road upgrade has a targeted immunity of 5% AEP (currently shown to be <50% AEP), with an expected reduction in duration of inundation to 0.5 hours in a 2% AEP flood event and 0.75 hours in a 1% AEP flood event.

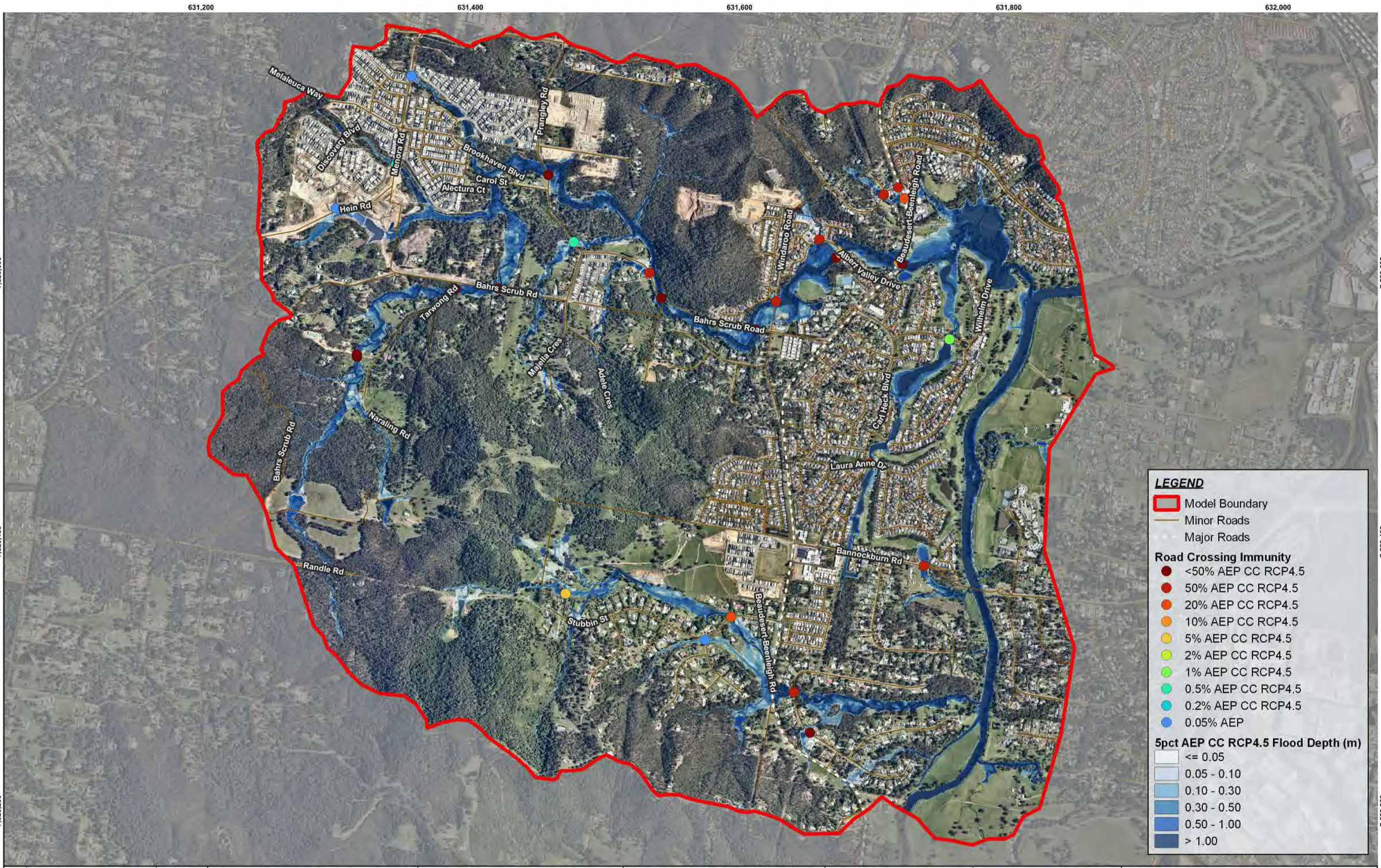

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Figure 11.8

Windaroo Creek Flood Study

Road Crossing Immunity

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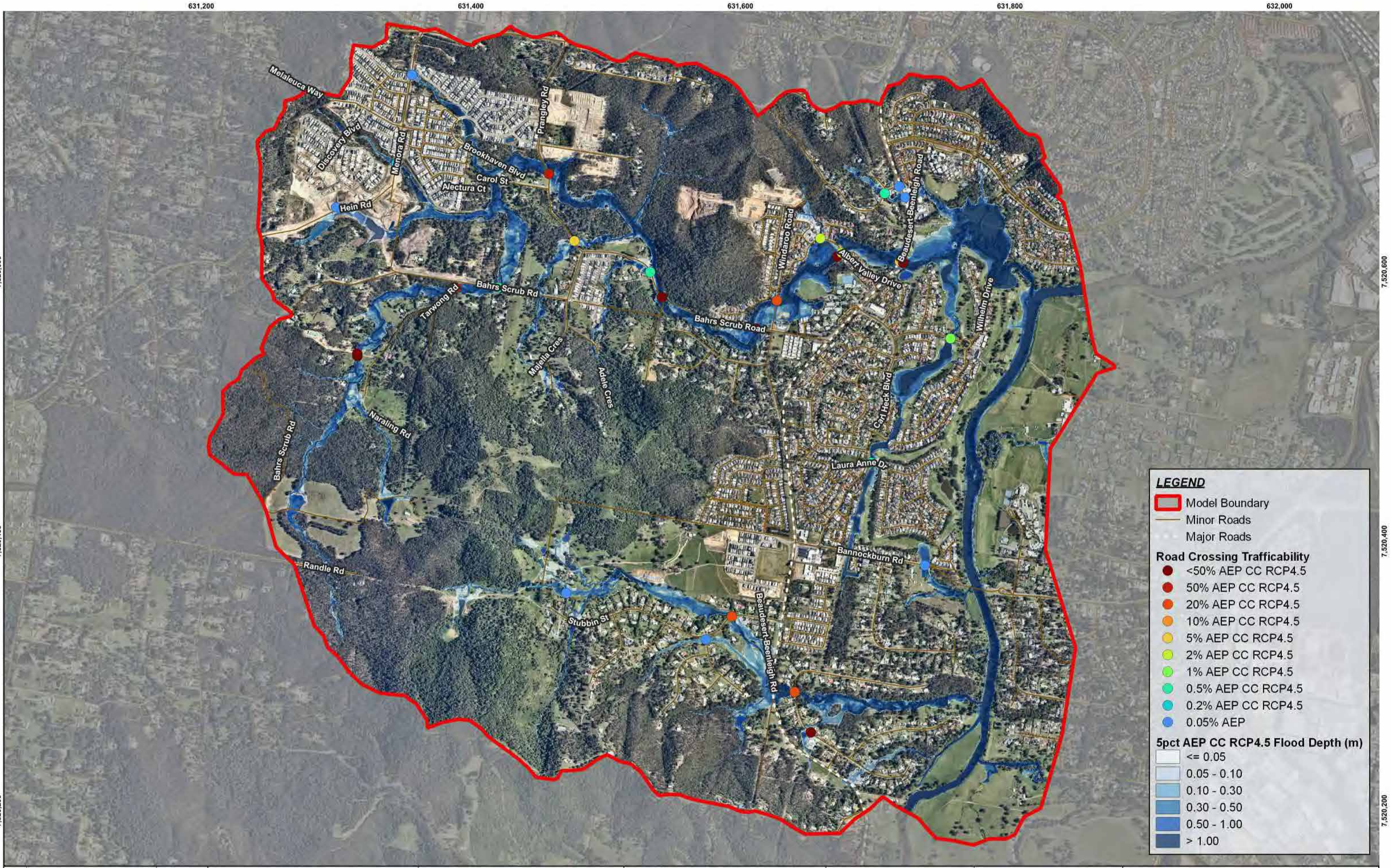

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Figure 11.9

Windaroo Creek Flood Study

Road Crossing Trafficability

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11.2.2 Evacuation Routes and Restrictions

As presented in the previous section, the flood immunity at road crossings across the catchment is generally low. This will result in roads being cut in frequent events which will result in evacuation and access restrictions. The lower portion of the Windaroo Creek catchment has an evacuation route immunity less than the 5% AEP flood event. However, the duration of inundation at road crossings was also determined to be relatively short (less than 6 hours) and therefore this does not pose a significant isolation risk to the community.

An analysis for the time of inundation and duration of inundation was undertaken for the 0.05% AEP event, which has been provided to Council in digital format. Evacuation route mapping is provided in Figure 11.10.

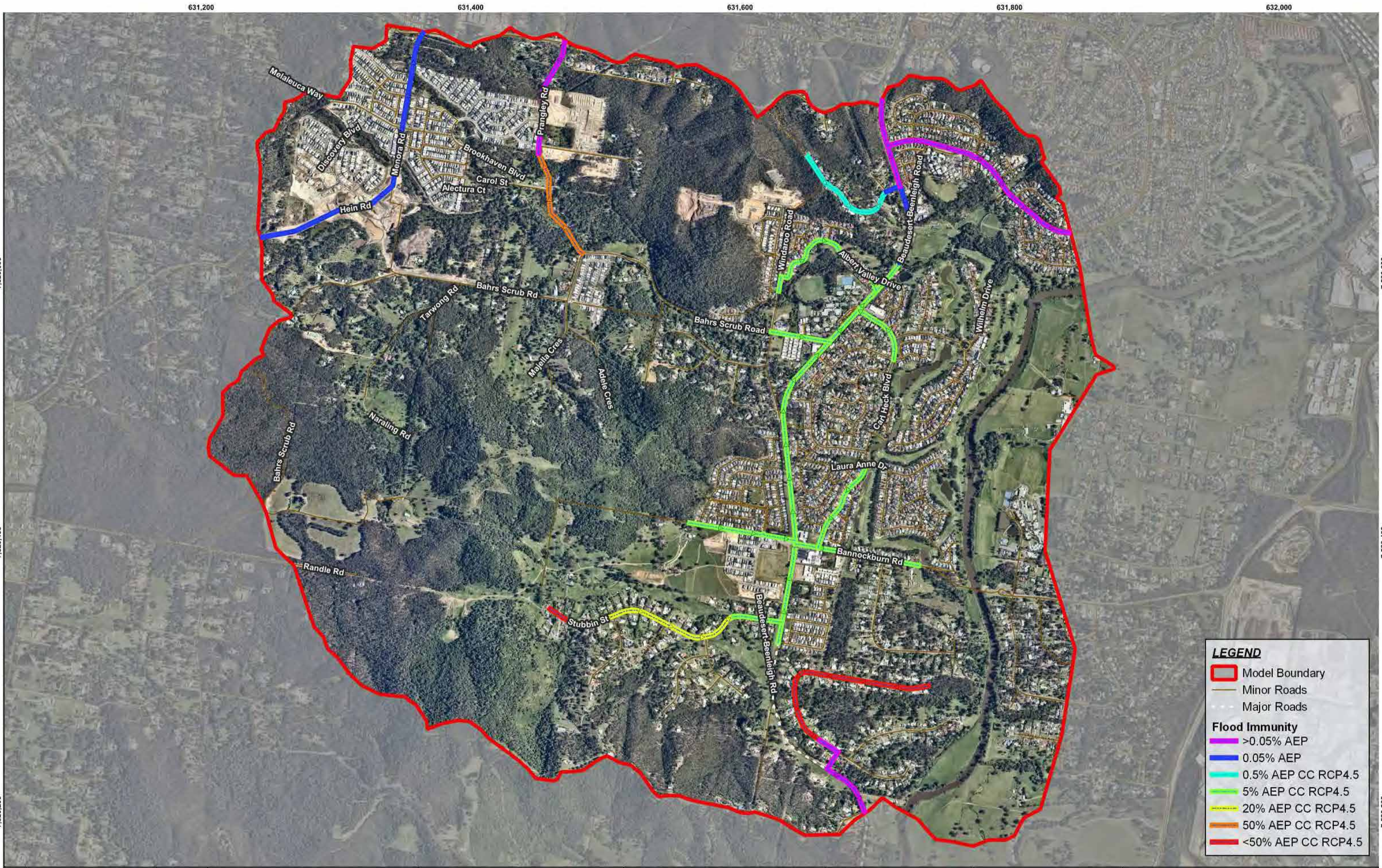

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Figure 11.10

Windaroo Creek Flood Study

Evacuation Route Immunity

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12. STRUCTURAL MITIGATION OPTION ASSESSMENT

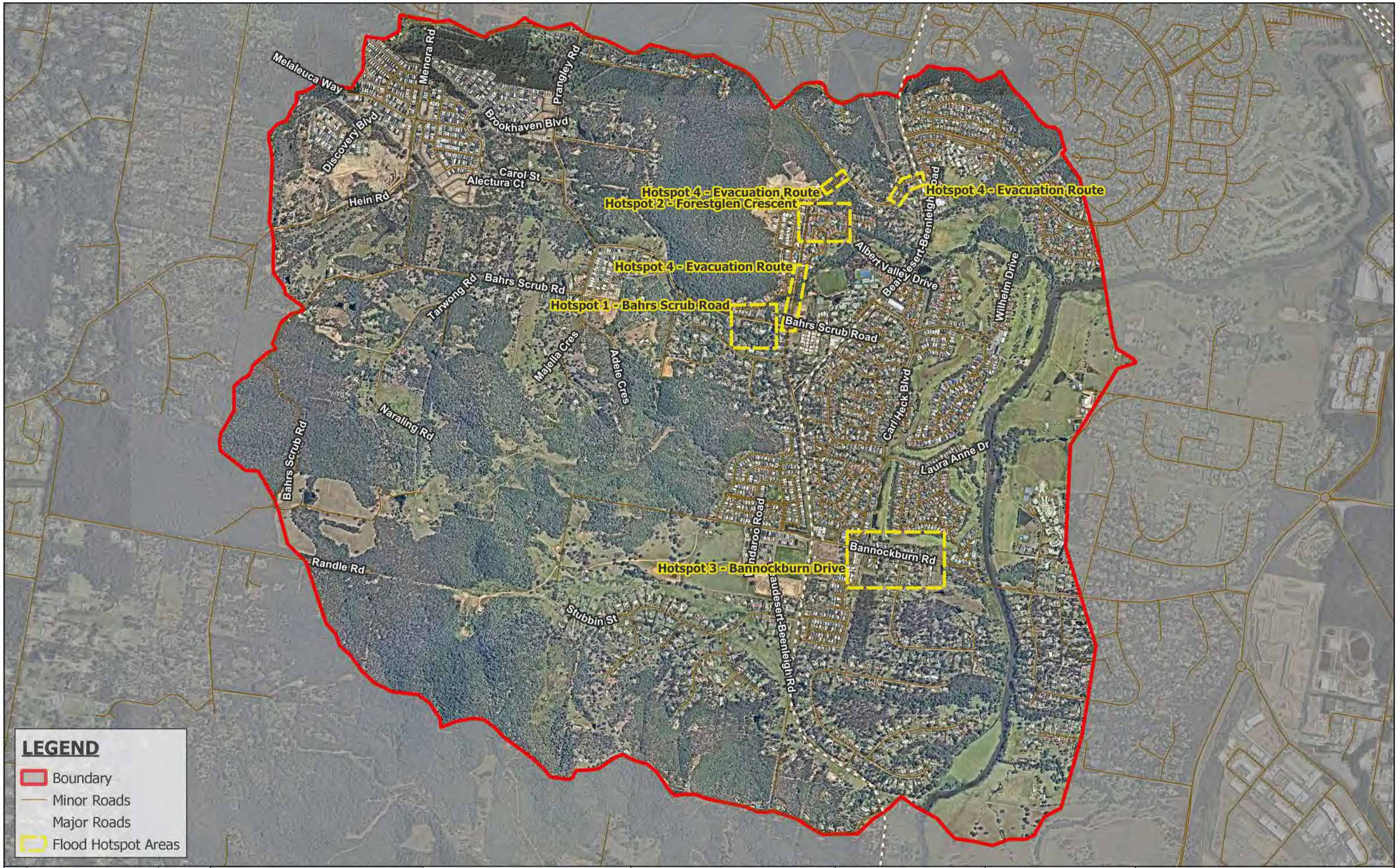
12.1 Impacted Areas

A review of the flood results for the range of events analysed has identified four (4) key flooding hotspot areas, that are impacted by Windaroo Creek flooding. These hotspot areas were identified based on the 1% AEP CC RCP4.5 event where possible building inundation above floor level was predicted to a number of properties with close proximity to each other. Potential improvements to evacuation route immunity was also considered. The GIS data from the Flood Damage Estimate as outlined in Section 13.1.3 was utilised to determine potential building inundation, with a summary of the number of buildings inundated above floor provided in Table 12.1.

The identified flooding hotspot areas within the catchment are shown in Figure 12.1.

TABLE 12.1: BUILDINGS POTENTIALLY INUNDATED

Flood Event (AEP)	Number of Buildings Potentially Inundated
20% CC RCP4.5	6
10% CC RCP4.5	11
5% CC RCP4.5	15
2% CC RCP4.5	19
1% CC RCP4.5	27
0.5% CC RCP4.5	38
0.2% CC RCP4.5	67
PMF	233



R	DETAILS	DATE
1	Final Issue	13-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	13-03-2024

NOTES:

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
Engeny has endeavoured to ensure accuracy and completeness of the data. Engeny assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DATA SOURCE
QLD Government Open Data Source

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Figure 12.1

Windaroo Creek Flood Study

Flood Hotspot Areas

Dwg Ref
M9000_082

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12.1.1 Qualitative Option Identification

It was evident from a review of the flood modelling results and impacted properties that there are limited opportunities for structural mitigation without causing adverse impacts. The potential structural mitigation options considered are outlined as follows:

- Levee protection – construction of earthen levees to protect flood affected buildings.
- Flow attenuation from upstream detention structures – construction of online detention structures was considered however was not deemed to be viable due to the limited number of properties that would benefit, the potential for the structures to be referable, and the anticipated environmental impacts associated with the earthworks. Creating online storage at road crossings was also considered to be unfeasible. There were also no identified areas within the catchment currently owned by Council where these structures could be placed, resulting in significant acquisition costs for Council.
- Cross drainage upgrade to reduce property inundation – The option to modify the cross-drainage capacity to reduce upstream property inundation was considered, or to offset impacts from other option elements.
- Cross drainage upgrade to improve road immunity – increase the cross-drainage capacity and therefore improving road immunity was considered to be a viable option, particularly for key evacuation/access routes.
- House raising – this is considered to be a private matter and whist Council can assist property owners in an advisory manner, funding would normally be provided by the property owner.
- Flood warning signage and warning systems are considered flood response modification measures, not structural mitigation measures and therefore were not considered in this study. However, it is recommended that Council strongly consider review and implementation of this within the Windaroo Creek catchment, particularly at flooded roads.

Summaries of the preferred mitigation options identified at each hotspot are provided in Table 12.2 to Table 12.5, with figures of the hotspot localities provided in Figure 12.2 to Figure 12.4.

From the qualitative assessment, the two options selected in consultation with Council to proceed to hydraulic assessment were:

- Hotspot 1 – Bahrs Scrub Road.
- Hotspot 4 – Evacuation Route Improvement.

TABLE 12.2: HOTSPOT 1 – BAHRS SCRUB ROAD QUALITATIVE OPTION ASSESSMENT

Parameter	Description
Description of Flooding Issue	Exceedance of flooding beyond the main channel inundates properties along Bahrs Scrub Road.
Estimated 1% AEP Property Flooding	5
Estimated 1% AEP Above Floor Inundation	5
Preferred Structural Mitigation Option	• Channel widening and clearing. • Levee, flood bund works. • Upgrade Bahrs Scrub Road culvert.
Constraints and Opportunities	• This hotspot experiences significant depths of flooding, and therefore a suitable mitigation option would require significant works to gain any flood improvements. • Flood impacts downstream as a result of the proposed levee and channel works are likely. • Clearing and works within the waterway are unlikely to be supported from an environmental perspective. • The channel works would require on-going maintenance.

Figure 12.2: Hotspot 1 – Bahrs Scrub Road Locality

TABLE 12.3: HOTSPOT 2 – FORESTGLEN CRESCENT QUALITATIVE OPTION ASSESSMENT

Parameter	Description
Description of Flooding Issue	Channel upstream of properties does not has the capacity to safely convey flows from the upstream catchment around properties and through to the main waterway.
Estimated 1% AEP Property Flooding	16
Estimated 1% AEP Above Floor Inundation	9
Preferred Structural Mitigation Option	• Concrete lined drain adjacent to property boundaries in current easement • Culvert upgrade at Albert Valley Drive.
Constraints and Opportunities	• Space constraints are a limiting factor for the feasibility of this option. A small levee was considered but was deemed non-viable.

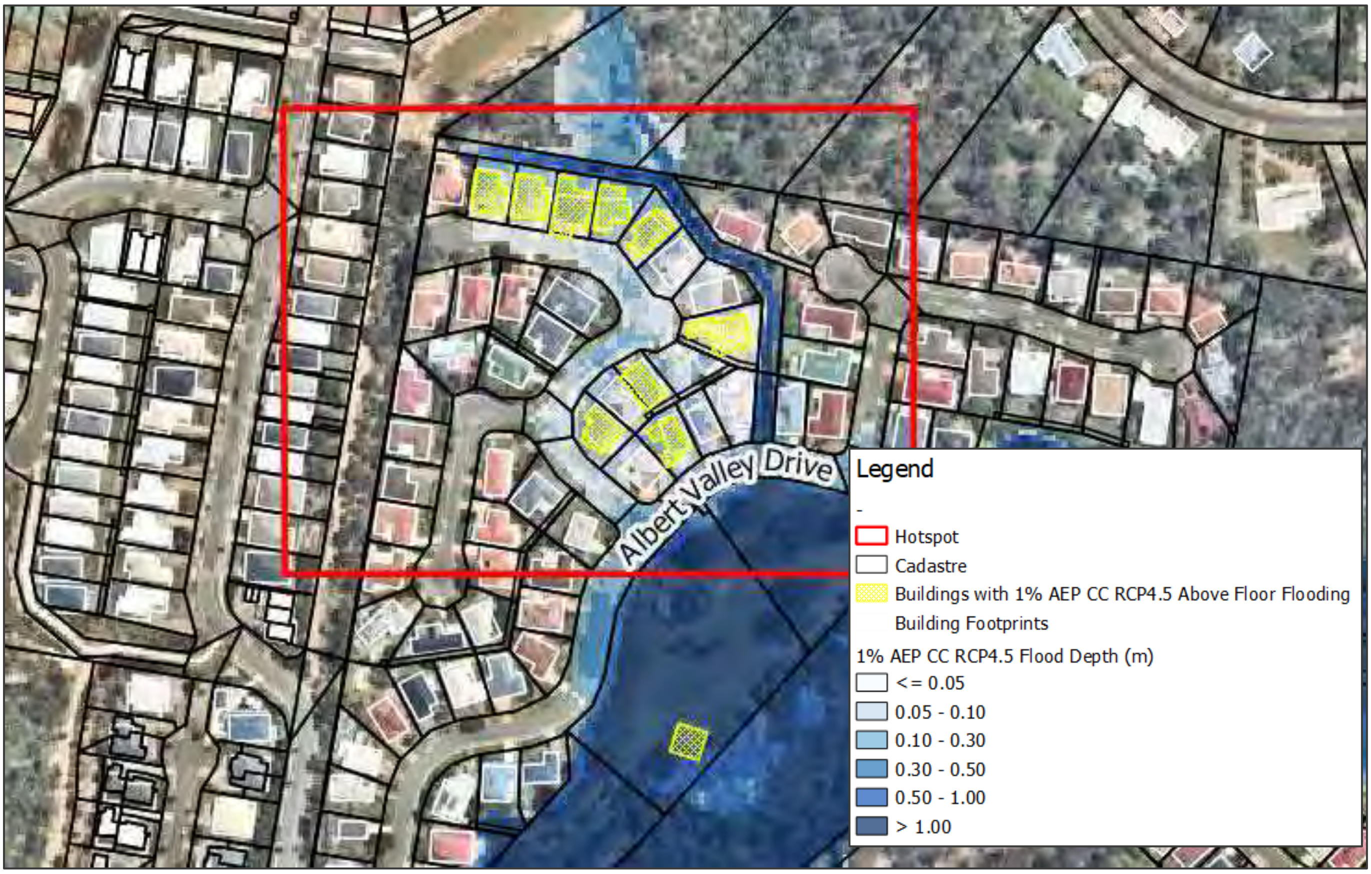


Figure 12.3: Hotspot 2 – Forestglen Crescent Locality

TABLE 12.4: HOTSPOT 3 – BANNOCKBURN DRIVE QUALITATIVE OPTION ASSESSMENT

Parameter	Description
Description of Flooding Issue	Flows from the upper catchment exceed the capacity of the underground pipe from Elise Street to the main waterway.
Estimated 1% AEP Property Flooding	6
Estimated 1% AEP Above Floor Inundation	2
Preferred Structural Mitigation Option	• Upgrade of the current underground pipe
Constraints and Opportunities	• This hotspot is not recommended for further assessment. The available footprint for works limits the capacity of any potential structural mitigation options and therefore will provide limited benefit to residents.

Figure 12.4: Hotspot 3 – Bannockburn Drive Locality

TABLE 12.5: HOTSPOT 4 – EVACUATION ROUTE QUALITATIVE OPTION ASSESSMENT

Parameter	Description
Description of Flooding Issue	• Properties located in the vicinity of and in the lower portion of the Windaroo Creek catchment do not have flood free access in a 1% AEP CCRCP4.5 event.
Preferred Structural Mitigation Option	• Upgrade to Windaroo Road culvert and road raise. • New link road from Nevron Drive and Janine Drive. • Road raise and culvert upgrade on Janine Drive.
Constraints and Opportunities	• The maximum width available for a culvert upgrade available on Council-owned land is limited. • Significant heights of road raises.

12.1.2 Flood Assessment of Options

The proposed upgrades were incorporated into the TUFLOW model to assess the benefit provided by the upgrade. The model was simulated for all design events. Flood impact mapping for the mitigation option assessment is provided in Appendix I. A summary of the configurations of the options and the results from the assessment are summarised below.

12.1.2.1 Structural Mitigation Option 1 – Bahrs Scrub Road

The configuration of Option 1 is shown on Figure 12.5 and is as summarised as follows:

- Channel widening to a maximum base width of 20 m and clearing for approximately 400 m.
- Levee, flood bund works to a height of 16 m AHD, for a length of approximately 500 m.
- Upgrade Bahrs Scrub Road culvert from 3/675 mm RCP to 4/4200x900 mm RCBC.

The results from the hydraulic assessment of Mitigation Option 1 were as follows:

- The proposed mitigation option results in immunity to 49-65 Bahrs Scrub Road, up to the 1% AEP CC RCP4.5 flood event, with overtopping occurring in events larger than this.
- Adverse impacts were observed downstream through the existing floodplain extent on Bahrs Scrub Road verge, 2 Bahrs Scrub Road, 2 and 14 Windaroo Road, and the Windaroo Road verge in events equal to, and greater in magnitude, than the 20% AEP CC RCP4.5 flood event.
- It is deemed that even though Mitigation Option 1 achieves the desired immunity to impacted properties on Bahrs Scrub Road it would not be feasible to offset the adverse impacts associated with the option therefore implementation of the option is not recommended unless further investigation is undertaken into works to offset the adverse flood impacts.
- 1% AEP CC RCP4.5 flood impact mapping is provided in Figure 12.6.

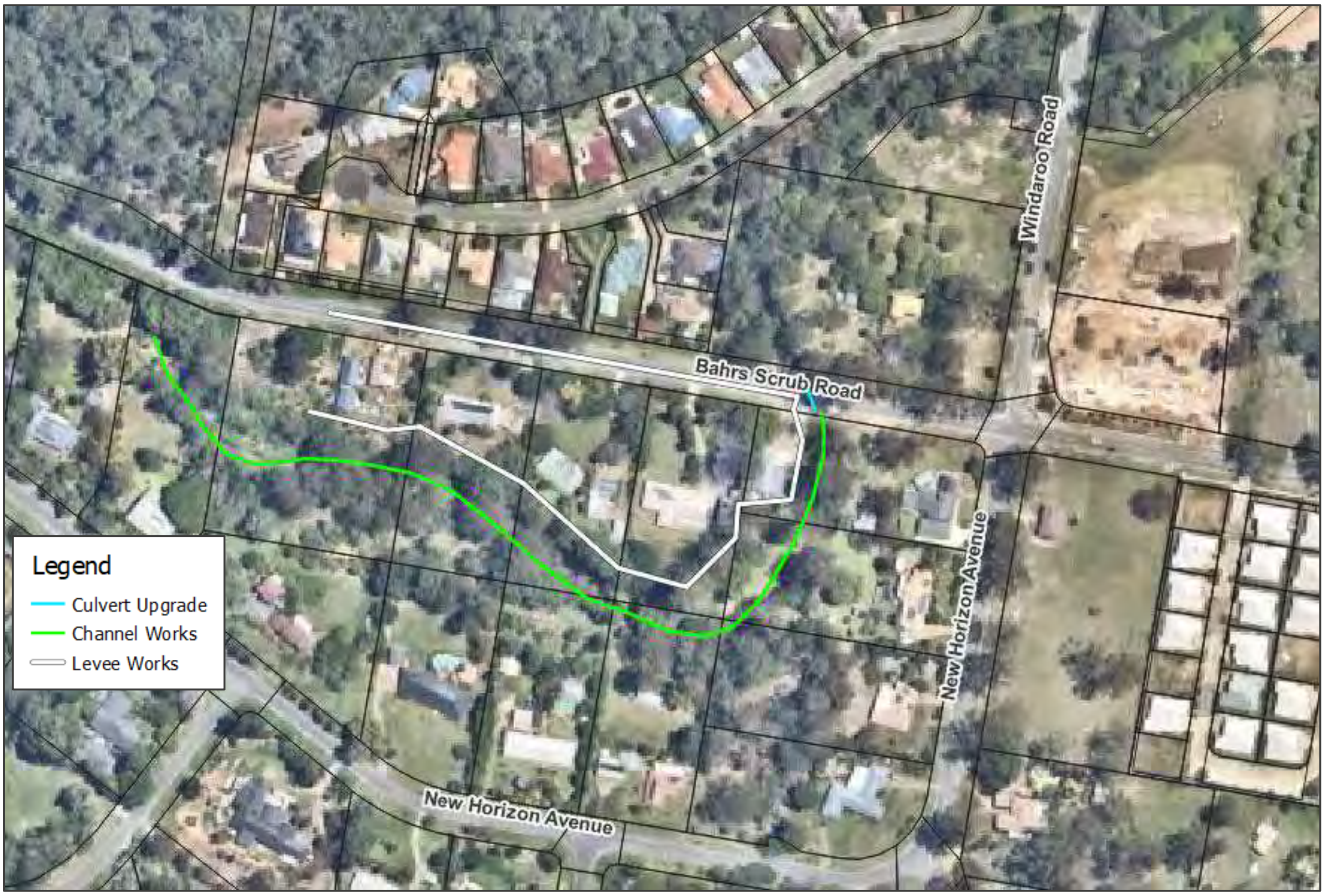


Figure 12.5: Mitigation Option 1 Layout

Figure 12.6: Mitigation Option 1 – 1% AEP CC RCP4.5 Flood Impact

12.1.2.2 Structural Mitigation Option 2 – Evacuation Route Improvement

The configuration of Option 2 is shown on Figure 12.7 and Figure 12.8 and is summarised as follows:

- Road raise at Windaroo Road to a height of 12.9 m AHD, for an approximate length of 290 m.
- Upgrade Windaroo Road culverts from 6/3600x2500 mm RCBC to 11/3600x3300 mm RCBC.
- Localised wingwall inlet and outlet channel profiling to allow for Windaroo Road culvert upgrade.
- Formalisation of new road between Nevron Drive and Janine Drive at an elevation of 21 m AHD. Length of new road is approximately 180 m.
- Installation of culvert at new road between Nevron Drive and Janine Drive at 3/1200 mm RCP.
- 1m road raise to Janina Drive for approximately 160 m.
- Upgrade of culverts at Janine Drive from 1/1050 mm RCP to 4/1200 mm RCP.

The results from the hydraulic assessment of Mitigation Option 2 is as follows:

- The proposed Mitigation Option 2 results in flood immunity of Windaroo Road in events up to and including the 1% AEP CC RCP4.5 flood event.
- In events up to an including the 10% AEP RCP4.5 flood event, flood levels are reduced upstream of Windaroo Road, in events exceeding this, the road raise cannot be offset by the culvert size and impacts are observed upstream of the crossing on 2 Bahrs Scrub Road. Downstream of Windaroo Road, adverse impacts are observed in all flood events on 2 Windaroo Road and on Windaroo Valley High School land.
- The proposed road between Nevron Drive and Janine Drive achieves 1% AEP CC RCP4.5 immunity.
- The proposed road upgrade at Janine Drive achieves 1% AEP CC RCP4.5 flood immunity. However, flood impacts downstream of Janine Drive impacting on Beaudesert Beenleigh Road and 145 Beaudesert Beenleigh Road are observed for the range of flood events modelled.

- It is not recommended that Windaroo Road is raised to meet 1% AEP CC RCP4.5 immunity due to the adverse impacts expected in the vicinity. Minor road raise works could achieve some improved trafficability, though flood warning and signage is the more feasible solution of this location. It is recommended that the connecting road between Nevron Drive is constructed. The proposed raise and culvert upgrade at Janine Drive could be considered for further investigation. With further optimisation of works downstream of Janine Drive, inclusive of potential easement acquisition and works on 145 Beaudesert Beenleigh Road, adverse impacts could be minimised.
- 1% AEP CC RCP4.5 flood impact mapping is provided in Figure 12.9.

Figure 12.7: Mitigation Option 2 Layout – South

Figure 12.8: Mitigation Option 2 Layout - North

Figure 12.9: Mitigation Option 2 – 1% AEP CC RCP4.5 Flood Impact

12.1.3 Costing of Options

Preliminary cost estimates for each structural mitigation option are summarised as follows:

- Structural Mitigation Option 1: $4.31M
- Structural Mitigation Option 2: $4.28M.

The preliminary estimates included 30% contingency and the breakdown is provided in Appendix J. No allowance for cost of any easement acquisition has been made.

Given that the mitigation options do not achieve the desired flood immunity outcomes without adverse impacts to private property and existing roads, it is not anticipated that the works will be feasible. Rather, it is advised that flooded road safety measures and flood warning systems in the catchment are considered to reduce the risk to residents during a flood event.

13. FLOOD DAMAGE ASSESSMENT

A flood damages assessment for the full range of flood events (incorporating climate change) has been completed and the process has been outlined in the below sections.

13.1 Methodology

13.1.1 Input GIS Data

To undertake a flood damage assessment, the following GIS data inputs were required:

- Design event maximum flood levels.
- Building polygons / assumed floor size of building.
- Floor levels.
- Classification of the type of building and the number of storeys.

The following process was undertaken to prepare the GIS dataset for the flood damage assessment:

- Confirmation that all buildings within the Windaroo Creek PMF flood extent are included in the supplied Council dataset or delineated where they are not. 999 buildings have been determined to be within the PMF flood extent.
- Removal of buildings that were less than 50 sqm or seen visually to be not residential or commercial buildings (i.e., sheds or auxiliary structures).
- Calculation of the floor area using geometry analysis tools. Classification of this calculated floor area into:
  - Residential:
    - small (< 140 sqm).
    - Medium (140-210 sqm).
    - Large (>210 sqm).
  - Commercial:
    - Small (<186 sqm).
    - Medium (186-650 sqm).
    - Large (Damage calculated based on sqm).
- Classification of the various residential buildings into the following type classifications:
  - Lowset, single storey (Slab-On-Ground or Stumps).
  - Highset.
  - Double storey.
  - Multi-unit single storey.
  - Multi-unit double storey.
- Classification of the various commercial buildings into the following value-type classifications:
  - Very Low (Florists, Garden Centers, Cafes, Newsagents, Consulting Rooms).
  - Low (Restaurants, Doctor Surgeries, Retail Outlets, Schools).
  - Medium (Libraries, Printing, Medical Instruments).
  - High (Chemists, Musical Instruments, Electrical Goods).
  - Very High (Cameras, Pharmaceuticals, Electronics).

- Council's 2016 surveyed floor level survey set was supplied for use in the assessment, however, on inspection very minimal entries were available within the catchment, and disagreement between the floor levels and the 2021 LiDAR was observed. Where there were buildings that were not included in this survey set, the average LiDAR elevation underneath the building polygon was inspected, with the following heights added to determine the floor level:
  - Slab-On-Ground: 150 mm.
  - Stumps: 500 mm.
- Finally, inspections of the design event flood heights were made against the building dataset.

13.1.2 Stage-Damage Curves

The stage damage curves utilised in the flood damage assessment were supplied by Council and are the same curves utilised in the Brisbane River Catchment Flood Study (BRCFS). The development of these curves is outlined extensively in the *Brisbane River Strategic Floodplain Management Plan – Technical Evidence Report* (BMT, 2018).

13.1.3 Base Case Flood Damage Estimate

Average Annual Damage (AAD) is used to account for the probabilistic nature of flood damage. It represents the theoretical tangible damage incurred on average each year if a very long period of flood records is considered. It takes into account the value of the damage in each flood and the probability of the flood.

13.1.3.1 Residential Flood Damages

951 buildings were determined to be residential properties within the investigation extent. The residential flood damages are a summation of:

- The direct damages (internal, external, and structural damages) as specified by the BRCFS stage-damage curves, adjusted to actual direct damage (70% of potential direct damage).
- Indirect damages estimated at 15% of the actual direct damage.
- Intangible damage, calculated by an uplift factor applied to actual direct and indirect damage as per factors provided by Council in Table 13.1.

TABLE 13.1: INTANGIBLE DAMAGE UPLIFT FACTORS

AEP	Intangibles Uplift Factor as % of 1% AEP Uplift Factor	Proposed Intangibles Uplift Factor
5% RCP4.5 CC	0%	0.00
2% RCP4.5 CC	60%	0.72
1% RCP4.5 CC	100%	1.20
PMF	380%	4.56

A summary of the residential flood damages in the Windaroo Creek catchment due to flood, and the contribution of each event to the AAD is summarised in Table 13.2.

TABLE 13.2: RESIDENTIAL FLOOD DAMAGE ESTIMATE

Flood Event (% AEP)	Potential Direct Flood Damage	Actual Direct Flood Damage	Indirect Flood Damage	Intangible Cost Estimate	Total Flood Damage	Contribution to Annual Average Damage
PMF / 0.001%	$46,298,000	$32,409,000	$4,861,000	$169,951,000	**$207,221,000**	**$62,000**
0.05%	$9,817,000	$6,872,000	$1,031,000	$36,036,000	**$43,938,000**	**$43,000**
0.20% RCP4.5 CC	$7,278,000	$5,094,000	$764,000	$7,030,000	**$12,888,000**	**$30,000**
0.50% RCP4.5 CC	$4,055,000	$2,838,000	$426,000	$3,917,000	**$7,181,000**	**$31,000**
1% RCP4.5 CC	$2,901,000	$2,031,000	$305,000	$2,802,000	**$5,138,000**	**$42,000**
2% RCP4.5 CC	$2,405,000	$1,683,000	$253,000	$1,394,000	**$3,330,000**	**$72,000**
5% RCP4.5 CC	$1,852,000	$1,296,000	$194,000	$-	**$1,491,000**	**$62,000**
10% RCP4.5 CC	$1,240,000	$868,000	$130,000	$-	**$998,000**	**$74,000**
20% RCP4.5 CC	$607,000	$425,000	$64,000	$-	**$488,000**	**$97,000**
50% RCP4.5 CC	$193,000	$135,000	$20,000	$-	**$155,000**	**$39,000**

13.1.3.2 Commercial Flood Damages

48 buildings were determined to be commercial properties within the PMF flood extent. These included schools, restaurants, pubs, and golf clubs. These were classified into commercial classes in accordance with the *Brisbane River Strategic Floodplain Management Plan – Technical Evidence Report* (BMT, 2018). The commercial flood damages are a summation of:

- The direct damages as specified by the BRCFS stage-damage curves, adjusted to actual direct damage (80% of potential direct damage).
  - Small and Medium commercial properties direct damage is calculated as a total damage value per depth of flooding above floor levels.
  - Large commercial properties direct damage is calculated as damage per m^2 value per depth of flooding above floor levels.
- Indirect damages estimated at 55% of the actual direct damage.
- Intangible damage, calculated by an uplift factor applied to actual direct and indirect damage as per factors provided by Council in Table 13.1.

A summary of the residential flood damages in the Windaroo Creek catchment due to flood, and the contribution of each event to the AAD is summarised in Table 13.3.

TABLE 13.3: COMMERCIAL FLOOD DAMAGE ESTIMATE

Flood Event (% AEP)	Potential Direct Flood Damage	Actual Direct Flood Damage	Indirect Flood Damage	Intangible Cost Estimate	**Total Flood Damage**	**Contribution to Annual Average Damage**
PMF / 0.001%	$2,514,000	$2,011,000	$1,106,000	$14,215,000	**$17,333,000**	**$5,000**
0.05%	$411,000	$329,000	$181,000	$2,322,000	**$2,832,000**	**$3,000**
0.20% RCP4.5 CC	$269,000	$216,000	$119,000	$401,000	**$735,000**	**$2,000**
0.50% RCP4.5 CC	$98,000	$79,000	$43,000	$146,000	**$268,000**	**$1,000**
1% RCP4.5 CC	$28,000	$22,000	$12,000	$41,000	**$75,000**	**$1,000**
2% RCP4.5 CC	$15,000	$12,000	$7,000	$13,000	**$32,000**	**$1,000**
5% RCP4.5 CC	$10,000	$10,000	$4,000	$-	**$12,000**	**$1,000**
10% RCP4.5 CC	$10,000	$10,000	$4,000	$-	**$12,000**	**$1,000**
20% RCP4.5 CC	$-	$-	$-	$-	**$-**	**$-**
50% RCP4.5 CC	$-	$-	$-	$-	**$-**	**$-**

13.1.3.3 Total Flood Damages

The total damage from commercial and residential properties is shown in Table 13.4 and Figure 13.1. The contribution of each event to the AAD is shown graphically in Figure 13.2, this includes both residential and commercial properties. The estimation of AAD involves calculating the area underneath the curve shown in this figure. The 20% AEP RCP4.5 climate change flood event contributes the largest to the AAD in the catchment, whereas the 0.2% AEP RCP4.5 climate change and 0.5% AEP RCP4.5 climate change flood event contributes the least.

TABLE 13.4: TOTAL FLOOD DAMAGES ESTIMATE

Flood Event (% AEP)	Residential Flood Damage	Commercial Flood Damage	Total Flood Damages	Total Contribution to Average Annual Damage
PMF / 0.001%	$207,221,000	$17,333,000	**$224,554,000**	**$66,000**
0.05%	$43,938,000	$2,832,000	**$46,770,000**	**$45,000**
0.20% RCP4.5 CC	$12,888,000	$735,000	**$13,623,000**	**$32,000**
0.50% RCP4.5 CC	$7,181,000	$268,000	**$7,449,000**	**$32,000**
1% RCP4.5 CC	$5,138,000	$75,000	**$5,213,000**	**$43,000**
2% RCP4.5 CC	$3,330,000	$32,000	**$3,362,000**	**$73,000**
5% RCP4.5 CC	$1,491,000	$12,000	**$1,503,000**	**$63,000**
10% RCP4.5 CC	$998,000	$12,000	**$1,010,000**	**$75,000**
20% RCP4.5 CC	$488,000	$-	**$488,000**	**$97,000**
50% RCP4.5 CC	$155,000	$-	**$155,000**	**$39,000**

Figure 13.1: Damage vs Annual Exceedance Probability Event

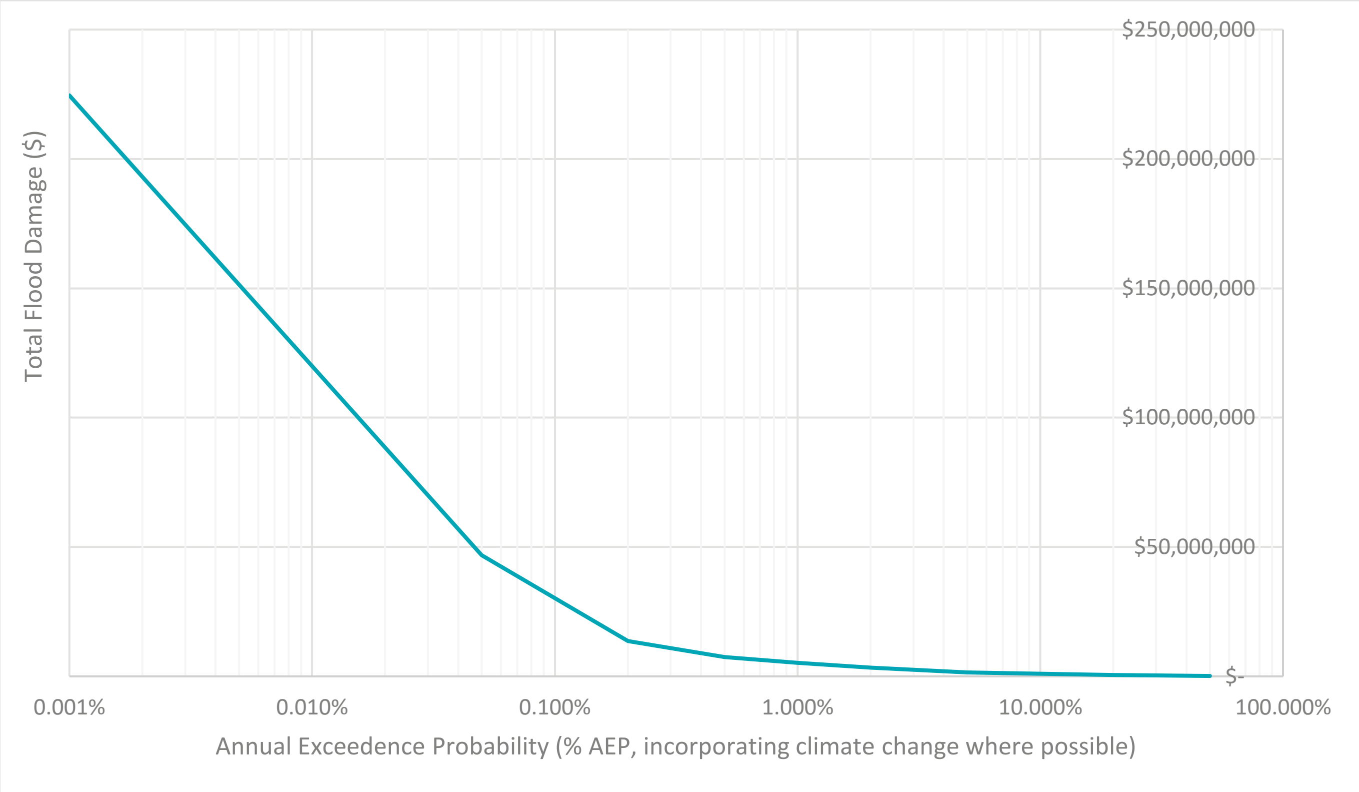
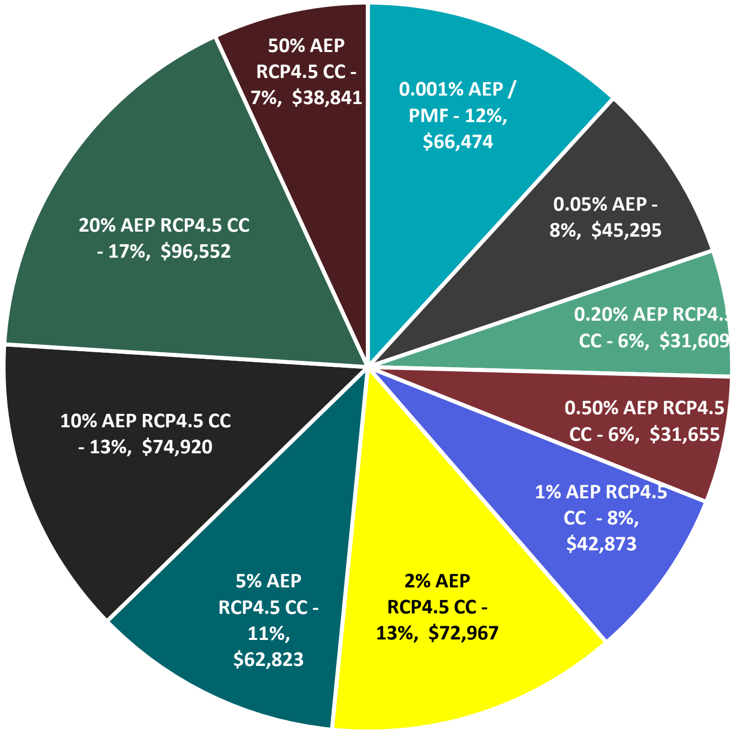


Figure 13.2: **Event Contribution to AAD**



13.1.4 Mitigated Case Flood Damage Estimate

A flood damages assessment was undertaken for the two structural mitigation options assessed in the hydraulic model, utilising the same flood events and approach as outlined in the previous sections. The updated estimate (incorporating residential and commercial damages is summarised in Table 13.5.

As expected, Structural Mitigation Option 1 has the greater reduction in flood damage of the two options due to the properties on Bahrs Scrub Road that gain flood immunity due to this option. Very minimal changes to the flood damage estimate are observed as a result of Structural Mitigation Option 2. Both options indicate greater flood damages in the PMF flood event due to raised flood levels resultant of the road upgrades and loss of floodplain storage present in both options.

TABLE 13.5: MITIGATION CASE FLOOD DAMAGES ESTIMATE

Flood Event (%AEP)	**Base Case** Total Flood Damages	**Structural** Mitigation Option 1 **Total Flood Damages**	**Difference (Option 1 minus Base)**	**Structural** Mitigation Option 2 **Total Flood Damages**	**Difference (Option 2 minus Base)**
PMF / 0.001%	$224,554,000	$225,337,000	**$783,000**	$227,078,000	**$2,524,000**
0.05%	$46,770,000	$39,259,000	**-$7,511,000**	$45,931,000	**-$839,000**
0.20% RCP4.5 CC	$13,623,000	$10,630,000	**-$2,993,000**	$13,239,000	**-$384,000**
0.50% RCP4.5 CC	$7,449,000	$4,996,000	**-$2,453,000**	$7,116,000	**-$333,000**
1% RCP4.5 CC	$5,213,000	$3,076,000	**-$2,137,000**	$4,938,000	**-$275,000**
2% RCP4.5 CC	$3,362,000	$1,848,000	**-$1,514,000**	$3,129,000	**-$233,000**
5% RCP4.5 CC	$1,503,000	$3,022,000	**$1,519,000**	$1,359,000	**-$144,000**
10% RCP4.5 CC	$1,010,000	$510,000	**-$500,000**	$875,000	**-$135,000**
20% RCP4.5 CC	$488,000	$225,000	**-$263,000**	$407,000	**-$81,000**
50% RCP4.5 CC	$155,000	$25,000	**-$130,000**	$155,000	**$0**

14. FLOODPLAIN MANAGEMENT PLANNING SUMMARY

The floodplain management planning for the Windaroo Creek catchment has included definition of flood risks based on hydraulic model results and consideration for:

- Hydraulic risk.
- Hydraulic function.
- Time and duration of inundation at flooded road crossings.
- Low and high flood islands.
- Road crossing flood immunity.
- Road crossing flood trafficability.
- Evacuation road flood immunity.
- Flooding hotspot areas.

Outputs from the flood risk analysis have included mapping and digital outputs which were provided to Council to enable further consideration and flood risk planning.

14.1 Summary of Key Floodplain Management Issues

The key floodplain risk and management issues for the Henderson Creek catchment are summarised below:

- The greatest flood risk across the catchment is considered to generally relate to safety at flooded roads due to the relatively quick catchment response time and low immunity of road crossings. Minimal localities with flooding expected above floor in the 1% AEP CC RCP4.5 flood event were identified.
- The number of buildings identified to be potentially flooded in the 1% AEP CC RCP4.5 flood event was 27.
- The flood island mapping indicates that isolation risk exists in the lower portion of the catchment, between the river and creek inundation extents.
- Three flooding hotspots were determined based on multiple buildings shown to be inundation within close proximity of each other, and one due to limited evacuation capability for residents in the 1% AEP CC RCP4.5 flood event.
- A qualitative flood mitigation assessment was undertaken on the hotspots, with a flood assessment of the preferred option at Bahrs Scrub Road (Option 1) and evacuation route immunity (Option 2) undertaken.
- Mitigation Option 1 is not recommended for further consideration, due to adverse impacts from the option, and the minimal number of residents the option improves flood risk for. Mitigation Option 2 could be considered for further investigation, to optimise and minimise adverse flood impacts from the option. However, both mitigation options do not result in lowering of estimated flood damage by any large amount.
- The cost estimate for Option 1 is $4.19M, and for Option 2 it is $4.16M.
- Additional options for flood risk management in the catchment include a review of the risk associated with flooded roads, seek to prioritise road crossings based on risk, and identify safety improvement measures for high priority roads.

15. QUALIFICATIONS

(a) In preparing this document, including all relevant calculation, and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

(b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

(c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

   (i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

   (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

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APPENDIX A: CATCHMENT PARAMETERS

ENGENY

A.1 May 2015 Calibration Event Model Catchment Parameters

ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)
Sub_001	13.64	10.81	Sub_042	12.83	2.98	Sub_079	2.99	1.67	Sub_124	2.66	44.04
Sub_002	14.14	2.72	Sub_043	19.35	4.60	Sub_080	6.07	0.00	Sub_125	10.16	35.01
Sub_003	6.78	0.84	Sub_044	23.38	1.86	Sub_081	4.51	2.22	Sub_126	7.16	20.74
Sub_004a	5.33	14.38	Sub_045	4.58	3.82	Sub_082	2.47	0.81	Sub_127	15.35	33.49
Sub_004b	11.25	4.74	Sub_046	10.21	7.64	Sub_083	3.46	0.00	Sub_128	27.25	25.36
Sub_005	20.75	2.40	Sub_047	3.62	11.75	Sub_084	3.92	0.77	Sub_129	13.24	45.03
Sub_006a	21.37	0.00	Sub_048	0.84	8.04	Sub_085	8.27	4.82	Sub_130	16.91	41.40
Sub_006b	8.73	0.92	Sub_049	4.46	3.00	Sub_086	7.38	0.00	Sub_131	25.22	50.66
Sub_007	11.15	1.06	Sub_050	18.61	1.22	Sub_087	5.52	0.00	Sub_132	12.45	54.73
Sub_008a	19.79	0.05	Sub_051	14.41	0.92	Sub_088	13.53	0.37	Sub_133	18.02	43.64
Sub_008b	9.14	0.00	Sub_052	13.71	0.66	Sub_089	25.19	5.66	Sub_134	10.65	28.61
Sub_009a	13.53	0.00	Sub_053	22.80	2.79	Sub_090	17.58	8.35	Sub_135	26.51	62.19
Sub_009b	16.01	0.00	Sub_054	16.09	5.22	Sub_091	5.42	0.00	Sub_136	11.69	47.08
Sub_010	6.76	0.30	Sub_055	13.89	2.51	Sub_092	4.31	6.53	Sub_137	20.54	58.42
Sub_011	6.84	0.00	Sub_056	10.83	5.99	Sub_093	7.43	3.64	Sub_138	25.71	53.30
Sub_012	6.20	0.00	Sub_057	11.59	1.29	Sub_094	15.95	9.96	Sub_139a	8.85	22.91
Sub_013	6.00	0.50	Sub_058	9.25	7.63	Sub_095	5.84	15.86	Sub_139b	22.43	30.05
Sub_014	6.69	0.00	Sub_059	8.37	2.05	Sub_096	8.76	3.96	Sub_140	6.88	2.18
Sub_015	15.35	0.46	Sub_060	6.33	4.20	Sub_097	11.75	0.43	Sub_141	24.33	10.61
Sub_016	10.99	6.65	Sub_061	3.94	0.00	Sub_098	3.41	0.88	Sub_142	18.68	37.41
Sub_017	7.27	12.83	Sub_062	8.97	2.21	Sub_099	4.41	0.00	Sub_143	22.66	8.86
Sub_018	13.75	0.95	Sub_063	8.42	3.75	Sub_100	6.05	10.81	Sub_144	11.60	10.58
Sub_019	7.34	0.57	Sub_064a	13.01	0.08	Sub_101	4.57	16.01	Sub_145	2.64	27.05
Sub_020	3.45	38.49	Sub_064b	6.29	0.94	Sub_102	4.71	10.79	Sub_146	8.16	9.43
Sub_021	2.58	64.77	Sub_065	20.44	0.24	Sub_103	3.11	0.00	Sub_147	1.46	26.03

ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)
Sub_022	17.52	60.23	Sub_066a	11.02	0.00	Sub_104	1.59	7.11	Sub_148	5.09	17.70
Sub_023	16.76	1.48	Sub_066b	9.45	0.42	Sub_105	5.70	9.32	Sub_149	4.97	24.57
Sub_024	2.21	0.00	Sub_067a	15.36	0.00	Sub_106	6.66	0.00	Sub_150a	6.05	0.83
Sub_025	5.87	19.41	Sub_067b	11.88	0.46	Sub_107	2.99	0.00	Sub_150b	2.75	5.09
Sub_026	10.84	20.45	Sub_068a	11.73	0.00	Sub_108	7.30	0.00	Sub_151	15.05	2.23
Sub_027	5.05	26.23	Sub_068b	12.95	0.00	Sub_109	3.14	0.00	Sub_152	6.11	2.60
Sub_028	4.92	6.30	Sub_068c	6.21	0.00	Sub_110a	3.30	0.00	Sub_153	8.96	0.27
Sub_029	3.90	33.26	Sub_069	21.41	0.00	Sub_110b	3.50	0.00	Sub_154a	9.72	24.10
Sub_030	12.06	38.49	Sub_070a	9.01	0.00	Sub_112	2.06	14.88	Sub_154b	14.24	17.03
Sub_031	2.94	11.09	Sub_070b	9.24	0.43	Sub_113	2.80	65.07	Sub_155a	5.87	3.82
Sub_032	5.13	28.09	Sub_070c	13.03	0.00	Sub_114	3.58	34.47	Sub_155b	2.63	12.60
Sub_033	16.71	22.59	Sub_071	16.99	1.53	Sub_115	2.45	41.65	Sub_156	7.42	5.77
Sub_034	5.24	19.91	Sub_072	10.93	4.42	Sub_116	5.26	12.55	Sub_157	5.19	0.00
Sub_035	6.68	10.74	Sub_073	26.73	1.72	Sub_117	6.01	0.50	Sub_158	6.62	1.47
Sub_036	4.27	3.16	Sub_074	16.29	4.55	Sub_118	1.43	38.29	Sub_159	13.71	7.00
Sub_037	3.79	10.08	Sub_075	8.92	9.15	Sub_119	6.62	2.45	Sub_160	9.50	13.53
Sub_038	6.95	6.26	Sub_076	5.60	6.18	Sub_120	6.09	7.46	Sub_161	5.99	14.16
Sub_039	5.80	13.23	Sub_077a	3.52	3.55	Sub_121	3.01	19.62	Sub_162	4.86	12.12
Sub_040	8.78	2.97	Sub_077b	6.34	1.70	Sub_122	2.95	37.17	Sub_163	1.74	18.22
Sub_041	11.83	2.68	Sub_078	5.21	7.01	Sub_123	13.24	39.68			

A.2 February 2020 and March 2022 Calibration Event Model Catchment Parameters

ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)
B001	22.66	8.86	W001	15.35	27.70	W046	9.73	0.72	W089	11.02	0.00
B002	11.60	9.95	W002	12.59	7.66	W047a	10.21	7.64	W090	9.45	0.42
B003	2.64	27.05	W003	8.82	19.51	W047b	4.58	3.82	W091	9.36	0.11
B004	1.02	5.29	W004	13.24	44.77	W048	4.45	11.18	W092	5.70	0.00
B005	3.84	1.88	W005	14.33	40.20	W049	4.46	3.00	W093	20.44	0.00
B006	5.99	4.81	W006	10.21	31.12	W050	20.96	1.43	W094	10.39	0.00
B007	8.16	9.43	W007	23.44	51.55	W051	13.71	0.66	W095	21.41	0.00
B008	1.46	26.03	W008	15.90	40.41	W052	12.07	0.50	W096	20.60	0.19
B009	5.09	14.56	W009	7.16	20.36	W053	22.80	2.79	W097	10.68	0.00
B010	4.97	20.42	W010	9.96	33.84	W054	12.68	4.87			
B011	2.75	2.55	W011	18.02	35.35	W055	7.76	2.91			
B012	6.14	0.81	W012	10.65	13.53	W056	15.25	14.31			
B013	2.04	5.51	W013	26.51	61.14	W057	5.62	16.54			
B014	12.92	1.64	W014	38.10	44.65	W058	15.34	5.61			
B015	4.65	1.72	W015	25.71	48.80	W059	1.78	75.62			
B016	10.42	0.99	W016	42.52	31.76	W060	5.20	74.60			
B017	14.24	12.41	W017	70.62	21.89	W061	4.95	5.80			
B018	9.73	10.18	W018	12.45	48.95	W062	27.09	45.73			
B019	7.42	5.77	W019	10.99	20.87	W063	17.40	52.22			
B021	12.89	0.75	W020	5.05	26.23	W064	6.53	76.14			
B022	9.72	17.29	W021	9.07	39.21	W065	13.89	2.51			
B023	11.32	9.16	W022	16.17	7.52	W066	27.40	21.56			
B024	20.92	1.84	W023	17.14	22.49	W067	17.46	38.57			
B025	11.96	4.71	W024	4.83	6.42	W068	5.57	48.67			
B026	5.33	14.38	W025	3.88	34.01	W069	2.56	1.25			

ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)
B027	23.67	2.11	W026	20.12	40.77	W070	1.83	1.09			
B028	8.30	0.96	W027	16.66	22.31	W071	7.03	6.05			
B029	15.24	0.00	W028	5.24	19.91	W072	15.01	5.99			
B030	3.63	0.00	W029	10.95	7.79	W073	4.76	7.82			
B031	8.87	0.77	W030	3.79	10.08	W074	7.80	3.10			
B032	22.14	0.05	W031	6.95	6.26	W075	8.04	1.00			
B033	12.27	0.00	W032	5.80	13.23	W076	10.45	5.61			
B034	12.47	0.00	W033	8.78	2.97	W077	9.92	2.53			
B035	11.58	0.00	W034	11.83	2.68	W078a	9.17	7.55			
B036	7.89	0.89	W035	12.83	2.98	W078b	22.43	3.56			
B037	14.18	0.00	W036	7.38	0.54	W079	7.09	1.66			
B038	13.48	0.00	W037	4.92	0.00	W080	10.74	3.78			
B039	13.86	0.07	W038	7.30	0.00	W081	11.68	2.86			
B040	15.45	7.04	W039	9.99	0.36	W082	17.39	2.96			
B041	9.50	4.31	W040	14.06	5.33	W083	5.30	2.45			
Dummy	0.95	0.00	W041	6.66	0.00	W084	11.69	1.11			
T001	6.88	2.18	W042	10.53	8.13	W085	11.45	0.48			
T002	18.68	32.85	W043	11.27	13.34	W086	10.15	0.00			
T003	24.33	9.52	W044	19.35	18.64	W087	19.30	0.36			
T004	7.09	9.37	W045	13.65	2.67	W088	11.08	0.45			
B001	22.66	8.86	W001	15.35	27.70	W046	9.73	0.72			

A.3 Design Event Model Catchment Parameters

ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)
B001	22.66	37.92	W001	15.35	33.54	W046	9.73	70.00	W089	11.02	0.00
B002	11.60	43.00	W002	12.59	24.99	W047a	10.21	71.61	W090	9.45	0.00
B003	2.64	66.61	W003	8.82	37.22	W047b	4.58	71.16	W091	9.36	0.28
B004	1.02	14.61	W004	13.24	45.03	W048	4.45	74.43	W092	5.70	0.00
B005	3.84	13.33	W005	14.33	40.20	W049	4.46	70.54	W093	20.44	0.67
B006	5.99	15.21	W006	10.21	55.70	W050	20.96	42.78	W094	10.39	1.10
B007	8.16	39.49	W007	23.44	54.01	W051	13.71	27.83	W095	21.41	0.73
B008	1.46	62.77	W008	15.90	53.46	W052	12.07	60.84	W096	20.60	1.72
B009	5.09	25.87	W009	7.16	21.93	W053	22.80	70.95	W097	10.68	0.30
B010	4.97	35.95	W010	9.96	36.46	W054	12.68	71.32			
B011	2.75	11.27	W011	18.02	43.64	W055	7.76	71.01			
B012	6.14	10.00	W012	10.65	28.61	W056	15.25	72.51			
B013	2.04	19.80	W013	26.51	61.69	W057	5.62	72.58			
B014	12.92	12.91	W014	38.10	52.37	W058	15.34	70.66			
B015	4.65	10.00	W015	25.71	54.02	W059	1.78	78.65			
B016	10.42	8.62	W016	42.52	57.03	W060	5.20	71.71			
B017	14.24	19.30	W017	70.62	56.88	W061	4.95	51.78			
B018	9.73	11.20	W018	12.45	54.73	W062	27.09	70.94			
B019	7.42	8.38	W019	10.99	45.76	W063	17.40	71.10			
B021	12.89	9.46	W020	5.05	68.98	W064	6.53	76.22			
B022	9.72	29.88	W021	9.07	53.15	W065	13.89	70.35			
B023	11.32	11.80	W022	16.17	69.96	W066	27.40	72.15			
B024	20.92	55.87	W023	17.14	68.47	W067	17.46	75.08			
B025	11.96	25.35	W024	4.83	68.61	W068	5.57	74.56			

ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)	ID	Area (ha)	Impervious Fraction (%)
B026	5.33	16.37	W025	3.88	55.09	W069	2.56	70.16			
B027	23.67	4.41	W026	20.12	72.25	W070	1.83	70.00			
B028	8.30	8.65	W027	16.66	45.64	W071	7.03	72.66			
B029	15.24	0.26	W028	5.24	61.77	W072	15.01	71.99			
B030	3.63	2.07	W029	10.95	57.07	W073	4.76	75.27			
B031	8.87	1.30	W030	3.79	58.47	W074	7.80	72.41			
B032	22.14	0.00	W031	6.95	41.93	W075	8.04	65.22			
B033	12.27	0.00	W032	5.80	59.53	W076	10.45	72.24			
B034	12.47	0.00	W033	8.78	64.67	W077	9.92	70.36			
B035	11.58	0.28	W034	11.83	68.58	W078a	9.17	72.74			
B036	7.89	3.05	W035	12.83	62.13	W078b	22.43	61.42			
B037	14.18	0.00	W036	7.38	70.00	W079	7.09	70.32			
B038	13.48	37.91	W037	4.92	70.00	W080	10.74	67.43			
B039	13.86	54.01	W038	7.30	70.00	W081	11.68	28.80			
B040	15.45	52.97	W039	9.99	70.08	W082	17.39	14.83			
B041	9.50	16.24	W040	14.06	70.78	W083	5.30	2.45			
Dummy	0.95	0.00	W041	6.66	70.00	W084	11.69	6.30			
T001	6.88	50.84	W042	10.53	71.41	W085	11.45	0.49			
T002	18.68	46.90	W043	11.27	71.82	W086	10.15	0.85			
T003	24.33	49.67	W044	19.35	70.59	W087	19.30	0.05			
T004	7.09	51.73	W045	13.65	70.67	W088	11.08	0.00			
B001	22.66	37.92	W001	15.35	33.54	W046	9.73	70.00			

APPENDIX B: STORMWATER NETWORK

B.1 Stormwater Network

ID	Type	Manning's "n" Roughness	US Invert (m AHD)	DS Invert (m AHD)	Width (m)	Height (m)	Number of
CUL_001	R	0.013	6.42	6.35	3.6	2.4	6
CUL_003	R	0.013	8.21	8.15	3.6	2.5	6
CUL_004	R	0.013	16.835	16.62	2.4	1.5	3
CUL_005	C	0.013	43.3	43.239	0.375	0	2
CUL_006	C	0.013	43.428	43.082	0.825	0	1
CUL_007	R	0.013	34.372	34.332	3	1.2	2
CUL_008	C	0.013	32.657	32.544	0.9	0	2
CUL_009	C	0.013	32.657	32.544	0.825	0	2
CUL_010	C	0.013	33	32.935	0.525	0	3
CUL_011	C	0.013	33	32.935	0.375	0	1
CUL_012	R	0.013	40.458	40.125	1.5	0.9	2
CUL_015	C	0.013	22.465	22.438	1.5	0	3
CUL_016	C	0.013	27.931	27.487	1.05	0	2
CUL_017	C	0.013	37.965	37.504	1.5	0	2
CUL_019	C	0.013	63.405	63.055	0.3	0	1
CUL_020	C	0.013	62.115	61.91	1.35	0	1
CUL_021	C	0.013	16.416	16.216	1.2	0	2
CUL_022	C	0.013	14.242	14.216	0.6	0	8
CUL_024	C	0.013	10.834	10.692	0.675	0	3
CUL_026	C	0.013	8.022	7.737	1.35	0	1
CUL_027	C	0.013	7.2	6.496	1.2	0	4
CUL_028	C	0.013	6.532	5.833	0.6	0	1
CUL_029	C	0.013	8.555	8.428	1.35	0	2
CUL_030	C	0.013	36.82	34.87	1.2	0	2
CUL_031	C	0.013	9.8	9.77	1.65	0	3
CUL_032	C	0.013	7.73	7.59	2.1	0	4
CUL_033	C	0.013	10.137	10.087	0.9	0	1
CUL_038	C	0.013	10.964	10.53	0.45	0	1

ID	Type	Manning's "n" Roughness	US Invert (m AHD)	DS Invert (m AHD)	Width (m)	Height (m)	Number of
CUL_039	C	0.013	19.831	19.7	1.35	0	4
CUL_040	C	0.013	36.868	36.44	1.35	0	2
CUL_041	C	0.013	10.4	8.865	1.8	0	2
CUL_042	C	0.013	5.25	4.25	1.8	0	2
CUL_044	C	0.013	47.716	46.871	0.6	0	1
CUL_045	C	0.013	43.589	43.311	1.95	0	1
CUL_046	C	0.013	31.83	28.65	0.75	0	1
CUL_047	C	0.013	4.621	4.6	0.3	0	1
CUL_048	R	0.013	9.342	9.341	0.3	0.3	3
CUL_049	R	0.013	9.162	9.074	1.8	0.9	5
CUL_051	R	0.013	43.798	43.327	1.8	0.9	2
CUL_052	C	0.013	47.44	44.2	1.2	0	1
CUL_053	C	0.013	32.279	32.079	1.2	0	4
CUL_054	R	0.013	31	30.4	1.2	0.6	2
CUL_055	C	0.013	51.265	51.022	0.3	0	1
CUL_056	C	0.013	46.461	46.196	0.3	0	1
CUL_057	C	0.013	46.372	45.773	0.3	0	1
CUL_058	C	0.013	32.337	32.194	0.75	0	1
CUL_059	C	0.013	58.55	58.5	0.45	0	1
CUL_060	C	0.013	24.855	24.574	0.66	0	1
CUL_061	C	0.013	65.828	65.778	0.45	0	1
CUL_062	C	0.013	65.457	64.557	0.75	0	1
CUL_063	C	0.013	42.971	42.29	1.05	0	2
CUL_064	C	0.013	39.371	38.781	0.9	0	1
CUL_065	C	0.013	15.971	15.709	0.3	0	1
CUL_066	C	0.013	9.696	9.323	0.9	0	1
CUL_067	R	0.013	9.612	9.36	0.3	0.3	3
CUL_068	C	0.013	24.41	23.63	0.35	0	1
CUL_069	C	0.013	22.626	22.448	0.15	0	1
CUL_070	C	0.013	48.6	47.895	0.6	0	1

ID	Type	Manning's "n" Roughness	US Invert (m AHD)	DS Invert (m AHD)	Width (m)	Height (m)	Number of
CUL_071	C	0.013	18.616	18.365	0.6	0	1
CUL_073	C	0.013	6.231	5.884	0.675	0	1
CUL_074	C	0.013	12.334	12.01	1.05	0	1

APPENDIX C: RATIONAL METHOD PARAMETERS

C.1 Catchment W001 Rational Method Parameters

Catchment Parameters		
Catchment Area (ha)	1173.55	
Fraction Impervious (%)	31%	Refer relevant Local Government Planning Scheme Policy
10-year 1-hour Rainfall Intensity (mm/h)	82.4	
Land Description	[redacted]	Refer QUDM (2016) Table 4.5.3 & 4.5.4 (page 4-8)
Soil Permeability		Refer QUDM (2016) Table 4.5.3 & 4.5.4 (page 4-8)
Runoff Coefficient (-)	0.75	
Total Time of Concentration	142	
Bransby-Williams		
Time of Concentration (min)	201.3	Refer QUDM (2016) Equation 4.9 (page 4-20)
Include in Total ToC?	No	
Modified Stream Velocity Method		
Flow Path Length (m)	10007	
Travel Velocity (m/s)	1.2	Refer QUDM (2016) Table 4.6.6 (page 4-21)
Time of Concentration (min)	142.8	
Include in Total ToC?	Yes	

Design Event AEP (%)	Rational Method Peak Flow	WBNM Peak Flow (m3/s)	Peak Flow Difference (m3/s)	Peak Flow Difference (%)
1	228.0	210.08	-17.9	-8%
2	191.8	186.46	4.8	3%
5	166.7	181.83	15.1	10%
10	116.3	129.44	13.1	11%
18				
20	87.4	100.55	13.2	15%
39				
50	50.0	53.36	3.3	7%
63				

Design Event AEP (%)	Rainfall Intensity (mm/h)	Frequency Factor (Fy) (-)
1	71.5	1.2
2	63.1	1.15
5	52.8	1.05
10	41.8	1
18	36.8	0.95
20	35.1	0.94
39	28.7	0.85

C.2 Catchment B001 Rational Method Parameters

Catchment Parameters		
Catchment Area (ha)	462.41	
Fraction Impervious (%)	20%	Refer relevant Local Government Planning Scheme Policy
10-year 1-hour Rainfall Intensity (mm/h)	61.3	
Land Description	Medium Density Rural	Refer QUDM (2016) Table 4.5.3 & 4.5.4 (page 4-8)
Soil Permeability	Medium	Refer QUDM (2016) Table 4.5.3 & 4.5.4 (page 4-8)
Runoff Coefficient (-)	0.59	
Total Time of Concentration	90	
Bransby-Williams		
Time of Concentration (min)	88.8	Refer QUDM (2016) Equation 4.9 (page 4-20)
Include in Total ToC?	No	
Modified Stream Velocity Method		
Flow Path Length (m)	4878	
Travel Velocity (m/s)	0.9	Refer QUDM (2016) Table 4.6.6 (page 4-21)
Time of Concentration (min)	90.3	
Include in Total ToC?	Yes	

Design Event AEP (%)	Rational Method Peak Flow	WBNM Peak Flow (m3/s)	Peak Flow Difference (m3/s)	Peak Flow Difference (%)
1	90.8	90.77	0.2	0%
2	58.9	59.1	0.2	0%
5	47.9	51.51	3.6	8%
10	38.1	39.94	1.8	5%
18				
20	28.7	29.8	1.1	4%
39				
50	16.4	15.81	-0.6	-3%
63				

Design Event AEP (%)	Rainfall Intensity (mm/h)	Frequency Factor (Fy) (-)
1	84.4	1.2
2	72.8	1.15
5	63.1	1.05
10	52.8	1
18	10.8	0.95
20	48.4	0.94
39	7.1	0.85

C.3 Catchment T001 Rational Method Parameters

Catchment Parameters		
Catchment Area (ha)	56.90	
Fraction Impervious (%)	48%	Refer relevant Local Government Planning Scheme Policy
10-year 1-hour Rainfall Intensity (mm/h)	62.4	
Land Description	[redacted]	Refer QUDM (2016) Table 4.5.3 & 4.5.4 (page 4-8)
Soil Permeability		Refer QUDM (2016) Table 4.5.3 & 4.5.4 (page 4-8)
Runoff Coefficient (-)	0.75	
Total Time of Concentration	51	
Bransby-Williams		
Time of Concentration (min)	19.9	Refer QUDM (2016) Equation 4.9 (page 4-20)
Include in Total ToC?	No	
Modified Stream Velocity Method		
Flow Path Length (m)	350	
Travel Velocity (m/s)	0.8	Refer QUDM (2016) Table 4.6.6 (page 4-21)
Time of Concentration (min)	32.8	
Include in Total ToC?	Yes	

Design Event AEP (%)	Rational Method Peak Flow	WBNM Peak Flow (m3/s)	Peak Flow Difference (m3/s)	Peak Flow Difference (%)
1	16.6	16.79	0.2	1%
2	14.1	14.63	0.5	3%
5	10.9	11.94	1.1	10%
10	8.9	9.77	0.9	10%
18				
20	6.9	7.98	0.6	9%
39				
50	4.1	4.4	0.1	1%
63				

Design Event AEP (%)	Rainfall Intensity (mm/h)	Frequency Factor (Fy) (-)
1	110.7	1.2
2	102.9	1.15
5	87.6	1.05
10	75.2	1
18	66.4	0.99
20	61.6	0.94
39	51.4	0.85

C.4 Catchment W013 Rational Method Parameters

Catchment Parameters		
Catchment Area (ha)	42.52	
Fraction Impervious (%)	57%	Refer relevant Local Government Planning Scheme Policy
10-year 1-hour Rainfall Intensity (mm/h)	62.4	
Land Description	[redacted]	Refer QUDM (2016) Table 4.5.3 & 4.5.4 (page 4-8)
Soil Permeability		Refer QUDM (2016) Table 4.5.3 & 4.5.4 (page 4-8)
Runoff Coefficient (-)	0.77	
Total Time of Concentration	39	
Bransby-Williams		
Time of Concentration (min)	10.8	Refer QUDM (2016) Equation 4.9 (page 4-20)
Include in Total ToC?	No	
Modified Stream Velocity Method		
Flow Path Length (m)	350	
Travel Velocity (m/s)	2	Refer QUDM (2016) Table 4.6.6 (page 4-21)
Time of Concentration (min)	2.9	
Include in Total ToC?	Yes	

Design Event AEP (%)	Rational Method Peak Flow	WBNM Peak Flow (m3/s)	Peak Flow Difference (m3/s)	Peak Flow Difference (%)
1	15.5	16.14	0.7	4%
2	13.3	14.31	1.0	8%
5	10.3	12.21	1.9	19%
10	8.4	10.11	1.7	20%
18				
20	6.6	8.01	1.4	21%
39				
50	4.2	5.22	1.1	26%
63				

Design Event AEP (%)	Rainfall Intensity (mm/h)	Frequency Factor (Fy) (-)
1	141.5	1.2
2	126.7	1.15
5	107.6	1.05
10	92.7	1
18	81.2	0.95
20	77.5	0.94
39	64.2	0.85

C.5 Catchment B021 Rational Method Parameters

Catchment Parameters		
Catchment Area (ha)	12.89	
Fraction Impervious (%)	9%	Refer relevant Local Government Planning Scheme Policy
10-year 1-hour Rainfall Intensity (mm/h)	61.3	
Land Description	Dense Bushland	Refer QUDM (2016) Table 4.5.3 & 4.5.4 (page 4-8)
Soil Permeability	Medium	Refer QUDM (2016) Table 4.5.3 & 4.5.4 (page 4-8)
Runoff Coefficient (-)	0.44	
Total Time of Concentration	21	
Bransby-Williams		
Time of Concentration (min)	9.0	Refer QUDM (2016) Equation 4.9 (page 4-20)
Include in Total ToC?	No	
Modified Stream Velocity Method		
Flow Path Length (m)	540	
Travel Velocity (m/s)	3	Refer QUDM (2016) Table 4.6.6 (page 4-21)
Time of Concentration (min)	3.0	
Include in Total ToC?	Yes	

Design Event AEP (%)	Rational Method Peak Flow	WBNM Peak Flow (m3/s)	Peak Flow Difference (m3/s)	Peak Flow Difference (%)
1	3.7	4.08	0.4	9%
2	3.2	3.49	0.3	8%
5	2.5	2.77	0.2	10%
10	2.1	2.2	0.1	5%
18				
20	1.6	1.84	0.2	12%
39				
50	1.0	0.97	-0.1	-6%
63				

Design Event AEP (%)	Rainfall Intensity (mm/h)	Frequency Factor (Fy) (-)
1	197.3	1.2
2	178.0	1.15
5	152.6	1.05
10	132.4	1
18	17.6	0.95
20	111.1	0.94
39	13.5	0.85

APPENDIX D: REPRESENTATIVE DESIGN STORM SELECTION

D.1 Selected Storm Temporal Patterns

Storm AEP	Storm Duration	Selected Storm Temporal Pattern
PMP	60-minute	9
	90-minute	6
	120-minute	10
	180-minute	11
	270-minute	3
	360-minute	4
0.05%	60-minute	4
	90-minute	3
	120-minute	3
	180-minute	2
	270-minute	1
	360-minute	4
0.2%	60-minute	4
	90-minute	3
	120-minute	3
	180-minute	2
	270-minute	1
	360-minute	4
0.5%	60-minute	9
	90-minute	3
	120-minute	3
	180-minute	2
	270-minute	7
	360-minute	4
1%*	60-minute	9
	90-minute	3
	120-minute	3
	180-minute	2
	270-minute	1
	360-minute	4

Storm AEP	Storm Duration	Selected Storm Temporal Pattern
2%	60-minute	5
	90-minute	3
	120-minute	3
	180-minute	2
	270-minute	1
	360-minute	4
5%	60-minute	8
	90-minute	6
	120-minute	9
	180-minute	4
	270-minute	9
	360-minute	9
10%	60-minute	8
	90-minute	6
	120-minute	10
	180-minute	1
	270-minute	9
	360-minute	5
20%	60-minute	7
	90-minute	2
	120-minute	8
	180-minute	1
	270-minute	7
	360-minute	6
50%	60-minute	4
	90-minute	7
	120-minute	8
	180-minute	5
	270-minute	5
	360-minute	3

**As per the methodology outlined in this flood report, all temporal patterns have been simulated for the 1% AEP flood event, in order to develop the maximum flood grids. These specified temporal patterns may be adopted for future alternative applications of the flood model.*

APPENDIX E: CRITICAL DURATION MAPPING

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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Appendix E.1

Windaroo Creek Flood Study
50% AEP Design Event

Critical Duration

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

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DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix E.2

Windaroo Creek Flood Study
20% AEP Design Event

Critical Duration

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix E.3

Windaroo Creek Flood Study
10% AEP Design Event

Critical Duration

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
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Appendix E.4

Windaroo Creek Flood Study
5% AEP Design Event

Critical Duration

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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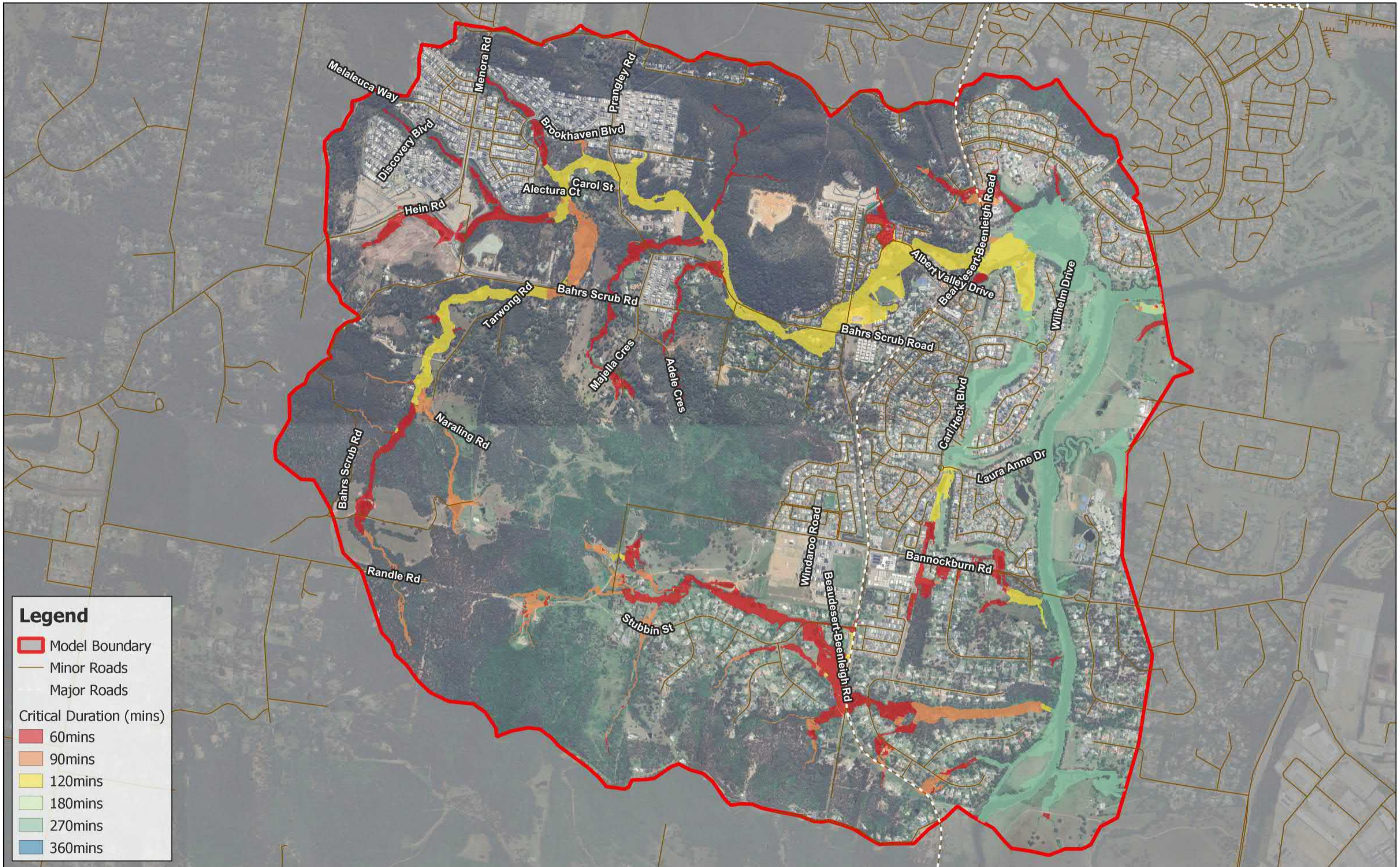
Appendix E.5

Windaroo Creek Flood Study
2% AEP Design Event

Critical Duration

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix E.6

Windaroo Creek Flood Study
1% AEP Design Event

Critical Duration

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix E.7

Windaroo Creek Flood Study
0.5% AEP Design Event

Critical Duration

Drg Ref. M9000_082

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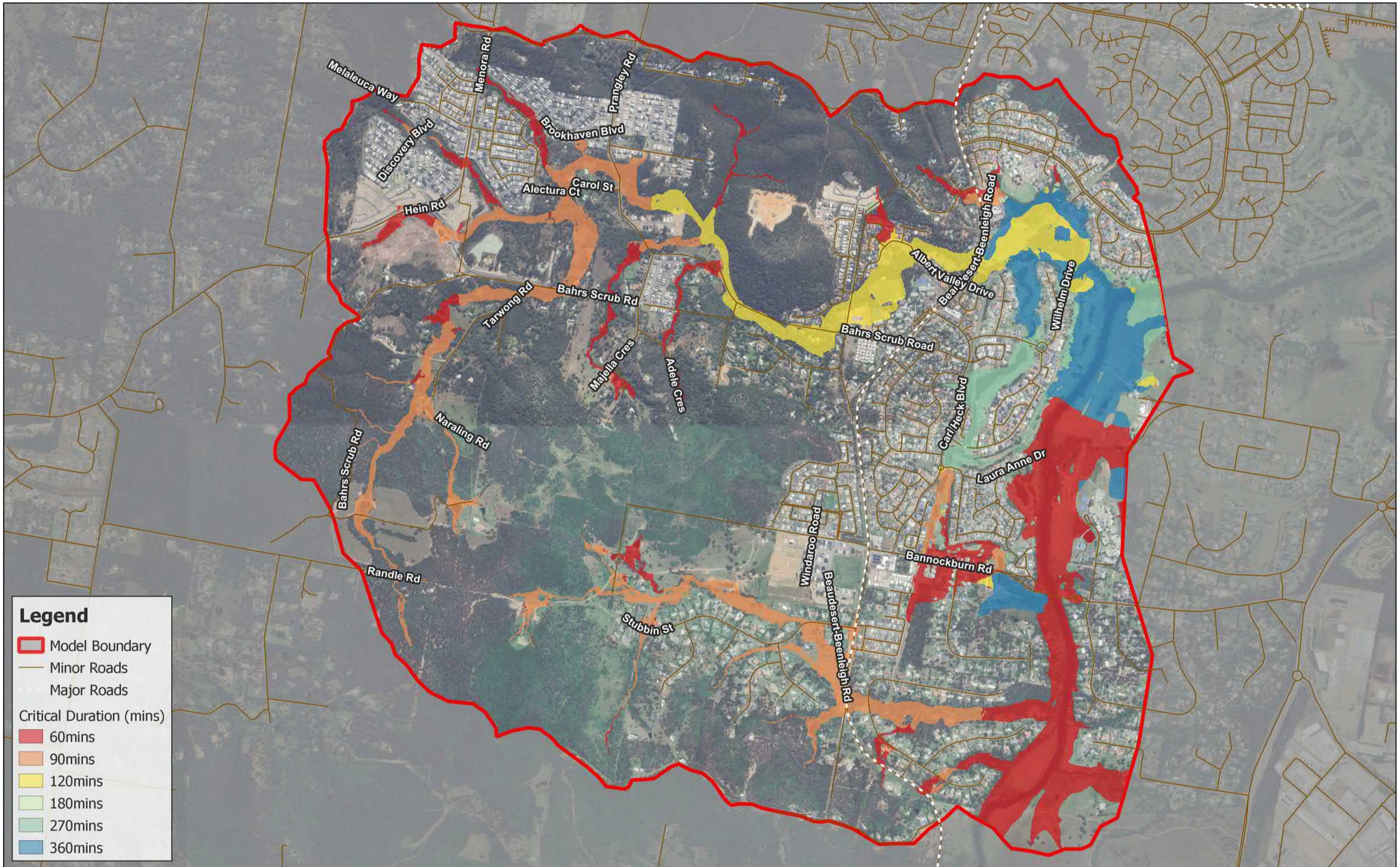

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix E.8

Windaroo Creek Flood Study
0.2% AEP Design Event

Critical Duration

Drg Ref. M9000_082

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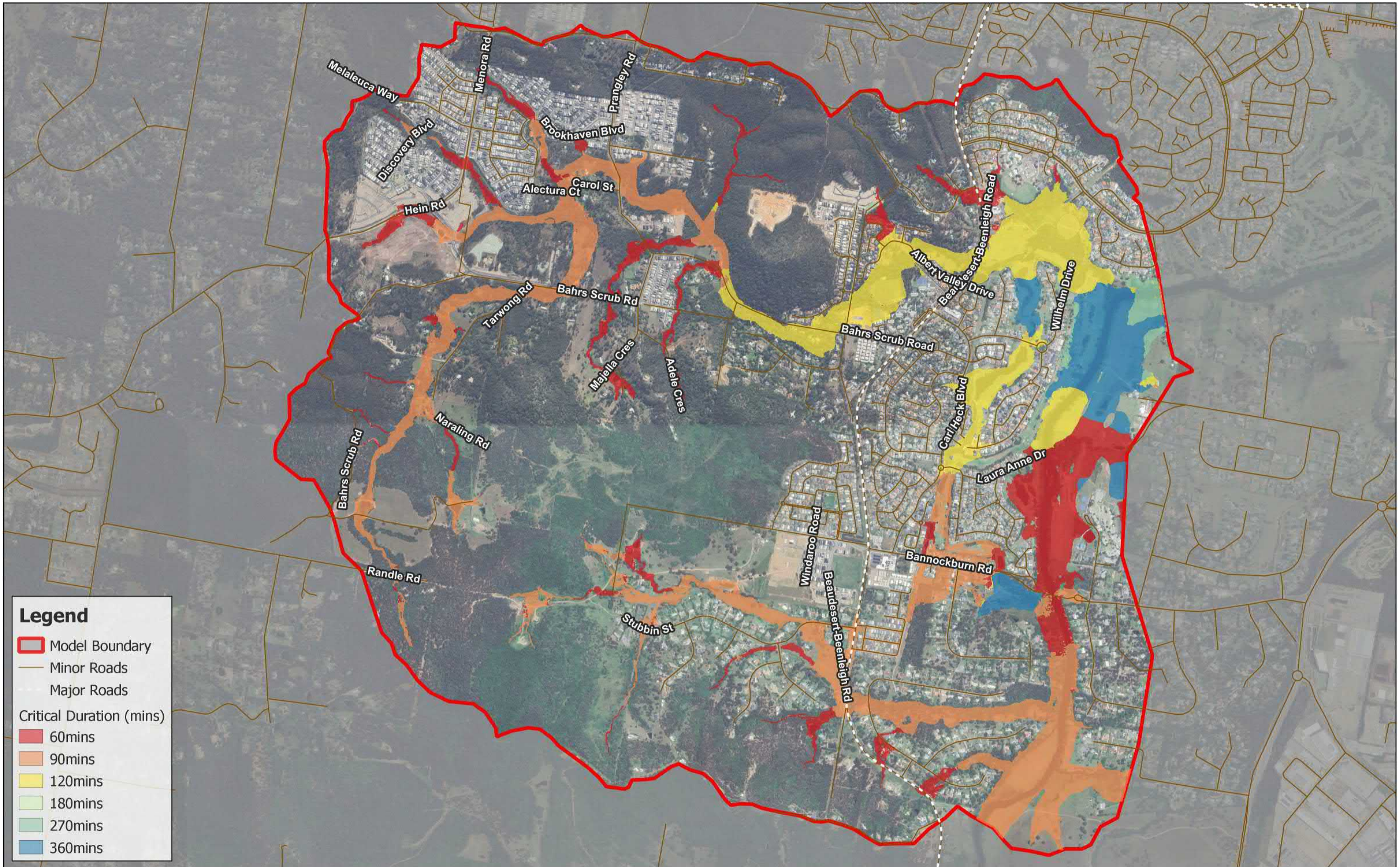

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
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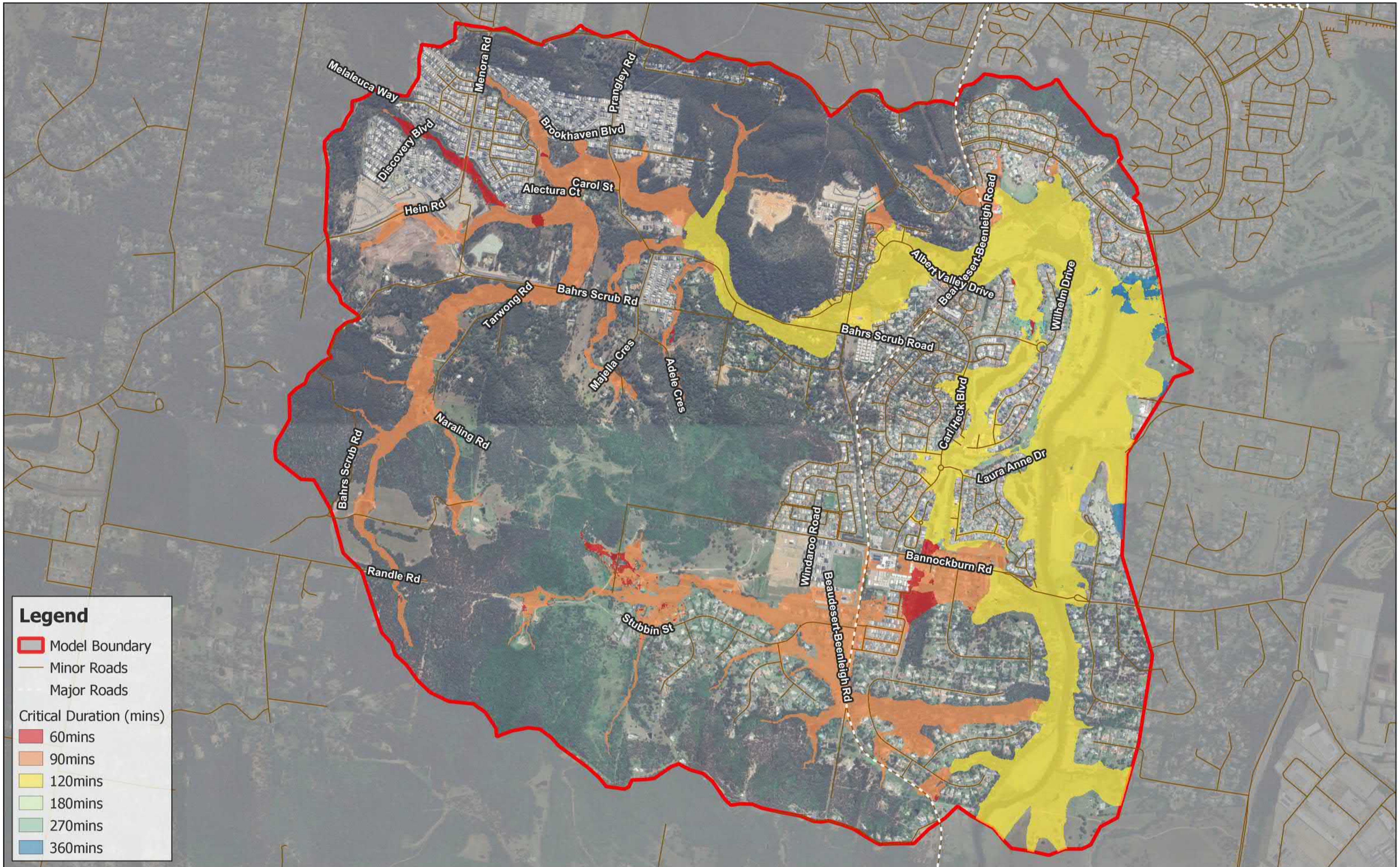
Appendix E.9

Windaroo Creek Flood Study
0.05% AEP Design Event

Critical Duration

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix E.10

Windaroo Creek Flood Study
PMP Design Event

Critical Duration

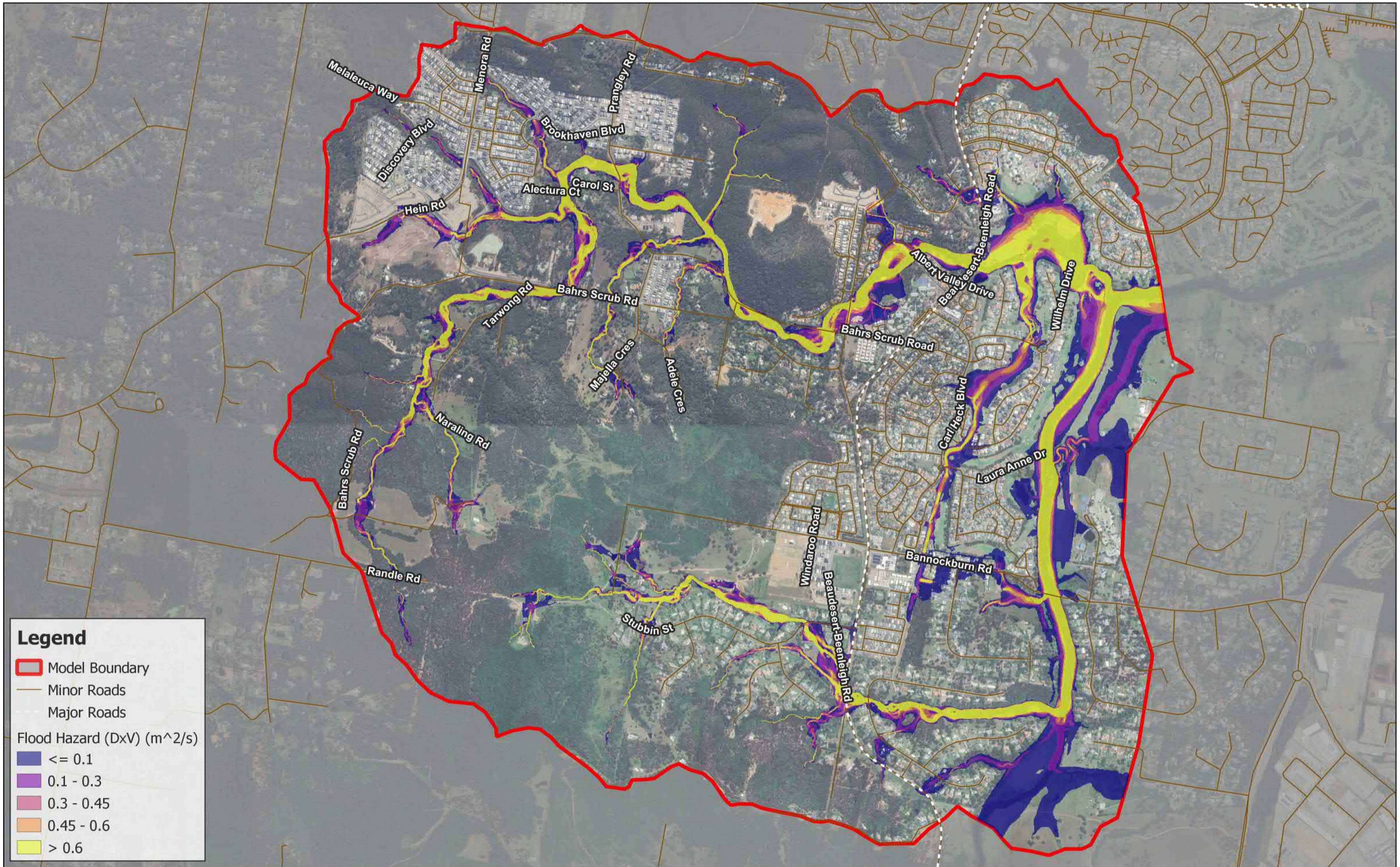
Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

APPENDIX F: PEAK FLOW ANALYSIS

AEP	Durn	PO_005	PO_009	PO_011	PO_025	PO_042	PO_064	PO_070	PO_154	PO_161	PO_171	PO_183	PO_233	PO_245	PO_163	BahrsScrubAl
1pct	060m	120.97	123.14	115.92	109.43	80.71	25.58	46.44	130.45	17.79	7.16	40.35	69.32	123.16	18.27	94.16
1pct	090m	126.6	125.08	127.82	112.9	83.8	23.91	47.04	143.9	18.04	7.31	39.26	69.8	124.92	18.09	101.45
1pct	120m	139.14	135.37	140.32	121.96	83.71	22.38	47.7	158.8	18.22	5.58	39.84	66.72	135.96	17.98	108.66
1pct	180m	127.66	127.01	131.31	111.81	78.23	19.67	43.65	156.99	17.85	4.3	36.18	63.67	126.47	17.15	102.02
1pct	270m	124.65	123.59	128.13	108.15	74.06	19.11	40.82	159.68	17.84	3.15	34.13	59.02	122.82	17.18	100.31
1pct	360m	116.75	113.71	120.31	100.84	71.46	22.48	42.45	148.57	17.79	5.39	37.37	62.26	113.78	17.44	95.17
2pct	060m	103.16	104.4	101	93.72	64.98	21.39	38.52	115.53	17.2	4.28	33.38	57.91	104.53	17.3	84.99
2pct	090m	115.08	112.72	116.39	100.82	73.71	24.14	41.17	135.34	17.79	5.35	34.84	62.28	112.47	17.41	93.52
2pct	120m	116.68	115.3	119.46	104.6	74.44	18.12	41.74	143.02	17.61	3.07	31.61	61.4	114.43	17.09	94.85
2pct	180m	106.63	105.01	107.39	94.62	66.97	16.7	36.66	127.89	16.98	1.16	27.95	54.13	105.68	16.28	88.05
2pct	270m	106.46	104.77	109.15	92.83	65.35	16.42	36.53	133.92	16.54	0.81	28.25	52.71	104.3	16.01	88.79
2pct	360m	99.45	96.98	103.24	85.3	60.29	17.16	33.37	128.45	16.26	0.65	24.55	48.39	96.37	15.54	84.69
5pct	060m	80.84	80.26	80	74.29	46.86	16.87	27.52	89.47	16.17	0.64	24.94	42.64	80.95	15.65	72.79
5pct	090m	98.49	96.72	100.83	89.11	63.52	19.81	35.92	115.36	16.98	2.86	31.3	53.75	96.49	16.33	83.8
5pct	120m	93.25	91.95	94.64	83.05	59.01	17.3	34.37	110.24	16.42	0.7	26.84	50.54	91.67	15.64	79.85
5pct	180m	93.92	91.01	97.9	81.33	56.49	18.29	33.21	118.39	16.14	1.98	29.83	48.52	91.03	15.19	81.28
5pct	270m	85.66	83.78	85.6	74.82	52.45	14.61	30.25	101.75	15.09	0.09	24.59	43.66	85.63	14.48	75.3
5pct	360m	86.95	83.59	88.44	73.8	49.84	13.13	28.21	109.11	14.89	0	21.86	42.04	84.95	14.16	76.14
10pct	060m	64.97	64.14	64.57	58.42	33.91	13	20.5	73.94	14.64	0	20.33	32.45	64.3	14.05	62.82
10pct	090m	78.08	74.76	80.69	66.61	48.92	16.46	27.54	93.63	15.7	0.27	22.93	42.01	74.52	14.83	71.33
10pct	120m	74.89	72.94	74.68	67.33	47.58	12.34	27.35	88.36	14.88	0	22.48	40.79	73.97	14.21	69.61
10pct	180m	77.68	77.92	76.48	69.19	45.84	20.26	29.13	87.61	15.92	3.16	27.93	44.38	78.66	15.51	71.28
10pct	270m	70.75	69	71.4	60.71	42.77	11.79	24.45	86.03	13.72	0	21.16	35.44	69.59	13.14	67.14
10pct	360m	68.03	65.77	70.86	58.01	41.23	9.74	22.99	87.93	13.22	0	17.55	34.46	65.6	12.52	65.44
20pct	060m	50.59	50.02	50.99	44.63	26.84	11.37	14.33	58.64	12.95	0	14.8	23.57	50.31	12.59	50.56
20pct	090m	57.33	55.84	60.1	48.11	31.95	13.12	17.85	72.37	13.52	0	16.07	28.48	55.35	12.92	57.46
20pct	120m	53.46	51.36	55.8	44.56	31.86	8.83	18.84	68.67	12	0	15.26	28.34	51.08	11.36	53.61
20pct	180m	61.9	60.82	62.53	53.24	35.67	12.27	21.86	74.82	14.04	0	20.87	34.12	61.02	13.57	60.95
20pct	270m	54.26	53.08	55.66	46.48	30.88	7.67	18.58	69.46	11.55	0	16.03	27.68	52.98	10.82	54.28
20pct	360m	49	46.98	50.66	41.55	28.78	6.64	16.6	62.58	10.46	0	13.49	25.02	47.19	9.79	49.36
50pct	060m	29.35	28.97	29.14	25.77	15.68	6.16	4.27	35.27	8.31	0	5.55	9.39	29.07	8.02	29.32
50pct	090m	31.62	30.58	32.36	25.52	15.91	5.88	6.91	40.61	7.89	0	7.57	12.44	30.33	7.34	31.46
50pct	120m	31.04	29.79	31.89	25.1	14.86	5.32	7.5	40.86	7.55	0	7.41	13.18	29.48	6.98	30.91
50pct	180m	35.1	33.69	35.96	29.22	16.94	5.96	9.29	45.48	8.78	0	8.83	15.7	33.84	8.18	35.28
50pct	270m	32.69	32.09	33.35	28.27	19.59	5.06	11.38	41.6	7.53	0	9.94	17.69	32.05	7.15	32.9
50pct	360m	27.89	26.58	28.17	23.11	15.97	5.76	8.36	36.7	7.41	0	7.6	13.68	26.6	7.22	27.97
0p5pct	060m	139.32	140.12	137.73	128.11	99.31	28.99	55.77	160.98	18.5	10.98	48.03	82.72	140.02	18.88	107.65
0p5pct	090m	153.03	152.48	157.41	137.38	101.3	29.63	57.51	185.33	19.21	10.94	48.69	84.91	152.51	18.84	119.21
0p5pct	120m	163.28	160.88	168.34	145.17	102.73	23.18	57.19	204.36	19.81	7.76	43.35	82.23	161.09	19.05	125.53
0p5pct	180m	147.9	145.85	151.67	131.21	89.54	21.61	49.68	181.42	18.78	6.47	42.05	72.06	144.8	17.99	115.38
0p5pct	270m	143.87	138.33	153.32	120.4	82.7	18.46	45.43	198.52	19.87	3.66	33.94	66.06	137.88	18.57	115.7
0p5pct	360m	131.99	127.81	136.55	113.57	79.76	22.72	45.47	171.7	18.53	5.72	39.3	67.12	127.81	17.75	105.32
0p2pct	060m	170.08	172.16	172.06	158.92	119.43	28.38	71.33	206.69	51.04	19.18	57.59	102.73	171.77	22.55	125.51
0p2pct	090m	182.5	185.09	192.44	167.55	122.98	31	71.41	239.48	26.38	19.99	60.63	104.68	183.55	24.8	136.83
0p2pct	120m	187.99	193.09	203.39	171.78	121.09	24.77	67.64	253.03	27.5	15.27	51.52	98.02	192.33	26.03	143.07
0p2pct	180m	170.59	169.1	178.26	151.89	104.08	22.91	58.22	221.63	20.91	13.2	49.23	84.38	167.59	20.16	128.6
0p2pct	270m	163.08	160.2	169.71	140.34	98.22	22.38	56.5	212.08	23.2	12.13	46.58	82.89	159.18	20.42	122.69
0p2pct	360m	151.88	148.29	159.89	130.13	91.51	21.32	51.56	203.54	21.4	9.1	40.47	76.12	148.04	19.26	116.85
0p05pct	060m	212.13	232.45	234.66	214.06	162.49	36.34	93.86	287.3	51.04	30.96	74.31	135.23	230.85	36.34	163.36
0p05pct	090m	220.25	244.14	258.8	220.54	162.39	38.2	97.44	328.76	40.24	31.25	80.2	142.6	243.05	38.1	177.14
0p05pct	120m	222.87	247.39	262.53	219.56	152	31.07	84.76	338.2	41.71	26.11	64.11	123.6	243.94	39.24	179.8
0p05pct	180m	200.97	209.57	225.68	188.57	127.73	27.67	72.88	286.92	31.72	19.88	60.83	104.37	208.9	29.79	156.7
0p05pct	270m	193.79	198.59	211.74	174.68	122.33	26.58	71.23	277.23	36.62	21.68	57.65	102.77	197.61	34.3	148.88
0p05pct	360m	181.62	183.38	198.54	161.05	112.98	24.27	63.57	257.5	29.74	16.15	48.7	93.55	182.55	27.71	139.83
PMP	060m	428.39	684.76	715.51	599.54	414.73	126.36	270.25	934.84	173.88	116.87	280.43	407.8	648.45	132.78	429.57
PMP	090m	451.13	730.93	776.9	617.83	448.08	121.1	290.7	1026.8	144.46	111.03	288.09	417.97	681.81	138	460.33
PMP	120m	462.09	753.42	819.84	624.73	420.52	88.69	238.27	1114.3	159.55	97.51	180.56	365.55	704.1	152.05	478.31
PMP	180m	446.88	721.73	790.39	599.77	412.93	80.86	238.26	1086.3	160.13	96.08	180.56	360.4	678.84	152.39	463.76
PMP	270m	413.99	652.17	699.05	554.82	387.63	90.97	233.61	929.27	133.42	89.63	192.44	358.06	616.19	126.66	421.43
PMP	360m	385.4	589.9	644.78	506.72	353.28	74.31	203.2	866.85	124.42	77.08	156.33	313.02	563.15	118.01	392.61
1pct_RCP4p5	060m	134.52	137.02	130.66	121.35	92.13	27.92	53.36	142.86	18.2	9.69	45.12	78.34	137.16	18.98	103.19
1pct_RCP4p5	090m	142.86	141.5	146.56	127.9	94.13	25.97	52.77	159.62	18.48	9.71	45.84	78.21	141.68	18.68	112.68
1pct_RCP4p5	120m	155.13	151.65	157.37	135.84	91.8	24.28	52.87	175.69	18.84	7.81	44.01	73.98	152	18.54	119.45
1pct_RCP4p5	180m	141.17	140.1	145.23	123.31	86.84	21.57	48.1	171.86	18.49	5.91	39.89	69.65	139.47	17.77	111.28
1pct_RCP4p5	270m	137.69	135.92	142.13	117.6	81.52	21.01	45.12	173.84	18.55	4.9	37.53	65.47	134.96	17.75	109.48
1pct_RCP4p5	360m	128.94	124.98	133.35	110.85	78.01	22.48	43.23	161.86	18.21	5.39	37.37	63.23	124.99	17.48	103.1
2pct_RCP4p5	060m	116.24	117.45	112.25	104.95	76.49	23.5	44.16	126.28	17.64	5.77	37.63	66.33	117.84	17.87	92.04
2pct_RCP4p5	090m	128.22	126.71	131.18	113.84	82.83	26.19	46.89	148.49	18.22	7.31	41.05	70.45	126.75	18.26	102.81
2pct_RCP4p5	120m	130.47	128.65	133.74	116.87	82.9	19.87	46.96	157.45	18.21	4.72	35.76	67.72	127.84	17.72	104.54
2pct_RCP4p5	180m	117.56	116.92	117.89	105.16	73.95	18.41	40.48	138.53	17.45	3.07	33.01	59.92	117.05	16.76	94.41
2pct_RCP4p5	270m	118.09	116.92	120.8	103.06	72.39	18.14	40.55	146.13	17.19	2.53	31.6	58.4	116.31	16.82	95.8
2pct_RCP4p5	360m	110.12	107.45	113.42	94.87	66.8	17.16	36.9	139.67	16.87	0.75	28.4	53.36	106.65	16.19	91.17
5pct_RCP4p5	060m	90.4	91.24	89.18	84.49	55.32	19.22	31.85	98.77	16.62	2.2	28.75	48.97	91.54	16.36	77.55
5pct_RCP4p5	090m	110.05	108.41	111.01	100.34	70.72	21.72	40.2	125.77	17.5	4.15	35.27	60.16	108.2	16.9	90.69
5pct_RCP4p5	120m	104.8	103.71	105.71	93.3	66.74	19.22	38.67	121.32	16.98	2.32	30.12	56.46	103.09	16.38	87.11
5pct_RCP4p5	180m	104.4	101.09	108.16	90.15	63.37	20.22	37.32	129.54	16.76	3.75	35.18	54	101.55	15.87	88.15
5pct_RCP4p5	270m	94.26	93.3	94.19	82.74	60.03	16.17	33.72	111.15	15.92	0.68	27.13	48.7	94.62	15.37	80.23
5pct_RCP4p5	360m	95.45	91.98	97.39	81.08	55.84	14.39	31.18	119.28	15.79	0.07	23.83	46.06	93.54	15.01	81.49
10pct_RCP4p5	060m	73.23	72.52	72.56	66.3	40.6	14.74	24.21	81.89	15.47	0.13	22.95	37.13	72.8	14.9	68.32
10pct_RCP4p5	090m	86.33	83.7	88.93	75.81	55.82	18.34	31.02	102.38	16.34	1.02	25.31	46.8	83.64	15.6	75.89
10pct_RCP4p5	120m	83.84	82.48	83.53	76.02	55.27	13.64	30.6	97.46	15.76	0.03	24.59	45.8	83.99	15.06	74.44
10pct_RCP4p5	180m	85.47	85.67	84.1	76.86	51.87	22.43	34.04	96.97	16.39	4.63	33.93	50.13	87.3	16.44	75.32
10pct_RCP4p5	270m	78.52	76.67	78.73	68.15	47.33	13.28	27.3	93.93	14.43	0	22.88	39.69	77.65	13.83	71.73
10pct_RCP4p5	360m	75.48	73.52	78.59	64.56	45.29	10.99	25.36	96.51	14.08	0	19.19	37.71	73.4	13.31	70.13
20pct_RCP4p5	060m	57.56	57.05	57.52	50.81	30.71	13.66	17.73	65.42	13.78	0	18.09	28.45	57.33	13.35	57.11
20pct_RCP4p5	090m	64.01	62.43	66.78	53.9	36.48	15.1	20.55	79.54	14.35	0	18.16	32.54	61.77	13.76	62.76
20pct_RCP4p5	120m	60.27	58.2	61.98	51.59	36.48	9.77	21.38	75.78	13.03	0	17.12	31.76	57.83	12.29	59.47
20pct_RCP4p5	180m	68.99	68.21	69.54	59.62	41.21	14.66	25.5	82.19	14.83	0.13	22.96	38.6	68.2	14.31	66.19
20pct_RCP4p5	270m	60.02	58.8	61.09	51.26	34.24	8.77	20.82	76.03	12.59	0	17.75	30.64	58.6	11.79	59.22
20pct_RCP4p5	360m	54.27	51.98	56.01	46.12	31.83	7.21	18.63	68.95	11.48	0	14.99	27.67	52.52	10.74	54.61
50pct_RCP4p5	060m	33.94	33.46	33.69	29.56	18	7.02	6.05	40.53	9.38	0	7.68	12.04	33.42	9.09	33.8
50pct_RCP4p5	090m	36.35	35.16	37.07	29.39	17.96	6.58	8.9	45.62	8.98	0	8.93	15.54	34.72	8.39	35.99
50pct_RCP4p5	120m	35.8	34.11	36.67	28.67	16.97	5.9	9.67	46.11	8.56	0	9.33	16.58	34.03	7.97	35.76
50pct_RCP4p5	180m	39.95	38.47	41.17	33.18	19.84	6.61	11.43	51.12	9.91	0	11.1	19.44	38.57	9.28	40.23
50pct_RCP4p5	270m	37.52	36.59	38.22	32.11	21.98	5.57	12.82	46.81	8.32	0	11.02	19.87	36.31	7.92	37.35
50pct_RCP4p5	360m	31.72	30.49	32.26	26.86	18.25	6.44	9.42	41.59	8.52	0	8.96	16.43	30.39	8.3	31.87
0p5pct_RCP4p5	060m	156.29	156.42	156.08	145.24	111.45	31.51	63.06	180.09	19.34	13.93	54.51	92.92	156.55	19.76	119.2
0p5pct_RCP4p5	090m	171.62	171.49	177.61	154.76	114.06	32.05	64.65	209.48	21.58	13.7	53.79	95.46	170.8	20.75	130.9
0p5pct_RCP4p5	120m	178.71	178.94	187.28	160.87	114.41	25.26	62.84	227.09	22.33	10.14	47.89	90.77	178.71	21.55	137.23
0p5pct_RCP4p5	180m	162.7	160.48	167.61	144.3	98.88	23.47	54.51	199.8	19.53	8.52	46.36	79.01	159.16	18.49	124.65
0p5pct_RCP4p5	270m	157.43	151.59	168.19	131.62	90.5	20.18	50.01	217.43	22.65	5.6	37.28	72.29	151.07	21.13	124.62
0p5pct_RCP4p5	360m	145.7	140.81	150.62	125.04	88.39	22.72	48.71	188.88	19.16	5.72	39.3	71.64	141	18.2	115.13
0p2pct_RCP4p5	060m	187.56	194.45	195.43	179.01	134.73	31.23	80.01	236.47	51.04	23.84	63.44	114.94	193.75	27.35	139.36
0p2pct_RCP4p5	090m	198.42	206.37	215.75	187.48	137.82	33.64	81.21	273.16	31.69	24.02	68.64	118.46	203.98	29.74	152.13
0p2pct_RCP4p5	120m	202.67	214.17	225.99	189.37	132.83	26.72	74.58	284.31	32.82	19.33	56.78	108.45	212.58	31.28	156.4
0p2pct_RCP4p5	180m	183.68	185.36	196.63	166.67	114.15	24.89	64.3	246.76	24.96	15.84	54.17	92.82	183.46	23.79	139.6
0p2pct_RCP4p5	270m	177.21	176.27	187.22	154.74	108.56	24.16	62.79	238.74	27.31	15.93	51.32	91.28	175.62	26.03	133.73
0p2pct_RCP4p5	360m	165.49	163.31	176.28	143.09	100.41	22.02	56.78	225.97	23.85	11.77	43.63	83.53	162.83	22.47	126.61
0p05pct_RCP4p5	060m	228.12	261.11	263.77	240.04	182	40.55	104.23	326.86	51.04	36.35	82.3	149.99	257.84	43.07	181.42
0p05pct_RCP4p5	090m	235.4	273.61	289.82	244.47	180.34	42.87	107.74	370.36	46.95	36.38	89.03	159.18	270.45	44.45	194.99
0p05pct_RCP4p5	120m	236.87	273.4	292.65	243.03	169.21	34.53	93.18	378.82	48.35	31.35	70.77	135.69	268.64	45.53	197.55
0p05pct_RCP4p5	180m	213.53	230.29	248.72	206.97	140.07	30.1	80.39	319.25	37.56	23.98	67	114.68	229.43	35	170.17
0p05pct_RCP4p5	270m	207.16	219.62	234.27	193.72	135.53	28.67	78.88	309.59	43.35	26.63	63.44	113.39	217.54	40.87	162.39
0p05pct_RCP4p5	360m	195.3	202.29	219.29	178.38	124.26	26.26	69.78	286.27	34.72	20.29	53.47	102.9	201.28	32.66	152.31

APPENDIX G: DESIGN EVENT MAPPING



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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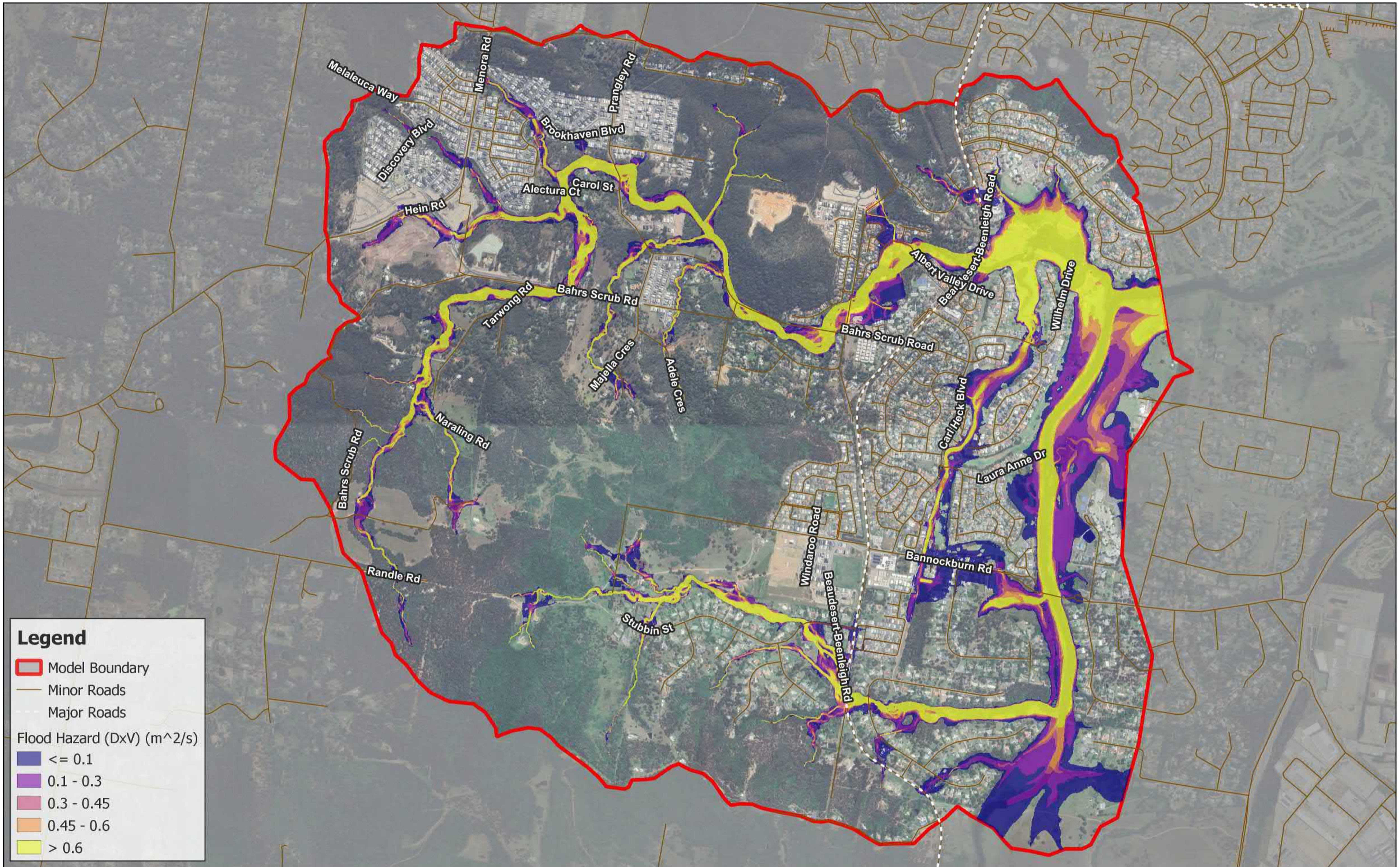
Appendix G.37

Windaroo Creek Flood Study
0.5% AEP Design Event

Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



Legend

- Model Boundary
- Minor Roads
- Major Roads

Flood Hazard (DxV) (m^2/s)

- <= 0.1
- 0.1 - 0.3
- 0.3 - 0.45
- 0.45 - 0.6
- > 0.6

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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DATA SOURCE
QLD Government Open Data Source

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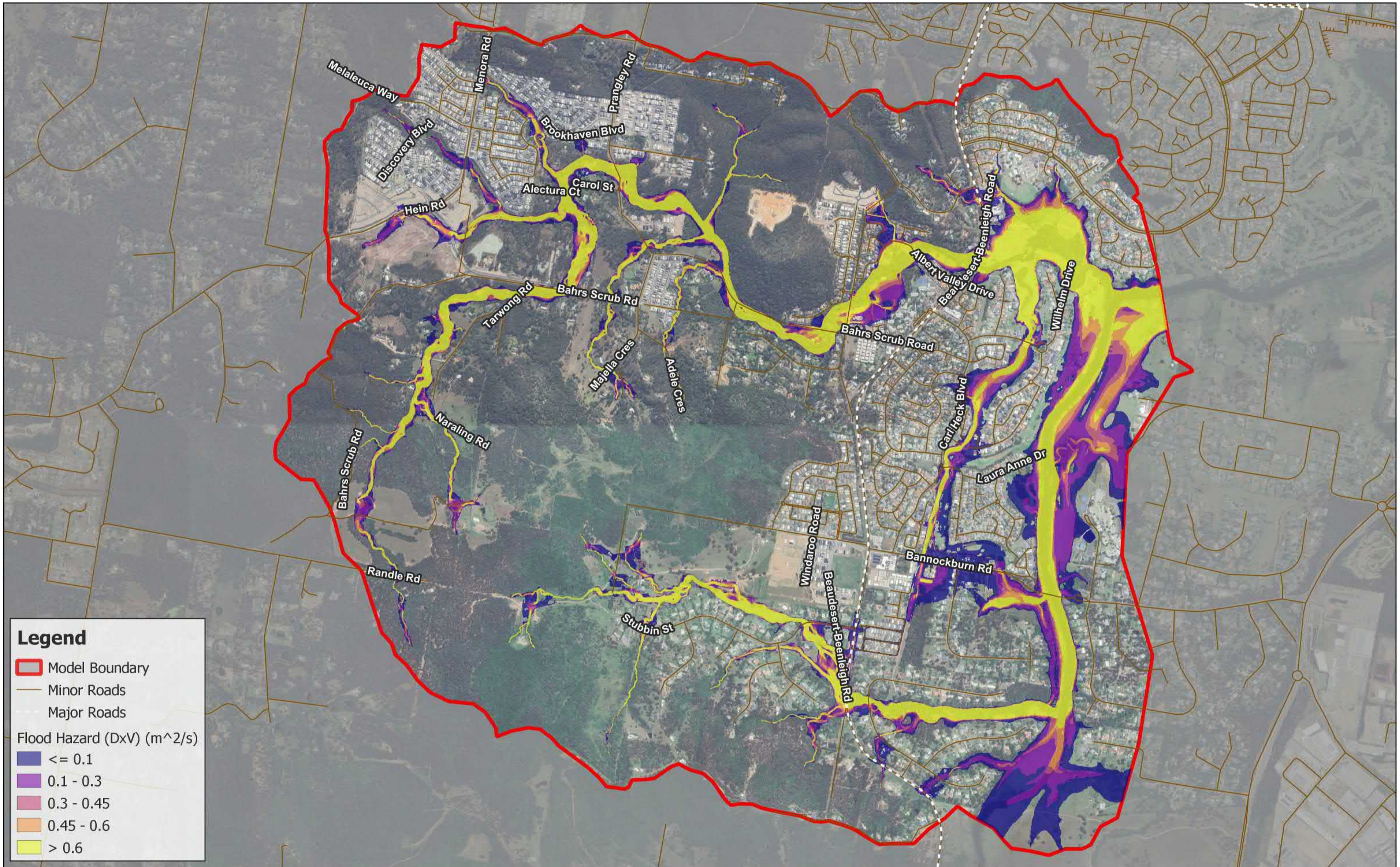
Appendix G.38

Windaroo Creek Flood Study
0.2% AEP Design Event

Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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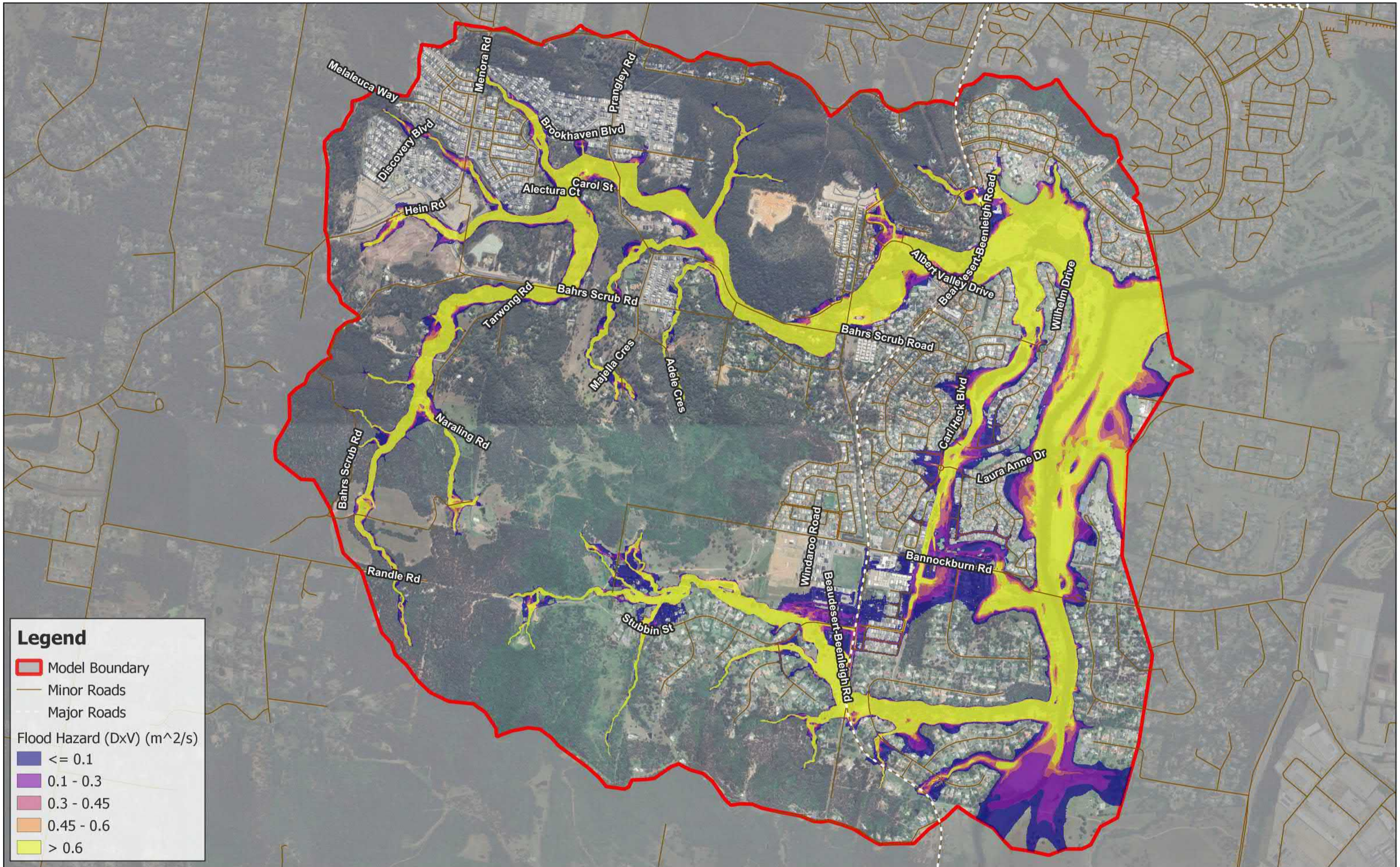
Appendix G.39

Windaroo Creek Flood Study
0.05% AEP Design Event

Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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Appendix G.40

Windaroo Creek Flood Study
PMP Design Event

Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

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DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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CITY OF LOGAN

Appendix G.41

Windaroo Creek Flood Study
50% AEP Design Event

Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix G.42

Windaroo Creek Flood Study
20% AEP Design Event

Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix G.43

Windaroo Creek Flood Study
10% AEP Design Event

Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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Appendix G.44

Windaroo Creek Flood Study
5% AEP Design Event

Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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Appendix G.45

Windaroo Creek Flood Study
2% AEP Design Event

Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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Appendix G.46

Windaroo Creek Flood Study
1% AEP Design Event

Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix G.47

Windaroo Creek Flood Study
0.5% AEP Design Event

Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix G.48

Windaroo Creek Flood Study
0.2% AEP Design Event

Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix G.49

Windaroo Creek Flood Study
0.05% AEP Design Event

Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

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DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix G.50

Windaroo Creek Flood Study
PMP Design Event

Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix G.51

Windaroo Creek Flood Study
50% AEP Design Event

Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix G.52

Windaroo Creek Flood Study
20% AEP Design Event

Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix G.53

Windaroo Creek Flood Study
10% AEP Design Event

Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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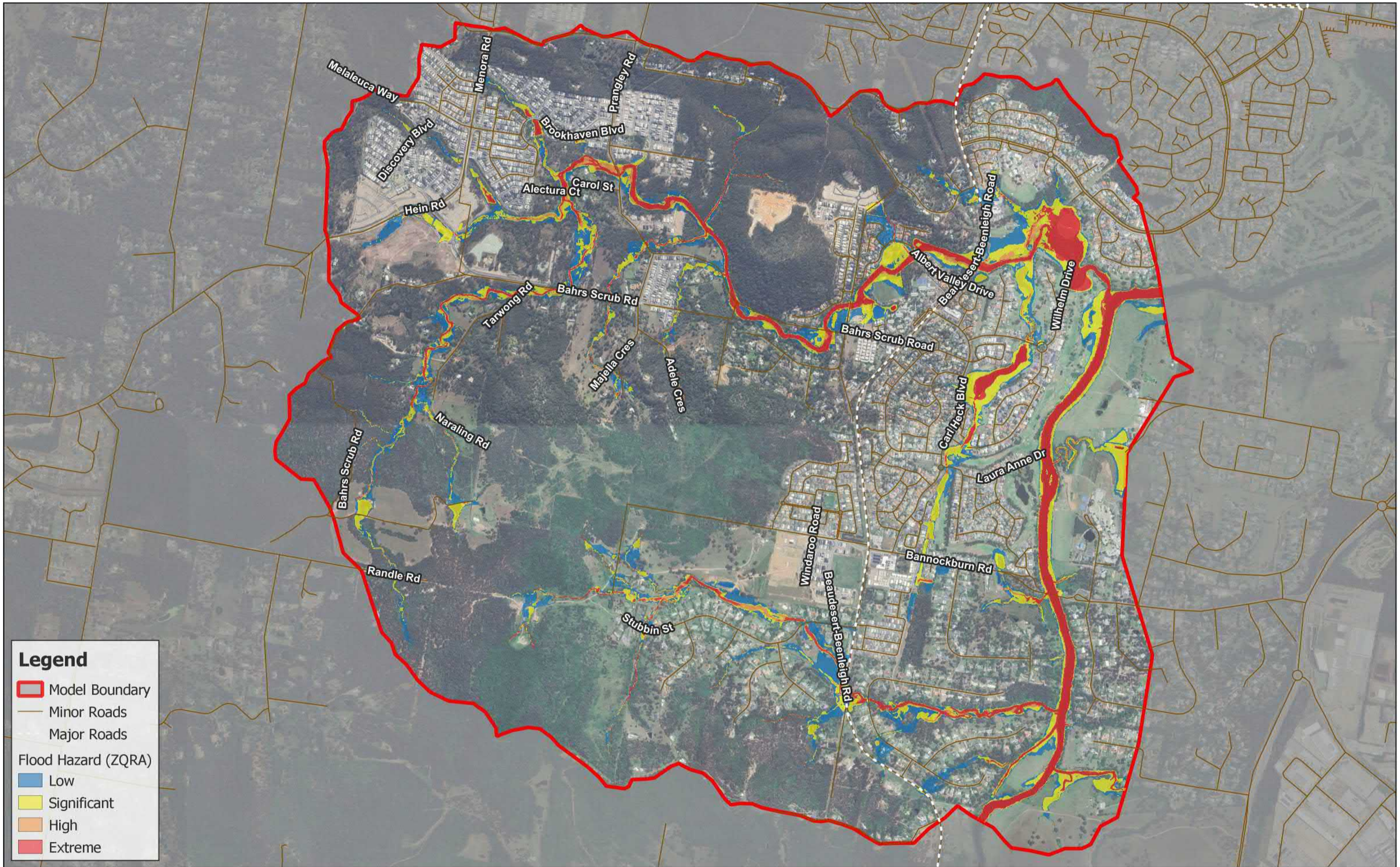
Appendix G.54

Windaroo Creek Flood Study
5% AEP Design Event

Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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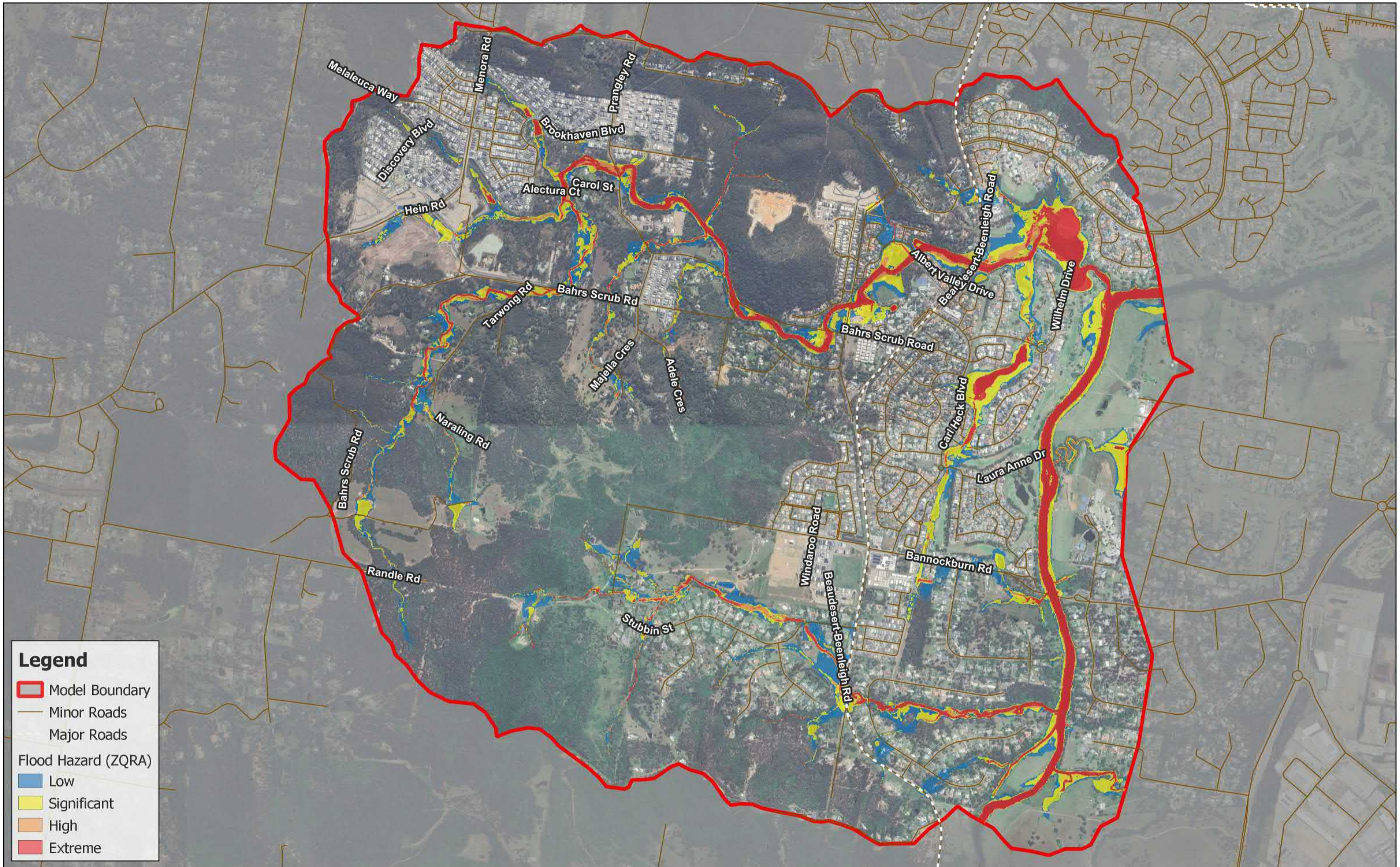
Appendix G.55

Windaroo Creek Flood Study
2% AEP Design Event

Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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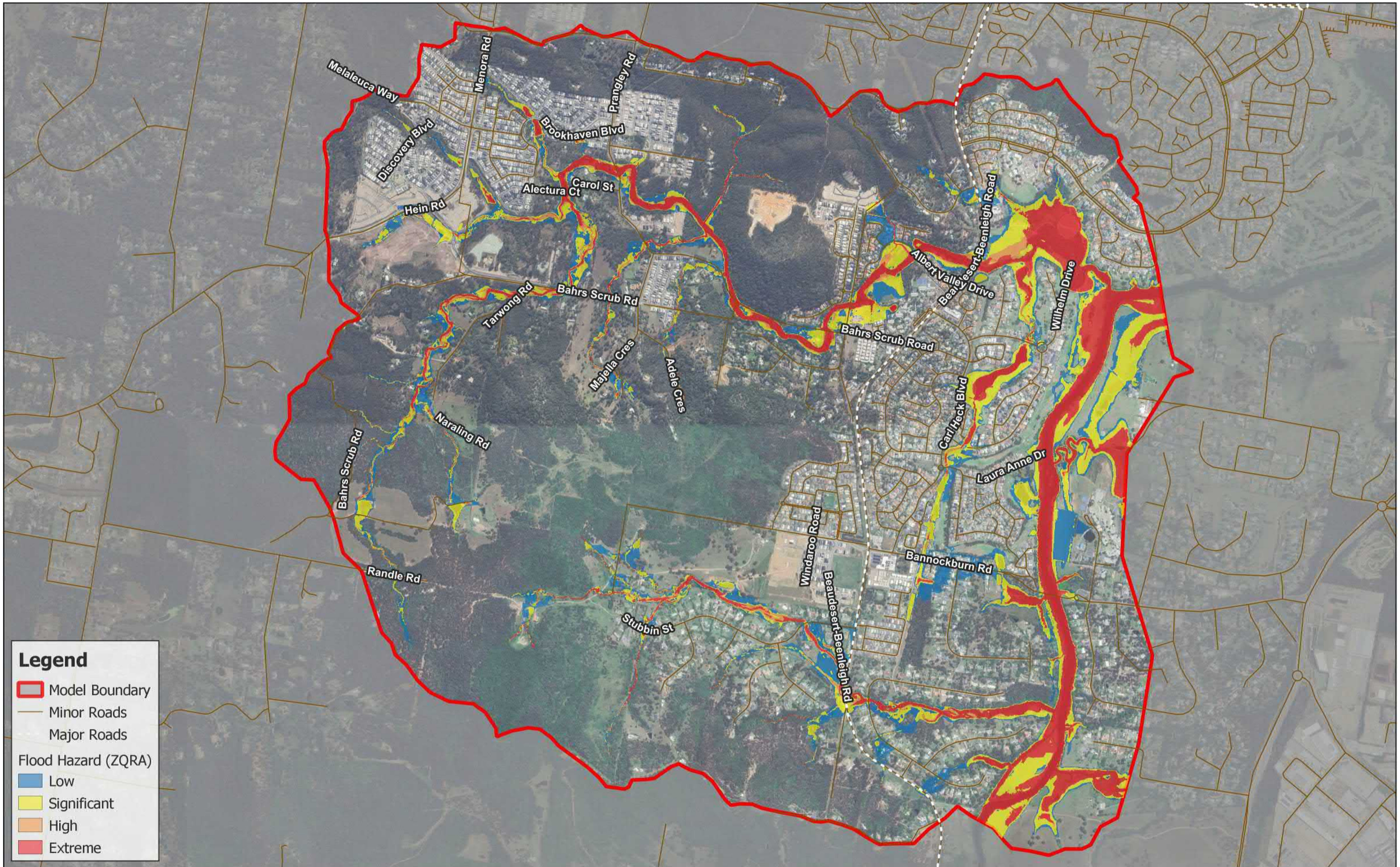
Appendix G.56

Windaroo Creek Flood Study
1% AEP Design Event

Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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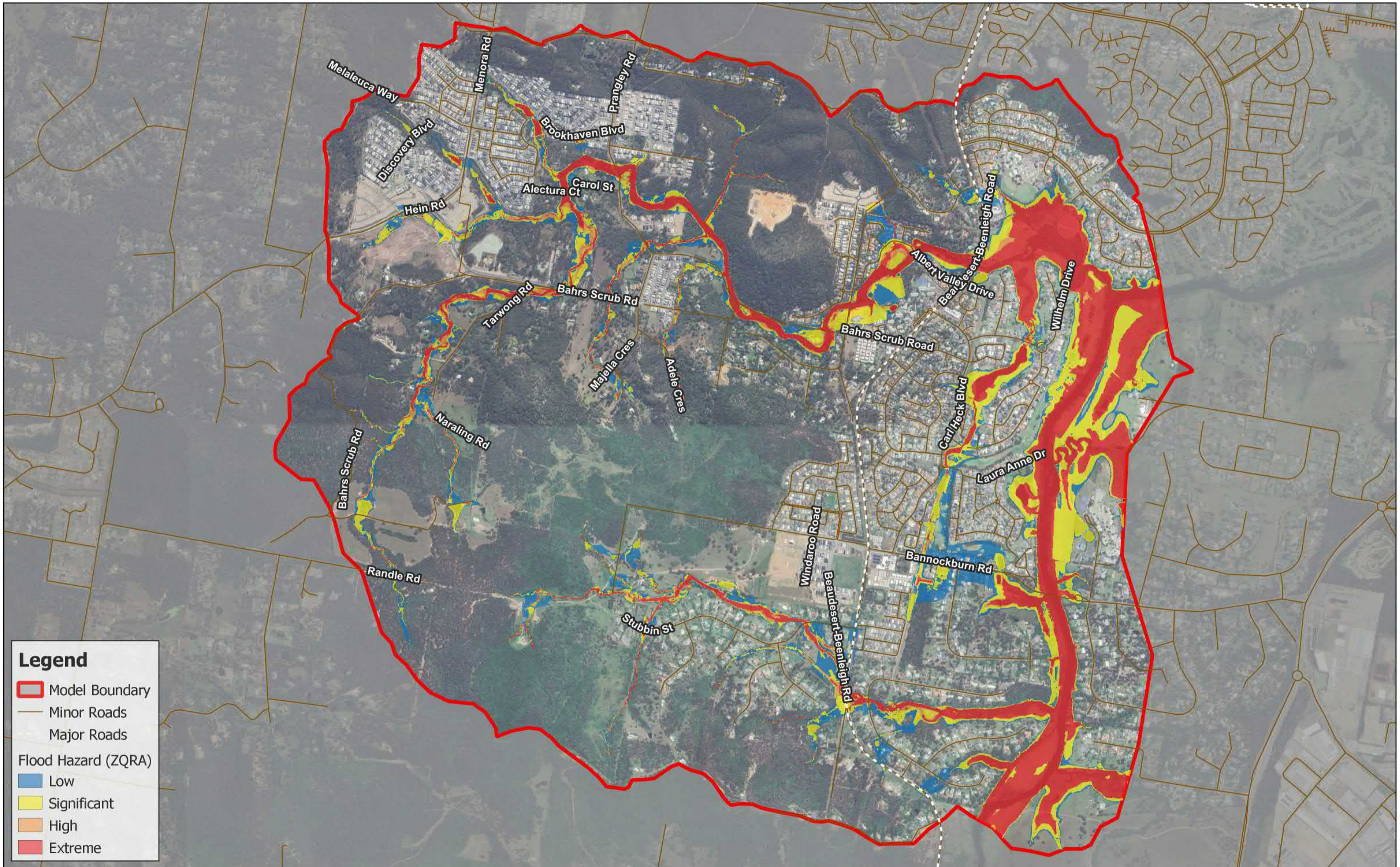
Appendix G.57

Windaroo Creek Flood Study
0.5% AEP Design Event

Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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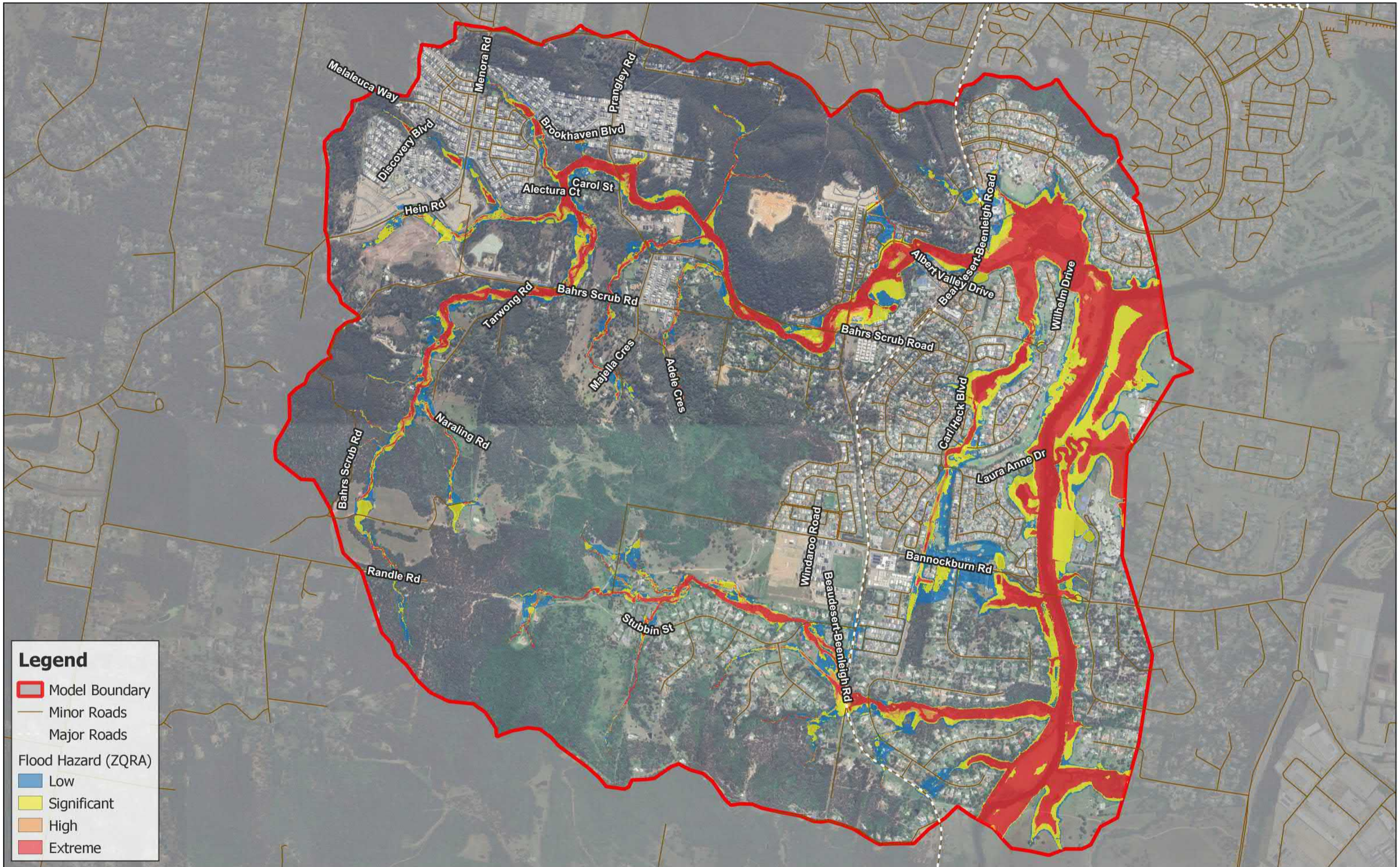
Appendix G.58

Windaroo Creek Flood Study
0.2% AEP Design Event

Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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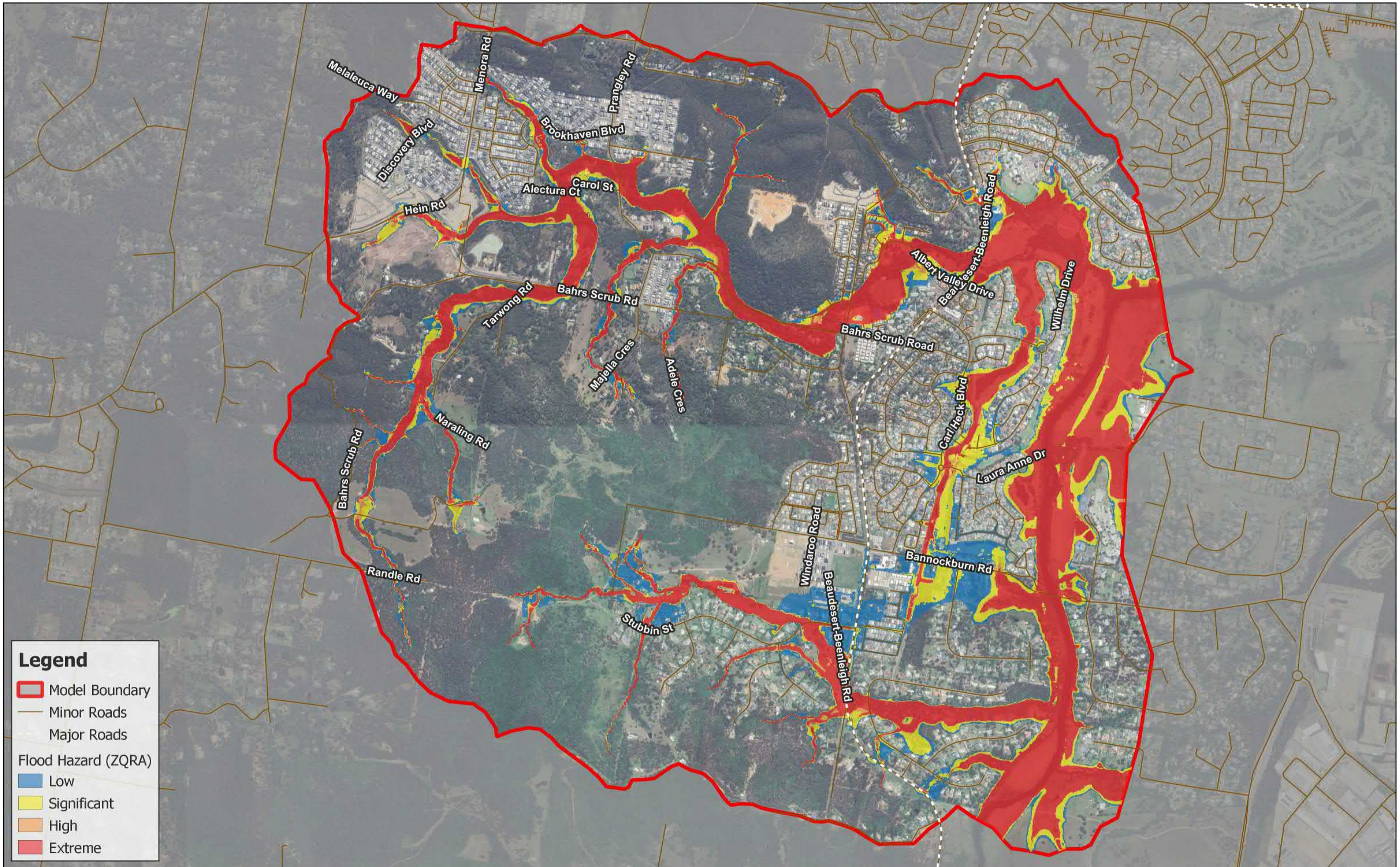
Appendix G.59

Windaroo Creek Flood Study
0.05% AEP Design Event

Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix G.60

Windaroo Creek Flood Study
PMP Design Event

Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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CITY OF LOGAN

Appendix G.1

Windaroo Creek Flood Study
50% AEP Design Event

Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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CITY OF LOGAN

Appendix G.2

Windaroo Creek Flood Study
20% AEP Design Event

Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
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CITY OF LOGAN

Appendix G.3

Windaroo Creek Flood Study
10% AEP Design Event

Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix G.4

Windaroo Creek Flood Study
5% AEP Design Event

Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix G.5

Windaroo Creek Flood Study
2% AEP Design Event

Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix G.6

Windaroo Creek Flood Study
1% AEP Design Event

Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix G.7

Windaroo Creek Flood Study
0.5% AEP Design Event

Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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CITY OF LOGAN

Appendix G.8

Windaroo Creek Flood Study
0.2% AEP Design Event

Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix G.9

Windaroo Creek Flood Study
0.05% AEP Design Event

Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

Appendix G.10

Windaroo Creek Flood Study
PMP Design Event

Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
Engeny has endeavoured to sure accuracy and completeness of the data. Engeny assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

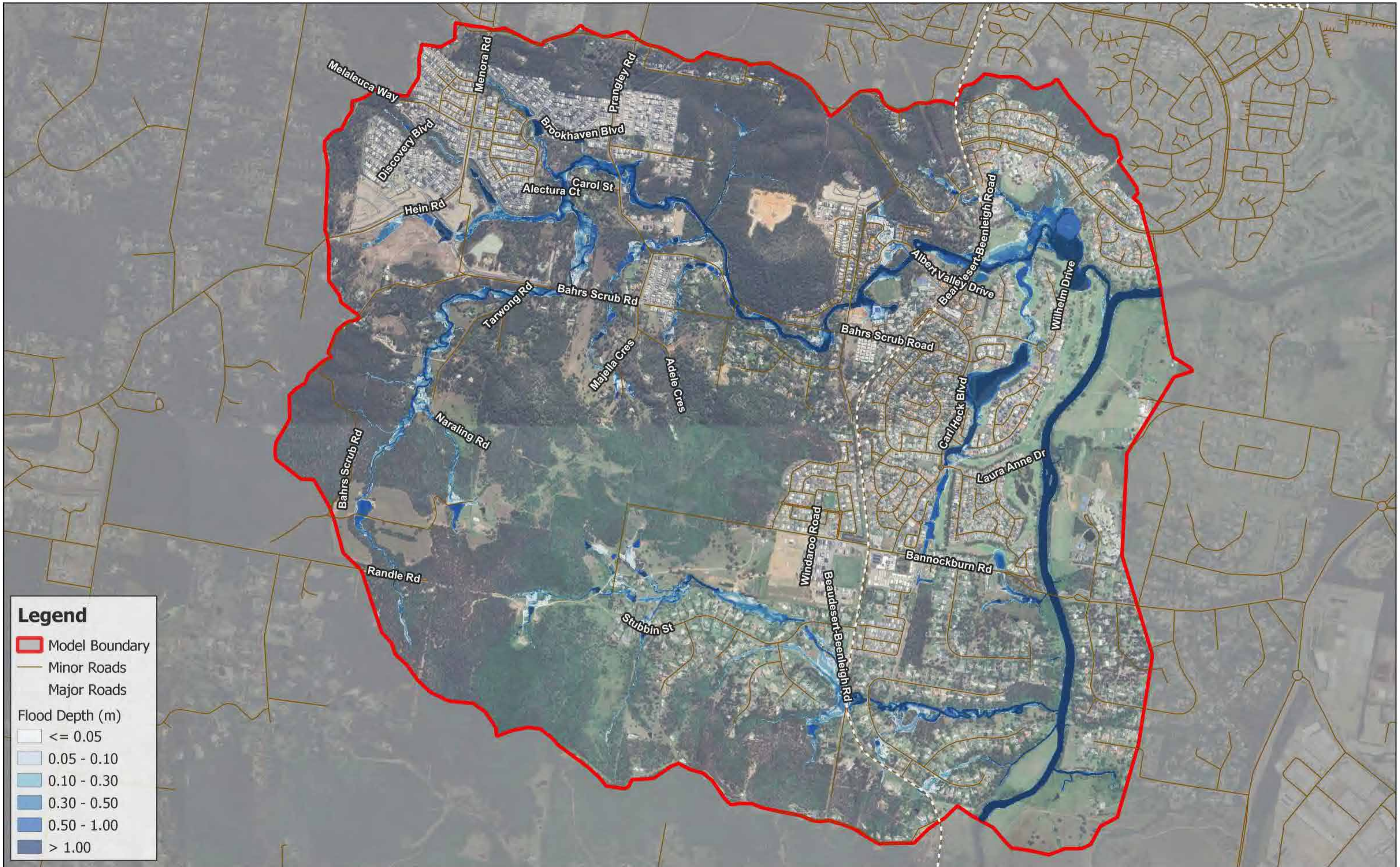
Appendix G.11

Windaroo Creek Flood Study
50% AEP Design Event

Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

Appendix G.12

Windaroo Creek Flood Study
20% AEP Design Event

Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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CITY OF LOGAN

Appendix G.13

Windaroo Creek Flood Study
10% AEP Design Event

Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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Appendix G.14

Windaroo Creek Flood Study
5% AEP Design Event

Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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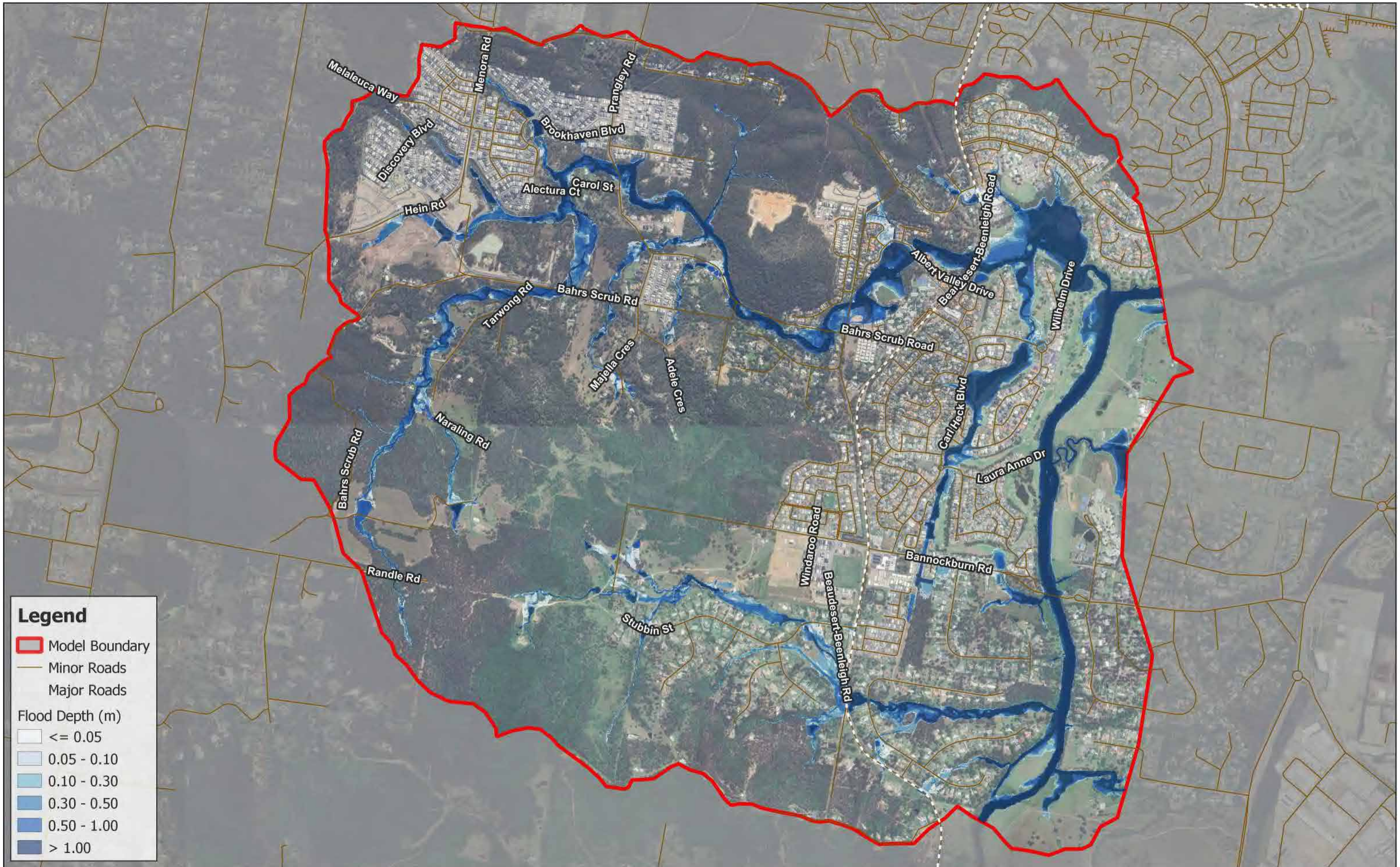
Appendix G.15

Windaroo Creek Flood Study
2% AEP Design Event

Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

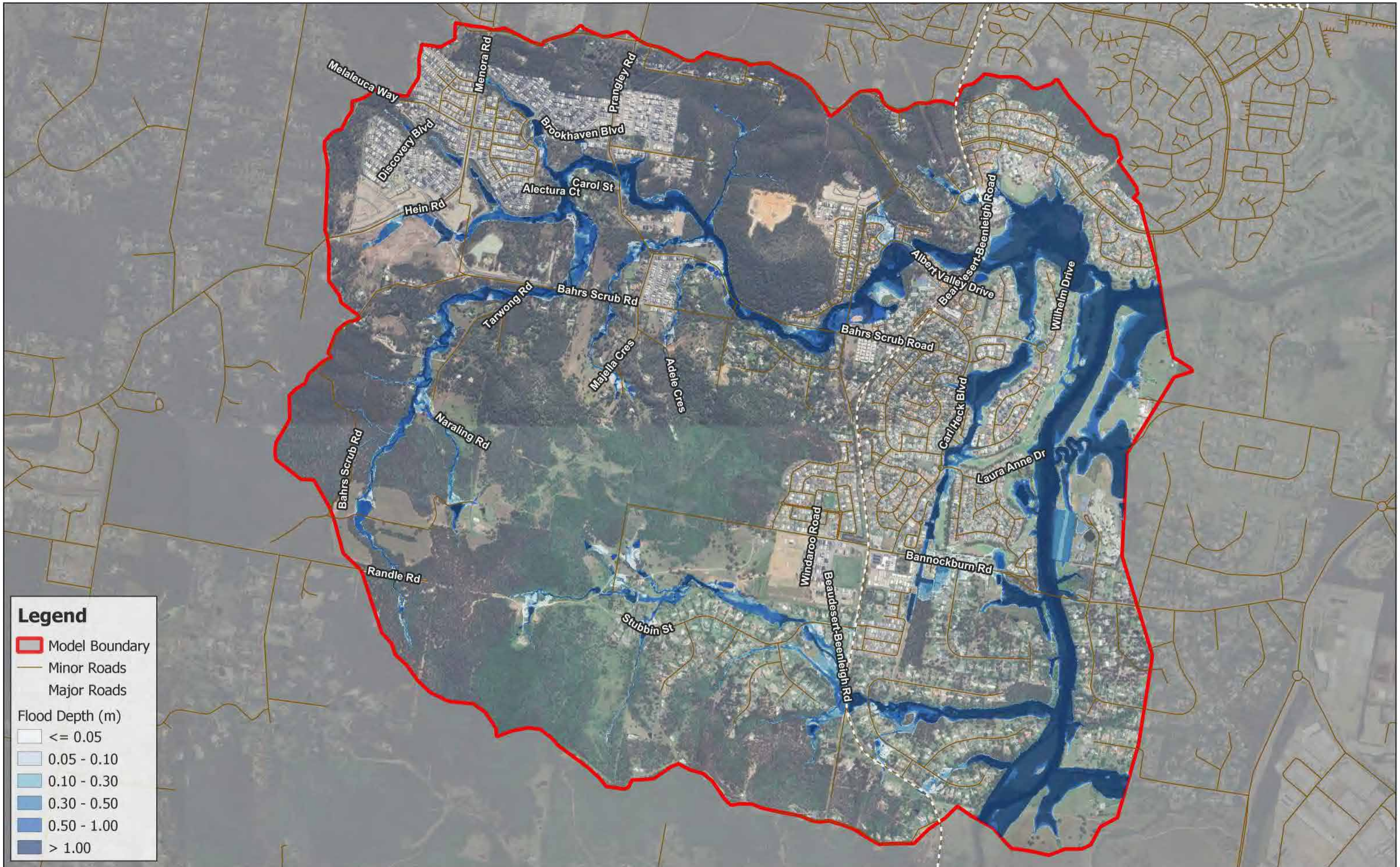
Appendix G.16

Windaroo Creek Flood Study
1% AEP Design Event

Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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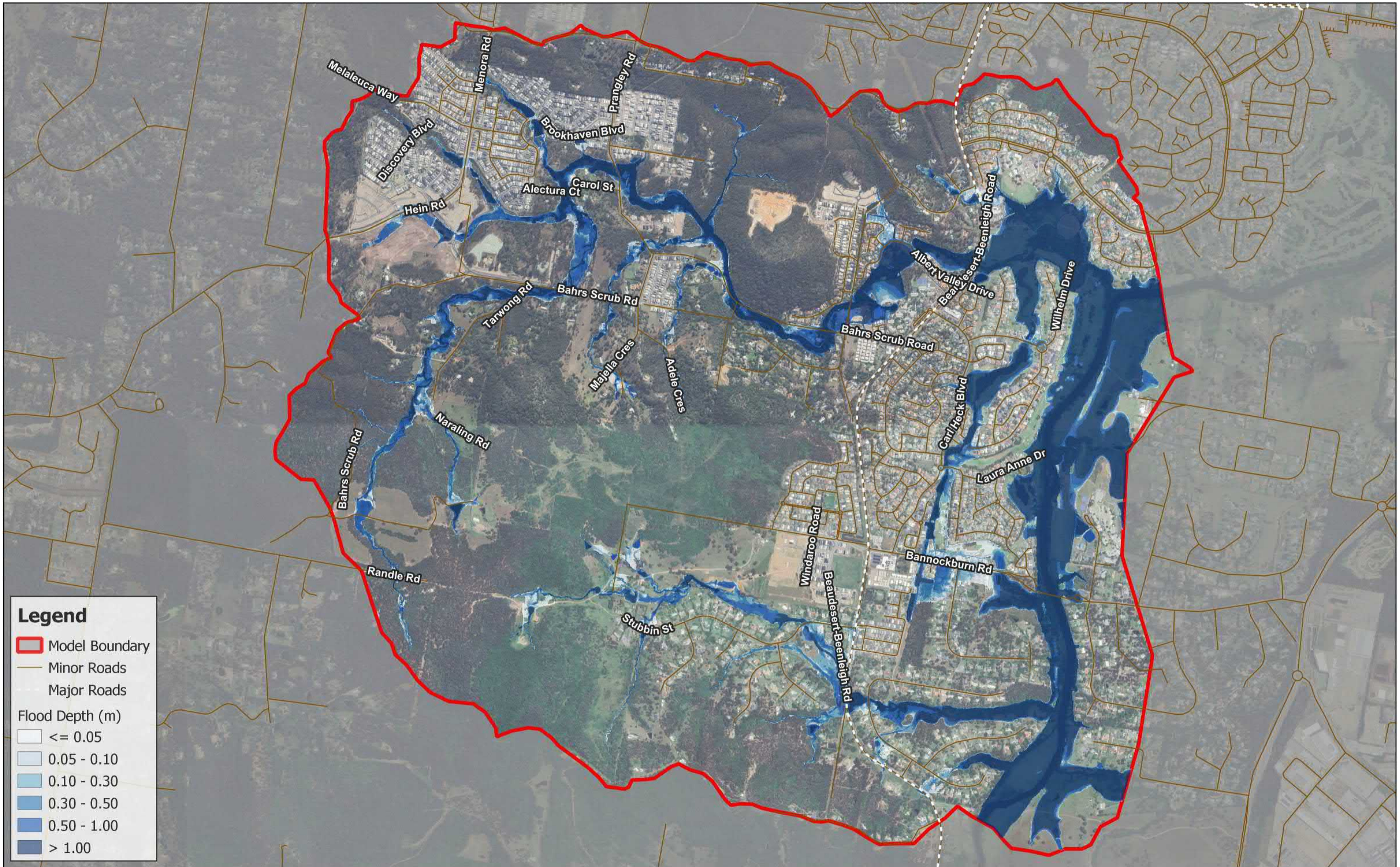
Appendix G.17

Windaroo Creek Flood Study
0.5% AEP Design Event

Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

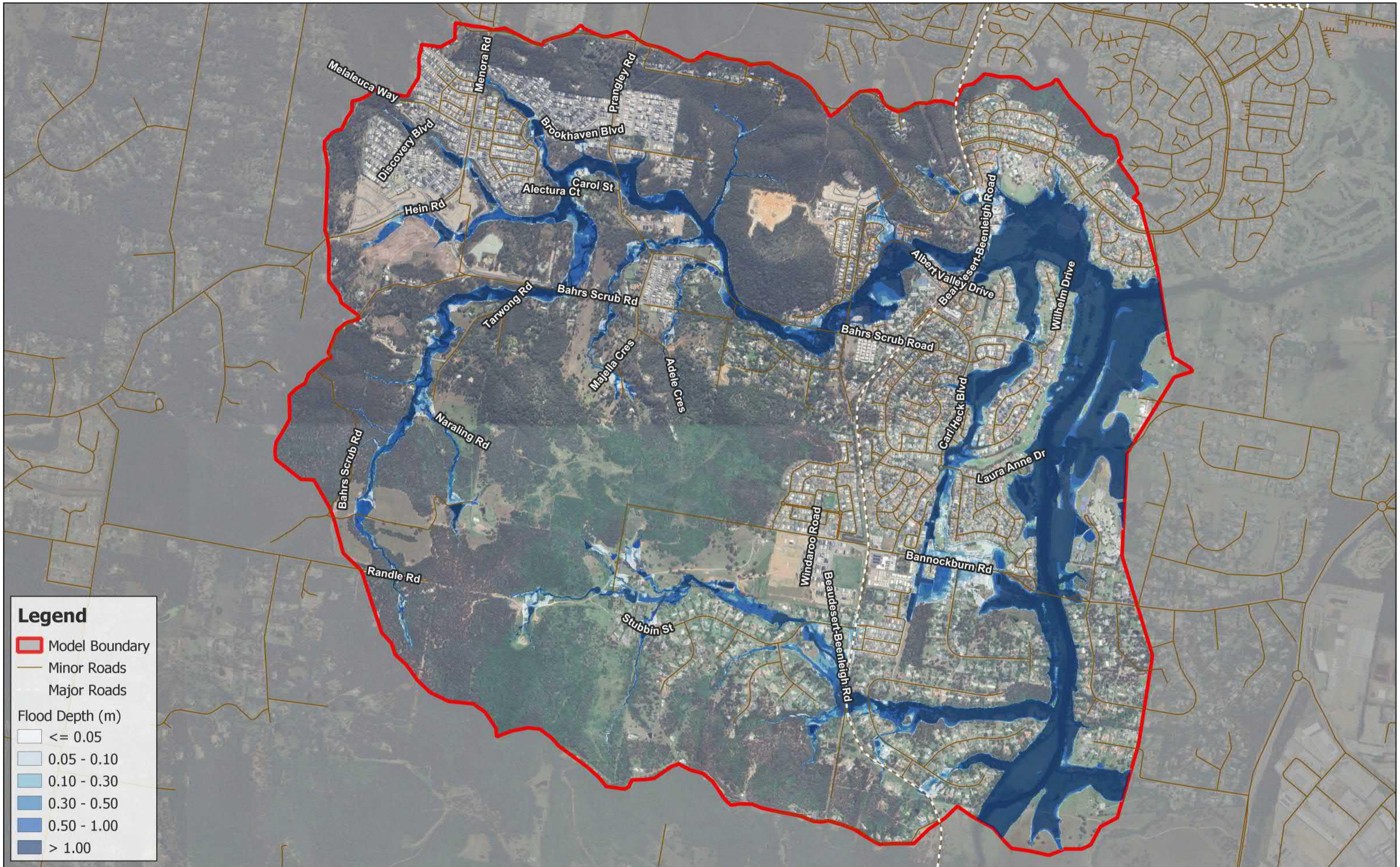
Appendix G.18

Windaroo Creek Flood Study
0.2% AEP Design Event

Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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QLD Government Open Data Source

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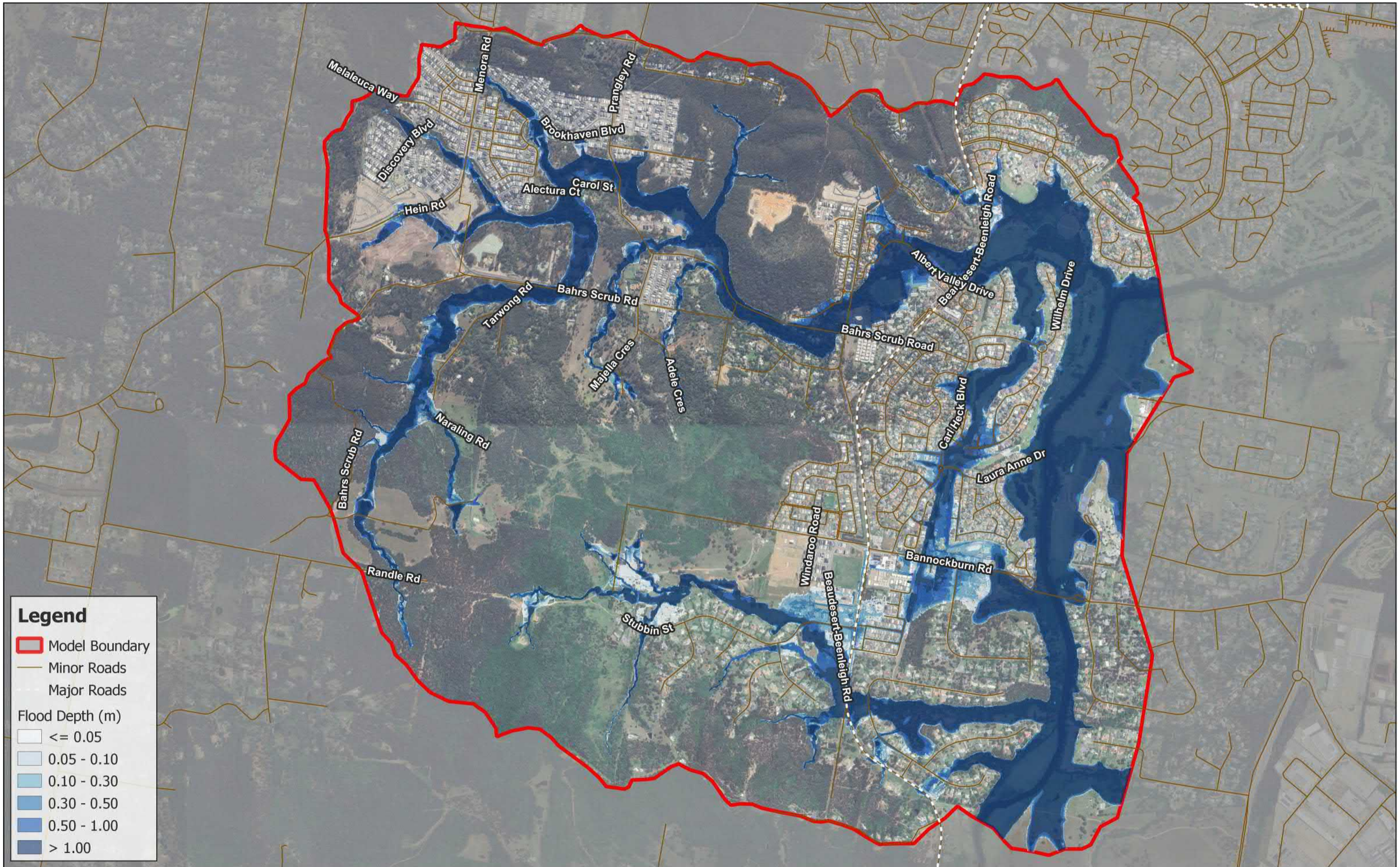
Appendix G.19

Windaroo Creek Flood Study
0.05% AEP Design Event

Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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Appendix G.20

Windaroo Creek Flood Study
PMP Design Event

Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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CITY OF LOGAN

Appendix G.21

Windaroo Creek Flood Study
50% AEP Design Event

Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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Appendix G.22

Windaroo Creek Flood Study
20% AEP Design Event

Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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CITY OF LOGAN

Appendix G.23

Windaroo Creek Flood Study
10% AEP Design Event

Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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CITY OF LOGAN

Appendix G.24

Windaroo Creek Flood Study
5% AEP Design Event

Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

Appendix G.25

Windaroo Creek Flood Study
2% AEP Design Event

Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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Appendix G.26

Windaroo Creek Flood Study
1% AEP Design Event

Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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Appendix G.27

Windaroo Creek Flood Study
0.5% AEP Design Event

Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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CITY OF LOGAN

Appendix G.28

Windaroo Creek Flood Study
0.2% AEP Design Event

Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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CITY OF LOGAN

Appendix G.29

Windaroo Creek Flood Study
0.05% AEP Design Event

Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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CITY OF LOGAN

Appendix G.30

Windaroo Creek Flood Study
PMP Design Event

Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

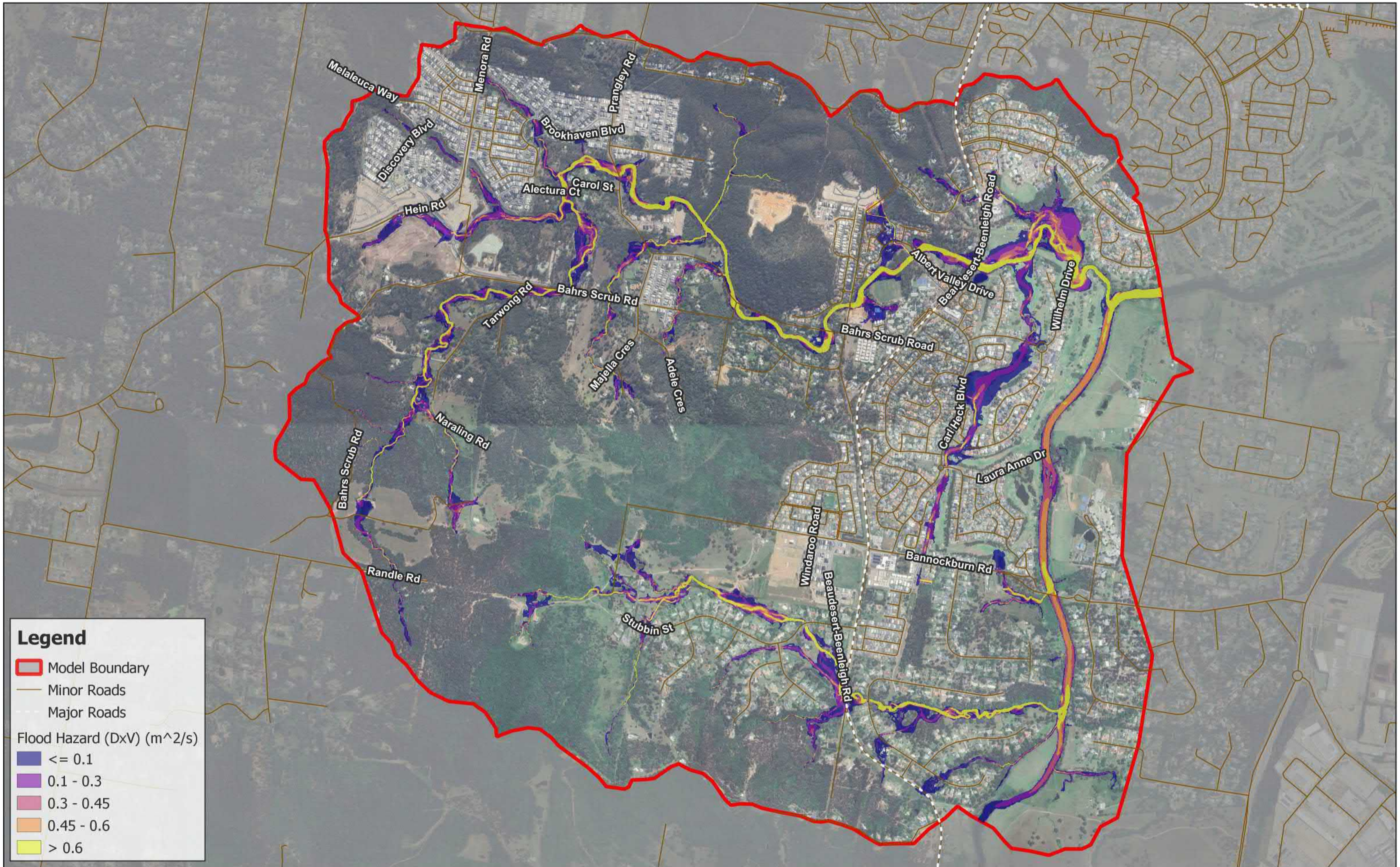
Appendix G.31

Windaroo Creek Flood Study
50% AEP Design Event

Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

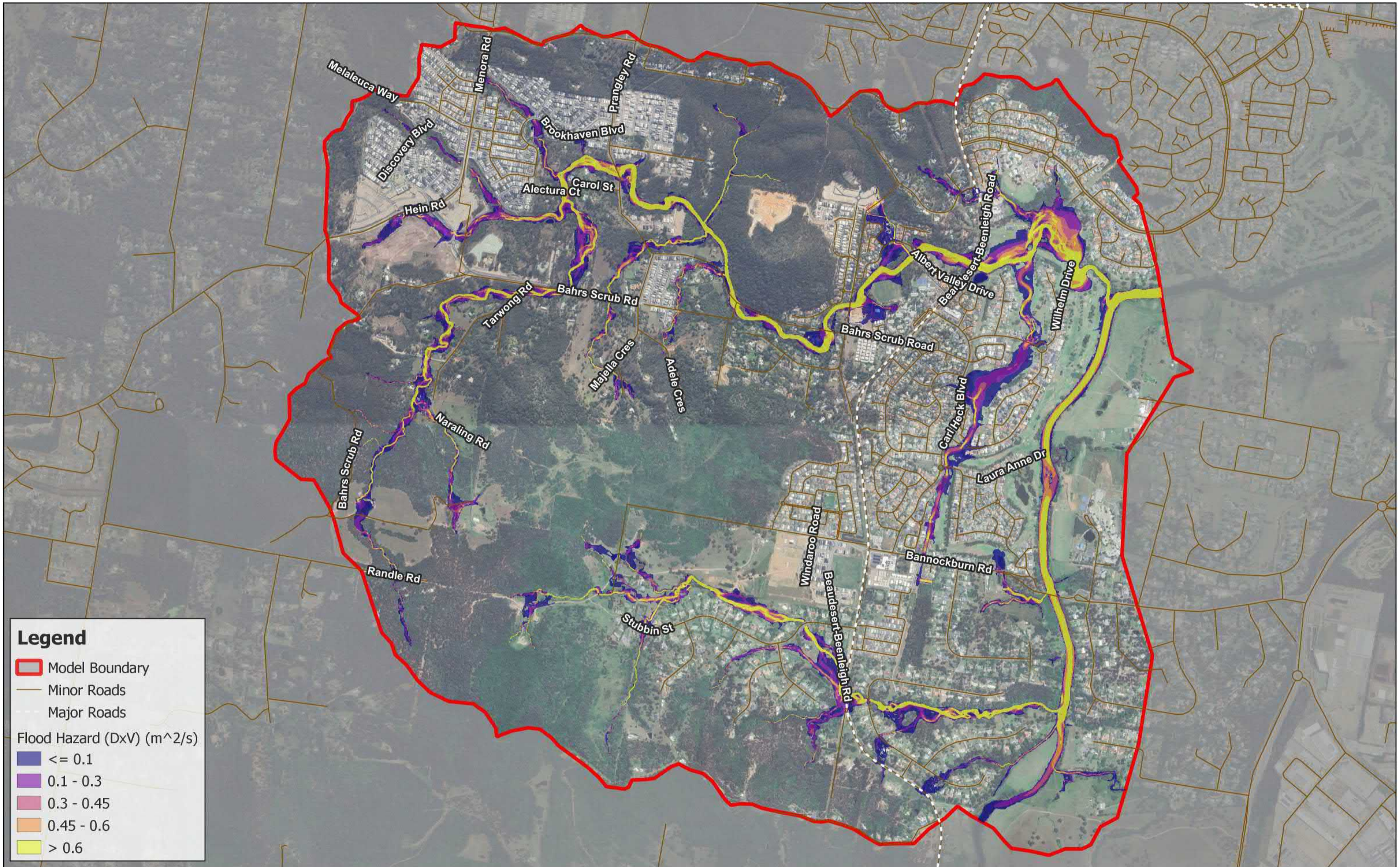
Appendix G.32

Windaroo Creek Flood Study
20% AEP Design Event

Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

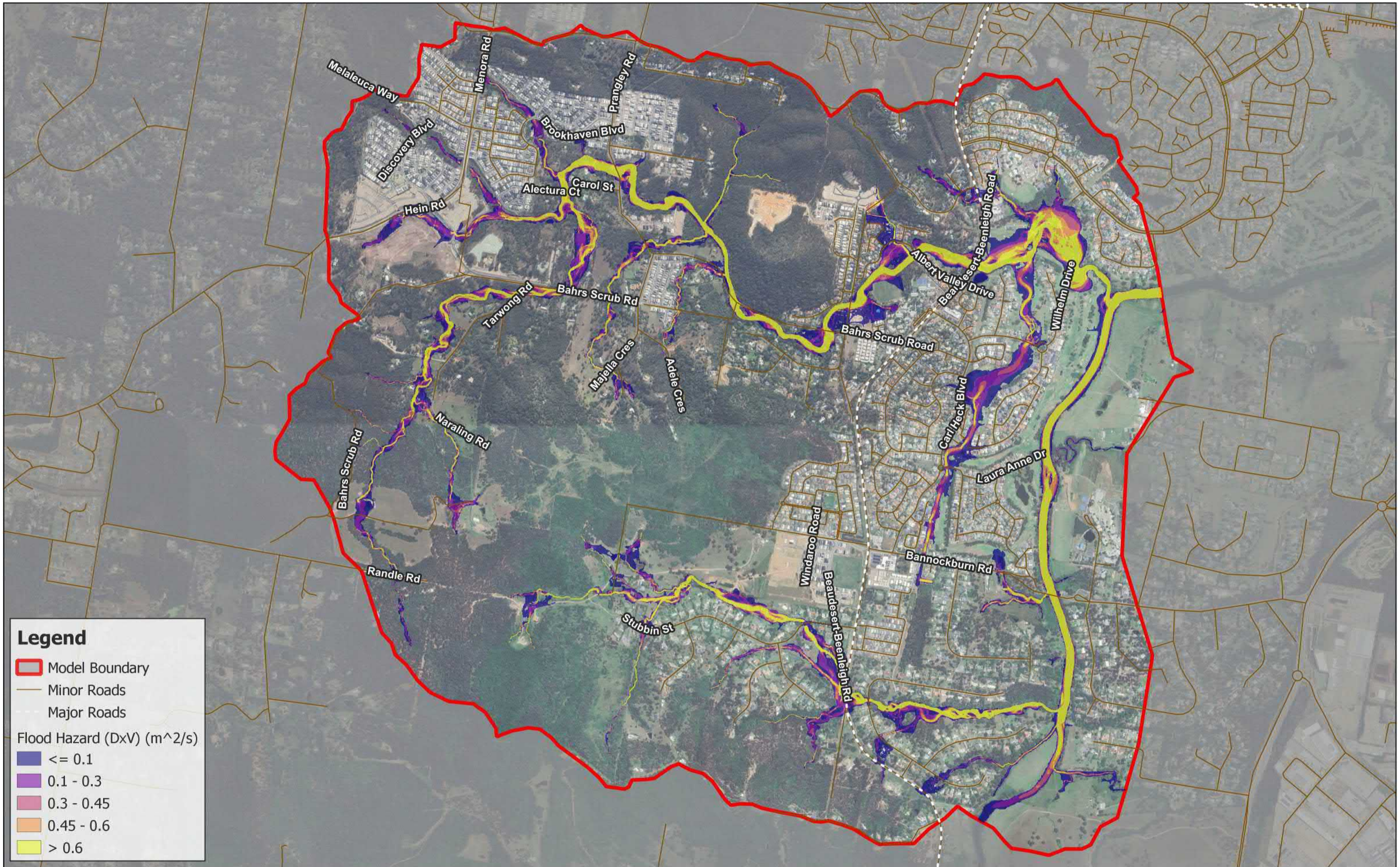
Appendix G.33

Windaroo Creek Flood Study
10% AEP Design Event

Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



Legend

- Model Boundary
- Minor Roads
- Major Roads

Flood Hazard (DxV) (m^2/s)

- <= 0.1
- 0.1 - 0.3
- 0.3 - 0.45
- 0.45 - 0.6
- > 0.6

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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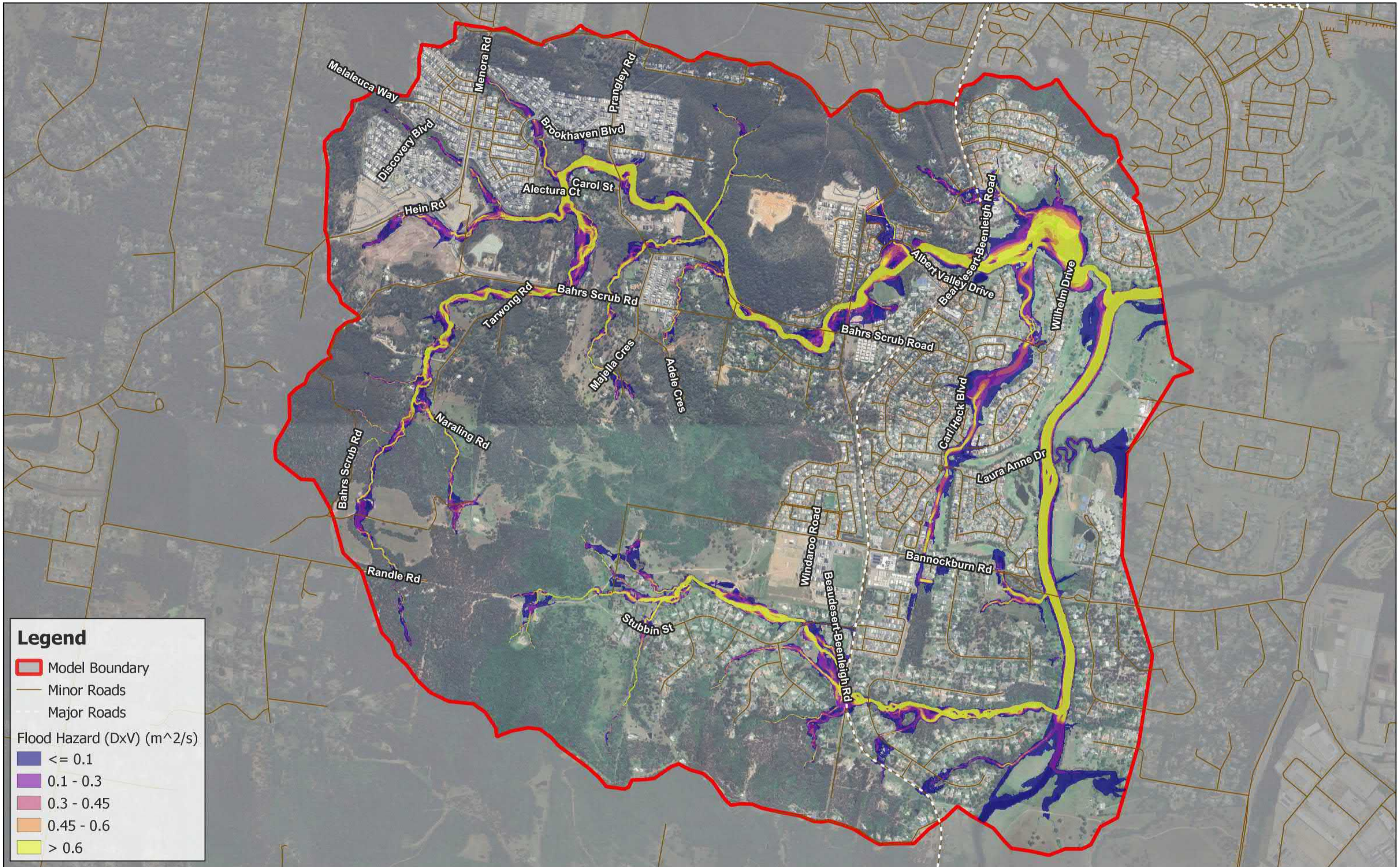
Appendix G.34

Windaroo Creek Flood Study
5% AEP Design Event

Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

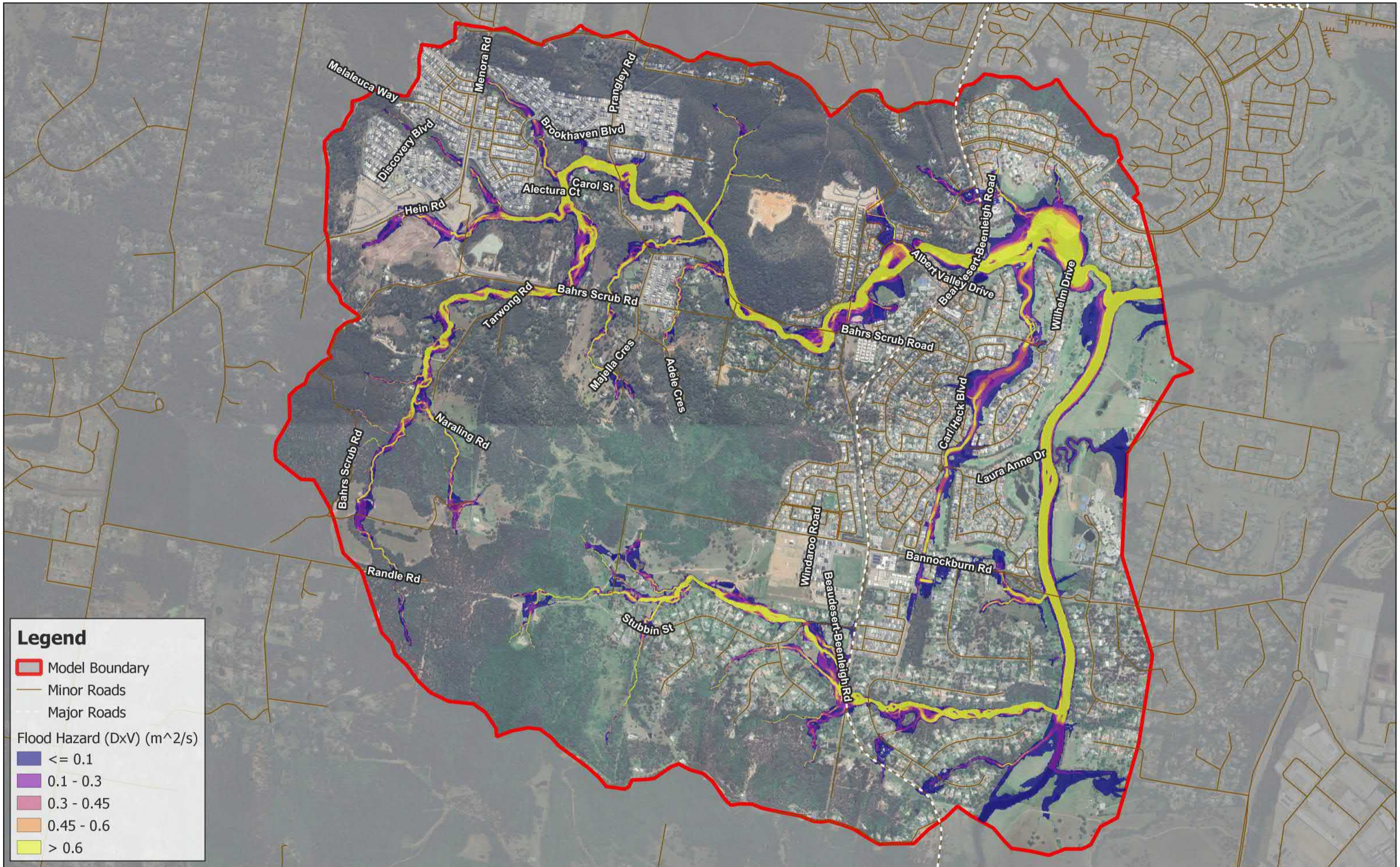
Appendix G.35

Windaroo Creek Flood Study
2% AEP Design Event

Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

Appendix G.36

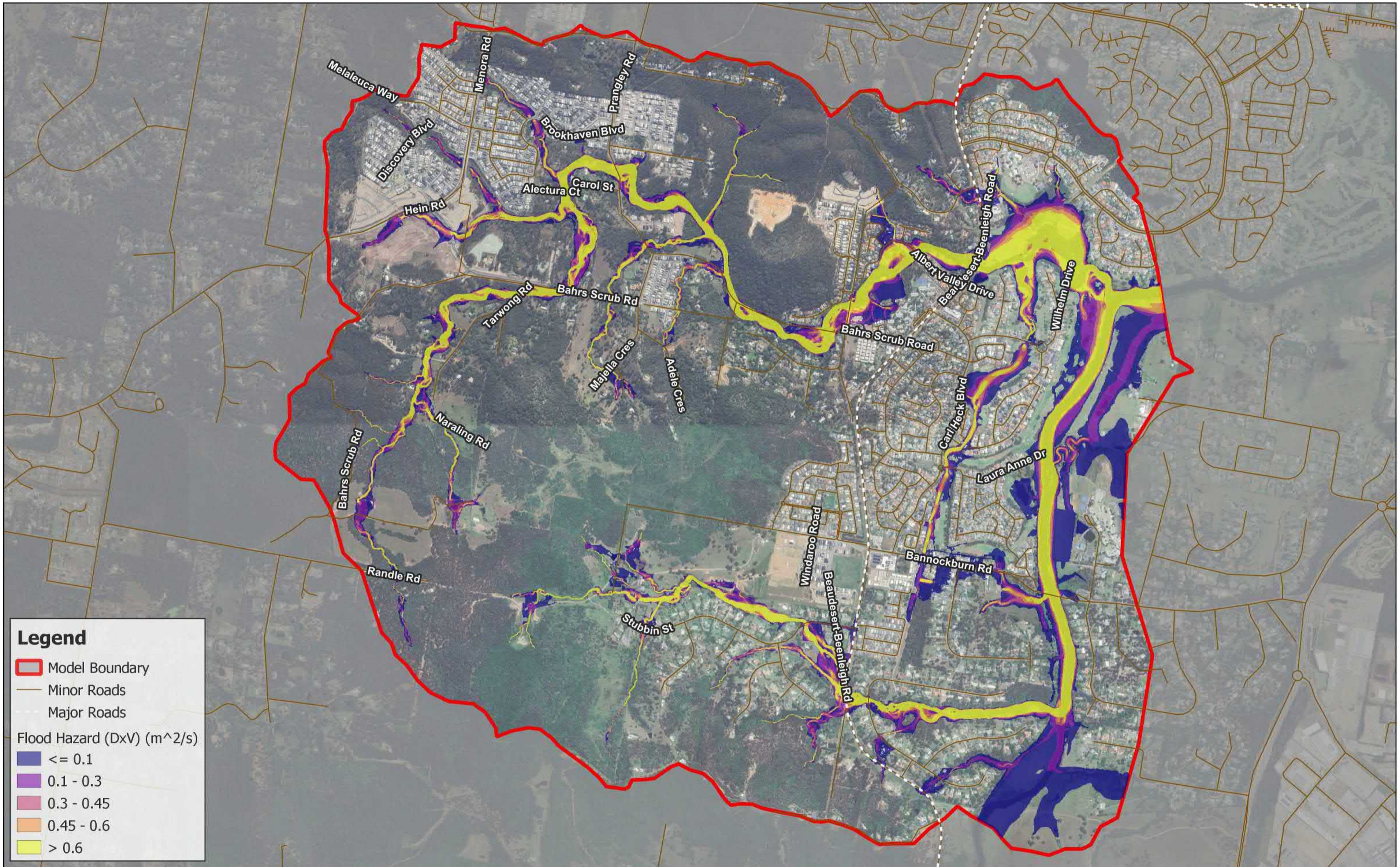
Windaroo Creek Flood Study
1% AEP Design Event

Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

APPENDIX H: CLIMATE CHANGE MAPPING



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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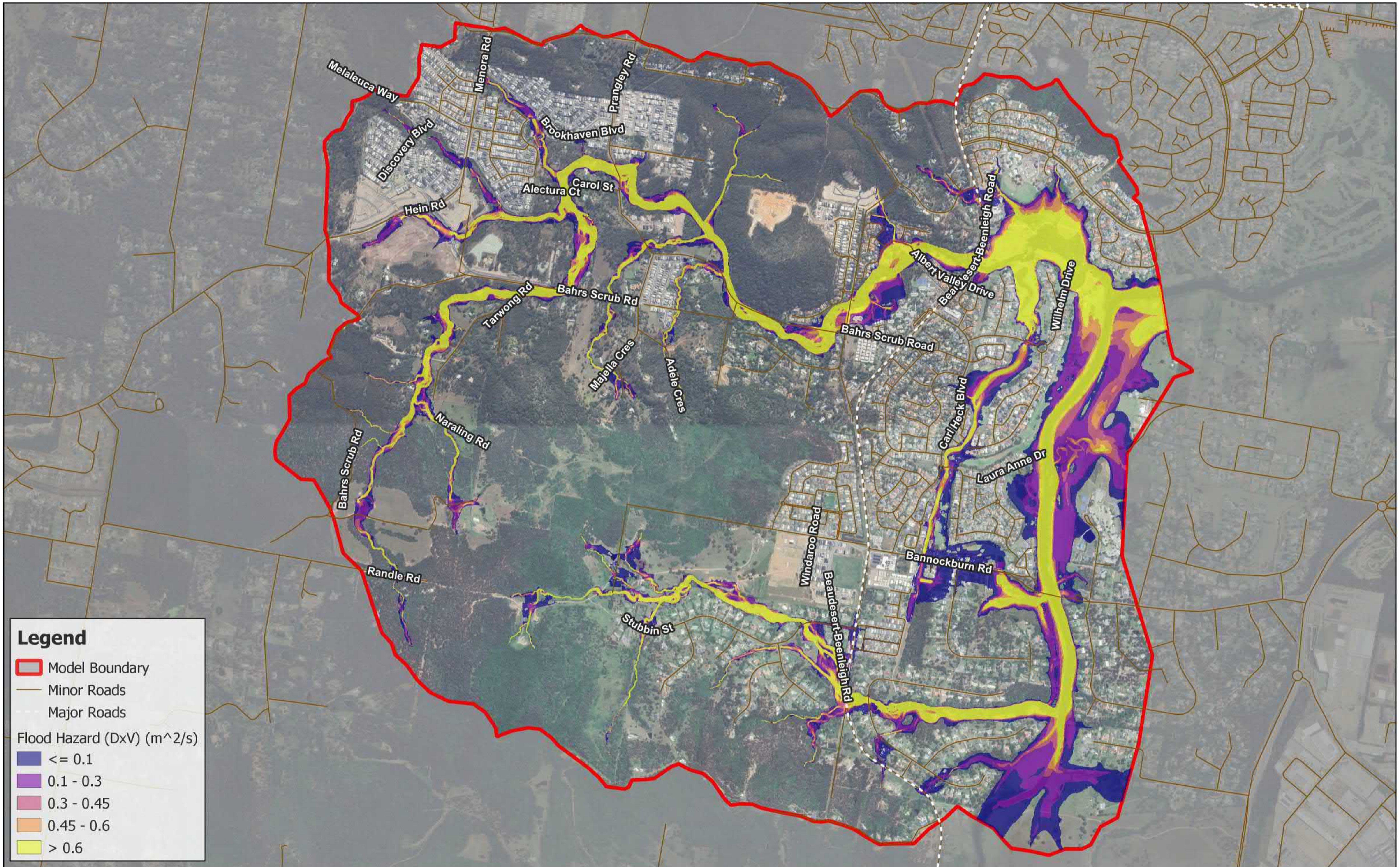
Appendix H.39

Windaroo Creek Flood Study
0.5% AEP Climate Change (RCP4.5)
Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
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CITY OF LOGAN

Appendix H.40

Windaroo Creek Flood Study
0.2% AEP Climate Change (RCP4.5)
Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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DATA SOURCE
QLD Government Open Data Source

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Appendix H.41

Windaroo Creek Flood Study
50% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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Appendix H.42

Windaroo Creek Flood Study
20% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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Appendix H.43

Windaroo Creek Flood Study
10% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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Appendix H.44

Windaroo Creek Flood Study
5% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

Appendix H.45

Windaroo Creek Flood Study
2% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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DATA SOURCE
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Appendix H.46

Windaroo Creek Flood Study
1% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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Appendix H.47

Windaroo Creek Flood Study
1% AEP Climate Change (RCP6)
Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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Appendix H.48

Windaroo Creek Flood Study
1% AEP Climate Change (RCP8.5)
Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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CITY OF LOGAN

Appendix H.49

Windaroo Creek Flood Study
0.5% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
QLD Government Open Data Source

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Appendix H.50

Windaroo Creek Flood Study
0.2% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZAEM1)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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Appendix H.51

Windaroo Creek Flood Study
50% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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DATA SOURCE
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Appendix H.52

Windaroo Creek Flood Study
20% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DATA SOURCE
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Appendix H.53

Windaroo Creek Flood Study
10% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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DATA SOURCE
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Appendix H.54

Windaroo Creek Flood Study
5% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix H.55

Windaroo Creek Flood Study
2% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix H.56

Windaroo Creek Flood Study
1% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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DATA SOURCE
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Appendix H.57

Windaroo Creek Flood Study
1% AEP Climate Change (RCP6)
Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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DATA SOURCE
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Appendix H.58

Windaroo Creek Flood Study
1% AEP Climate Change (RCP8.5)
Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N
0 500 1,000 m
SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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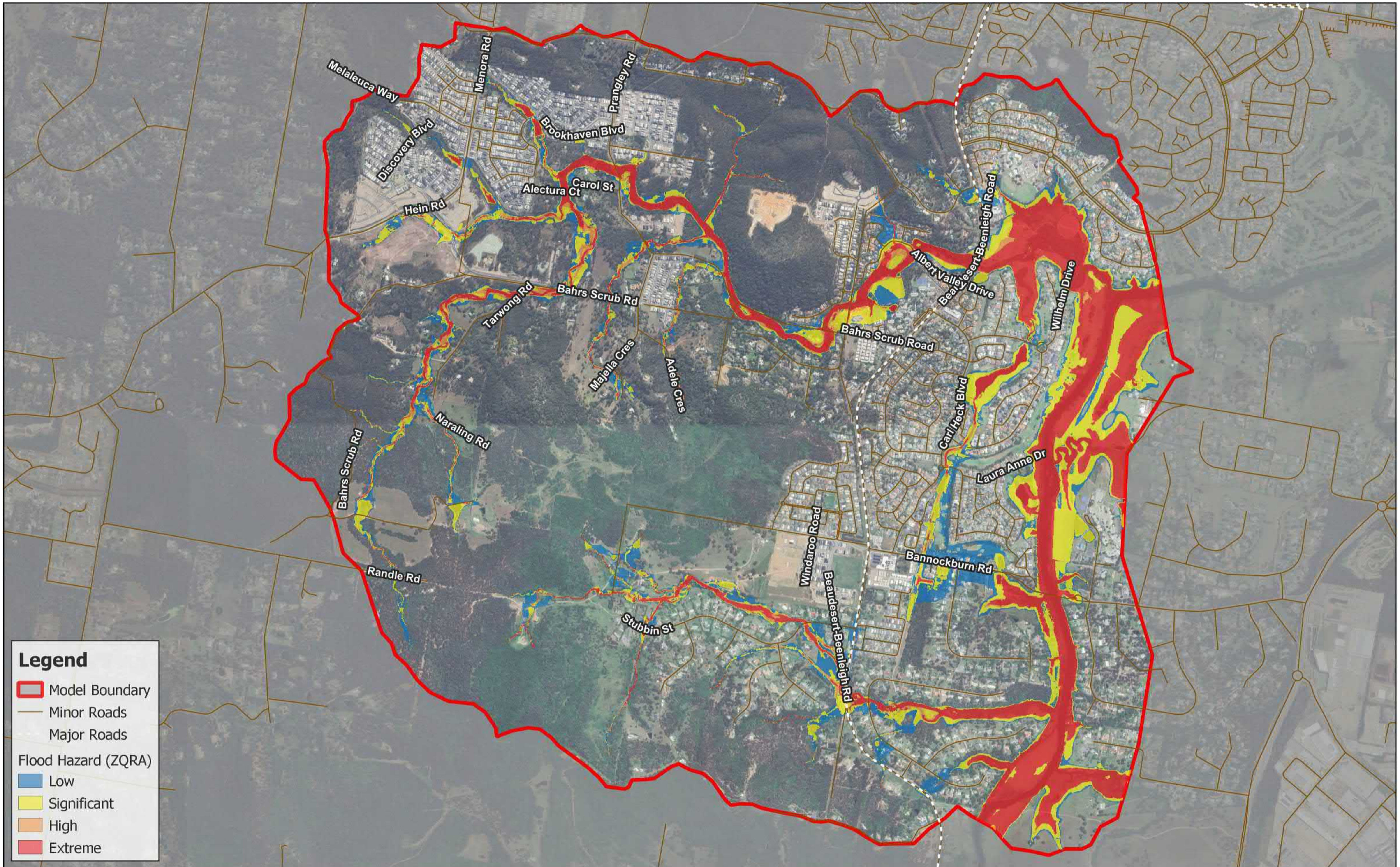
Appendix H.59

Windaroo Creek Flood Study
0.5% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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Appendix H.60

Windaroo Creek Flood Study
0.2% AEP Climate Change (RCP4.5)
Flood Flood Hazard (ZQRA)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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CITY OF LOGAN

Appendix H.1

Windaroo Creek Flood Study
50% AEP Climate Change (RCP4.5)
Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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CITY OF LOGAN

Appendix H.2

Windaroo Creek Flood Study
20% AEP Climate Change (RCP4.5)
Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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CITY OF LOGAN

Appendix H.3

Windaroo Creek Flood Study
10% AEP Climate Change (RCP4.5)
Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

Appendix H.4

Windaroo Creek Flood Study
5% AEP Climate Change (RCP4.5)
Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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CITY OF LOGAN

Appendix H.5

Windaroo Creek Flood Study
2% AEP Climate Change (RCP4.5)
Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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QLD Government Open Data Source

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CITY OF LOGAN

Appendix H.6

Windaroo Creek Flood Study
1% AEP Climate Change (RCP4.5)
Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

ENGENY

CITY OF LOGAN

Appendix H.7

Windaroo Creek Flood Study
1% AEP Climate Change (RCP6)
Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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Appendix H.8

Windaroo Creek Flood Study
1% AEP Climate Change (RCP8.5)
Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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Appendix H.9

Windaroo Creek Flood Study
0.5% AEP Climate Change (RCP4.5)
Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DATA SOURCE
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Appendix H.10

Windaroo Creek Flood Study
0.2% AEP Climate Change (RCP4.5)
Flood Height

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DISCLAIMER
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Appendix H.11

Windaroo Creek Flood Study
50% AEP Climate Change (RCP4.5)
Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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Appendix H.12

Windaroo Creek Flood Study
20% AEP Climate Change (RCP4.5)
Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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Appendix H.13

Windaroo Creek Flood Study
10% AEP Climate Change (RCP4.5)
Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N
0 500 1,000 m
SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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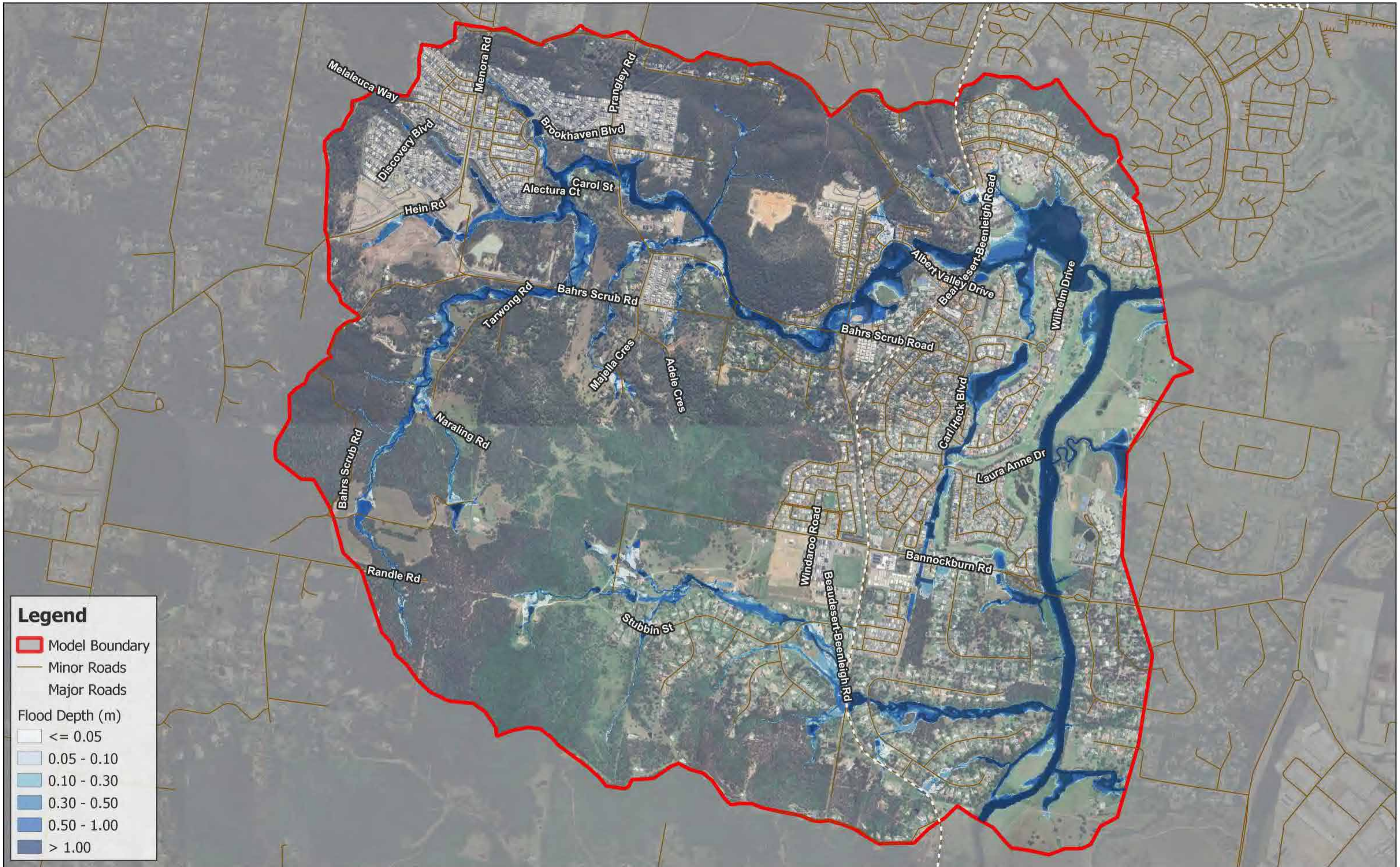
Appendix H.14

Windaroo Creek Flood Study
5% AEP Climate Change (RCP4.5)
Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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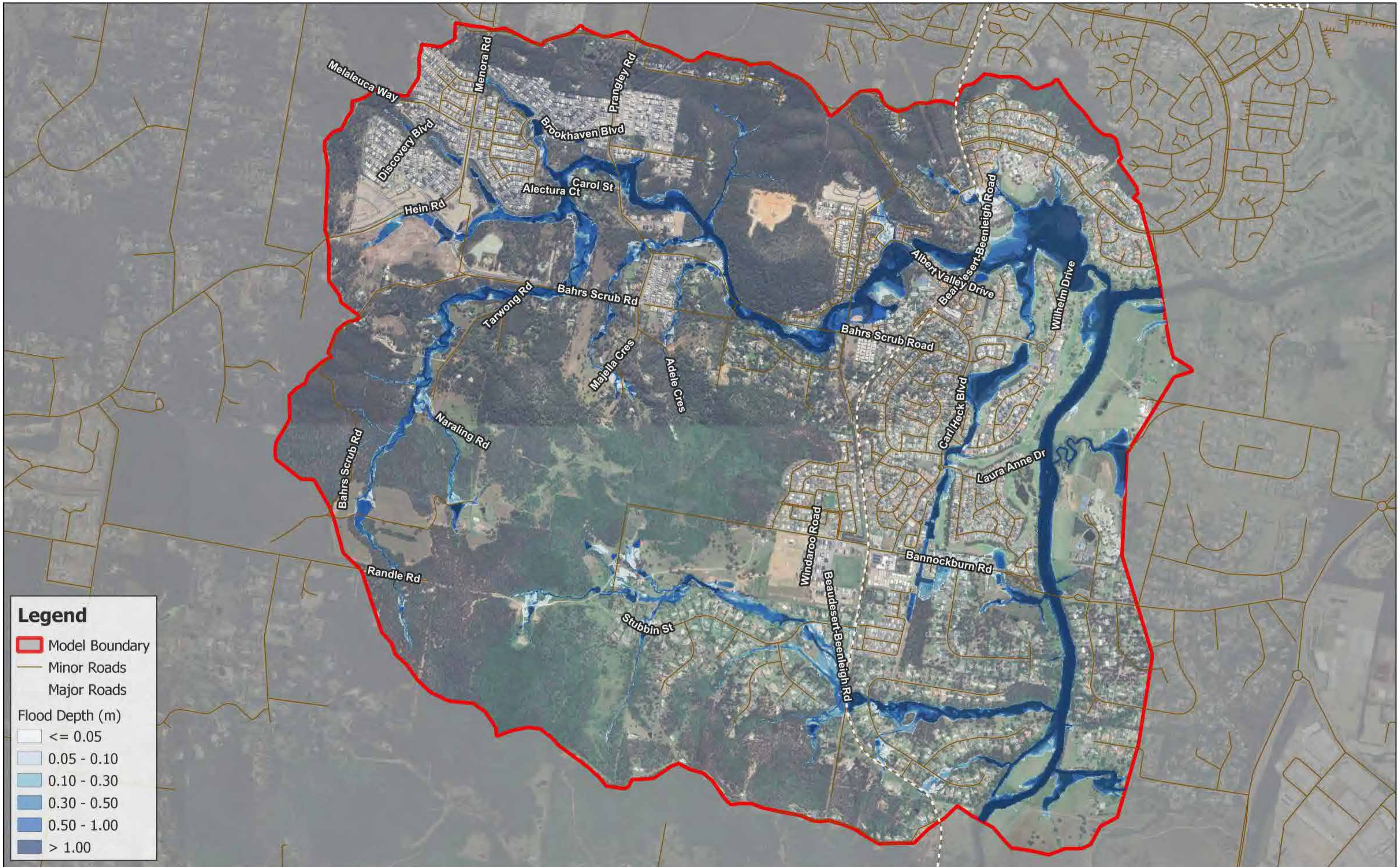
Appendix H.15

Windaroo Creek Flood Study
2% AEP Climate Change (RCP4.5)
Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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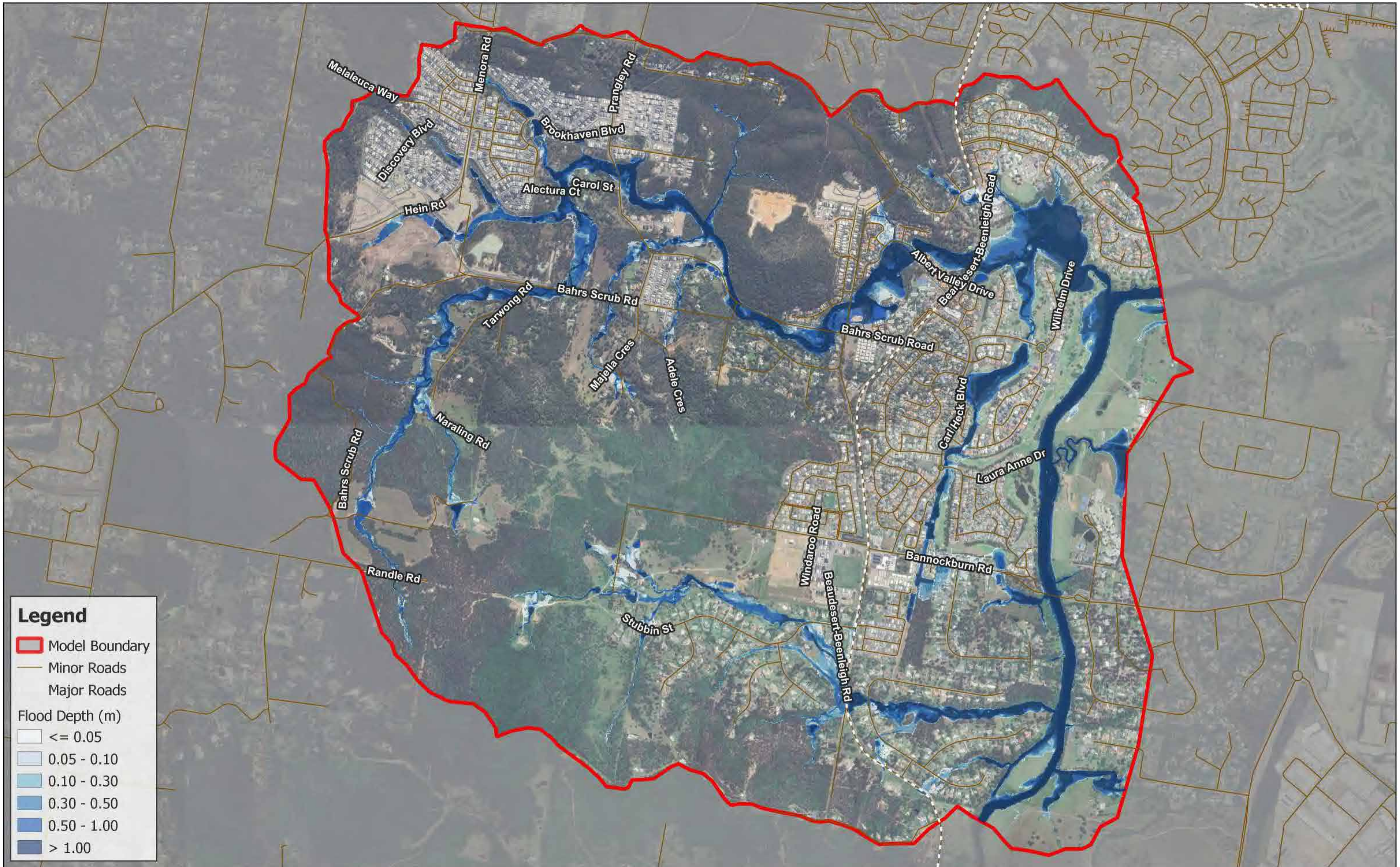
Appendix H.16

Windaroo Creek Flood Study
1% AEP Climate Change (RCP4.5)
Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix H.17

Windaroo Creek Flood Study
1% AEP Climate Change (RCP6)
Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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Appendix H.18

Windaroo Creek Flood Study
1% AEP Climate Change (RCP8.5)
Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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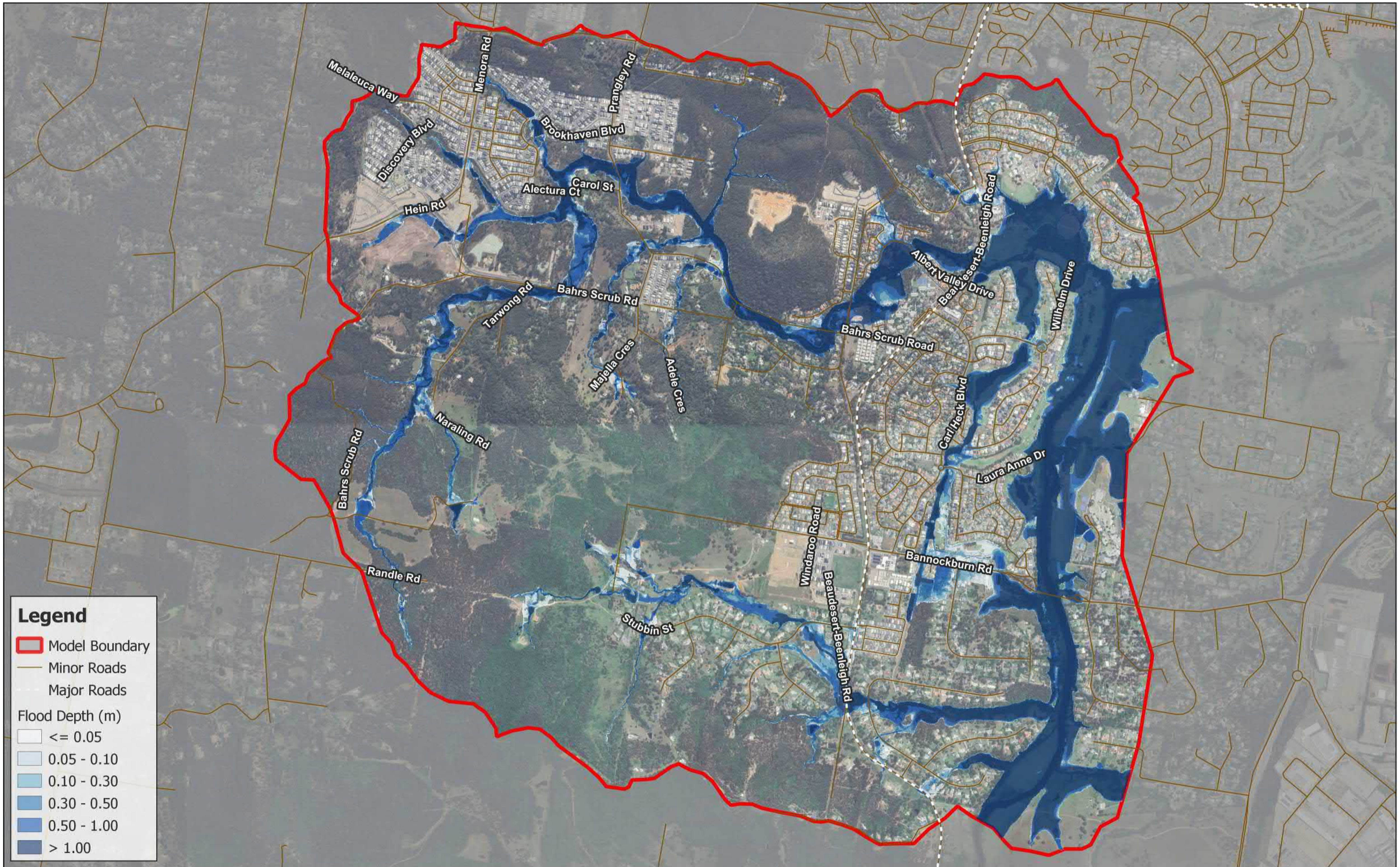
Appendix H.19

Windaroo Creek Flood Study
0.5% AEP Climate Change (RCP4.5)
Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix H.20

Windaroo Creek Flood Study
0.2% AEP Climate Change (RCP4.5)
Flood Depth

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix H.21

Windaroo Creek Flood Study
50% AEP Climate Change (RCP4.5)
Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix H.22

Windaroo Creek Flood Study
20% AEP Climate Change (RCP4.5)
Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix H.23

Windaroo Creek Flood Study
10% AEP Climate Change (RCP4.5)
Flood Velocity

Drg Ref. M9000_082

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix H.24

Windaroo Creek Flood Study
5% AEP Climate Change (RCP4.5)
Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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Appendix H.25

Windaroo Creek Flood Study
2% AEP Climate Change (RCP4.5)
Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
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Appendix H.26

Windaroo Creek Flood Study
1% AEP Climate Change (RCP4.5)
Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DISCLAIMER
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DATA SOURCE
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Appendix H.27

Windaroo Creek Flood Study
1% AEP Climate Change (RCP6)
Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix H.28

Windaroo Creek Flood Study
1% AEP Climate Change (RCP8.5)
Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix H.29

Windaroo Creek Flood Study
0.5% AEP Climate Change (RCP4.5)
Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

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DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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Appendix H.30

Windaroo Creek Flood Study
0.2% AEP Climate Change (RCP4.5)
Flood Velocity

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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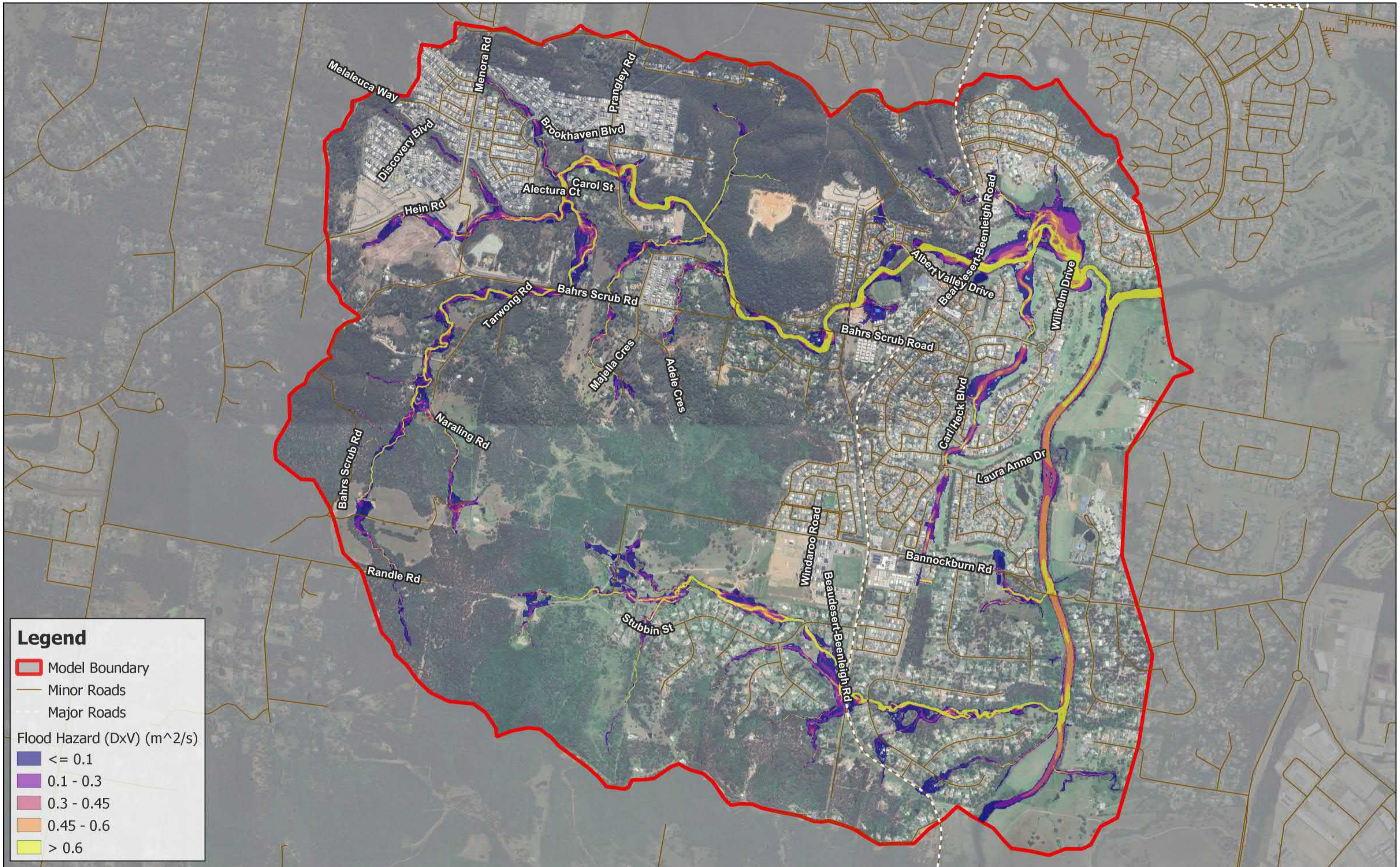
Appendix H.31

Windaroo Creek Flood Study
50% AEP Climate Change (RCP4.5)
Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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Appendix H.32

Windaroo Creek Flood Study
20% AEP Climate Change (RCP4.5)
Flood Flood Hazard (D x V)

Drg Ref. M9000_082

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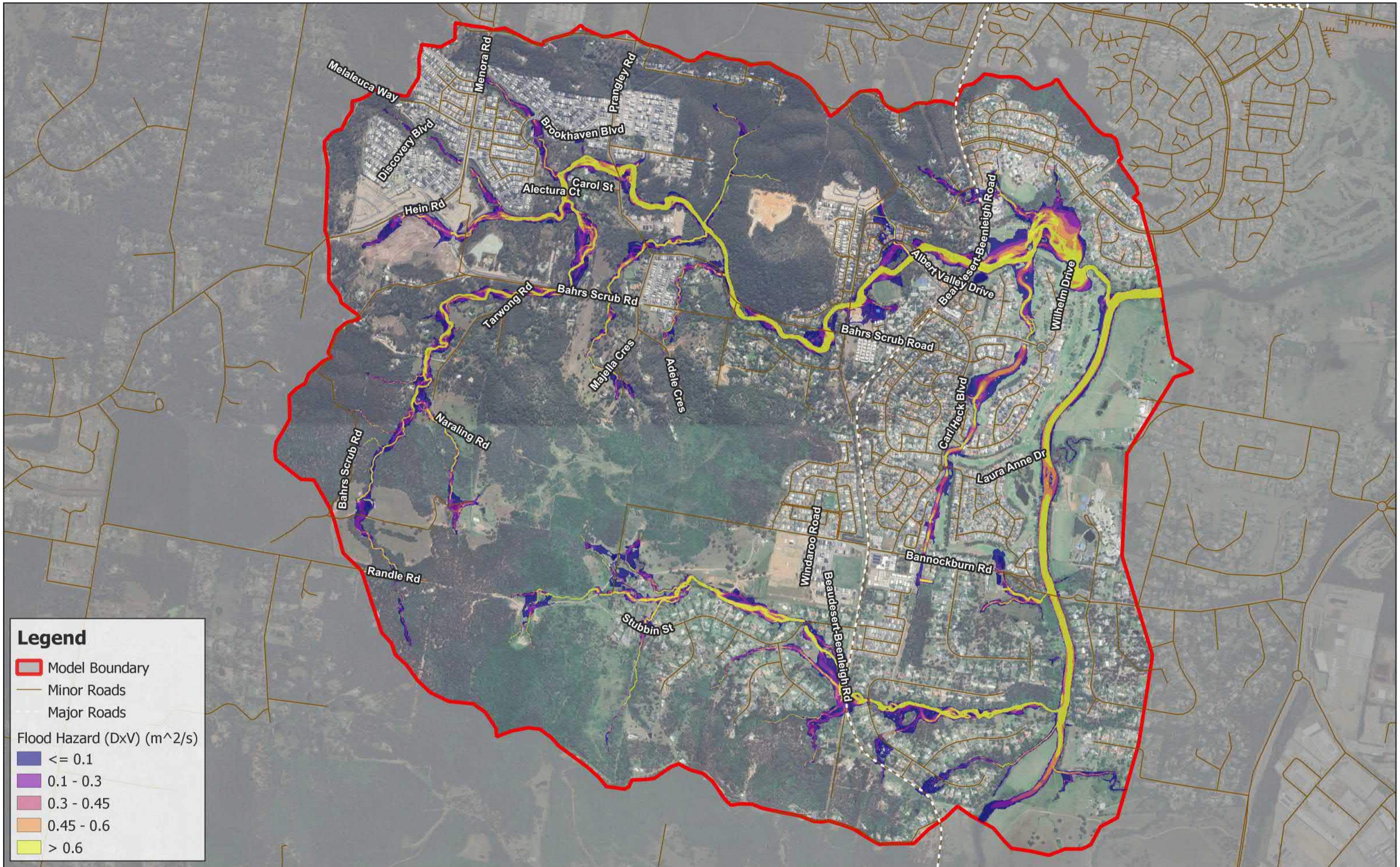

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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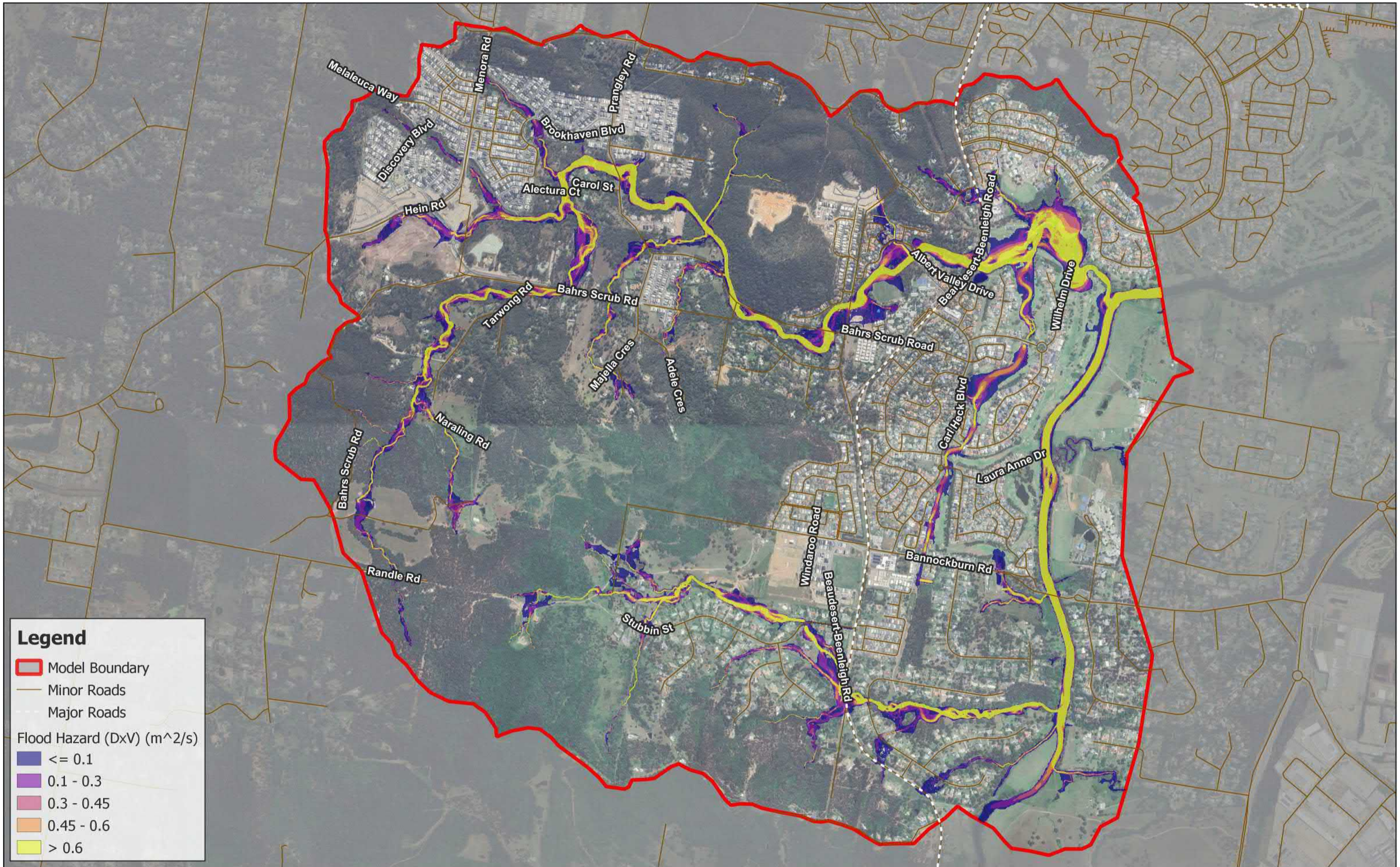
CITY OF LOGAN

Appendix H.33

Windaroo Creek Flood Study
10% AEP Climate Change (RCP4.5)
Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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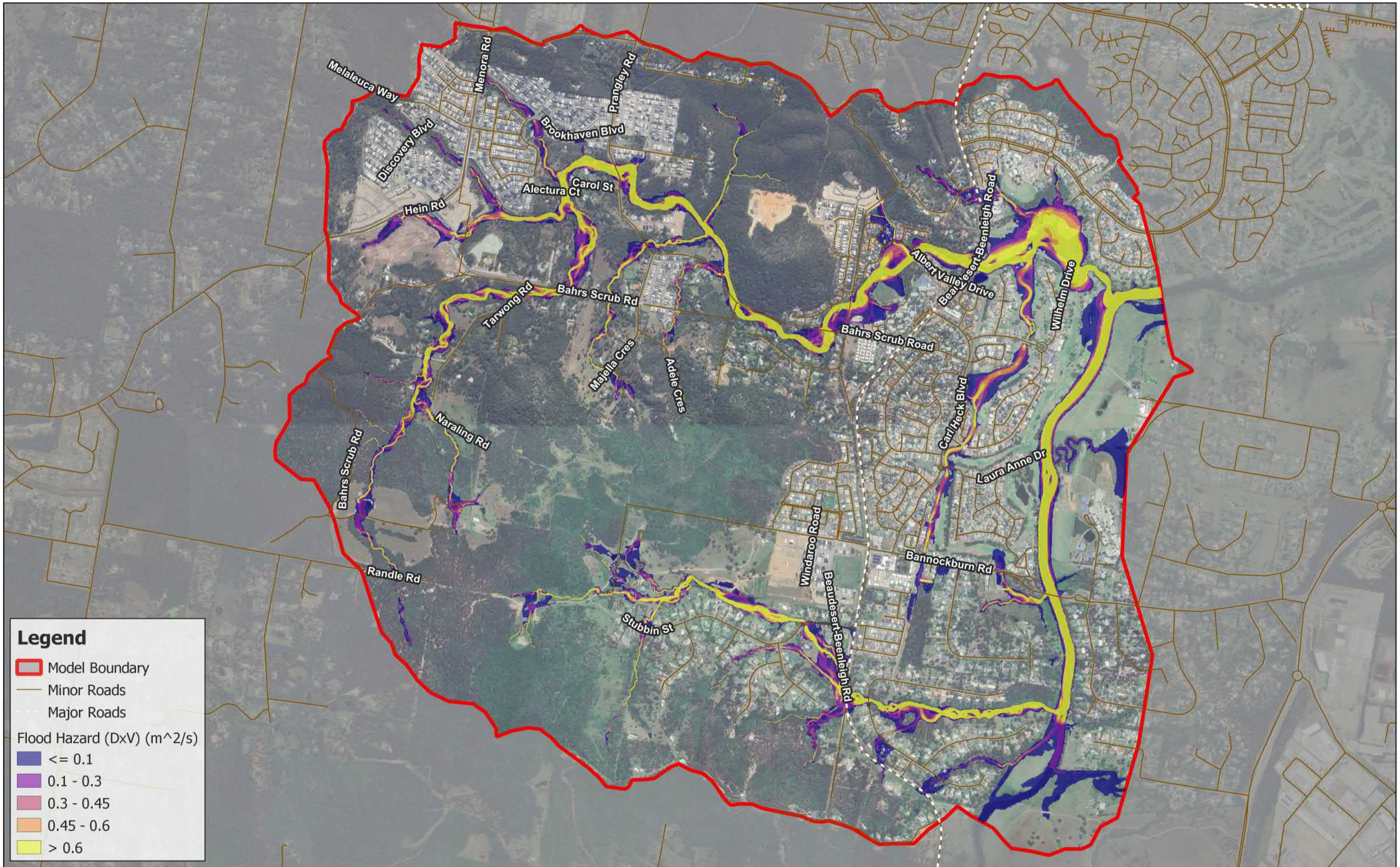
Appendix H.34

Windaroo Creek Flood Study
5% AEP Climate Change (RCP4.5)
Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

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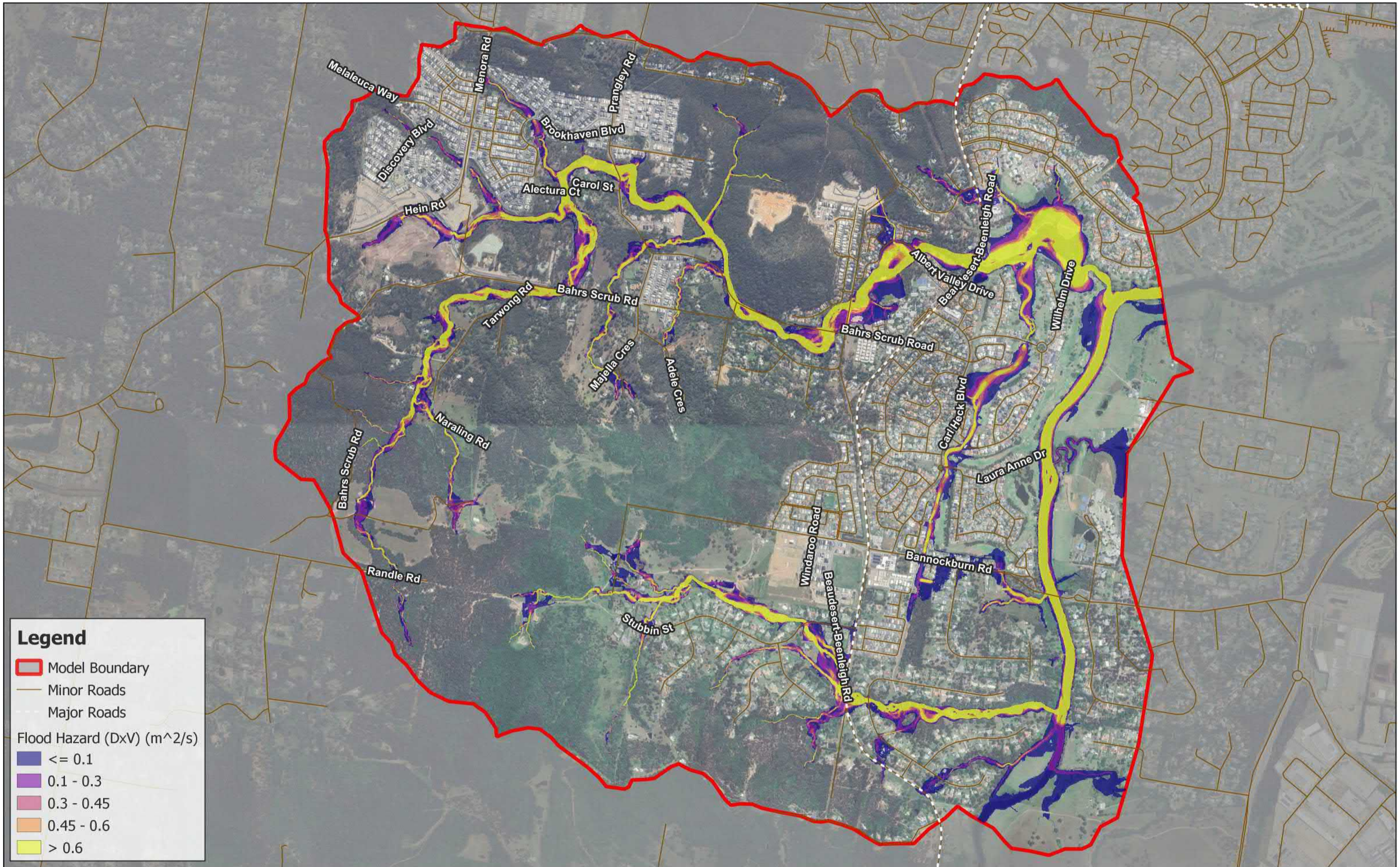
Appendix H.35

Windaroo Creek Flood Study
2% AEP Climate Change (RCP4.5)
Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000
GDA2020 / MGA zone 56

DATA SOURCE
QLD Government Open Data Source

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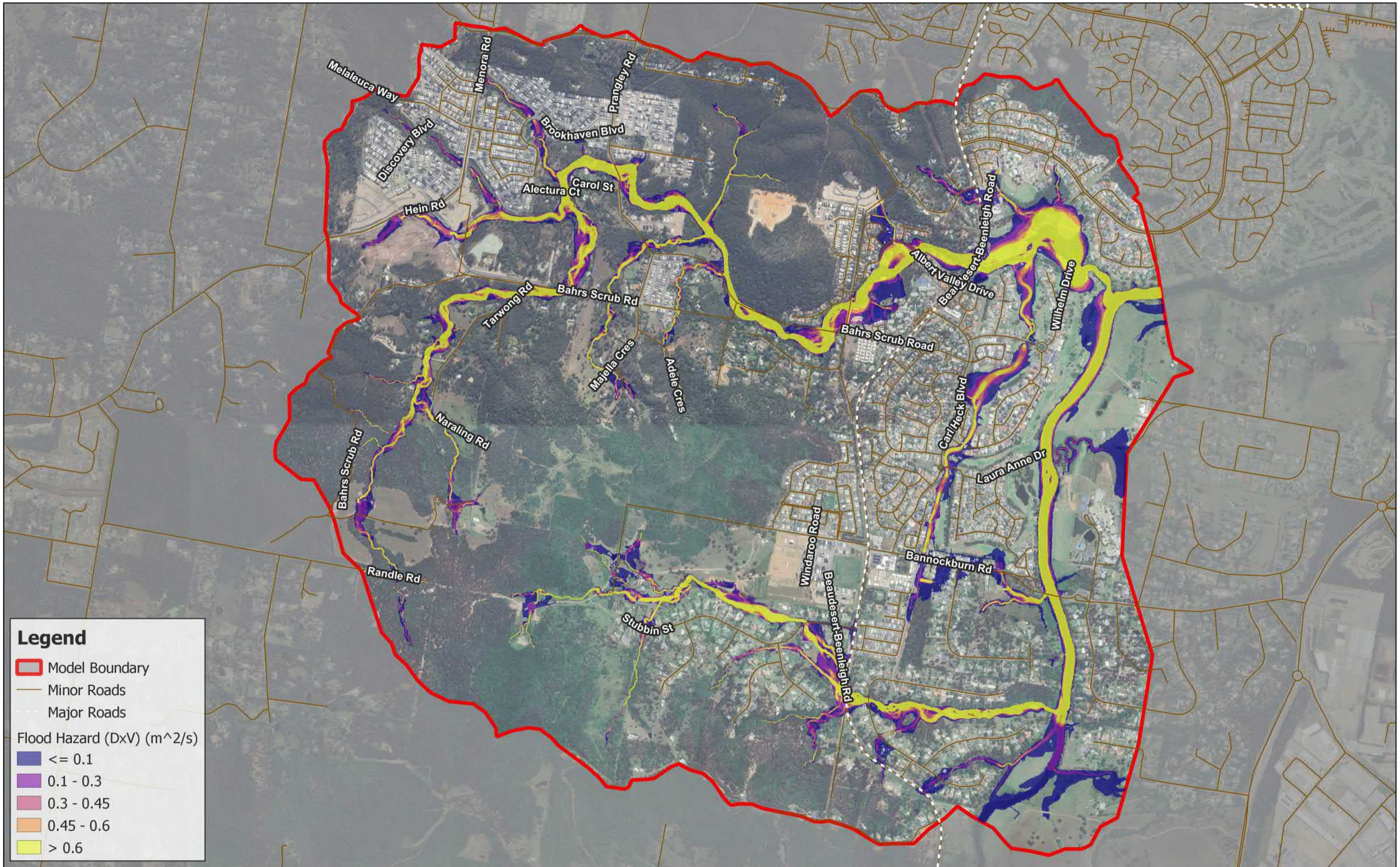
Appendix H.36

Windaroo Creek Flood Study
1% AEP Climate Change (RCP4.5)
Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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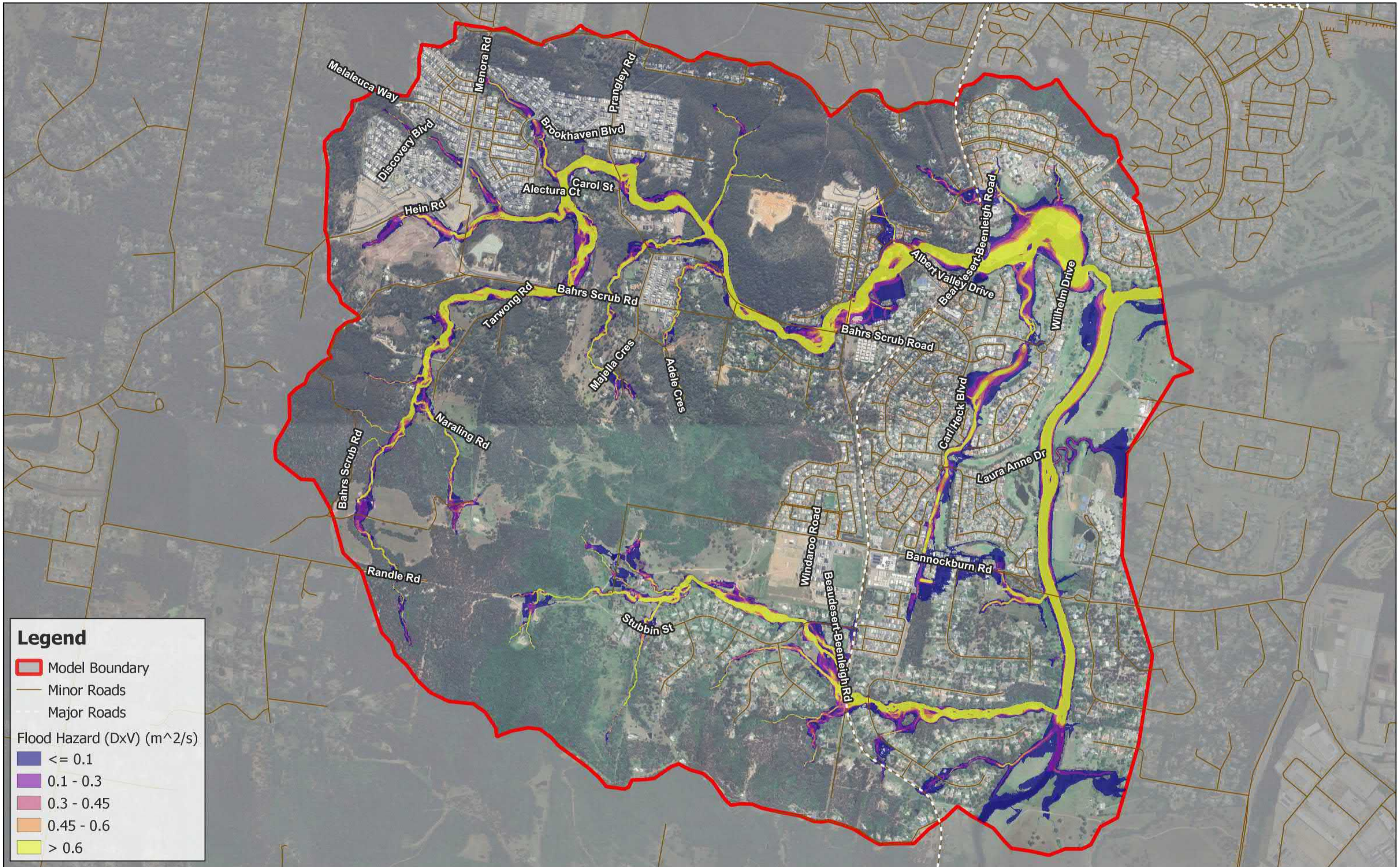
Appendix H.37

Windaroo Creek Flood Study
1% AEP Climate Change (RCP6)
Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	ST	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES: M9000_082

N

0 500 1,000 m

SCALE @ A3 - 1:20,000

GDA2020 / MGA zone 56

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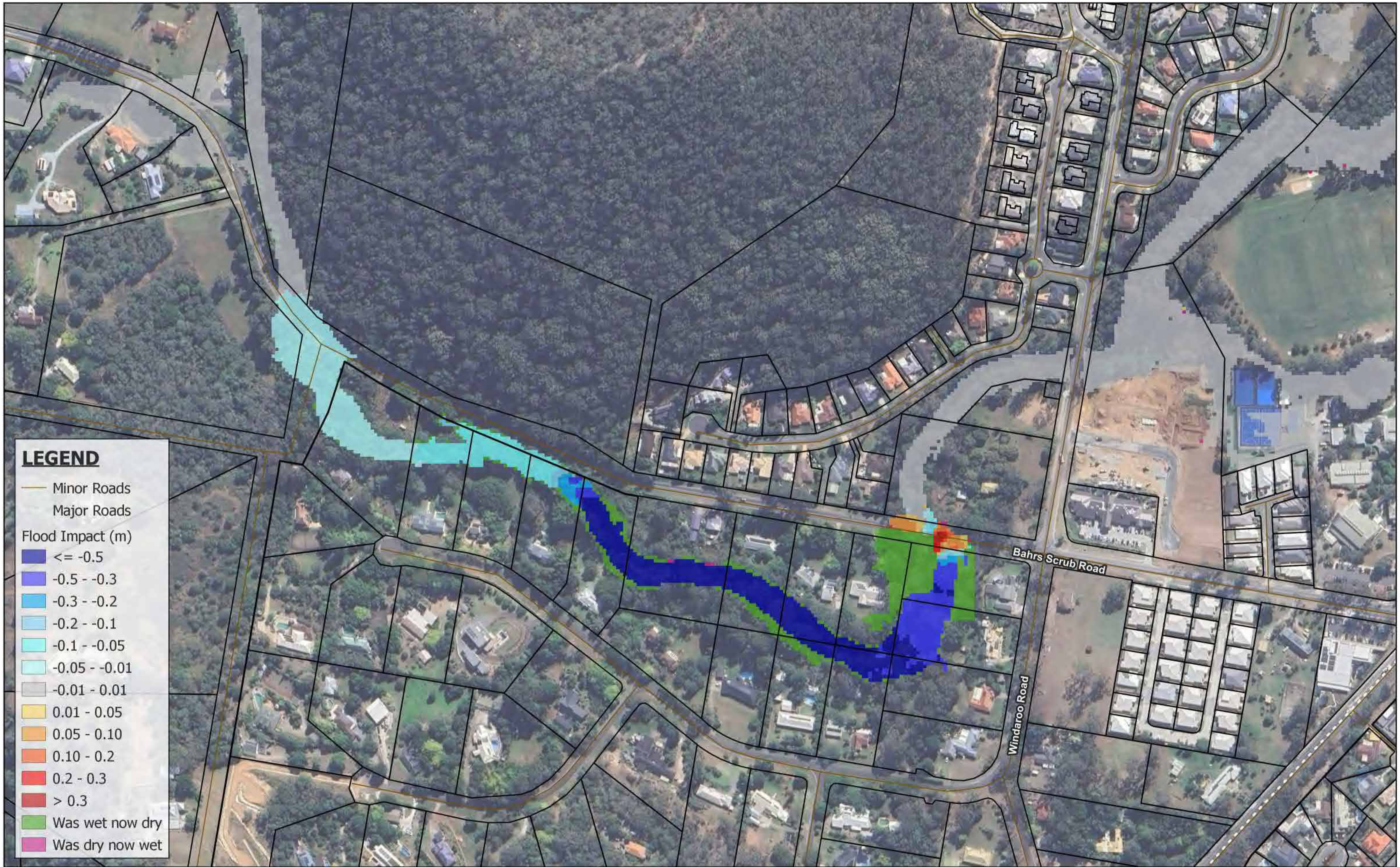
Appendix H.38

Windaroo Creek Flood Study
1% AEP Climate Change (RCP8.5)
Flood Flood Hazard (D x V)

Drg Ref. M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_LG.qgz

APPENDIX I: MITIGATION OPTION FLOOD IMPACT MAPPING



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:3,000
GDA2020 / MGA zone 56

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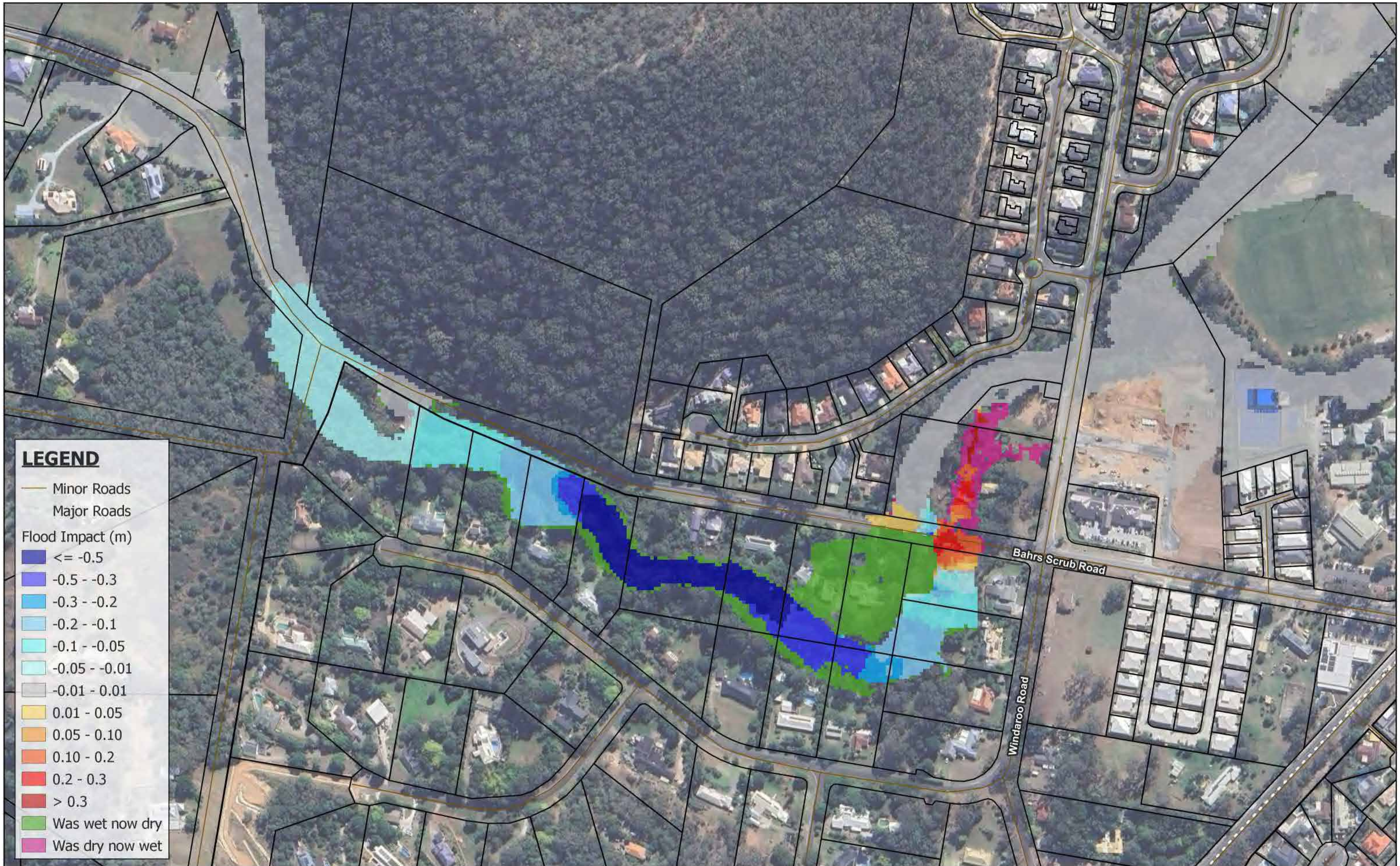
Appendix I 1

Windaroo Creek Flood Study

Structural Mitigation Option 1 – Bahrs Scrub Road
50% AEP Design Event Flood Impact

Dwg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:3,000
GDA2020 / MGA zone 56

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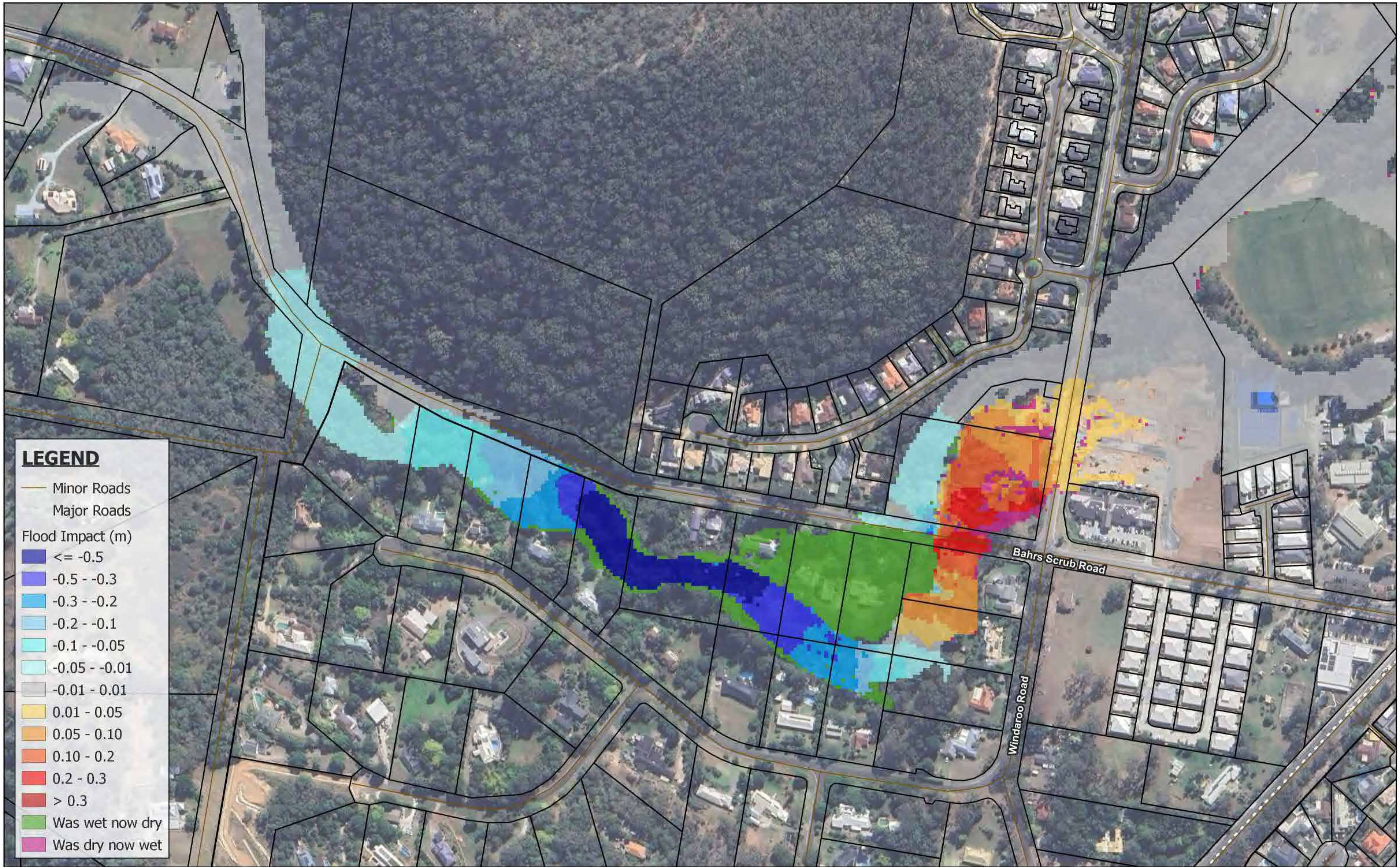
Appendix I 2

Windaroo Creek Flood Study

Structural Mitigation Option 1 – Bahrs Scrub Road
20% AEP Design Event Flood Impact

Dwg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:3,000
GDA2020 / MGA zone 56

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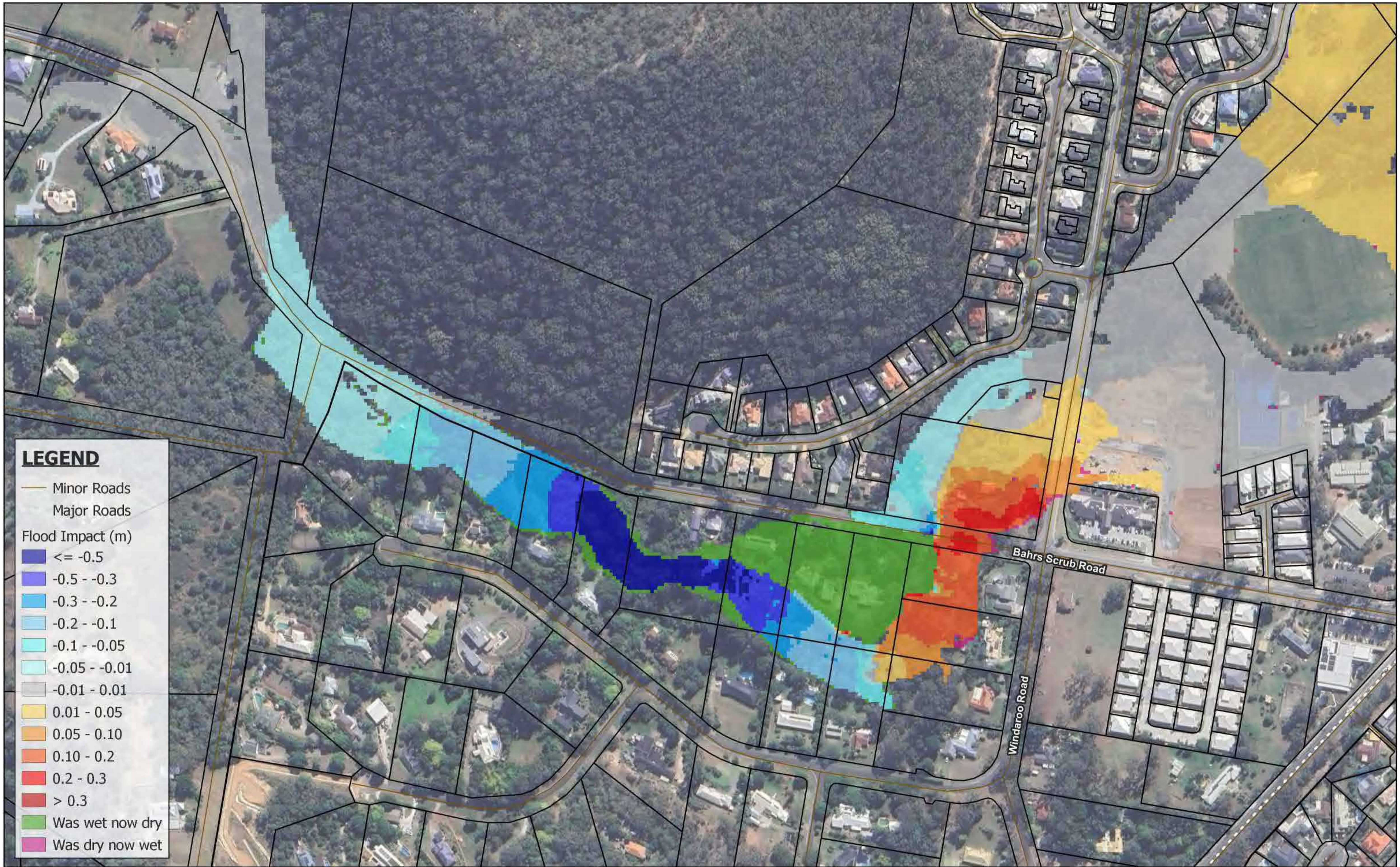
Appendix I 3

Windaroo Creek Flood Study

Structural Mitigation Option 1 – Bahrs Scrub Road
10% AEP Design Event Flood Impact

Drg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:3,000
GDA2020 / MGA zone 56

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QLD Government Open Data Source

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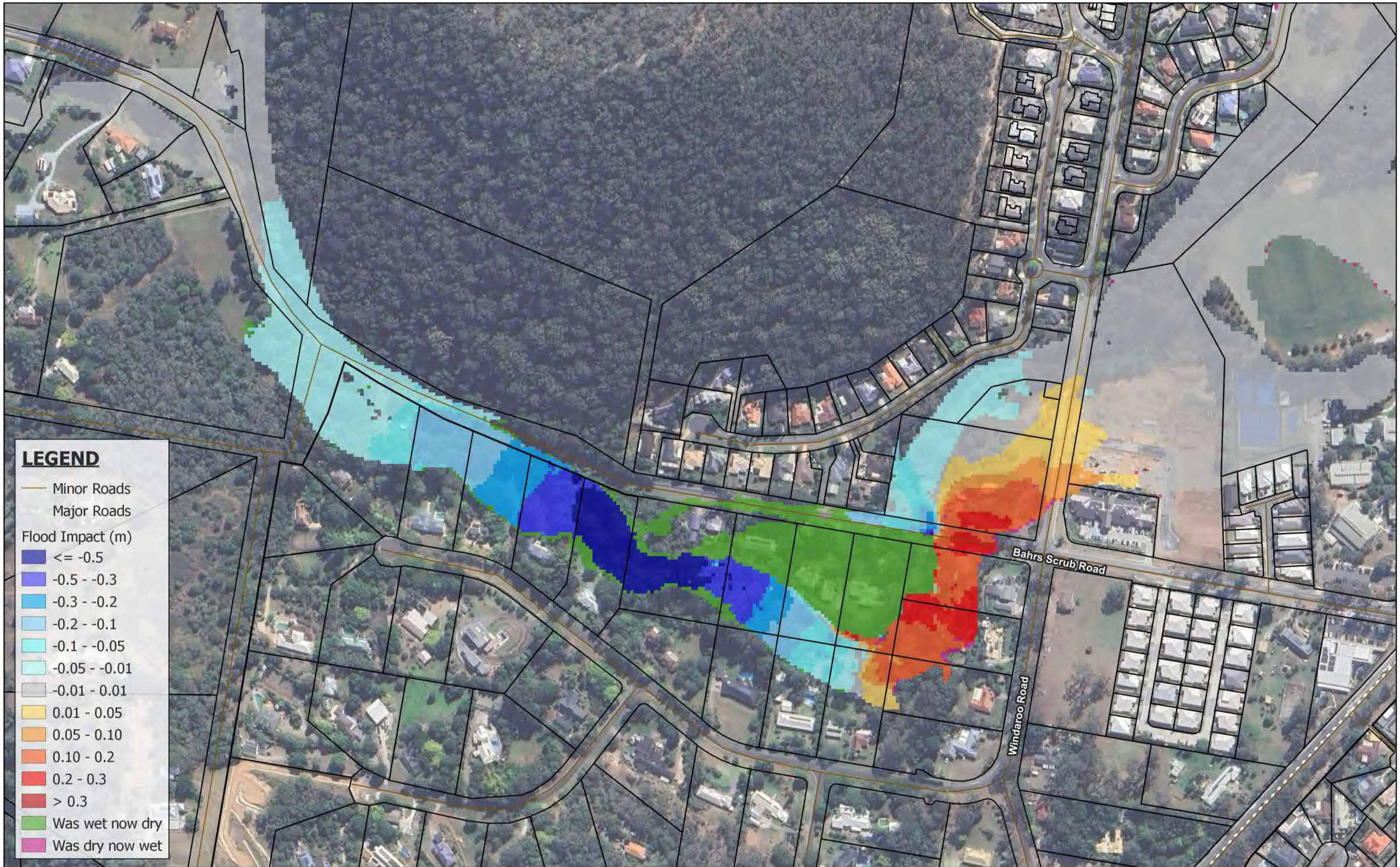
Appendix I 4

Windaroo Creek Flood Study

Structural Mitigation Option 1 – Bahrs Scrub Road
5% AEP Design Event Flood Impact

Dwg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



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DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:3,000
GDA2020 / MGA zone 56

DATA SOURCE
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Appendix I 5

Windaroo Creek Flood Study

Structural Mitigation Option 1 – Bahrs Scrub Road
2% AEP Design Event Flood Impact

Drg Ref
M9000_082

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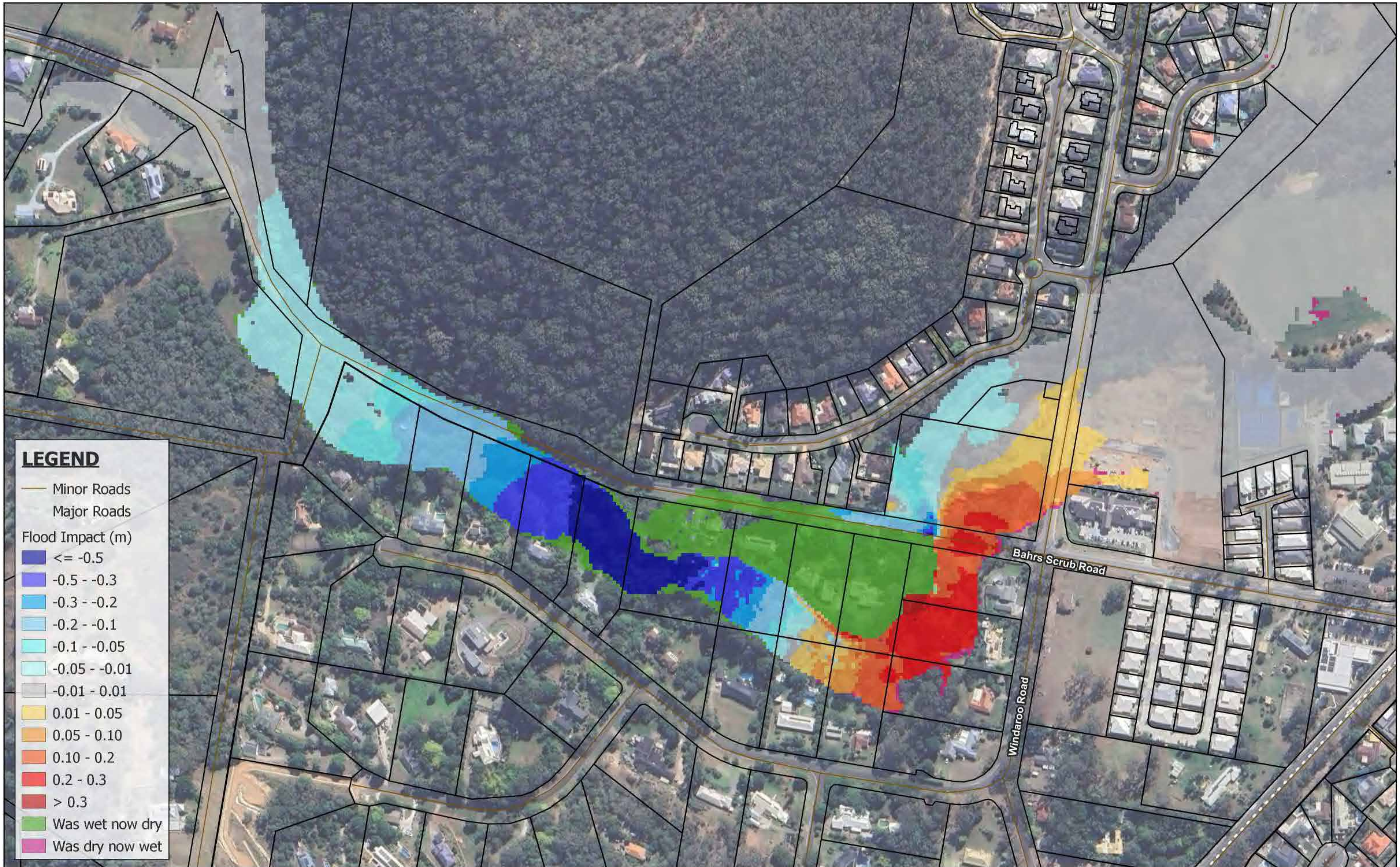

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:3,000
GDA2020 / MGA zone 56

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Appendix I 6

Windaroo Creek Flood Study

Structural Mitigation Option 1 – Bahrs Scrub Road
1% AEP Design Event Flood Impact

Drg Ref
M9000_082

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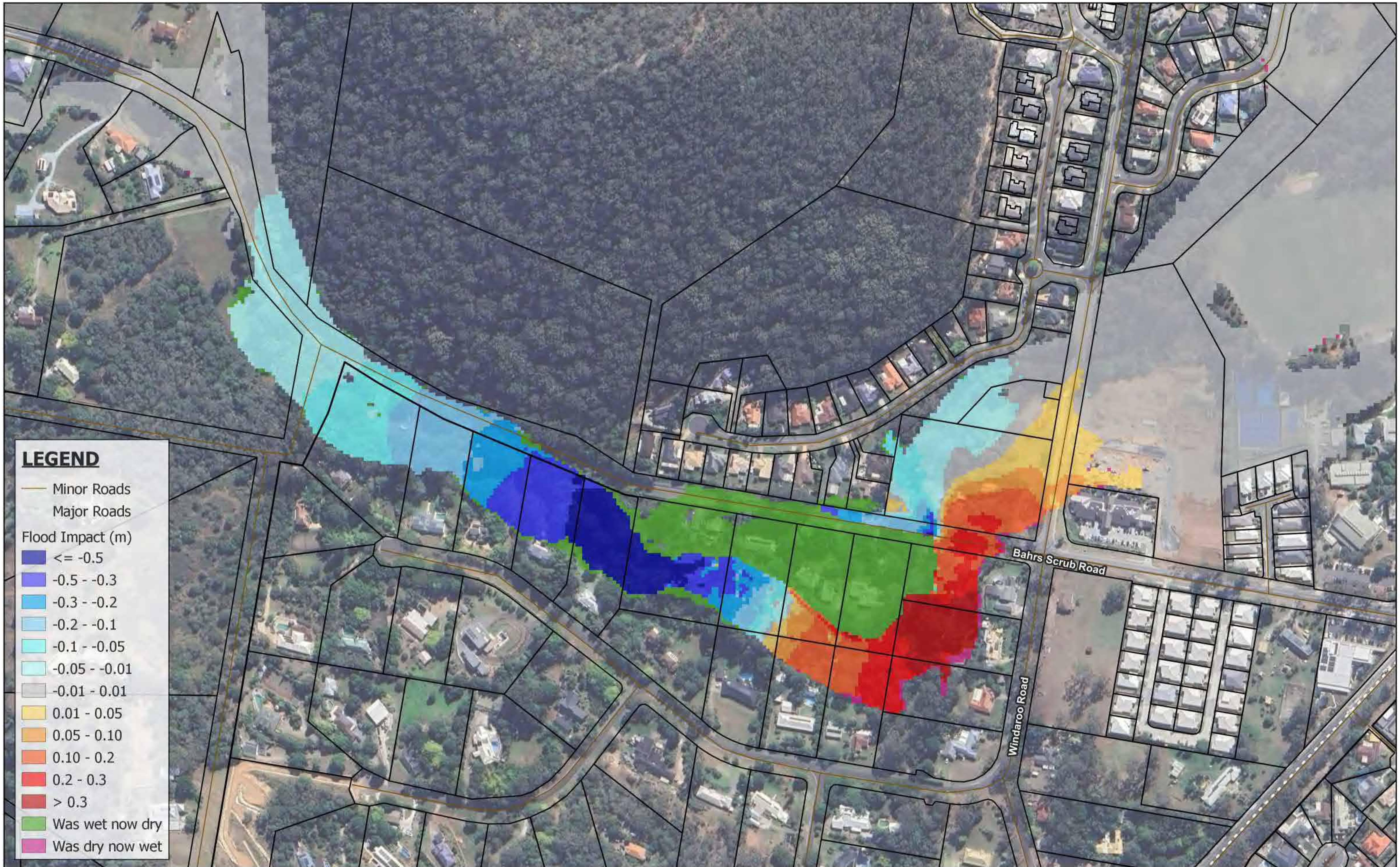

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:3,000
GDA2020 / MGA zone 56

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Appendix I 7

Windaroo Creek Flood Study

Structural Mitigation Option 1 – Bahrs Scrub Road
0.5% AEP Design Event Flood Impact

Drg Ref
M9000_082

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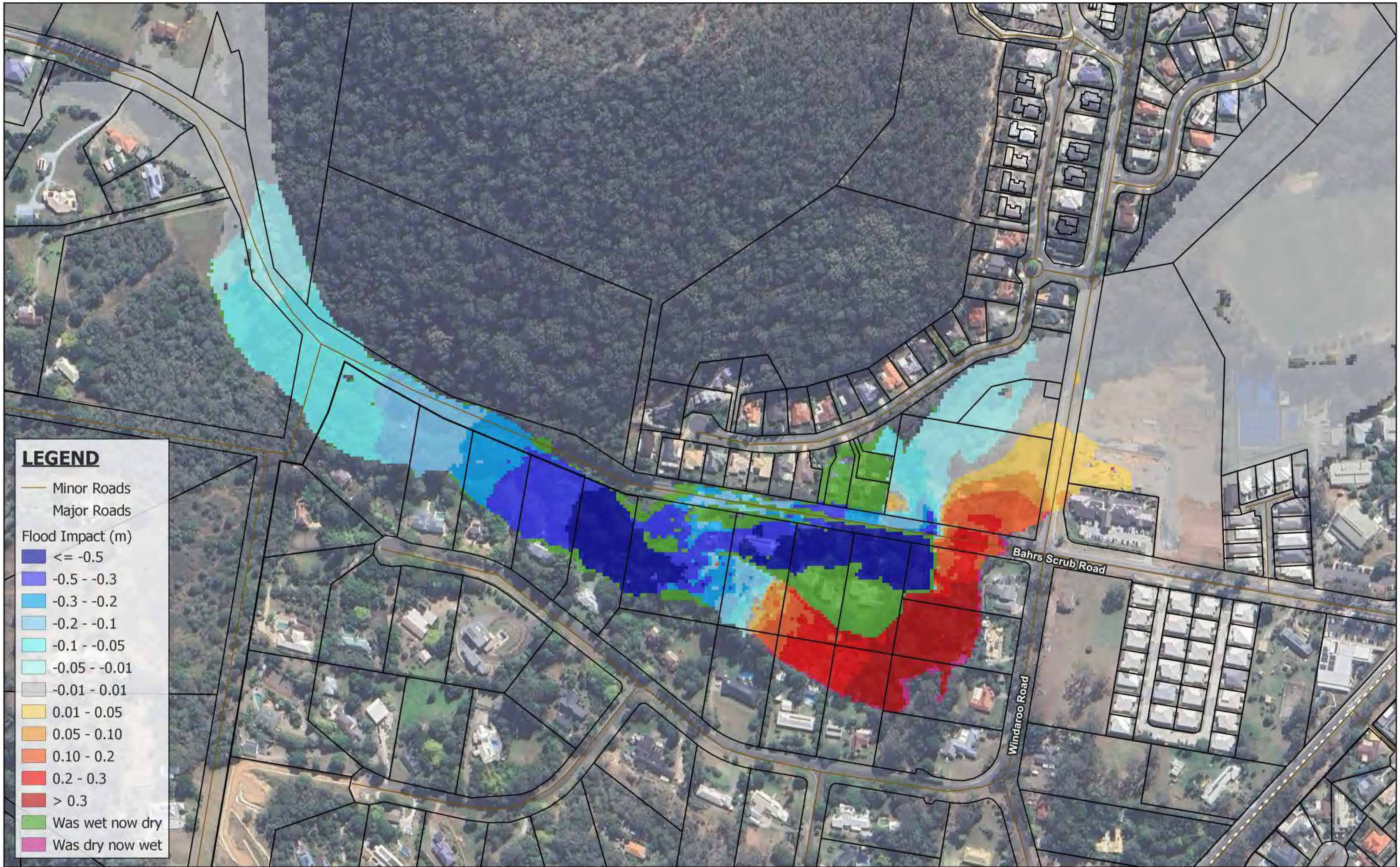

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:3,000
GDA2020 / MGA zone 56

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Appendix I 8

Windaroo Creek Flood Study

Structural Mitigation Option 1 – Bahrs Scrub Road
0.2% AEP Design Event Flood Impact

Dwg Ref
M9000_082

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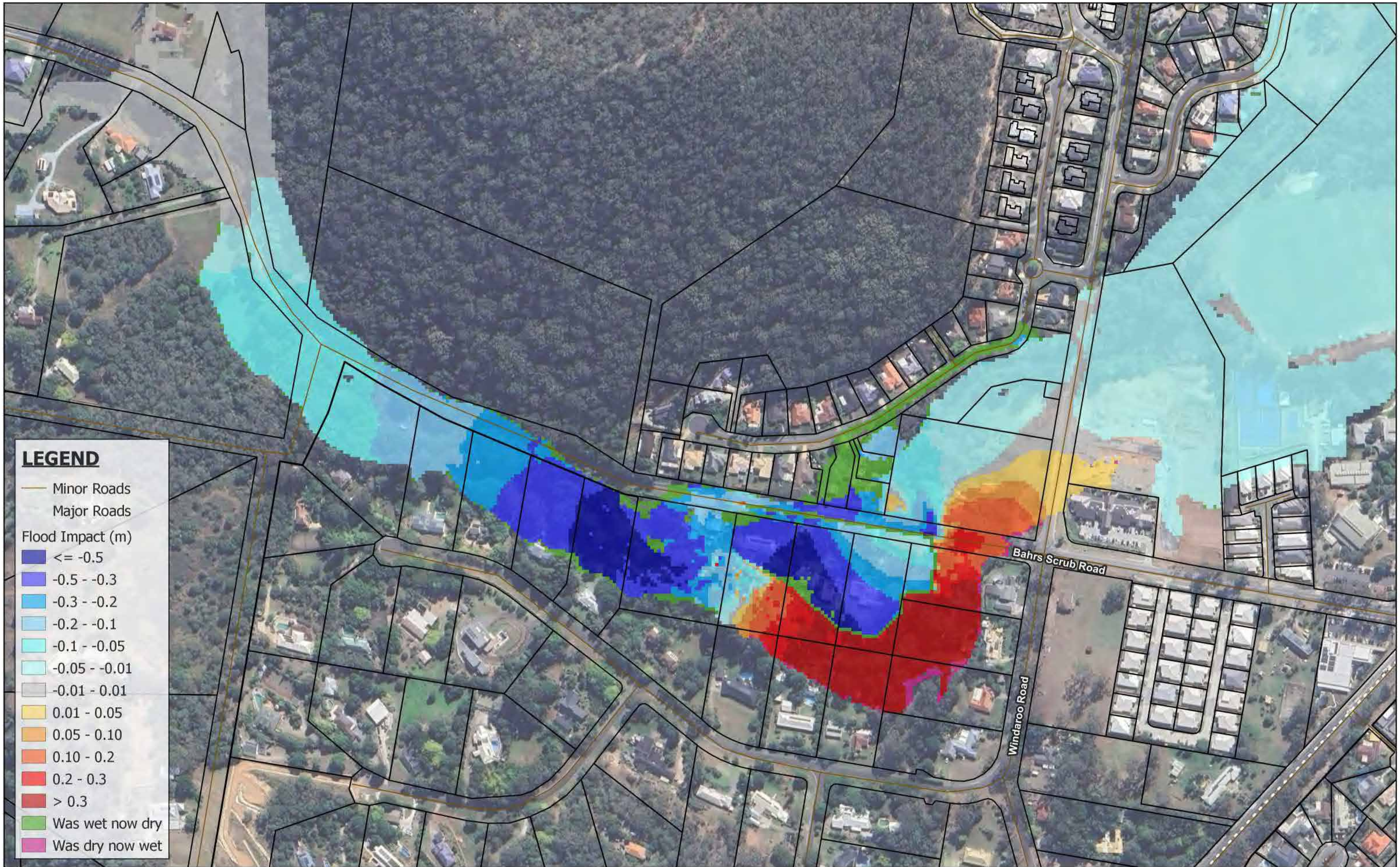

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DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

SCALE @ A3 - 1:3,000
GDA2020 / MGA zone 56

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Appendix I 9

Windaroo Creek Flood Study

Structural Mitigation Option 1 – Bahrs Scrub Road
0.05% AEP Design Event Flood Impact

Drg Ref
M9000_082

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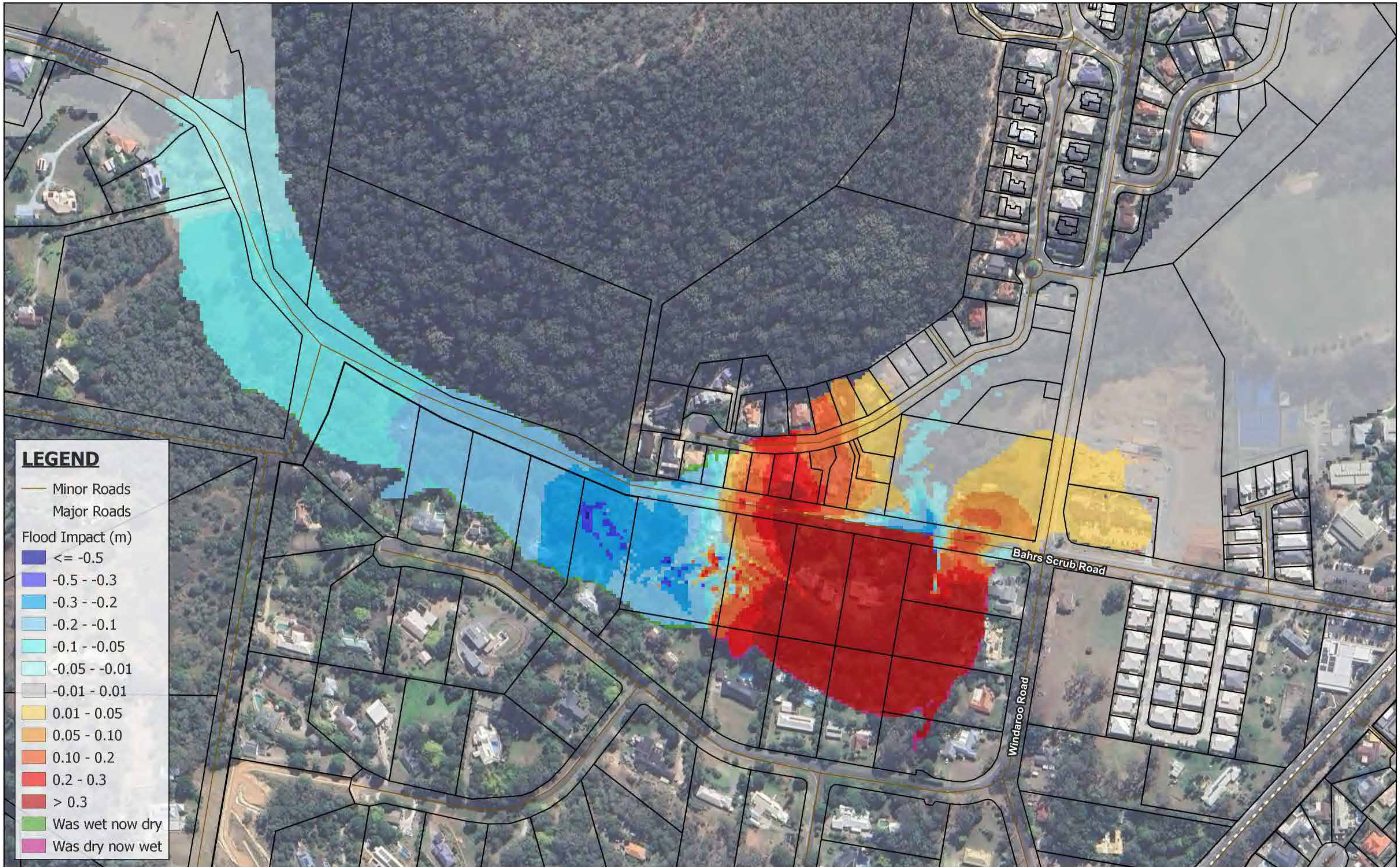

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1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:3,000
GDA2020 / MGA zone 56

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Appendix I 10

Windaroo Creek Flood Study

Structural Mitigation Option 1 – Bahrs Scrub Road
PMP Design Event Flood Impact

Drg Ref
M9000_082

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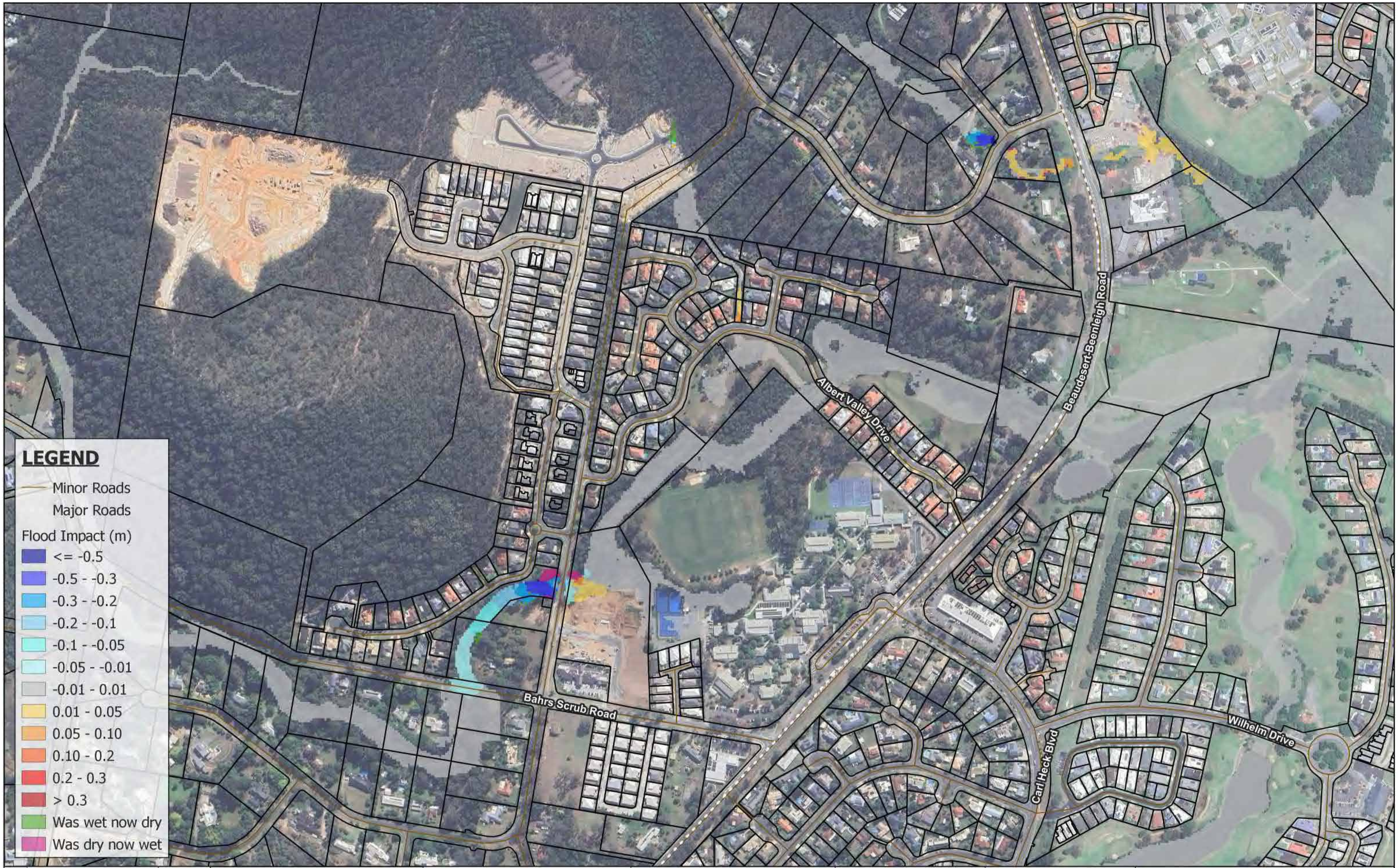

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:5,000
GDA2020 / MGA zone 56

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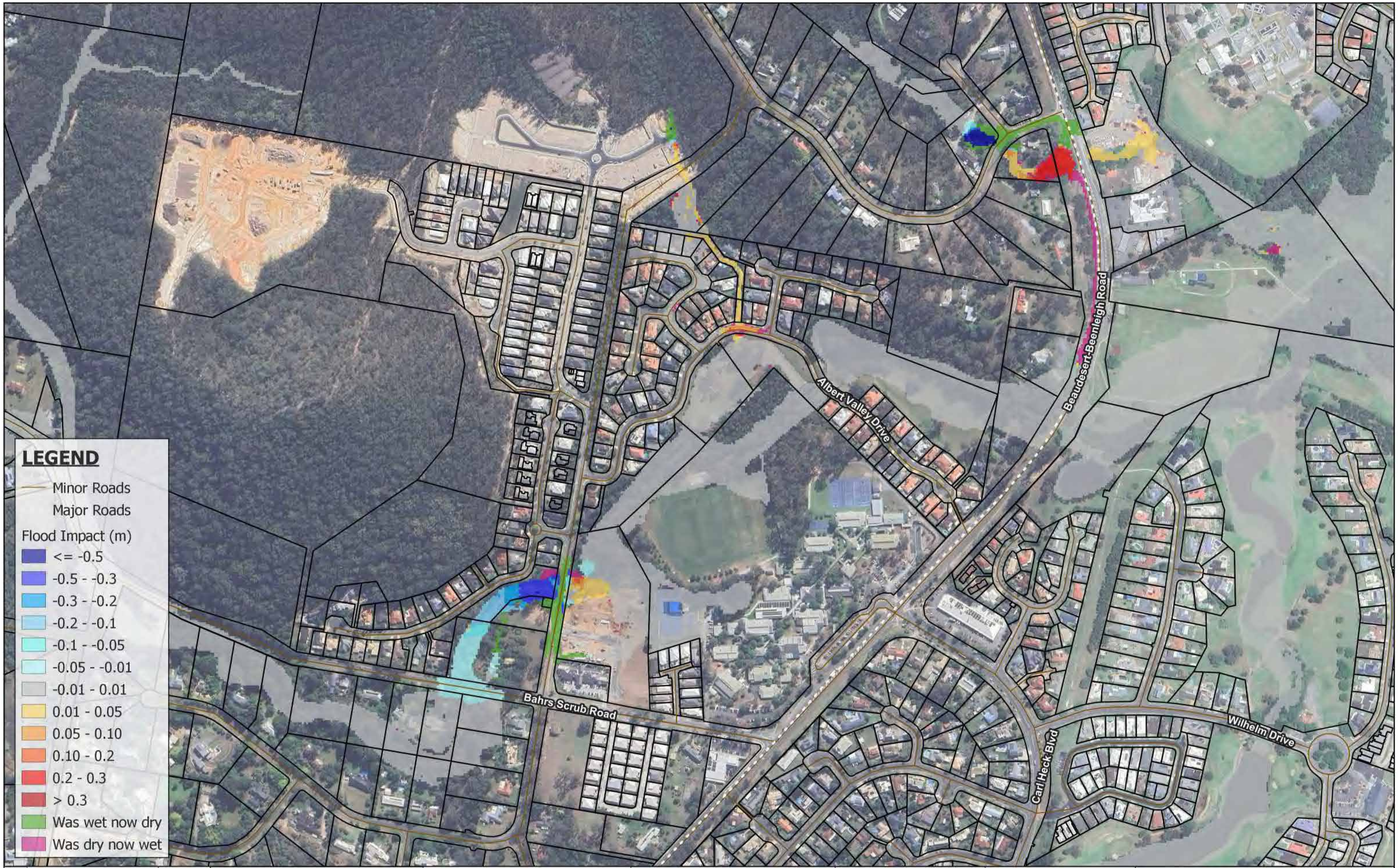
Appendix I 11

Windaroo Creek Flood Study

Structural Mitigation Option 2 – Evacuation Route Improvement
50% AEP Design Event Flood Impact

Drg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:5,000
GDA2020 / MGA zone 56

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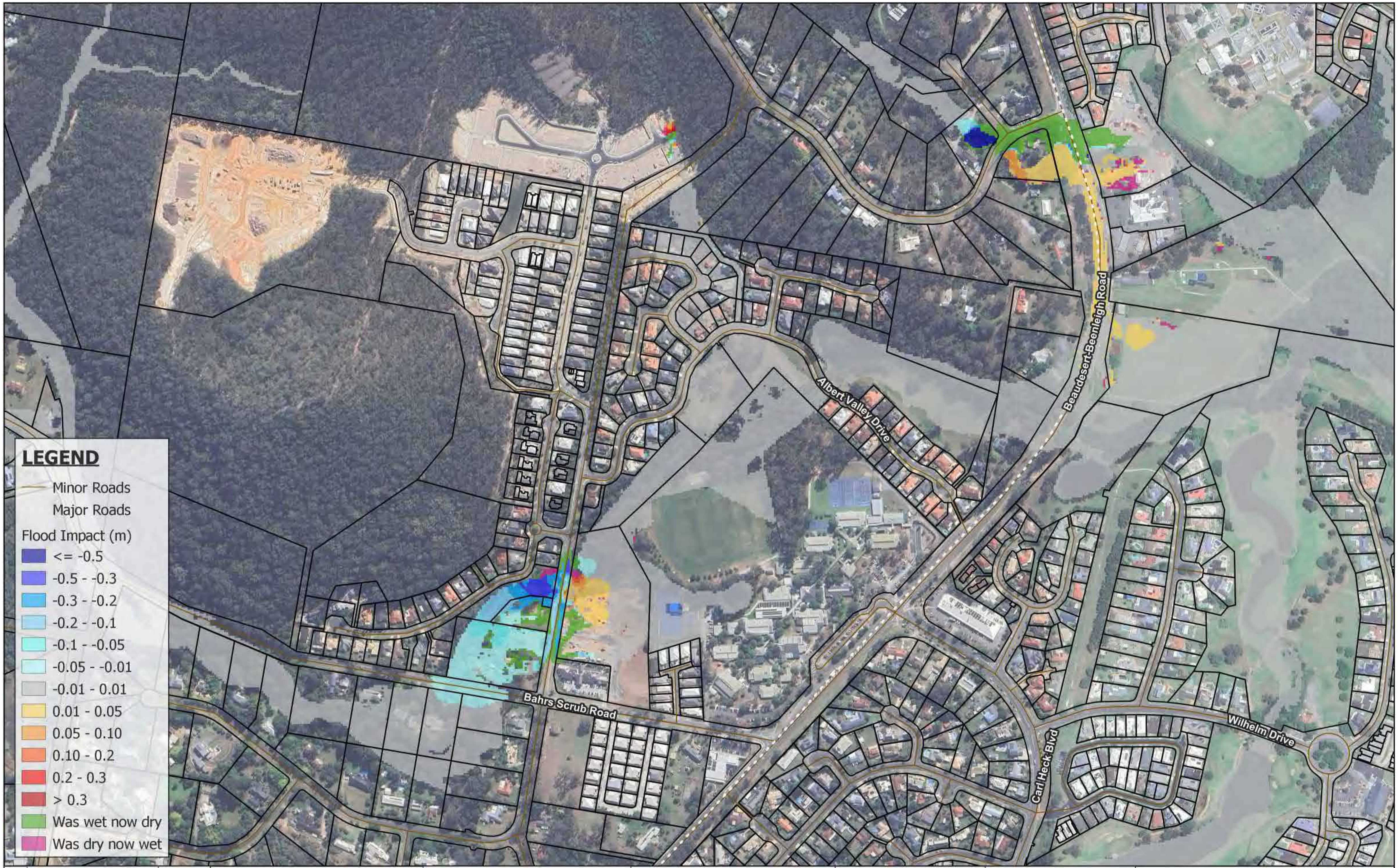
Appendix I 12

Windaroo Creek Flood Study

Structural Mitigation Option 2 – Evacuation Route Improvement
20% AEP Design Event Flood Impact

Dwg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:5,000
GDA2020 / MGA zone 56

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QLD Government Open Data Source

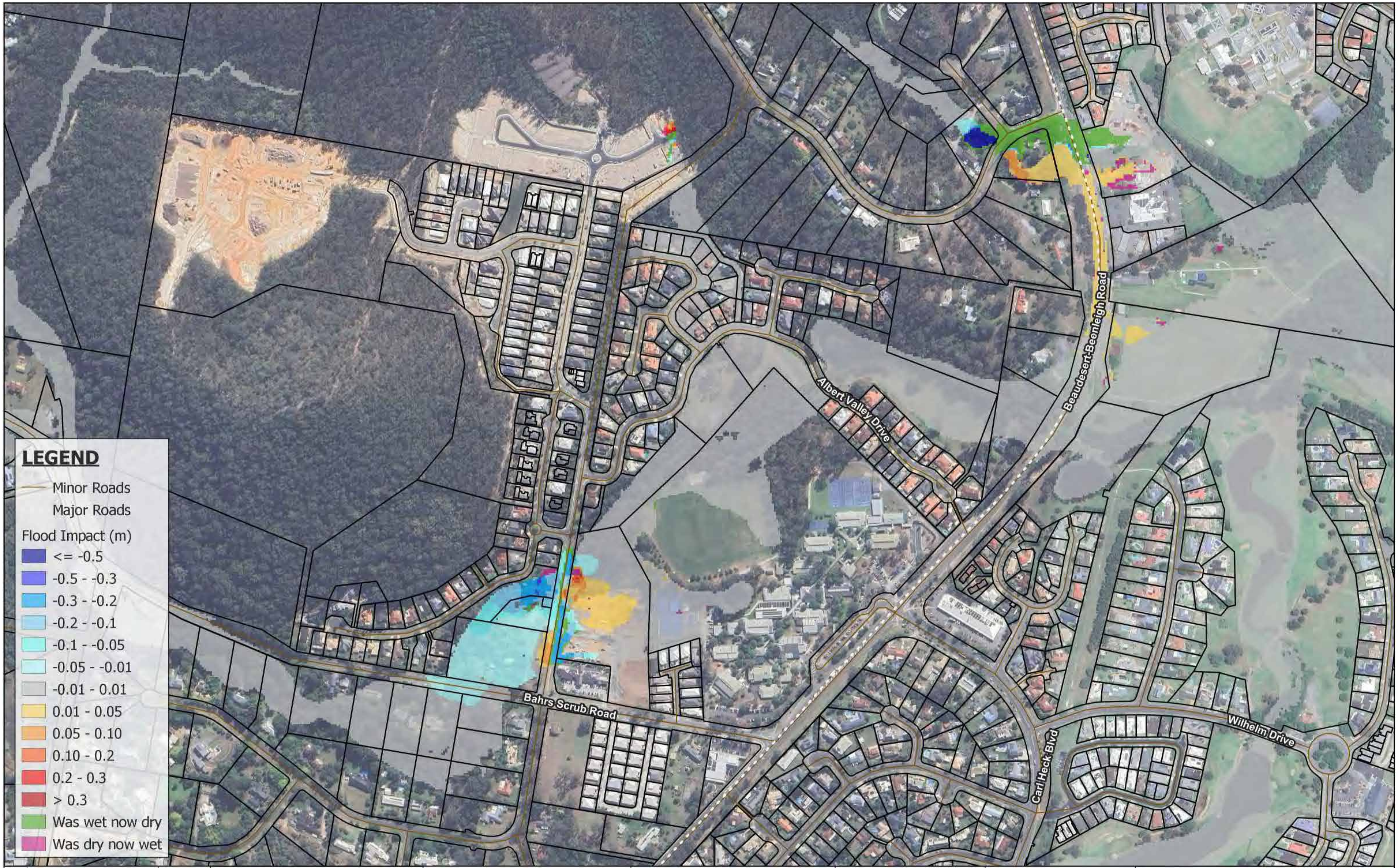
Appendix I 13

Windaroo Creek Flood Study

Structural Mitigation Option 2 – Evacuation Route Improvement
10% AEP Design Event Flood Impact

Dig Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:5,000
GDA2020 / MGA zone 56

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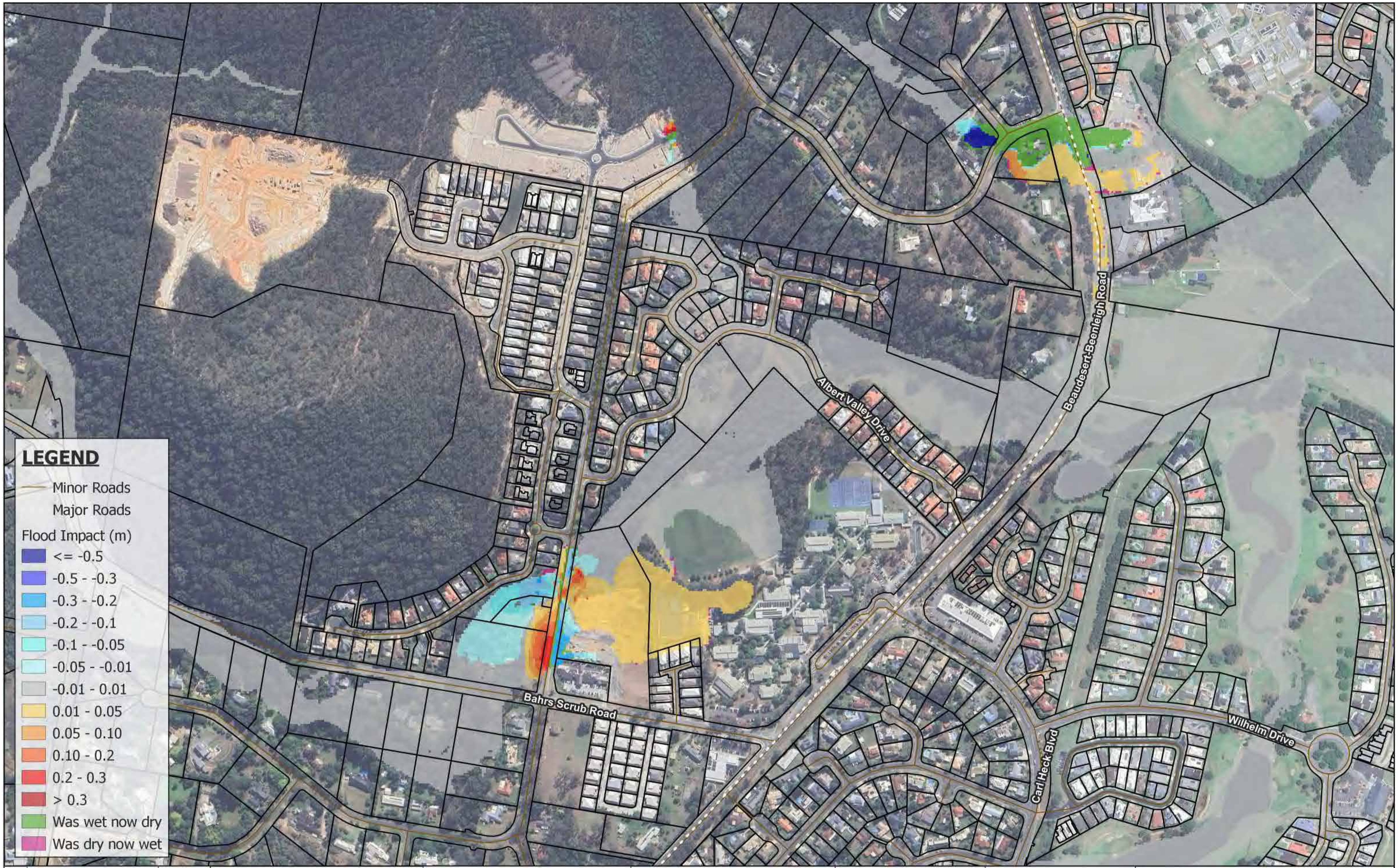
Appendix I 14

Windaroo Creek Flood Study

Structural Mitigation Option 2 – Evacuation Route Improvement
5% AEP Design Event Flood Impact

Dwg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:5,000
GDA2020 / MGA zone 56

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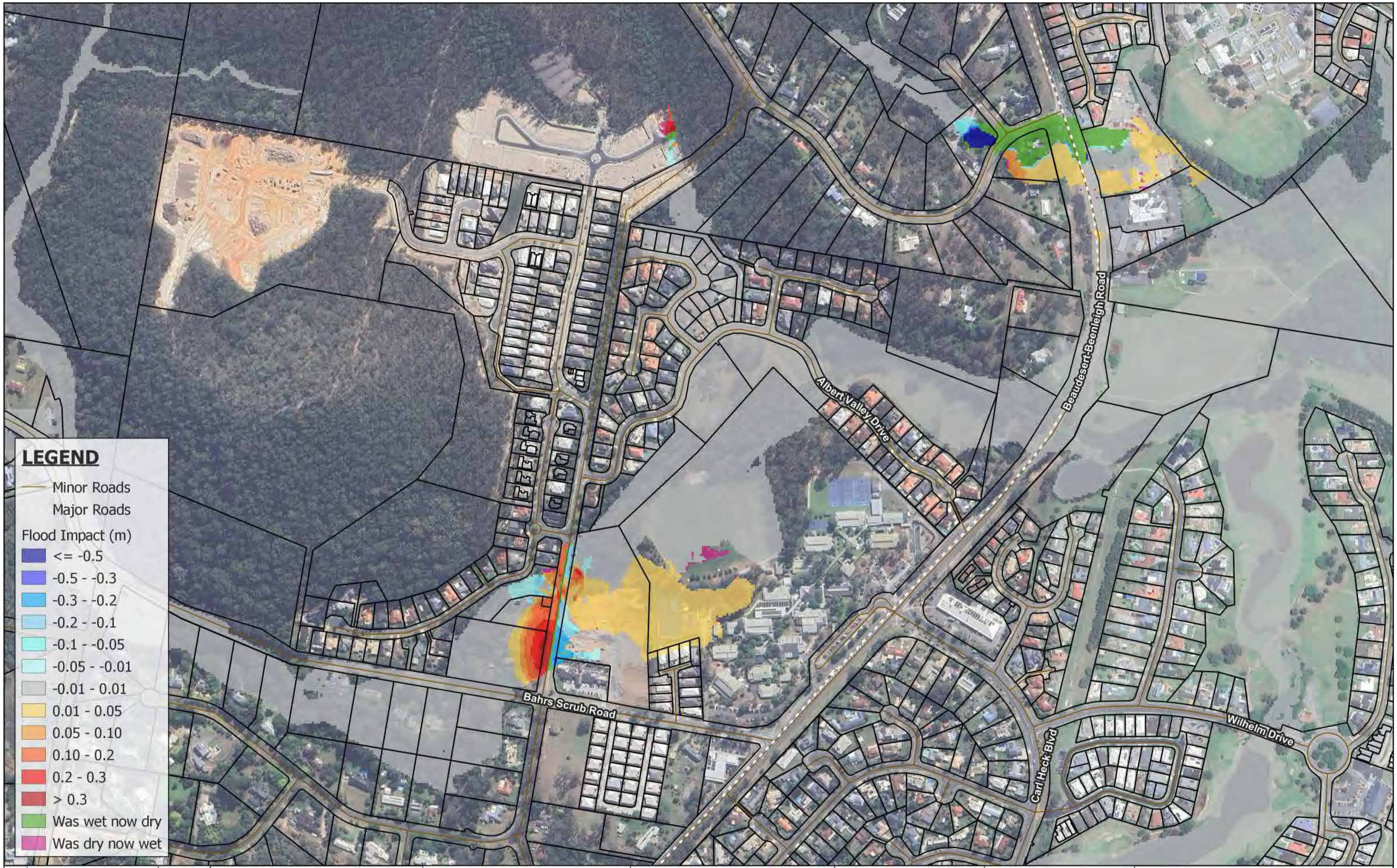
Appendix I 15

Windaroo Creek Flood Study

Structural Mitigation Option 2 – Evacuation Route Improvement
2% AEP Design Event Flood Impact

Dwg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:5,000
GDA2020 / MGA zone 56

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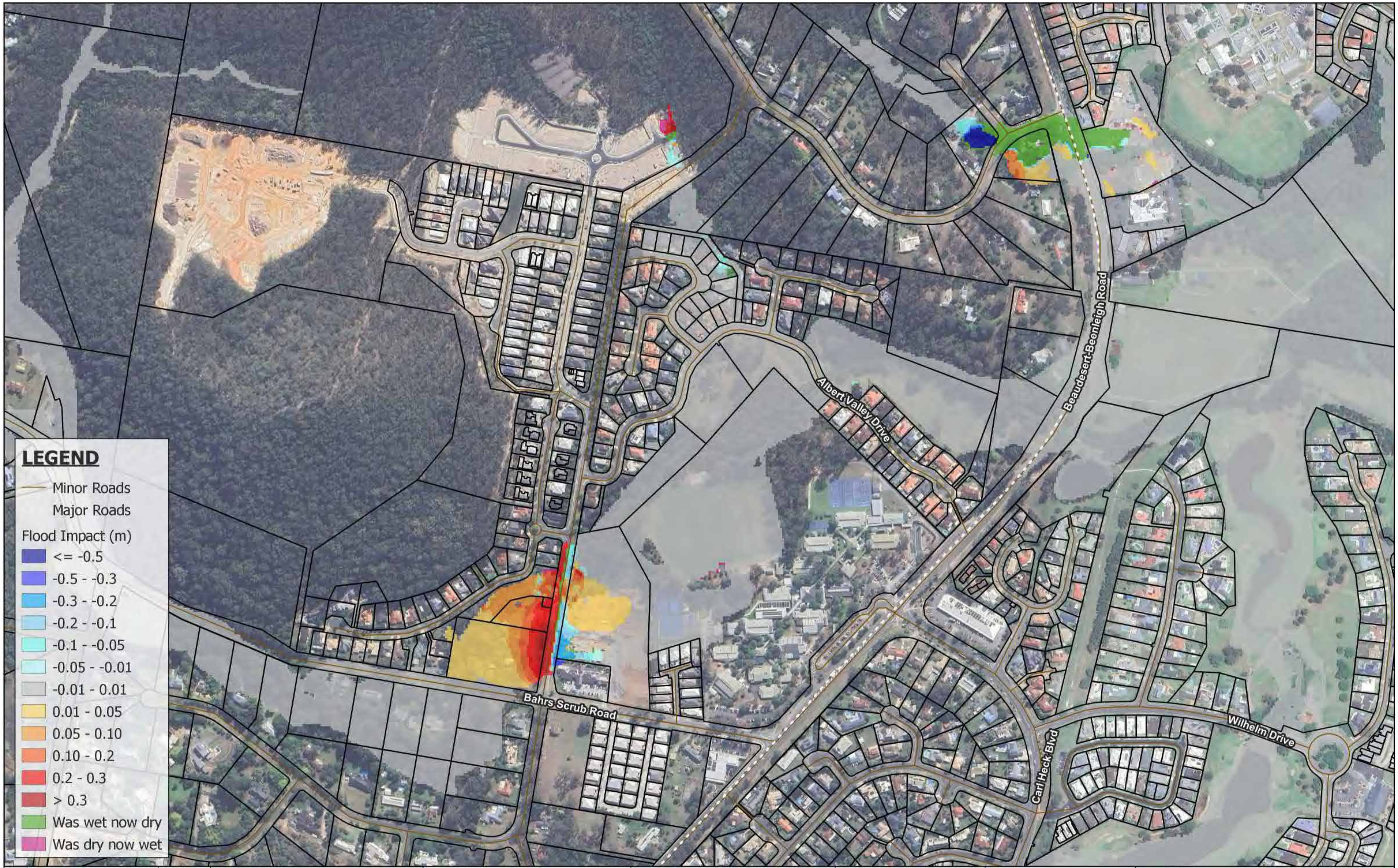
Appendix I 16

Windaroo Creek Flood Study

Structural Mitigation Option 2 – Evacuation Route Improvement
1% AEP Design Event Flood Impact

Drg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:5,000
GDA2020 / MGA zone 56

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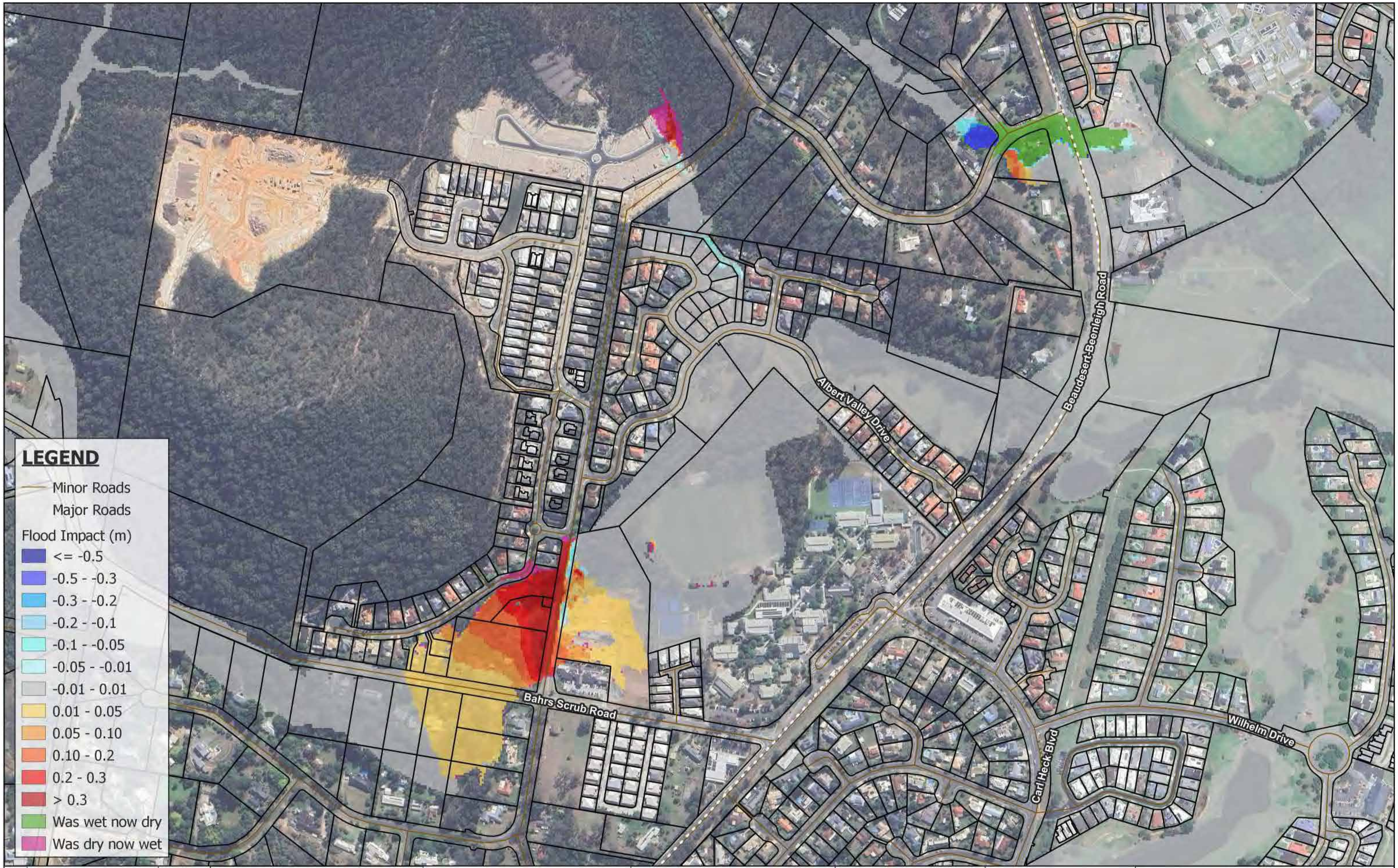
Appendix I 17

Windaroo Creek Flood Study

Structural Mitigation Option 2 – Evacuation Route Improvement
0.5% AEP Design Event Flood Impact

Dwg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz



R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:5,000
GDA2020 / MGA zone 56

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Appendix I 18

Windaroo Creek Flood Study

Structural Mitigation Option 2 – Evacuation Route Improvement
0.2% AEP Design Event Flood Impact

Drg Ref
M9000_082

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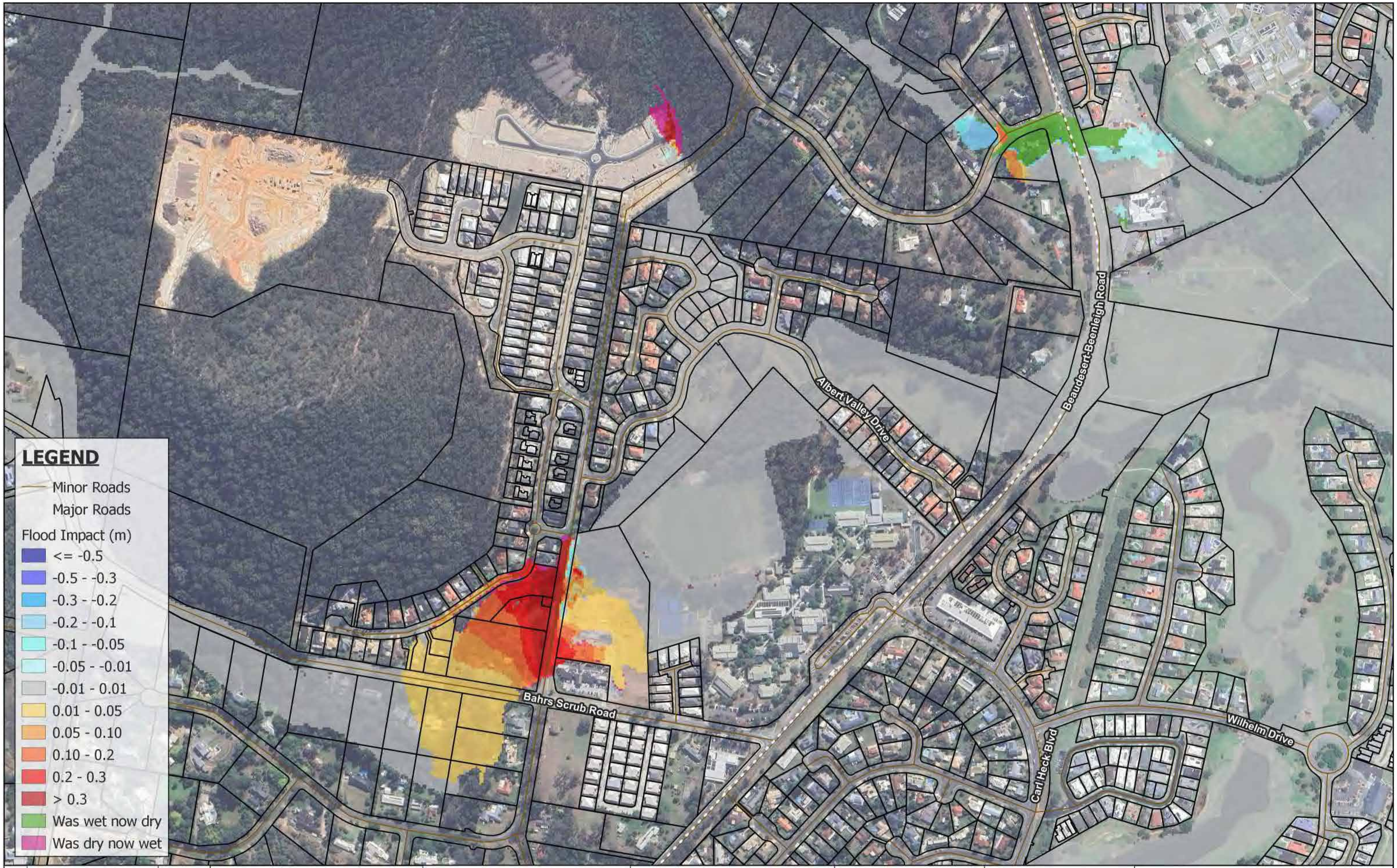

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1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:5,000
GDA2020 / MGA zone 56

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Appendix I 19

Windaroo Creek Flood Study

Structural Mitigation Option 2 – Evacuation Route Improvement
0.05% AEP Design Event Flood Impact

Drg Ref
M9000_082

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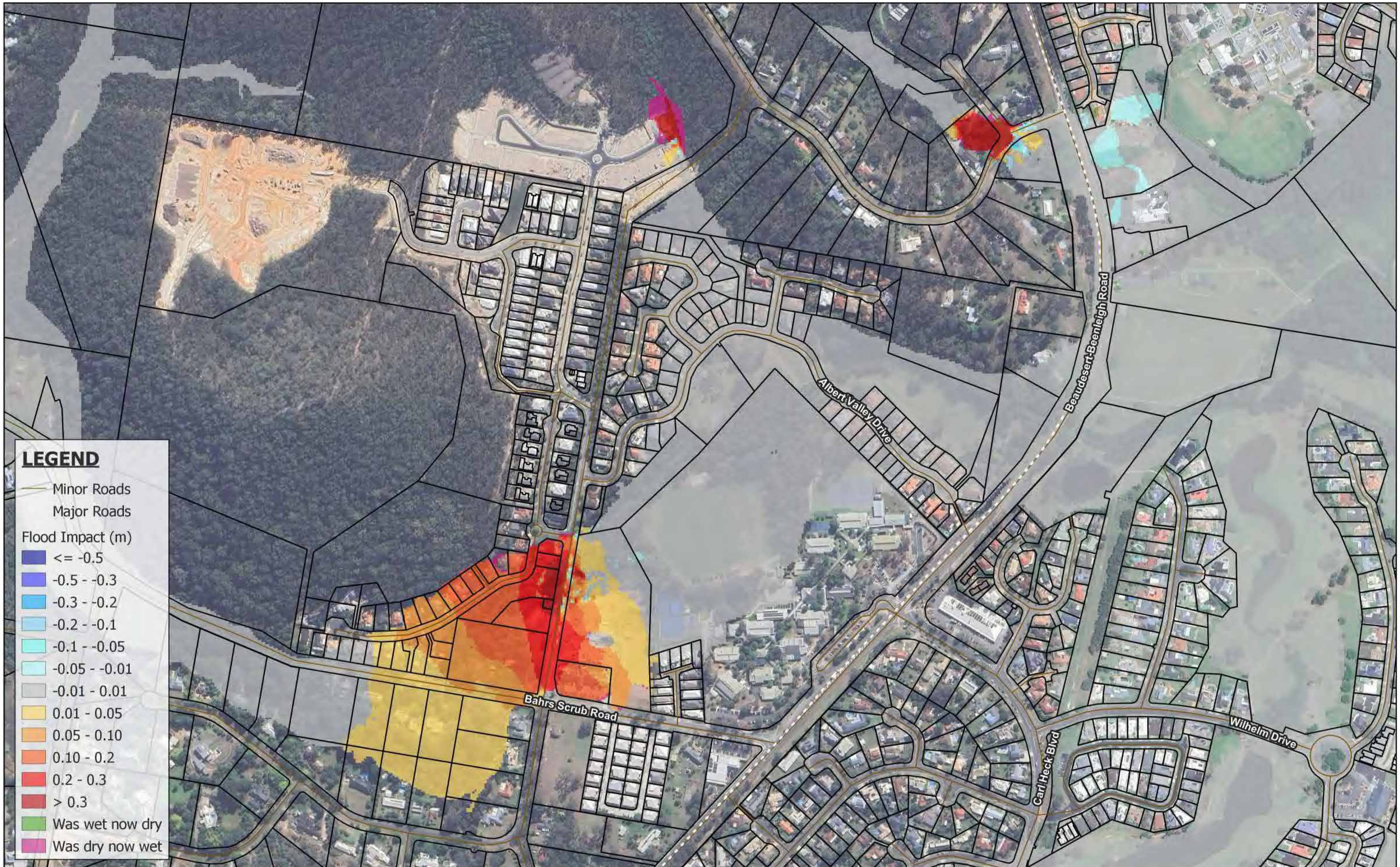

R	DETAILS	DATE
1	Final Issue	12-03-2024

DRAWN	LN	CHECKED	KM
APPROVED	MP	DATE	12-03-2024

NOTES:

N

0 0.5 1 km

SCALE @ A3 - 1:5,000
GDA2020 / MGA zone 56

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Appendix I 20

Windaroo Creek Flood Study

Structural Mitigation Option 2 – Evacuation Route Improvement
PMP Design Event Flood Impact

Dwg Ref
M9000_082

M:\Projects\M9000_Logan_City_Council\M9000_082 Windaroo Ck FS\05 Design\QGIS\Workspaces\M9000_082-WOR-003-E Working_Figure_ST.qgz

APPENDIX J: MITIGATION OPTION COST ESTIMATES

Cost Estimates

Structural Mitigation Option 1 - Bahrs Scrub Road

Feasibility Design

Project:	M9000_082
Date:	4/03/2024
Revision:	0
Revision Description:	Issue for Review
Work By:	CD
Reviewed:	KM

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Item No.	Item Description and Works Areas	Unit	Quantity	Rate ($AU)	Price ($AU)	Additional Comments
	Indirect Costs				**$ 984,002.04**	
	Mobilisation *Mobilisation of all plant, equipment, materials and labour to undertake the Works including establishment of site offices, crib sheds, workshops, laydown areas and compliance with statutory and site requirements*	%	5%		$ 109,334	
	Demobilisation *Demobilisation of all plant, equipment, labour, and surplus materials; reinstatement of laydown areas & access roads; removal of rubbish and waste*	%	5%		$ 109,334	
	Survey *Set out of Works and preparation of as-built drawings as defined by the Technical Specifications*	%	5%		$ 109,334	
	Traffic Control *Supply, install and maintain traffic control measures to the satisfaction of the Company's Representative*	%	5%		$ 109,334	
	Documentation *Preparation of final documentation for project close-out as defined in the Technical Specification*	%	5%		$ 109,334	
	Project Management, HSE & Supervision *For entire duration of the Works including preparation of all required management plans*	%	10%		$ 218,667	
	Approvals	%	5%		$ 109,334	
	Engineering Design - Concept and Detailed Design	%	5%		$ 109,334	
	Direct Costs				**$ 2,186,671.20**	
	Creek Widening Works					
	Clearing and grubbing *Clearing of vegetation in nominated areas, including removal of surface rocks*	m^2	15,120.0	$ 9.00	$ 136,080.00	
	Removal of existing trees and stumps 0.0m - 5.0m height, transfer to top (min. charge $550)	No	10.0	$ 50.00	$ 500.00	
	Removal of existing trees and stumps 5.5m - 10.0m height, transfer to top	No	10.0	$ 210.00	$ 2,100.00	
	Removal of existing trees and stumps 10.5m - 15.0m height, transfer to top	No	10.0	$ 320.00	$ 3,200.00	
	Removal of existing trees and stumps 15.5m - 20m height, transfer to top	No	10.0	$ 420.00	$ 4,200.00	
	Excavation *Cut to Spoil < 2km one way haul*	m^3	14,605.9	$ 35.00	$ 511,207.20	
	Topsoil, Seeding and Hydromulch *From stockpile, load, haul, place, and establish; 300mm of topsoil and hydromulch and amelioration*	m^2	13,824.0	$ 15.50	$ 214,272.00	
	Road Raise Bahrs Scrub Road					
	Removal of Existing Pavement Take up existing bitumious surfacing, including site separation and transport to tip	m^2	2,000.0	$ 5.00	$ 10,000.00	
	Fill Placement *Placement of fill to raise road (subgrade material)*	m^3	3,500.0	$ 100.00	$ 350,000.00	
	Road Sub-Base *Sub-base material (CBR 45) (QTMR Subtype 2.3) - 200mm thick depth, supply, place and compact*	m^3	600.0	$ 100.00	$ 60,000.00	
	Road Base Course *Base course material (CBR 80) (QTMR Subtype 2.1) - 200mm thick depth, supply, place and compact*	m^3	600.0	$ 140.00	$ 84,000.00	
	Bitumen Surfacing *Single coat seal, supply and spray*	m^2	2,000.0	$ 4.56	$ 9,120.00	
	Kerb Placement *Preparation for kerb construction and supply and place of new kerbing*	lineal m	200.0	$ 200.00	$ 40,000.00	
	Levee Placement					
	Fill Placement - Engineered Fill *Win, load, haul, place, compact incl key trench preparation and placement*	m^3	9,600.0	$ 30.00	$ 288,000.00	
	Topsoil, Seeding and Hydromulch *From stockpile, load, haul, place, and establish; 300mm of topsoil and hydromulch and amelioration*	m^2	15,464.0	$ 15.50	$ 239,692.00	
	Culvert Upgrade Bahrs Scrub Road					
	Demolition of existing culvert -3/675 RCP *Excavate, remove backfill, dispose to landfill*	lineal m	30.0	$ 50.00	$ 1,500.00	
	Placement of 4 / 4200mm wide x 900mm high RCBC *Lay, bed and joint above item*	lineal m	40.0	$ 2,424.00	$ 96,960.00	
	Placement of Precast Base Slab *2100 nominal size to 3600mm*	lineal m	40.0	$ 500.00	$ 20,000.00	
	Precast headwall *Supply, installation and apron construction for culvert Works*	No	2.0	$ 50,000.00	$ 100,000.00	
	Wingwall *Concrete Wingwalls for RCBCs (cast In situ reinforced)*	m^3	9.0	$ 1,200.00	$ 10,800.00	
	Placement of Dumped Rock Protection for Apron *Supply and place rock D50=600mm*	m^2	168.0	$ 30.00	$ 5,040.00	
	Sub total				**$ 3,170,673.24**	
	Escalation	%	6%		$ 190,240.39	
	Contingency	%	30%		$ 951,201.97	
			Total Project Cost		**$ 4,312,115.61**	

Cost Estimates

Structural Mitigation Option 2 - Evacuation Route Improvement

Feasibility Design

Project: M9000_082
Date: 4/03/2024
Revision: 0
Revision Description: Issue for Review
Work By: CD
Reviewed: KM

ENGENY

Item No.	Item Description and Works Areas	Unit	Quantity	Rate ($AU)	Price ($AU)	Additional Comments
	Indirect Costs				$ 1,047,995.05	
	Mobilisation *Mobilisation of all plant, equipment, materials and labour to undertake the Works including establishment of site offices, crib sheds, workshops, laydown areas and compliance with statutory and site requirements*	%	5%		$ 104,800	
	Demobilisation *Demobilisation of all plant, equipment, labour, and surplus materials; reinstatement of laydown areas & access roads; removal of rubbish and waste*	%	5%		$ 104,800	
	Survey *Set out of Works and preparation of as-built drawings as defined by the Technical Specifications*	%	5%		$ 104,800	
	Traffic Control *Supply, install and maintain traffic control measures to the satisfaction of the Company's Representative*	%	10%		$ 209,599	
	Documentation *Preparation of final documentation for project close-out as defined in the Technical Specification*	%	5%		$ 104,800	
	Project Management, HSE & Supervision *For entire duration of the Works including preparation of all required management plans*	%	10%		$ 209,599	
	Approvals	%	5%		$ 104,800	
	Engineering Design - Concept and Detailed Design	%	5%		$ 104,800	
	Direct Costs				$ 2,095,990.10	
	Windaroo Rd Road Upgrade					
	Removal of Existing Pavement Take up existing bitumious surfacing, including site separation and transport to tip	m^2	2,760.0	$ 5.00	$ 13,800.00	
	Fill Placement *Placement of fill to raise road (subgrade material)*	m^3	4,692.0	$ 100.00	$ 469,200.00	
	Road Sub-Base *Sub-base material (CBR 45) (QTMR Subtype 2.3) - 200mm thick depth, supply, place and compact*	m^3	828.0	$ 100.00	$ 82,800.00	
	Road Base Course *Base course material (CBR 80) (QTMR Subtype 2.1) - 200mm thick depth, supply, place and compact*	m^3	248.4	$ 140.00	$ 34,776.00	
	Bitumen Surfacing *Single coat seal, supply and spray*	m^2	2,760.0	$ 4.56	$ 12,585.60	
	Windaroo Rd Culvert Upgrade					
	Demolition of existing culvert -6/3600x2500 RCBC *Excavate, remove backfill, dispose to landfill*	lineal m	81.0	$ 266.67	$ 21,600.00	
	Placement of 11 / 3600mm wide x 3300mm high RCBC culverts *Lay, bed and joint above item*	lineal m	148.5	$ 4,118.00	$ 611,523.00	
	Placement of Precast Base Slab *2100 nominal size to 3600mm*	lineal m	148.5	$ 500.00	$ 74,250.00	
	Precast headwall *Supply, installation and apron construction for culvert Works*	No	2.0	$ 50,000.00	$ 100,000.00	
	Wingwall *Concrete Wingwalls for RCBCs (cast In situ reinforced)*	m^3	33.0	$ 1,350.00	$ 44,550.00	
	Excavation *Cut to Spoil < 2km one way haul*	m^3	654.9	$ 35.00	$ 22,921.50	
	Placement of Dumped Rock Protection for Apron *Supply and place rock D50=600mm*	m^2	396.0	$ 30.00	$ 11,880.00	
	Nevron Dr Road Formalisation					
	Clearing and grubbing *Clearing of vegetation in nominated areas, including removal of surface rocks*	m^2	1,800.0	$ 9.00	$ 16,200.00	
	Fill Placement *Placement of fill to raise road (subgrade material)*	m^3	759.0	$ 100.00	$ 75,900.00	
	Road Sub-Base *Sub-base material (CBR 45) (QTMR Subtype 2.3) - 200mm thick depth, supply, place and compact*	m^3	540.0	$ 100.00	$ 54,000.00	
	Road Base Course *Base course material (CBR 80) (QTMR Subtype 2.1) - 200mm thick depth, supply, place and compact*	m^3	162.0	$ 140.00	$ 22,680.00	
	Bitumen Surfacing *Single coat seal, supply and spray*	m^2	330.0	$ 4.56	$ 1,504.80	
	Nevron Dr Culvert Upgrade					
	Placement of 3/1200RCP *Excavation, lay, bed and backfill*	lineal m	39.0	$ 1,631.00	$ 63,609.00	
	Precast headwall *Supply, installation and apron construction for culvert Works*	No	2.0	$ 3,685.00	$ 7,370.00	
	Placement of Dumped Rock Protection for Apron *Supply and place rock D50=600mm*	m^2	36.0	$ 30.00	$ 1,080.00	
	Janine Dr Road Upgrade					
	Removal of Existing Pavement Take up existing bitumious surfacing, including site separation and transport to tip	m^2	1,820.0	$ 5.00	$ 9,100.00	
	Fill Placement *Placement of fill to raise road (subgrade material)*	m^3	1,820.0	$ 100.00	$ 182,000.00	
	Road Sub-Base *Sub-base material (CBR 45) (QTMR Subtype 2.3) - 200mm thick depth, supply, place and compact*	m^3	546.0	$ 100.00	$ 54,600.00	
	Road Base Course *Base course material (CBR 80) (QTMR Subtype 2.1) - 200mm thick depth, supply, place and compact*	m^3	163.8	$ 140.00	$ 22,932.00	
	Bitumen Surfacing *Single coat seal, supply and spray*	m^2	1,820.0	$ 4.56	$ 8,299.20	
	Janine Dr Culvert Upgrade					
	Demolition of existing culvert - 1/1050RCP *Excavate, remove backfill, dispose to landfill*	lineal m	81.0	$ 50.00	$ 4,050.00	
	Placement of 4/1200RCP *Excavation, lay, bed and backfill*	lineal m	39.0	$ 1,631.00	$ 63,609.00	
	Precast headwall *Supply, installation and apron construction for culvert Works*	No	2.0	$ 3,685.00	$ 7,370.00	
	Placement of Dumped Rock Protection for Apron *Supply and place rock D50=600mm*	m^2	60.0	$ 30.00	$ 1,800.00	
	Sub total				$ 3,143,985.15	
	Escalation	%	6%		$ 188,639.11	
	Contingency	%	30%		$ 943,195.55	
			Total Project Cost		$ 4,275,819.80	