West Gippsland
Catchment Management Authority

Date: 09/05/2025

South Gippsland Shire Council

Subject: Welshpool 421 Barry Road Flood Impact Assessment 2021

The Authority advises that it has reviewed the *Welshpool 421 Barry Road Flood Impact Assessment* (2021) and is satisfied that it provides an accurate estimation of the 1% AEP flood and is the best data available for this location.

Yours sincerely,

Ben Proctor
Senior Planning Officer – Statutory Planning

The information contained in this correspondence is subject to the following definition.

Definition

1. **AEP** as Annual Exceedance Probability is the likelihood of occurrence of a flood of given size or larger occurring in any one year. AEP is expressed as a percentage (%) risk and may be expressed as the reciprocal of ARI (Average Recurrence Interval).

   Please note that the 1% probability flood is not the probable maximum flood (PMF). There is always a possibility that a flood larger in height and extent than the 1% probability flood may occur in the future.

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Date | 19 July 2021

Flood Impact Assessment – 421 Barry Road, Welshpool

Dear Tom,

Thank you for commissioning Water Modelling Solutions to undertake the Flood Impact Assessment (FIA) at 421 Barry Road, Welshpool, VIC. I have prepared a short report outlining the results of the assessment for existing conditions for the proposed site.

1 OBJECTIVES

Water Modelling Solutions was commissioned to undertake a Flood Impact Assessment (FIA) to determine existing flood conditions for the 1% AEP Flood event, including whether existing flood depths in the 1% AEP exceed 300mm on the main access route as well as internal driveways. This is following advice provided by West Gippsland Catchment Management Authority (WGCMA) in order to allow safe vehicle egress to a proposed dwelling located at the south-east corner of the site as well as to ensure any proposed buildings and septic systems are located outside of the 1% AEP flood extent. The WGCMA does not currently have detailed information on the flood level, depth or velocity for this location, with the current 1% AEP flood extent based on historical information.

The site is located approximately 5km south-east of Welshpool township, which is located within the South Gippsland Shire Council municipality. The western portion of the site is currently zoned as Industrial 1 Zone (I1Z) while the east zoned as Farming Zone (FZ) as per the Department of Environment, Land, Water and Planning (DELWP) VicPlan (DELWP, 2021).

An overview of the Site as well as the existing 1% AEP flood extent from historical information is illustrated in Figure 1-1.

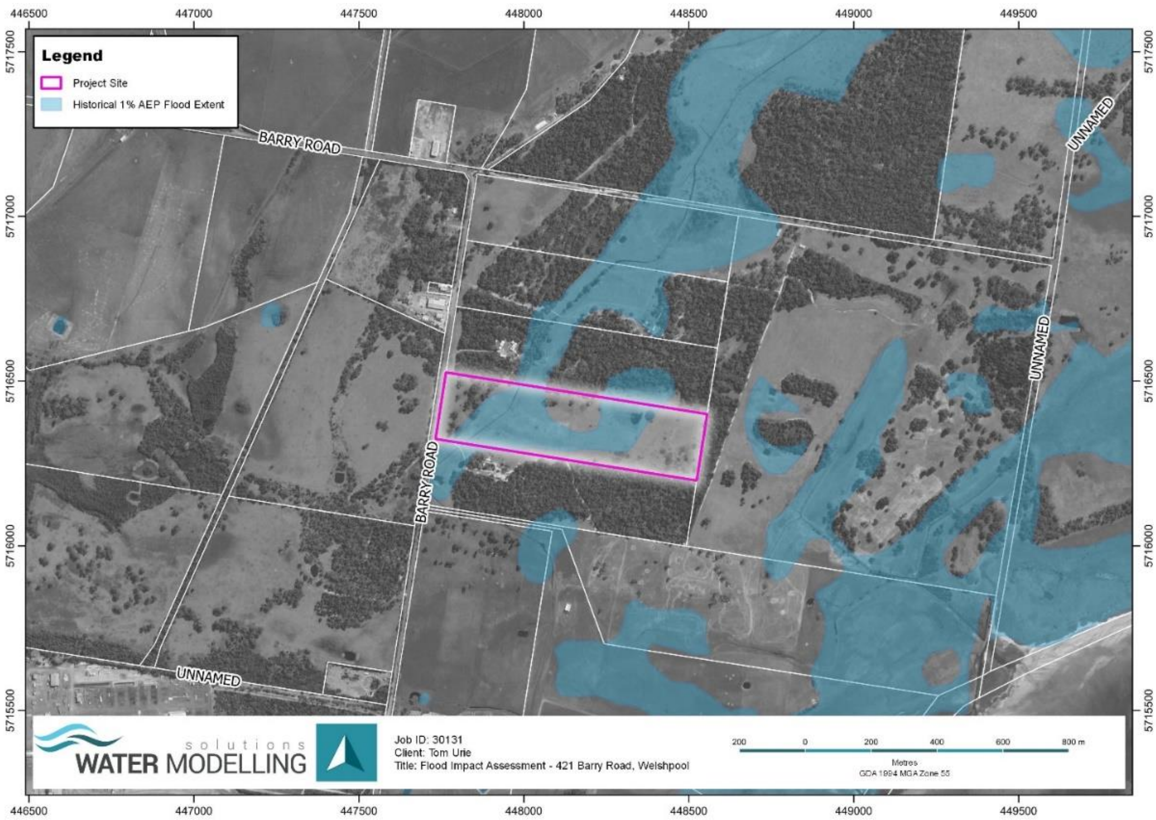

Figure 1-1 Subject Site

2 HYDROLOGIC MODELLING

The RORB hydrological model Version 6.45 (Laurenson, Mein and Nathan, 2010) was used for this study. RORB calculates flood hydrographs from storm rainfall hyetographs and can be used for modelling natural, part urban and fully urban catchments. RORB is an industry standard modelling package that is used widely in hydrological studies in Australia.

Critical duration and associated peak mean temporal pattern for the 1% AEP storm event (in accordance with ARR2019) was determined through a combined Monte Carlo/Ensemble approach (as discussed in Section 2.2 where results informed hydrograph inputs adopted for hydraulic modelling as discussed in Section 3.

Sub-catchment delineation of the Site and surrounding areas was determined through tools in ArcMap using purchased LiDAR in combination with publicly available LiDAR obtained online (Geoscience, 2021).

Values of fraction imperviousness were determined through aerial imagery adopting standard values based on land use where values were obtained from Australian Rainfall and Runoff: A Guide to Flood Estimation (ARR2019). The final sub-catchment value for fraction imperviousness was determined by weight averaging the FI areas per sub-catchment.

Catchment delineation for hydrologic modelling is illustrated in Figure 2-1.

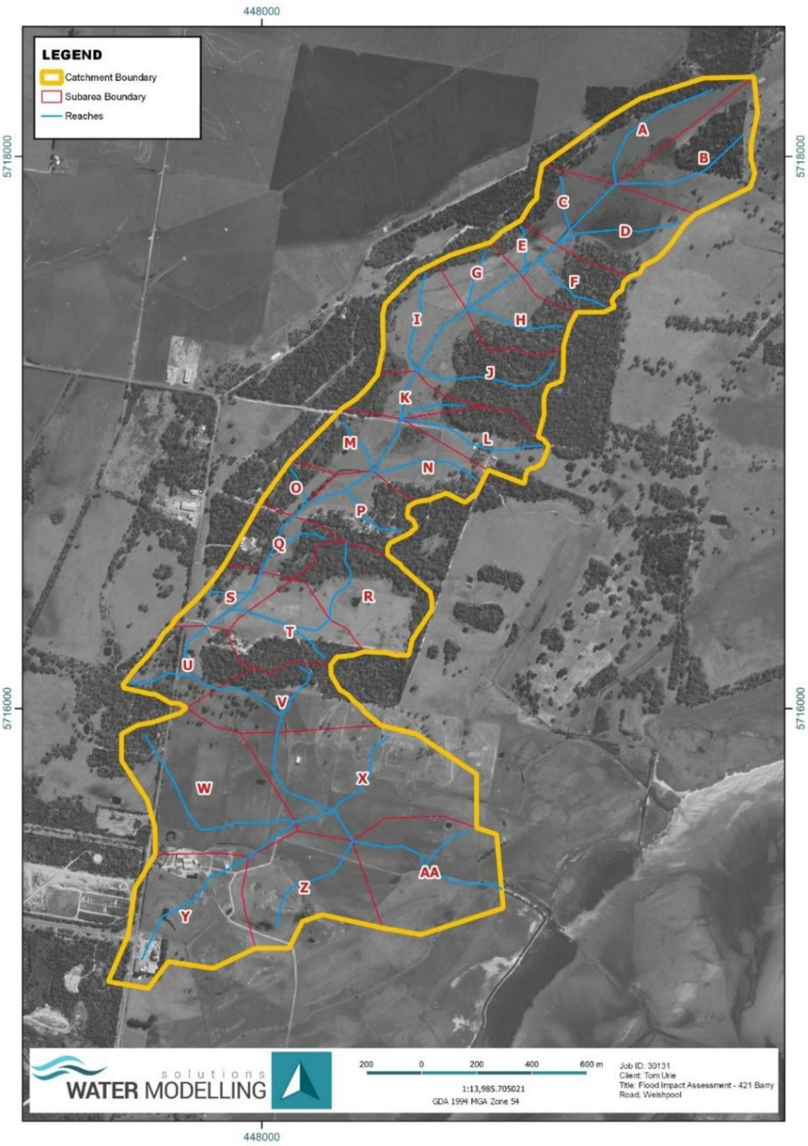

Figure 2-1 Hydrologic Model Catchment Delineation

2.1 LOSSES

For catchments, initial losses and continuing losses are required to be estimated for three catchment surface types (ARR2019, Book 5 Chapter 3.4 and Book 9 Chapter 6.4) including the following;

- Effective Impervious Area (EIA) – area of a catchment which contributes a rapid response to rainfall events (e.g. building roof discharging to the drainage network)
- Indirectly Connected Area (ICA) – impervious areas which are not directly connected to drainage structures but can generate runoff which does enter the drainage network (e.g. footpaths)
- Pervious Area (PA) – areas which do not contribute to the drainage systems (e.g. gardens)

Initial losses and continuing losses adopted for the ensemble simulation for each of the surface types are outlined in Table 2-1.

Table 2-1 Adopted initial losses and continuing losses

Fraction Imperviousness	Initial Loss (mm)	Continuing Loss (mm/h)
EIA	1.50	0.00
ICA	20.30	2.50
PA	29.00	3.80

2.1.1 Pre-Burst Rainfall

Use of standard design inputs in Victoria is likely to result in underestimation of design flow estimates when comparing calibrated flows to gauged data. Therefore, as per recent advice (HARC, 2020), Victorian catchments within the influence of loss region 3 (in lieu of further research) require the adoption of 75th percentile pre-burst rainfall where ARR2019 losses are adopted, where there is insufficient calibration data available to warrant using calibration losses.

As the project site is located within loss region 3, 75th percentile pre-burst rainfall was adopted for the purposes of this study.

2.1.2 Temporal Patterns

A range of design storms have been evaluated for durations ranging from 25 minutes to 72 hours for the 1% AEP event. In line with the procedure outlined in ARR2019 the full range of temporal patterns (TPs) for the South East Gippsland region were adopted for the Monte Carlo analysis.

Following the Monte Carlo analysis, an Ensemble Analysis was then modelled to determine which temporal pattern provided a peak flow closest to the Monte Carlo peak. The TP which provided the closest value was then adopted for design modelling. The adopted TPs are detailed in the following section.

2.2 MONTE CARLO ANALYSIS

A Monte Carlo (MC) analysis was undertaken in RORB, whereby thousands of model runs are simulated which consider a range of potential rainfall and catchment conditions. The Monte Carlo approach recognises that peak flows can be produced from a variety of combinations of catchment and rainfall conditions. This approach is considerably more robust than the traditional "design event"" approach which consists of modelling a single set of fixed parameters for each design event.

Within the MC analysis temporal patterns and continuing loss values were varied. Based on the results of the MC analysis it was deemed that adopting two critical duration events for design purposes was appropriate.

The Monte Carlo analysis output in RORB provides peak flows based on fitting a probability distribution to the range of modelled results at each location of interest. It does not provide a single set of results and hydrographs for use in design modelling. Therefore, following the Monte Carlo analysis, an Ensemble Analysis was modelled in RORB to determine which combination of parameters and temporal patterns produced a peak flow closest to the Monte Carlo peak. The adopted durations and temporal patterns are presented in the following section.

2.3 DESIGN FLOW SUMMARY

The key results from the hydrological modelling are summarised in Table 2-2 and show the adopted critical durations and associated temporal patterns for each of subareas and locations of interest. Based on this summary two durations were selected for modelling which provide the key durations for the subareas upstream of the project site as well as the critical duration for subareas located directly adjacent to the project site. The adopted design flows are within 4% of the Monte Carlo design flow estimate.

Table 2-2 1% AEP Design Flow Summary

Location	RORB Monte Carlo 1% AEP Peak Flow (m^3/s)	Critical Duration	Adopted Temporal Pattern	Adopted Ensemble 1% AEP Flow (m^3/s)
Upstream Catchments	5.55	4.5 hr	22	5.42
Subarea Q	0.86	2 hr	30	0.89
Subarea R	1.40	2 hr	25	0.93
Subarea S	0.82	2 hr	23	0.83
Subarea T	1.39	2 hr	30	1.38
Subarea U	1.14	2 hr	30	1.18

3 HYDRAULIC MODELLING

A TUFLOW steady state hydraulic model has been constructed to determine the existing flood extent and depths within the Site. TUFLOW is a two-dimensional model used widely in Australia for flooding and drainage studies and is considered the industry standard for flood impact analysis.

The hydrographs for the 1% AEP with various critical storm durations and temporal patterns were derived from RORB and applied to the TUFLOW model as the sub-catchments' excess rainfall hyetographs and hydrographs where appropriate.

For technical notes on model setup see Appendix A.

3.1 DESIGN FLOW COMPARISON

Due to the lack of available historical flood data for the area and the overall size of the flood impact assessment, a comparison using the rational method was completed comparing the result with the design RORB flows upstream of the site. The Rational Method is now considered inconsistent with best practice, however it remains a useful comparative and "rule of thumb" tool. It should be noted that the catchment is comparably small which further reduces the validity of the Rational Method and a comparison of the Rational Method with the RORB model should be only be taken as indicative.

A comparison of the Rational Method calculation and the RORB design flows for the subareas upstream of the project site are shown in Table 3-1.

Table 3-1 Comparison of Rational Method and RORB Output at Outlet of Model

AEP	Rational Method (m^3/s)	RORB Monte Carlo Flow (m^3/s)	Percentage Difference
1%	10.33	9.88	4.36

4 RESULTS

The results of the modelling outline flood impacts to the Subject Site with specific reference to the following as per advice from WGCMA:

- 1% AEP flood extent for the subject site
- 1% AEP flood depths on main access route as well as internal driveways.

4.1 FLOOD EXTENTS

For the existing scenario, the overland flow path from upstream catchments is concentrated within the constructed drainage channel located on the on the western side of the project site with maximum flood depths observed within this channel. Flows within the channel spill south of the main driveway access primarily due to the low elevations on the eastern side of the channel at this location. The 1% AEP flood extent is illustrated in Figure 4-1.

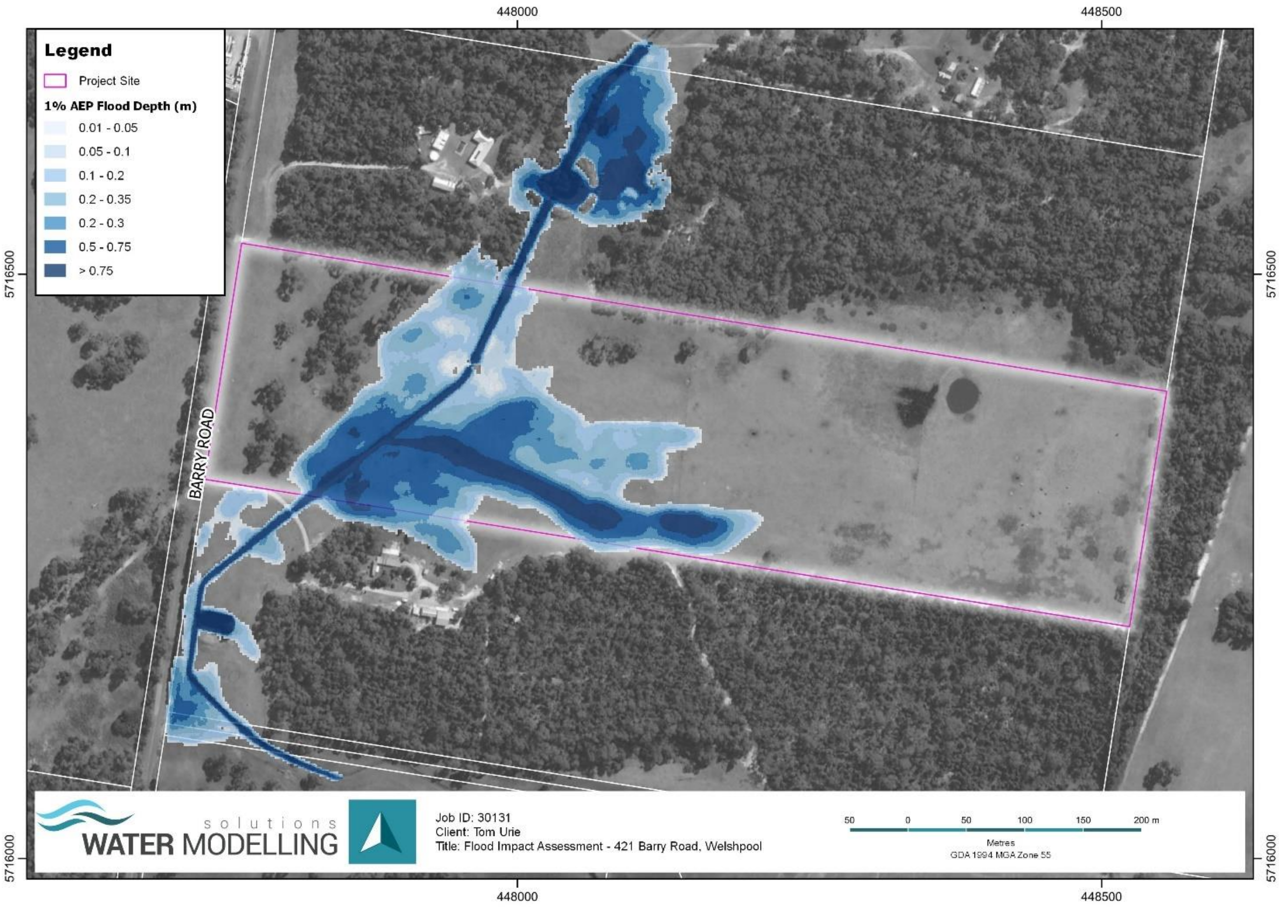

Figure 4-1 Existing 1% AEP Flood Depth

4.2 FLOOD DEPTHS

As part of approval from WGCMA, flood depths must not exceed 300mm on the main access route as well as internal driveways for the 1% AEP event to ensure safe access. As per preliminary designs, the flood depths observed on the main access route (as illustrated in Figure 4-2) reach a maximum depth of 260mm which is below the minimum WGCMA flood depth requirement.

It should be noted however that the flood depths observed within the constructed drainage channel reach up to 0.86m upstream of channel crossing with a water surface elevation of 4.89 mAHD. It is therefore recommended that any channel crossing is built entirely above the 1% AEP flood extent. Alternatively, if this is not possible from a constructability perspective, it is recommended that the impacts of any channel crossing structures are modelled as part of a design scenario to determine the potential afflux increases due to constructed assets.

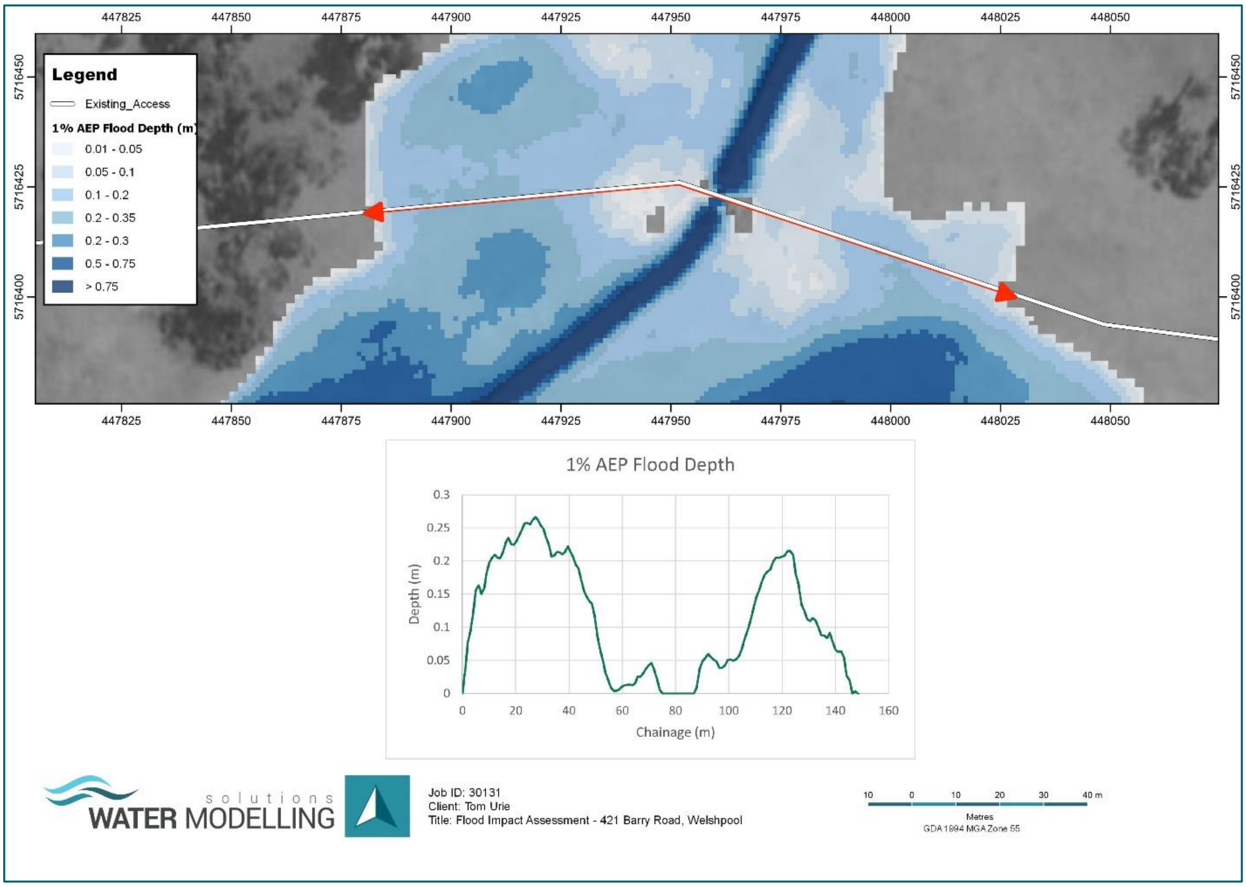

Figure 4-2 Access Road Flood Depth

5 SUMMARY AND CONCLUSIONS

Water Modelling Solutions was commissioned to undertake a Flood Impact Assessment (FIA) to determine existing flood extents for the 1% AEP Flood event and to determine whether existing flood depths in the 1% AEP exceed 300mm on the main access route as well as internal driveways. This is following advice provided by West Gippsland Catchment Management Authority (WGCMA) in order to allow safe vehicle egress to a proposed dwelling located at the south-east corner of the site as well as to ensure any proposed buildings and septic systems are located outside of the 1% AEP flood extent.

Results from the 1% AEP flood event show that the proposed building located at the south east corner of the lot will not be impacted by the 1% AEP flood extent. Safe egress through the main access road is also maintained in the 1% AEP flood event with maximum flood depths of 260mm observed, 40mm less than the maximum flood depth allowance of 300mm. It is recommended that due to the main access route crossing a constructed drainage channel that a minimum elevation of 4.6 mAHD be maintained at this crossing location.

Please do not hesitate to contact me if you have any queries or concerns.

Yours sincerely,

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Project Engineer
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REFERENCES

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) (2016). Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia.

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APPENDIX A

HYDRAULIC MODEL TECHNICAL DETAIL

A.1 TOPOGRAPHY

The Digital Elevation Model (DEM) has been constructed using LiDAR which was captured in 2008. The 2008 LiDAR is the most recent elevation data that was available. There were no amendments to the DEM in the existing case model. The catchment elevation is displayed in Figure A 1.

Figure A 1 Catchment Digital Elevation Model (DEM), 2008

A.2 HYDRAULIC STRUCTURES

Existing drainage within the catchment consisted of a constructed drainage channel located on the western side of the site. An existing culvert is located approximately 75m downstream from the northern boundary of the subject site which forms the main access to the eastern side of the lot and maintains conveyance of overland flows in the channel. Online data was unavailable for the culvert and was therefore inspected and measured manually onsite to confirm. Inverts were assumed to match the elevation within the DEM.

The location and imagery of the pipe from the site inspection are shown in Figure A 2 and Figure A 3 respectively.

Figure A 2 Existing Hydraulic Structures

Figure A 3 Cross culvert pipe from site inspection (south/downstream end)

A.3 MATERIALS

The area is primarily rural in the form of farming and industrial useage. The Manning's material roughness adopted in the TUFLOW model are displayed in Table A. 1. These values were adopted from ARR2019.

Material	Manning's N
Residential areas, Rural	0.20
Paved Roads and Carparks	0.12
Open pervious areas, medium vegetation (shrubs)	0.06
Open pervious areas, thick vegetation (trees)	0.10
Wetlands, emergent vegetation	0.07

Table A. 1 Manning's Roughness Values

A.4 INFLOWS

A hydrograph representing subareas upstream of the project site has been adopted at the northern extent of the hydraulic model extent. Several subareas located within the project boundary were also included within the model as hydrographs applied directly to the invert of constructed drainage channel at appropriate locations.

The critical duration and associated mean peak temporal patterns were determined through statistical analysis utilising the outputs from the RORB hydrological model. The critical duration for the upstream catchments was found to be the 4.5 hour duration whilst the critical duration for subareas within the hydraulic model extent was found to be the 2 hour duration. Several temporal patterns were identified for each of the subareas and are outlined in Table 2-2 1% AEP Design Flow Summary. The downstream boundary is a hydraulic slope boundary set to 0.3% where the slope was calculated from the existing LiDAR.

Locations of inflow and outflow boundary conditions are shown in Figure A 4.

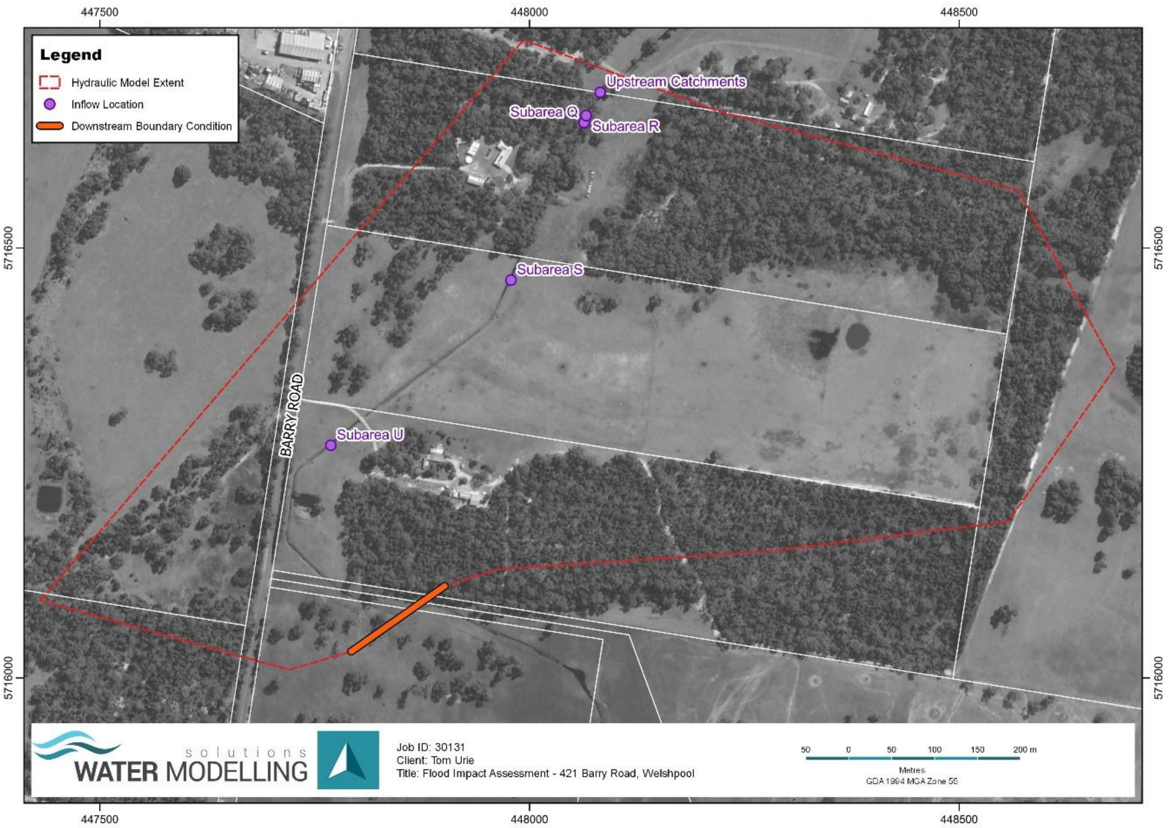

Figure A 4 Hydraulic Model Boundary Condition Locations