Memo

ADVERTISED PLAN

AFFLUX CONSULTING
STORMWATER MANAGEMENT SOLUTIONS

Kongwak Butter and Cheese Factory - Flood Modelling Results - Local Catchment

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To: Damien Backholer, Director - Kongwak Butter and Cheese

From: Chris Beardshaw, Principal Engineer - Afflux Consulting

Date: Tuesday 11 June 2024

Background

Afflux Consulting have been engaged to aid in the flooding and stormwater aspects associated with the proposed development in Kongwak. An initial memorandum dated 1 August 2023 was issued to advise on preliminary flood analysis for the regional catchment associated with 1486-1488 & 1492 Korumburra-Wonthaggi Rd, Kongwak. This work analysed the upstream hydrology and determined the risk of flooding for the site along the frontage of Foster Creek. This upstream analysis work should be read in conjunction with this memorandum to understand the larger upstream catchment hydrology.

This memorandum seeks to address the Department of Transport and Planning letter request for further information with reference no.: PA2402814 issued 23 April 2024. Particularly item 22 as quoted below:

> *A written statement (or updated Flood Modelling Analysis report) responding to the likelihood or potential of flooding caused by drainage channel proposed along southern boundary of site and reinstated dam to the north. Confirmation should also be provided that the proposed siting and elevation of cabin accommodation will not be impacted by water overflow at drainage channel or open paddock areas.*

Flood Modelling Approach

Hydrology

The flood modelling approach thus far has considered the analyses of regional hydrology and hydraulics (Foster Creek major catchment). This involved analysis of the large upstream catchment, and reconciliation of flows to regional parameters of the broader catchment (see Aug 2023 memo). The regional parameters as derived in this regional study have been scaled down, and a higher resolution local hydrology model constructed for this investigation.

The site hydrology was modelled using RORB (the standard Victorian flood hydrology model) with a catchment delineation and as schematised in Figure 1. The delineated site catchment was divided into reasonable-sized sub-catchments, rainfall losses, and scaled calibration parameters. An Ensemble approach was used to derive flows for the area. The peak flows from the two main branches discharging through the site and into Foster Creek can be seen below (Figure 2,Figure 3).

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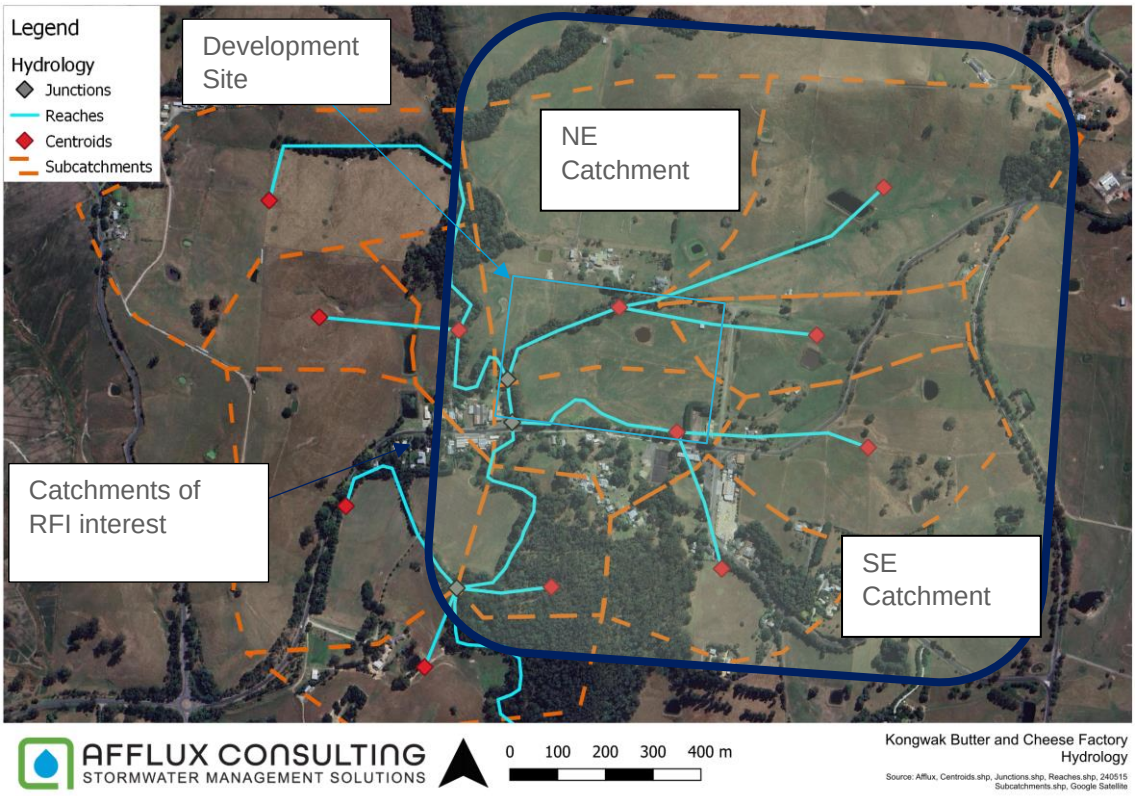


Figure 1. Catchment hydrology model

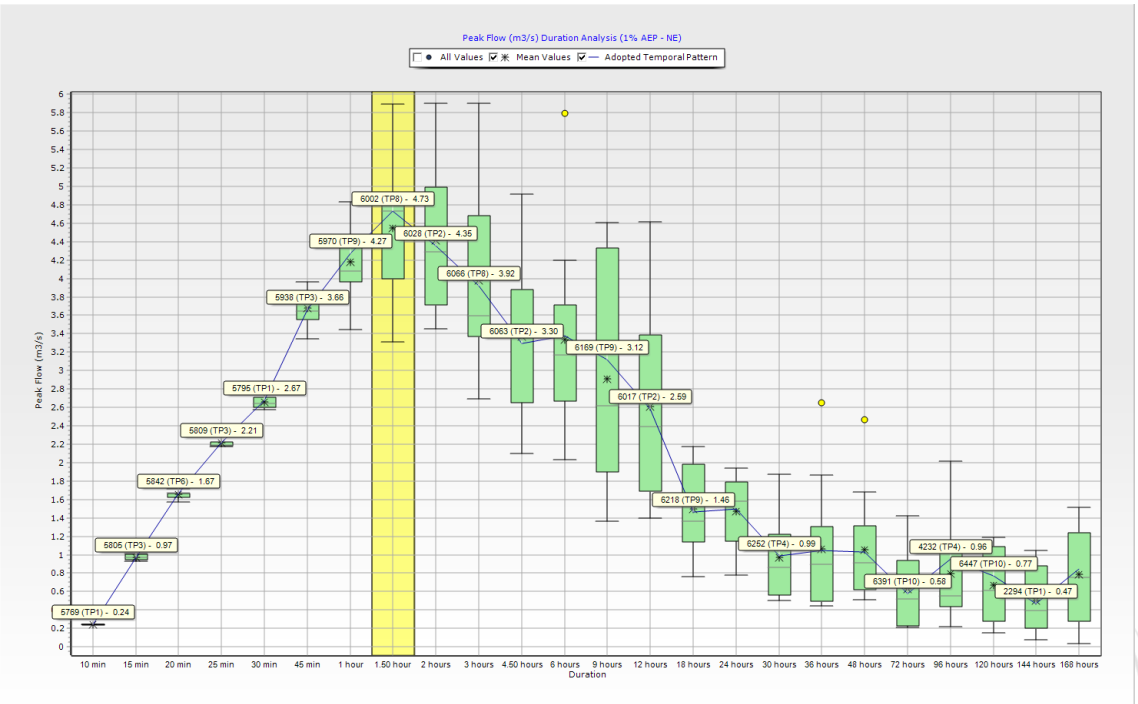


Figure 2. Existing Conditions Peak 1% AEP Flows @NE Catchment Box Plot

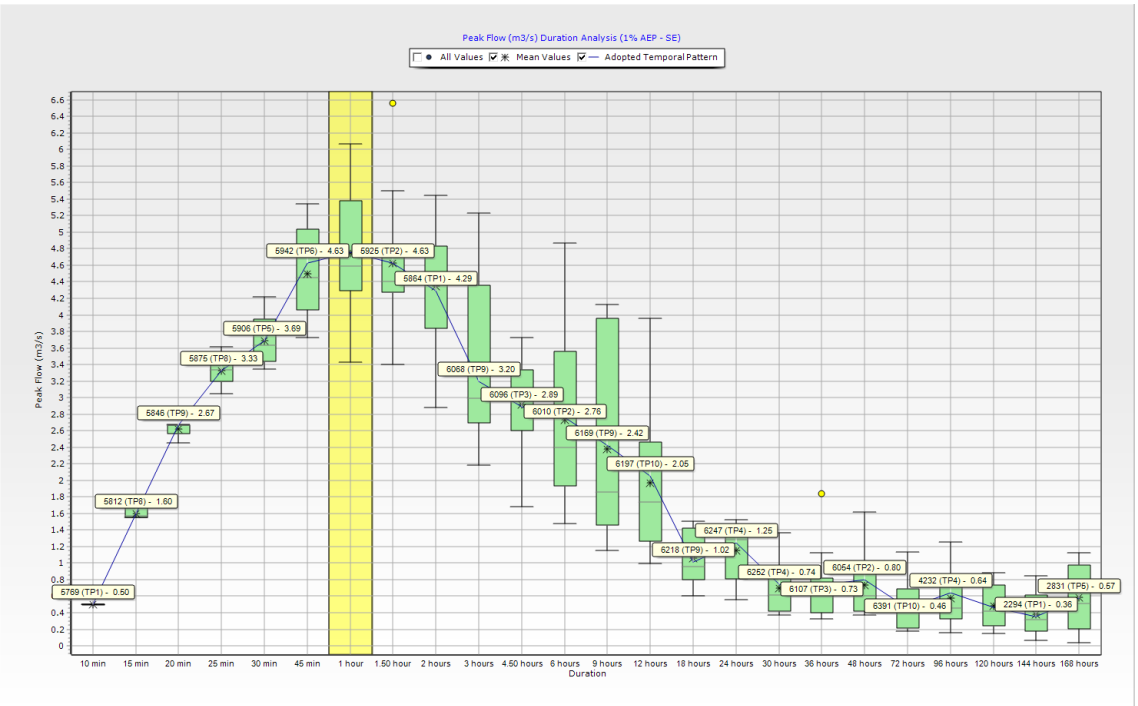


Figure 3. Existing Conditions Peak 1% AEP Flows @SE Catchment Box Plot

Hydraulic Modelling

A Tuflow 1d-2d flood model was constructed for the site and surrounds with the following assumptions:

- Model Parameters and setup as shown in Figure 3
- Peak flows for catchment based on 1%AEP 3-hour storm (as above)
- Model terrain based on site survey and local commercially derived LiDAR information (Figure 4)
- Model was run for both Existing Conditions and Developed Conditions assumptions.

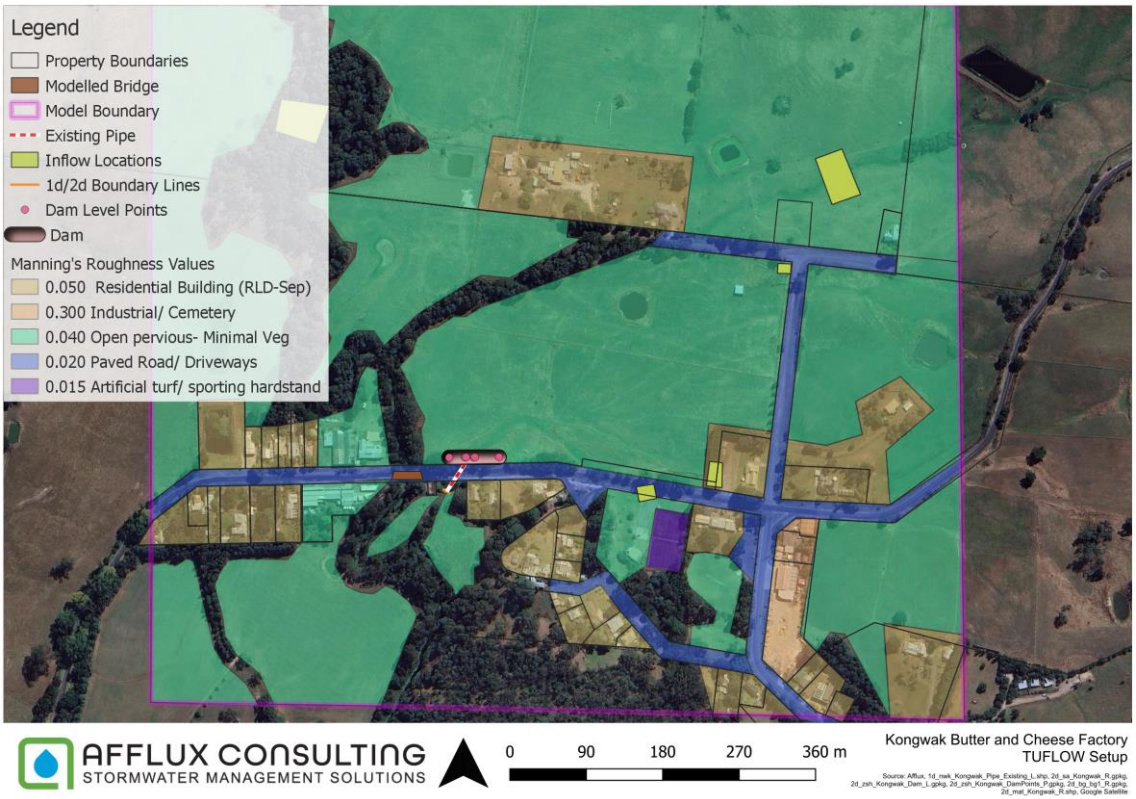


Figure 4. Hydraulic Model Setup

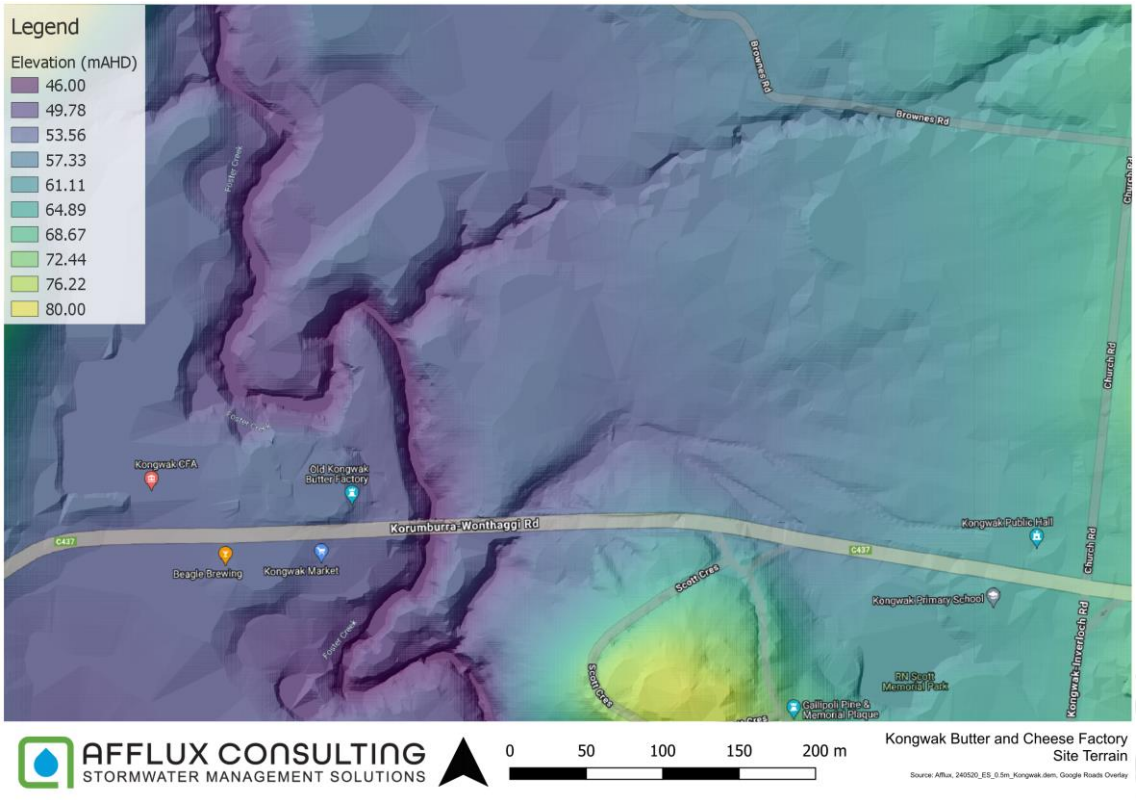


Figure 5. Site Terrain

A site inspection was conducted to ensure the accuracy of the model assumptions (see Figures 6-11). A selection of the key hydraulic points can be seen below.

Source: Afflux, 2024

Figure 6. Site ridge and valley

Source: Afflux, 2024

Figure 7. Gully on the west of Public Hall

Source: Afflux, 2024

Figure 8. Foster Creek bridge

Source: Afflux, 2024

Figure 9. Foster Creek

Source: Afflux, 2024

Figure 10. Church Road Gully Crossing

Source: Afflux, 2024

Figure 11. Church Rd looking Sth

1% AEP Flood Modelling Results

Existing Conditions

The existing site flood conditions results are shown below:

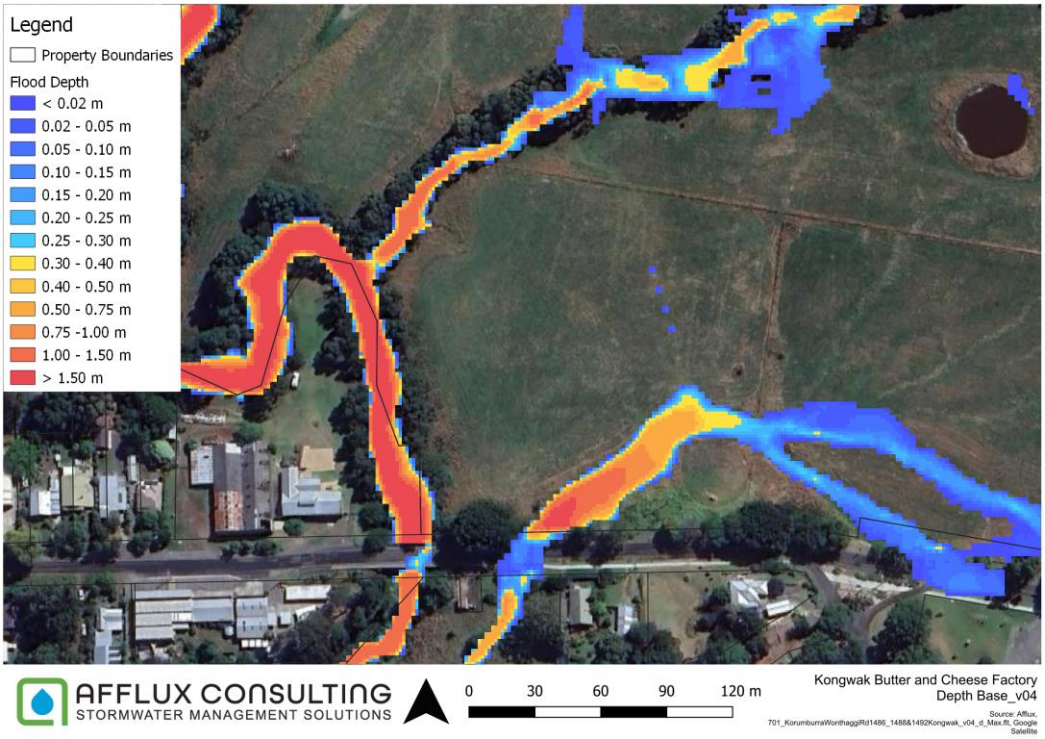


Figure 12. Flood depths for existing conditions

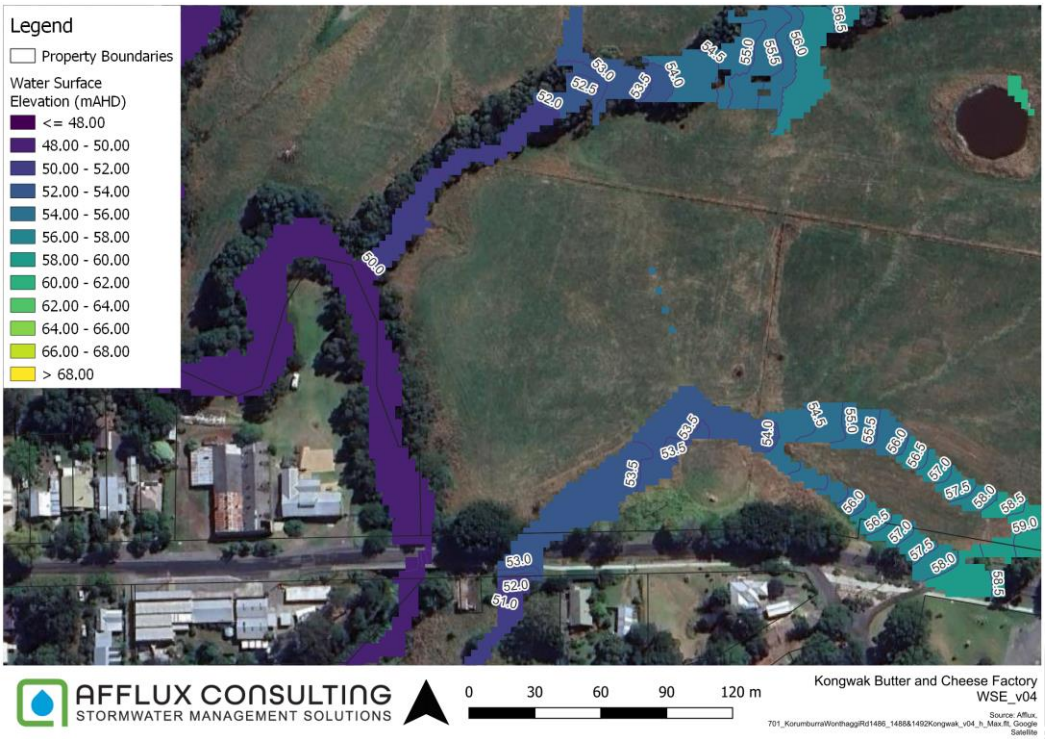


Figure 13. Water surface elevations for existing conditions

Development Assumptions

The planned development will involve the construction of a reservoir within the site area and a number of water quality treatments along the south eastern reach. To facilitate this, the overland flow paths along the southern boundary will be maintained and a dam wall will be built immediately upstream of Korumburra - Wonthaggi Road.

To mitigate potential flooding, various development scenarios were simulated, adjusting the dam crest level and discharge controls. Importantly, the peak discharge from the dam was considered to ensure no impact on Korumburra- Wonthaggi Road. Based on this testing a set of design parameters for the reservoir have been set, and future flood levels for the site evaluated. The proposed development plan can be seen in Figure 14.

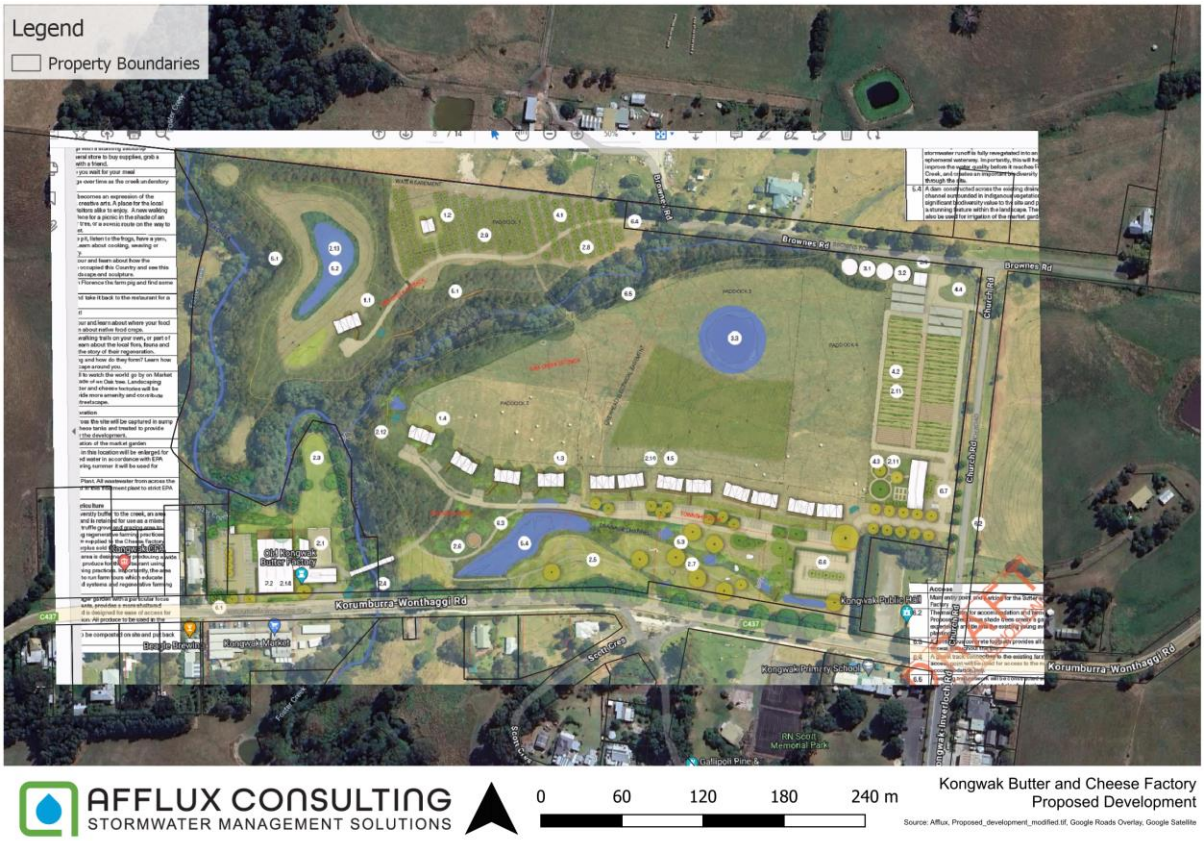


Figure 14. Proposed Development Plan

Developed Conditions

The development conditions assumed a Dam Crest of 54.2m AHD. A normal water level for the dam would be set at 53.5m AHD (as defined by box culverts within the crest). It is expected that this level would vary across seasons in line with any harvesting of water for agricultural purposes. The dam has been modelled as full in development conditions but given the proposed harvesting it is expected to provide some attenuation effects (reduction of flow, and therefore reduction of downstream flooding). Given the very low level of development proposed, the change in site hydrology is largely inconsequential, and the attenuation through the dam would further mitigate existing conditions.

The developed conditions flood depths, water surface elevations, and flood difference (afflux) as a result of the works can be seen below.

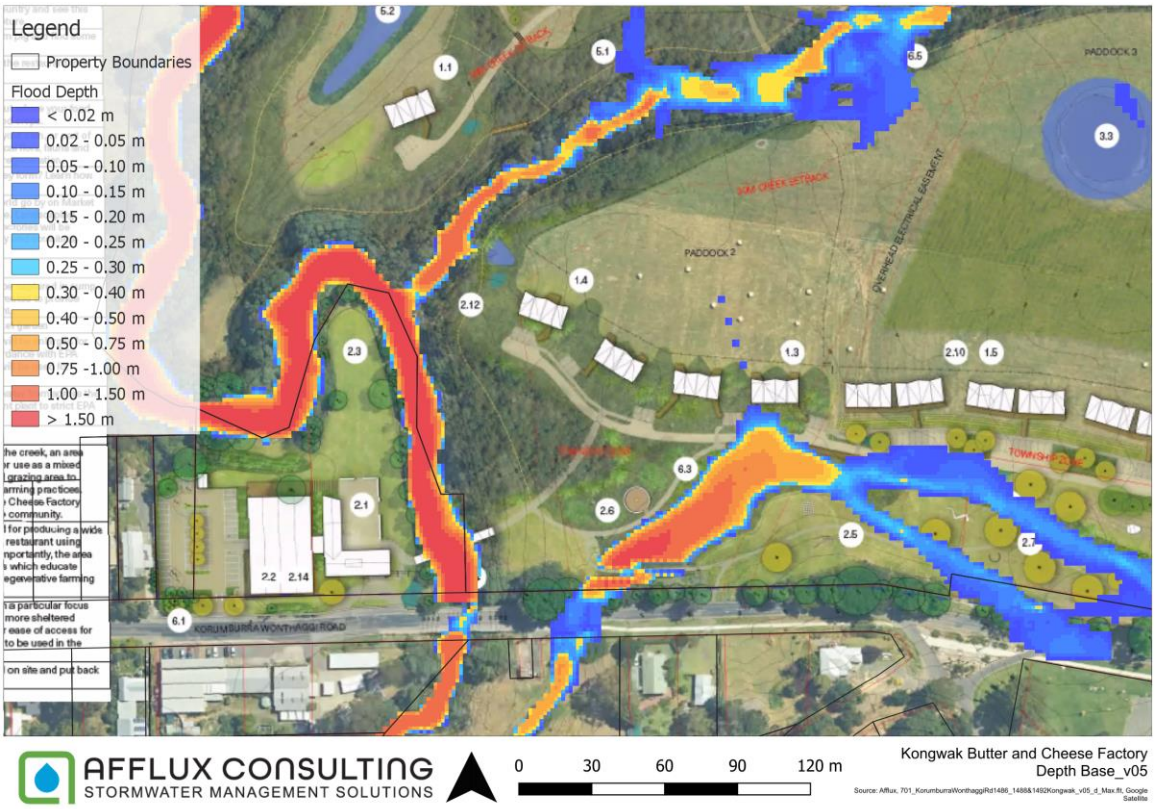


Figure 15. Flood depths for developed conditions

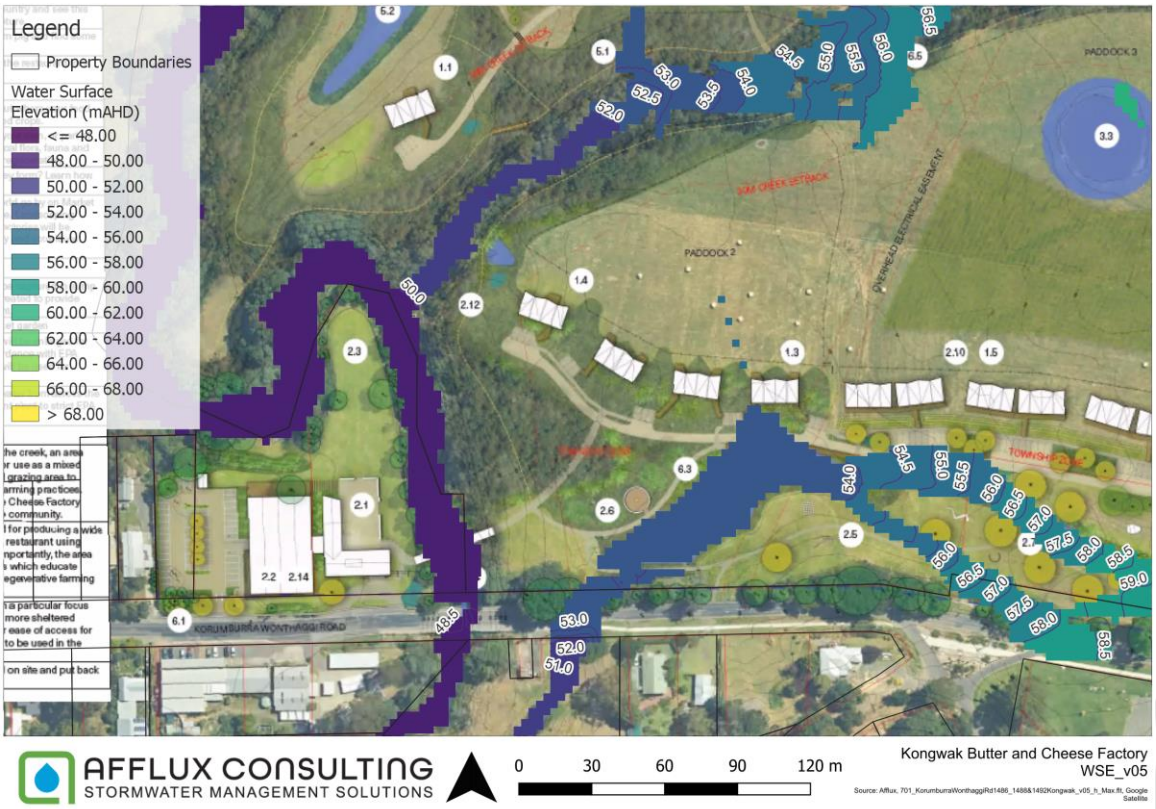


Figure 16. Water surface elevations for developed conditions

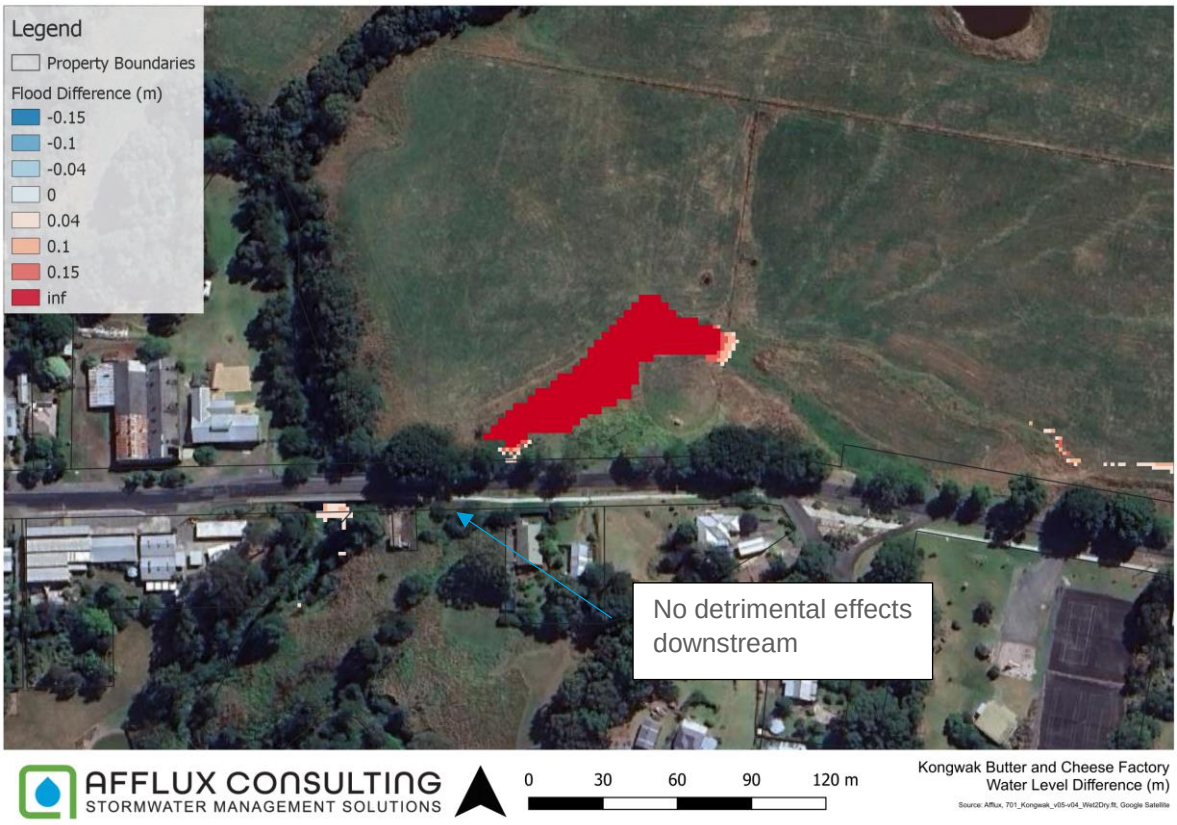


Figure 17. Flood difference (afflux) map

Harvestable Water and Water Quality

To determine the total harvestable water in the reservoir, daily rainfall and runoff modelling (MUSIC) was conducted. The following assumptions were made:

- The Kongwak Mean Annual Rainfall (MAR) is 1022 mm/y
- To provide 10 years of comparable rainfall estimates the Narre Warren North rainfall band (MAR 850-1100) was used
- The MUSIC model setup is shown in Figure 18
- The land use assumptions were based on the analysis of satellite imagery and Melbourne Water's 2023 MUSIC Guidelines

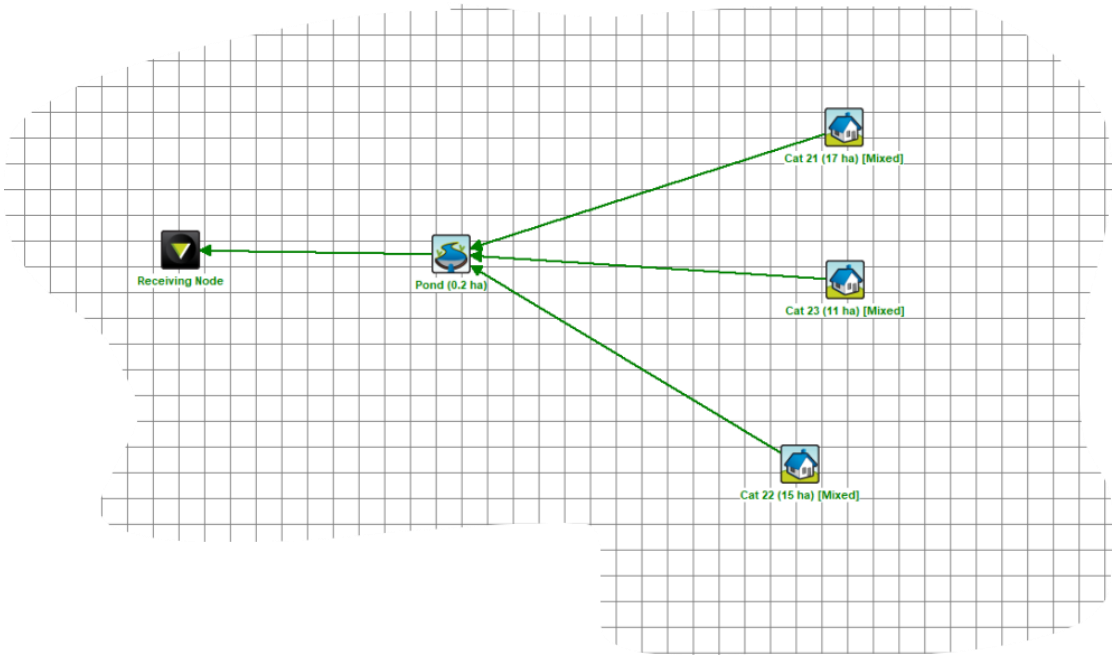


Figure 18. MUSIC model setup

Modelling results show that the proposed reservoir could be expected to yield 43.9 ML/year of reusable water supply at an industry standard 70% of assumed demand met (i.e. the maximum yield possible). An application for a 5.5 ML/yr extraction license has been sought, and could obviously be met with a much higher demand potential. The reservoir water balance can be seen in Figure 19.

Node Water Balance - Pond (0.2 ha)

	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	GP (kg/yr)
Flow In	153.84	13849.70	40.80	377.33	2964.71
ET Loss	1.81	0.00	0.00	0.00	0.00
Infiltration Loss	0.00	0.00	0.00	0.00	0.00
Low Flow Bypass Out	0.00	0.00	0.00	0.00	0.00
High Flow Bypass Out	0.00	0.00	0.00	0.00	0.00
Pipe Out	106.92	4193.43	16.48	227.15	0.00
Weir Out	0.00	0.00	0.00	0.00	0.00
Transfer Function Out	0.00	0.00	0.00	0.00	0.00
Reuse Supplied	43.91	1009.89	5.27	85.14	0.00
Reuse Requested	62.12	0.00	0.00	0.00	0.00
% Reuse Demand Met	70.69	0.00	0.00	0.00	0.00
% Load Reduction	30.50	69.72	59.61	39.80	100.00

Decimal Places 2

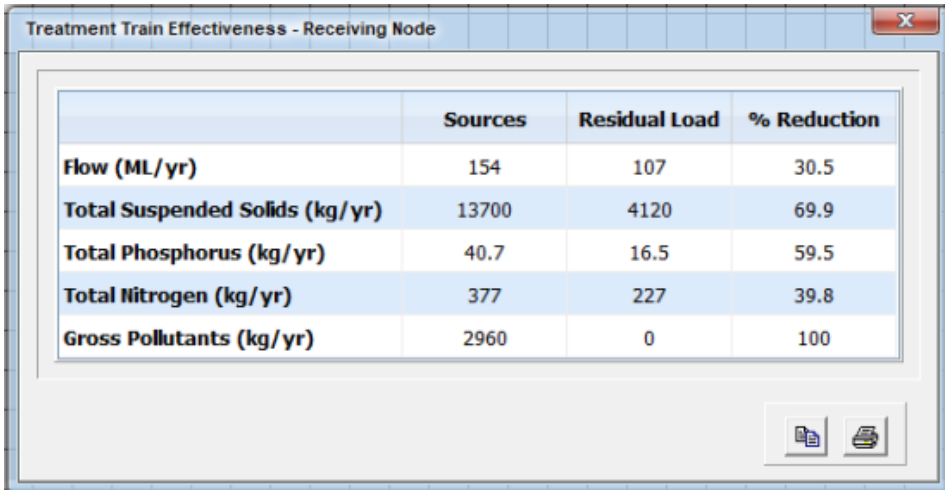
Figure 19. Reservoir Water Balance

Aside from the benefit of reusable water for irrigation, the proposed reservoir would also provide treatment some moderate water quality benefits. However it is important to note that a reservoir is not

as efficient as a wetland in terms of nutrient removal and as such further wetland treatments are proposed along the southern gully. Figure 20 shows the calculated treatment train effectiveness of the proposed reservoir as a standalone treatment. Further biodiversity outcomes could be considered as part of the design, with a number of notable current guidelines including:

https://www.sustainablefarms.org.au/wp-content/uploads/2021/07/Farm-Dam-Planting-Guide-brochure-8.2.pdf

Melbourne Water Farm Dam - Living Rivers Guidance



	Sources	Residual Load	% Reduction
Flow (ML/yr)	154	107	30.5
Total Suspended Solids (kg/yr)	13700	4120	69.9
Total Phosphorus (kg/yr)	40.7	16.5	59.5
Total Nitrogen (kg/yr)	377	227	39.8
Gross Pollutants (kg/yr)	2960	0	100

Figure 20. Treatment Train Effectiveness

Discussion

Based on the flood modelling results, it is evident that the flood extents and flow patterns in the proposed development match those of the existing conditions. The afflux associated with the development is contained within the proposed reservoir, indicating minimal impact in terms of flooding downstream. The planned cabins and pathways will occupy only a small portion of the primarily pervious-surfaced site, as such the corresponding hydrology results were expected. In addition to providing a reusable water supply, the reservoir is also expected to enhance the landscape aesthetics.

The channel along the south boundary mentioned in the RFI is an existing overland flow path. The results demonstrate that the 1% Annual Exceedance Probability (AEP) flows in the channel have largely been maintained.

The dam weir has been designed to convey adequate flows to maintain a safe water level in the reservoir during 1% AEP storm events, as depicted in Figure 11. A broad-crested weir design with a cross-sectional area of approximately 6.3m³ and an invert level of 53.5 mAHD was used, resulting in a water surface elevation of 53.81 mAHD. It is noted that this design can be adjusted to comply with construction requirements (for example, using box culverts instead of a weir), as long as the flow capacity is maintained or improved, while keeping the invert level constant.

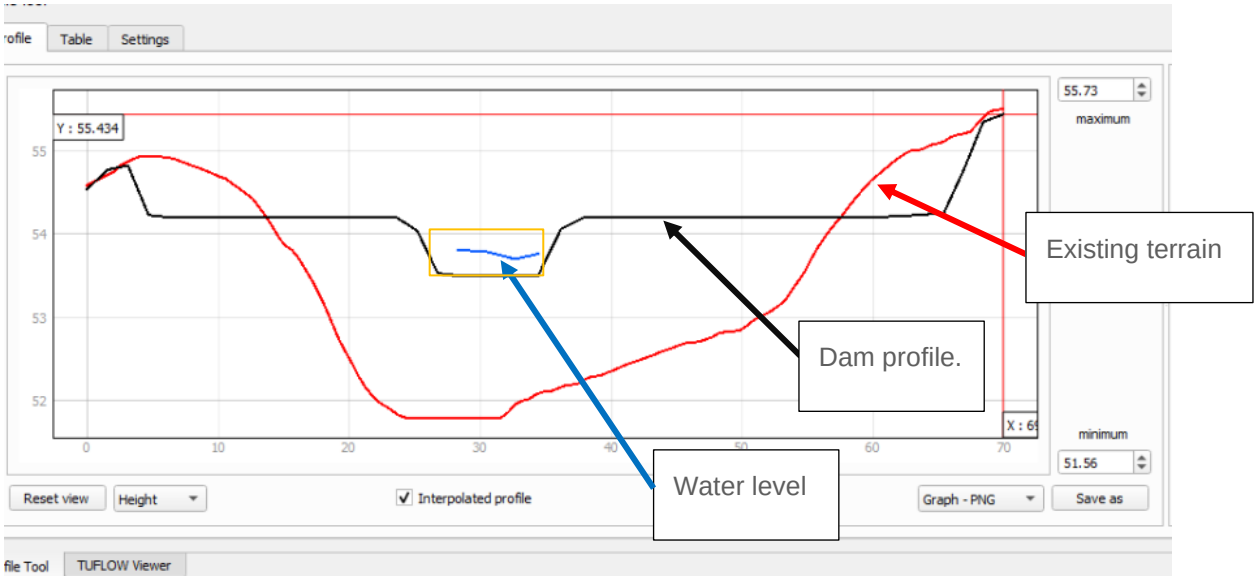


Figure 21. Proposed dam cross-section

Recommendations

We have assessed the hydrological and hydraulic changes associated with the development, and hereby recommend the following:

- Construction of a dam with crest level of no less than 54.1 or 300mm above the predicted 1% AEP.
- Construction of a dam weir with a cross-sectional area of at least 6.3 m³ with invert level of 53.5 mAHD
- Finished Floor Levels above 54.3m AHD or 300mm above the 1% AEP flood level at the construction location (note slightly higher flood level at upstream location).

Adhering to these recommendations will ensure that any adverse stormwater effects to the site itself, the neighbouring properties, and the environment will be minimal. The proposed FFL of the units will meet the standard Freeboard protection requirements of the WGCMA.

1486-1488 & 1492 Korumburra Wonthaggi Rd, Kongwak – Preliminary flood analysis

To: Kongwak Butter & Cheese

From: Chris Beardshaw

Date: **Tuesday 1 August 2023**

Introduction

Background

Afflux Consulting has been engaged by Kongwak butter and cheese to undertake a flood analysis and integrated water management plan to support the development of parcels at 1486-1488 & 1489 Korumburra-Wonthaggi Rd, Kongwak. The land use is intended to change from an existing disused cheese and butter factory into a destination hospitality venue.

The site does not have any official record of flooding, though clearly interacts with the Foster Creek. As such the West Gippsland Catchment Management Authority have requested an investigation to see if the property is likely to be subject to flooding from Foster Creek during a 1% AEP flood event.

This technical memo outlines the key findings in the preliminary flood analysis, to support the design of the project during the permit submission process. A detailed and refined flood analysis will then be undertaken to support the detailed design process and development proposal, including the proposed installation of a new bridge across Foster Creek.

Existing conditions

This memo specifically concerns itself with catchment flows in Foster Creek and the land directly surrounding Foster Creek. Foster Creek is currently an existing creek riparian corridor and the land parcels on 1486-1488 & 1492 are designated as land use for private residence and tourist accommodation. The northern border of all land parcels are bordering Foster Creek.

Existing infrastructure

A number of existing infrastructure includes:

- Korumburra-Wonthaggi Rd functions as a bridge over Foster Creek.
- The old cheese factory is left abandoned.
- The old butter factory is well kept and is located directly west of Foster Creek.
- The property on 1492 Korumburra-Wonthaggi Rd is currently a private residence.

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1.1. Flood modelling

Hydrology

For a high level assessment a number of regional hydrological estimate methods have been used for this catchment. CatchmentSIM was utilized to determine the relevant catchments (Figure 1) and a RORB model was constructed. The RORB model was reconciled to a number of regional estimates and the critical event at this location determined.

Hydrographs were extracted for the critical event at key reporting locations for inclusion in the TUFLOW (flood) model to gain an understanding of overland flow and interactions with various infrastructure components and design interventions within the study area.

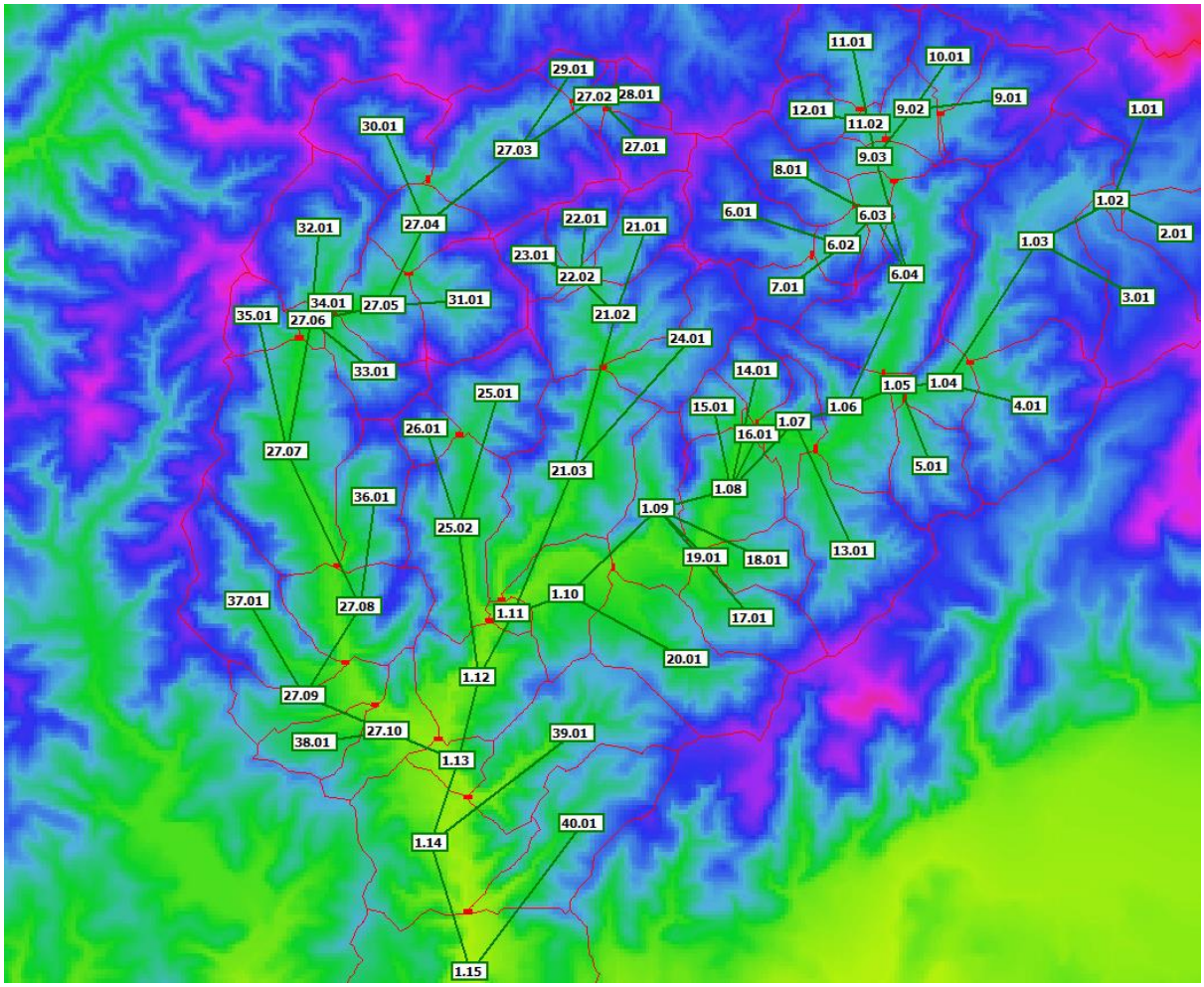


Figure 1. Catchment Model

Table 1: Design Hydrology Summary

Design Event	Flow (m^3/s)	Comment
9hr	126m^3/s	Fairly consistent in estimates

The full details of the hydrology modelling are provided in Appendix A.

Hydraulics

A hydraulic model has been developed for the area and is used to inform the remainder of analysis. Full details of the flood model are provided in Attachment 2 with key aspects summarised as follows:

- High resolution model through the study area (resolution is 3 m)
- Inclusion of bridge on Korumburra-Wonthaggi Rd based on DEM surfaces and information from VIC roads Open Data Hub. Major bridge assumptions shown below.
- Model run time at 30 hours to allow critical hydrograph to pass through the site.

Figure 2. Existing Bridge Structure

Table 2: Bridge Assumptions

Bridge Assumptions	Level / Factor	Comments
Deck Level	53.0 mAHD	Surveyed Level
Deck Depth	0.75m	Estimated
Guard Rail Depth	1m	Based on Visual inspection
Guardrail Blockage	30%	Estimate of blockage based on visual inspection
Pier Factor	2%	Blockage Factor on Xsect estimate
Deck width	10.9m	Road width

At this stage a single scenario has been modelled as indicated below

Scenario	Description
Existing conditions	Base model with surveyed data and a representation of 1% AEP flows with the following structures in place: Existing buildings with freeboard Existing road bridge on Korumburra-Wonthaggi Rd.

Table 3: Modelled scenario

Results

Existing conditions

Results for depth and water surface elevation are presented as Figure 1 and 2 for existing conditions and show the following:

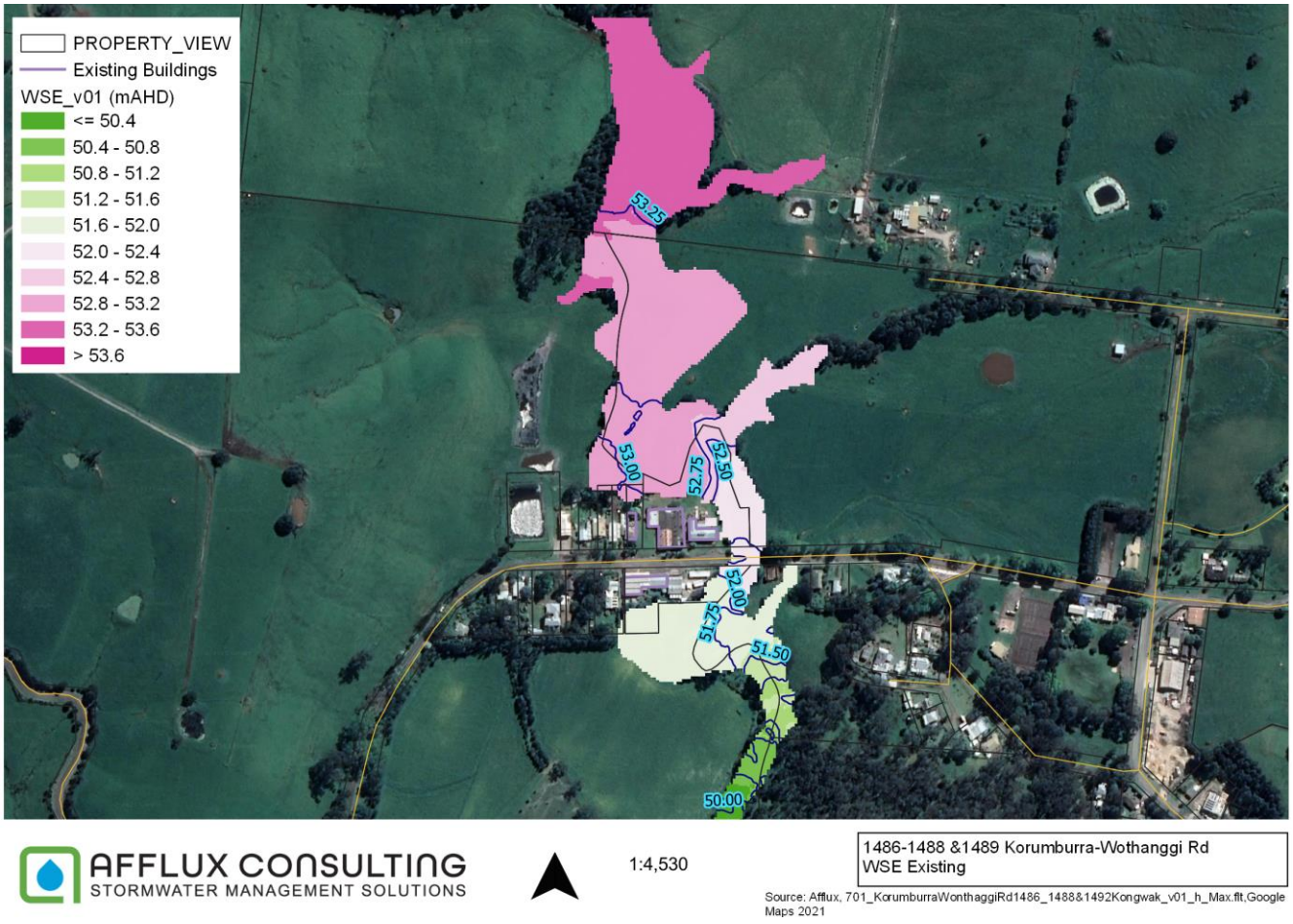


Figure 3. Water Surface Elevation- Existing conditions

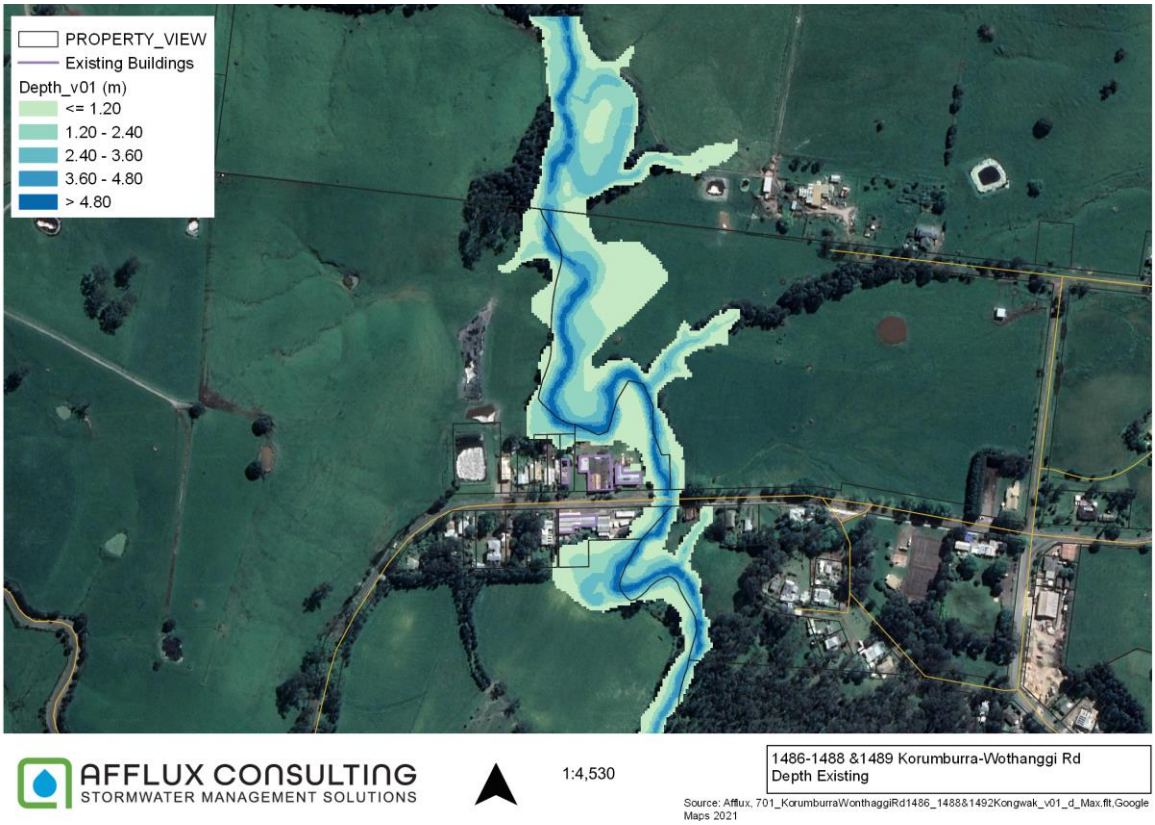


Figure 4. Water Depth- Existing conditions

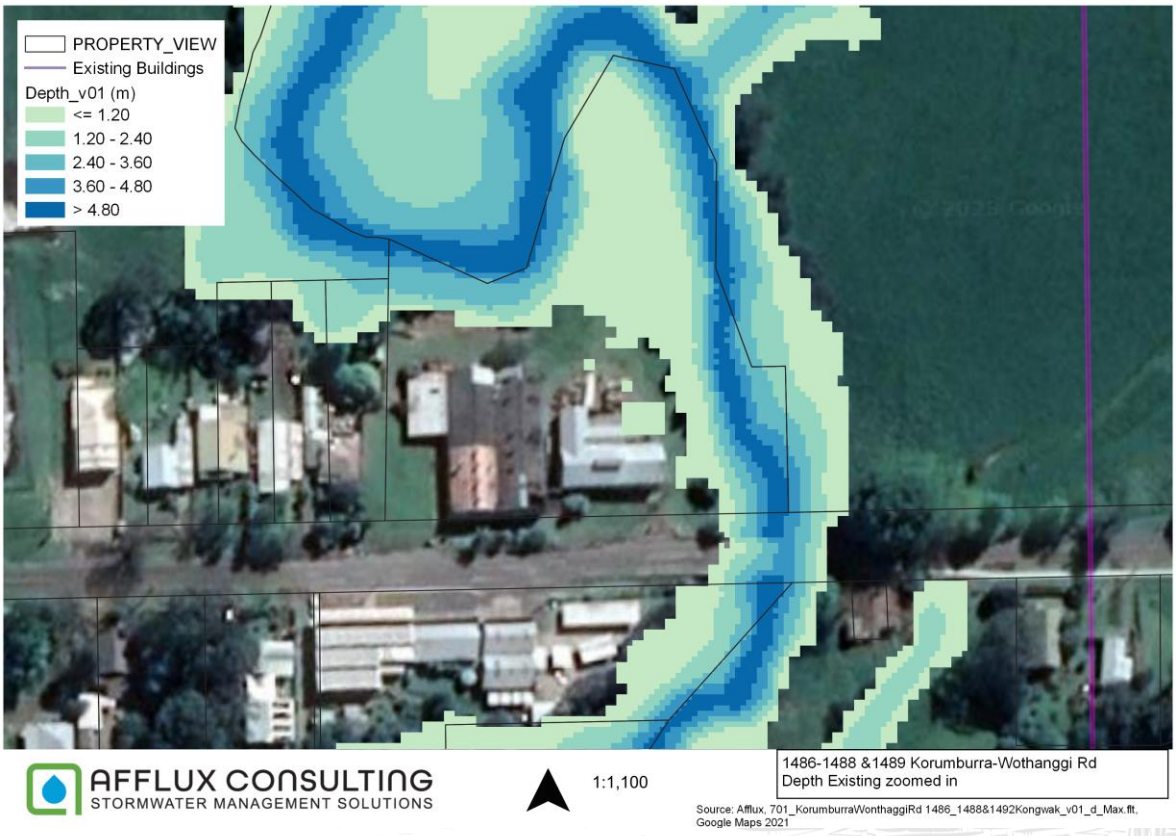


Figure 5. Water Depth – Existing conditions – zoomed in

Discussion

Flood mechanism

The flooding mechanisms for the area has been evaluated by reviewing time series plots of flood extent and velocities. Generally it shows the following:

- Water flowing down Foster Creek, stays well in the lower channel for several hours of the design event
- Around 3 hours into the event the water breaks into the macro channel and fills the upstream larger basin areas to the north of the site.
- There is a breakout of flows, south of Kongwak Market around 4 hours into the modelled event that spills west into a farm dam and slowly discharges back into Foster Creek.
- Around 6 hours into the modelled event that spills west towards the old cheese and butter factory. Where water will continue to build up in the terrace surrounding the butter factory until 8 hours into the modelled event.

Separate strategies will be required to deal with each of these separate advancements and should be delivered as a complete package to address flooding in its entirety.

The influence or relevance of each of these flood components in assessing the impact of the current site is addressed in the concept design approach below.

Figure 6. Proposed Building works and FFL's

Recommendations

Based on the analysis undertaken in this study we are able to make the following recommendations with relation to the development and future approvals pathways:

- The peak water level in this preliminary analysis is 52.3m AHD at the Korumburra-Wonthaggi Road.
- The design lower level of the Butter Factory main entrance is proposed at 52.77mAHD. It is understood that a heritage tiled floor is set at this level.
- Given the existing heritage entrance area would require significant approvals to modify and meet a 600mm freeboard, it is not recommended to modify this section and that a management approach for flood risk management be considered for this area. This may include the following considerations:
  - Use of the lower floor area be limited to non-habitable purposes
  - Consideration of flood warning/management plans for the accommodation facilities
  - Consideration of building materials and finishes on the lower administration area
- The upper accommodation facilities are set at 54.46m AHD and have significant freeboard
- The proposed Events courtyard (Ref 12) could be set at 52.9m AHD to meet freeboard requirements. It is understood that this area is more of a temporary facility and may be able to accept a lower level of freeboard
- Any bridge structure (Ref 17) should consider these levels in its design
- Landscape considerations for the open grassed area (Ref 8). This can be in consultation with flood velocities in the area

A number of ancillary technical items have been recommended for consideration in a more detailed analysis of the area:

- Any gauging information for Foster Creek should be considered in a more detailed analysis. The regional equation approach is consistent with a pre-liminary analysis of the site, but ideally this would be matched to a gauge and Flood Frequency Analysis
- Considerations for a Flood Management Plan for the site
- More detailed analysis of the existing bridge and proposed bridge structures
- Greater hydraulic sensitivity analysis. At this stage only a peak flow has been run through the model.

Conclusions

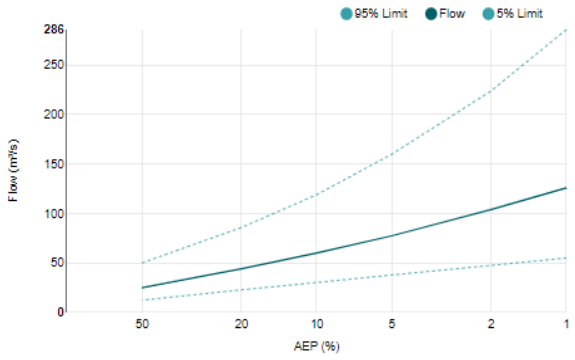
This preliminary flood analysis has provided flows and flood levels with enough detail to provide the CMA and Council with confidence that the development is not overly effected by flooding in its current form. There are a number of recommendations for future work that can be included as permit conditions of the development approval.

Appendix A - Hydrology

To assess the peak flow for the flood analysis, a comprehensive evaluation of various hydrological methods was conducted, the results are summarised in Figure 8. The different methods were generally consistent, indicating a well calibrated precision in predicting peak flows, thus enabling a more robust flood analysis. The predicted peak flow of 126 m^3/s is primarily reconciled with the RFFE ARR calculator and the results are shown in Figure 7.

To further refine the hydrological analysis, a RORB model was constructed and a number of other regional equations tested. As can be seen in Figure 8 all methods generally centred around a ~130m^3/s flow, and as such the RFFE estimate was adopted. All temporal patterns were run from 10min storm to 168hr storm from to derive a set of hydrographs for each event AEP and critical duration. Only the mean for the critical duration storm results was selected for design as recommended. These results are shown in Figure 9 and Figure 10.

Results | Regional Flood Frequency Estimation Model



AEP (%)	Discharge (m^3/s)	Lower Confidence Limit (5%) (m^3/s)	Upper Confidence Limit (95%) (m^3/s)
50	25.0	12.4	50.1
20	44.3	22.9	85.9
10	60.1	30.3	119
5	77.5	37.9	160
2	104	47.6	224
1	126	55.1	286

Input Data	
Date/Time	2023-08-15 13:38
Catchment Name	Catchment1
Latitude (Outlet)	-38.5203
Longitude (Outlet)	145.7086
Latitude (Centroid)	-38.4572
Longitude (Centroid)	145.7329
Catchment Area (km^2)	89.585
Distance to Nearest Gauged Catchment (km)	4.42
50% AEP 6 Hour Rainfall Intensity (mm/h)	5.254017
2% AEP 6 Hour Rainfall Intensity (mm/h)	11.305039
Rainfall Intensity Source (User/Auto)	Auto
Region	East Coast
Region Version	RFFE Model 2016 v1
Region Source (User/Auto)	Auto
Shape Factor	0.77
Interpolation Method	Natural Neighbour
Bias Correction Value	0.04

Statistics

Variable	Value	Standard Dev
Mean	3.257	0.425
Standard Dev	0.682	0.188
Skew	0.088	0.030

Note: These statistics come from the nearest gauged catchment. Details.

Correlation		
1.000		
-0.330	1.000	
0.170	-0.280	1.000

Note: These statistics are common to each region. Details.

Figure 7. RFFE ARR summary, source: http://rffe.arr-software.org/.

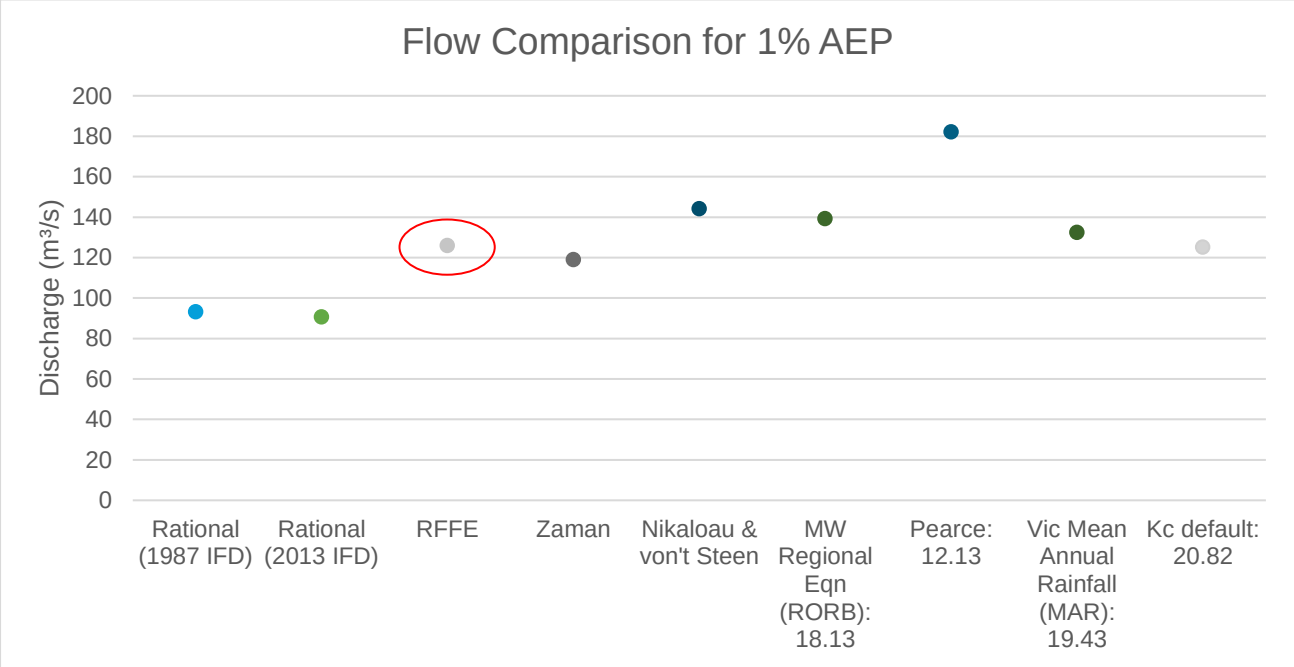


Figure 8. Flow method comparison for 1% AEP.

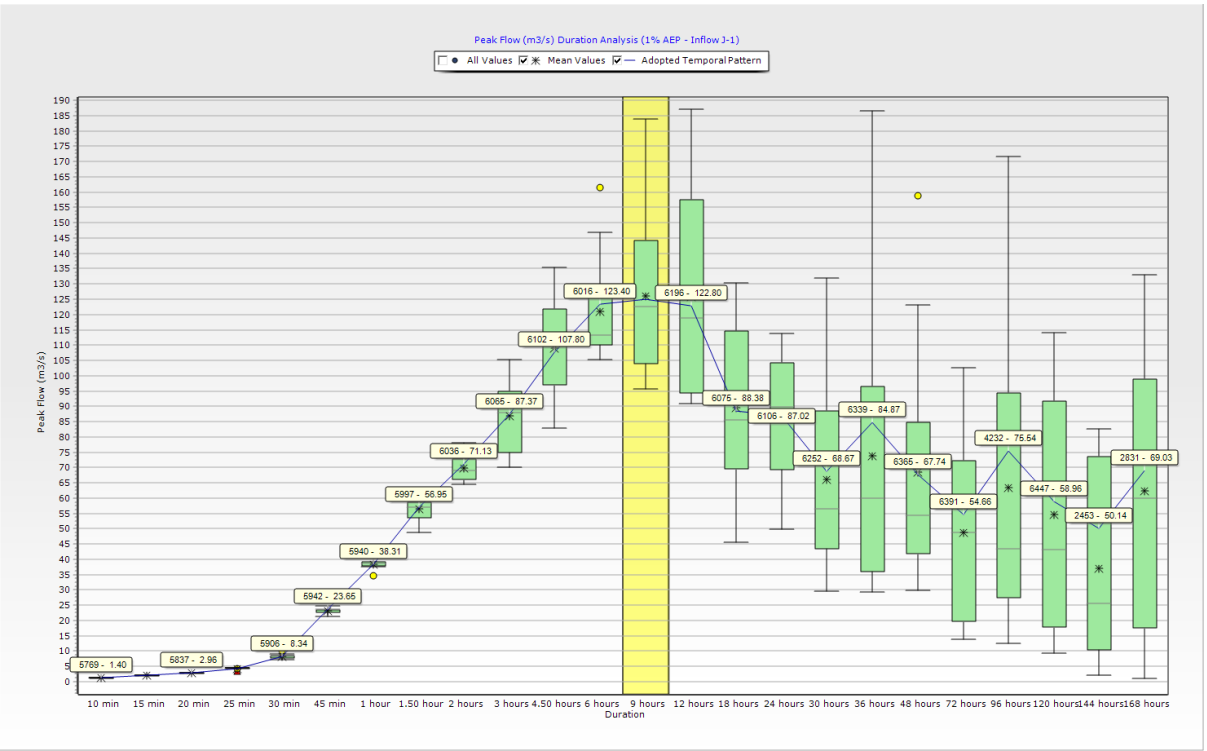


Figure 9. Catchment flows at 1% AEP.

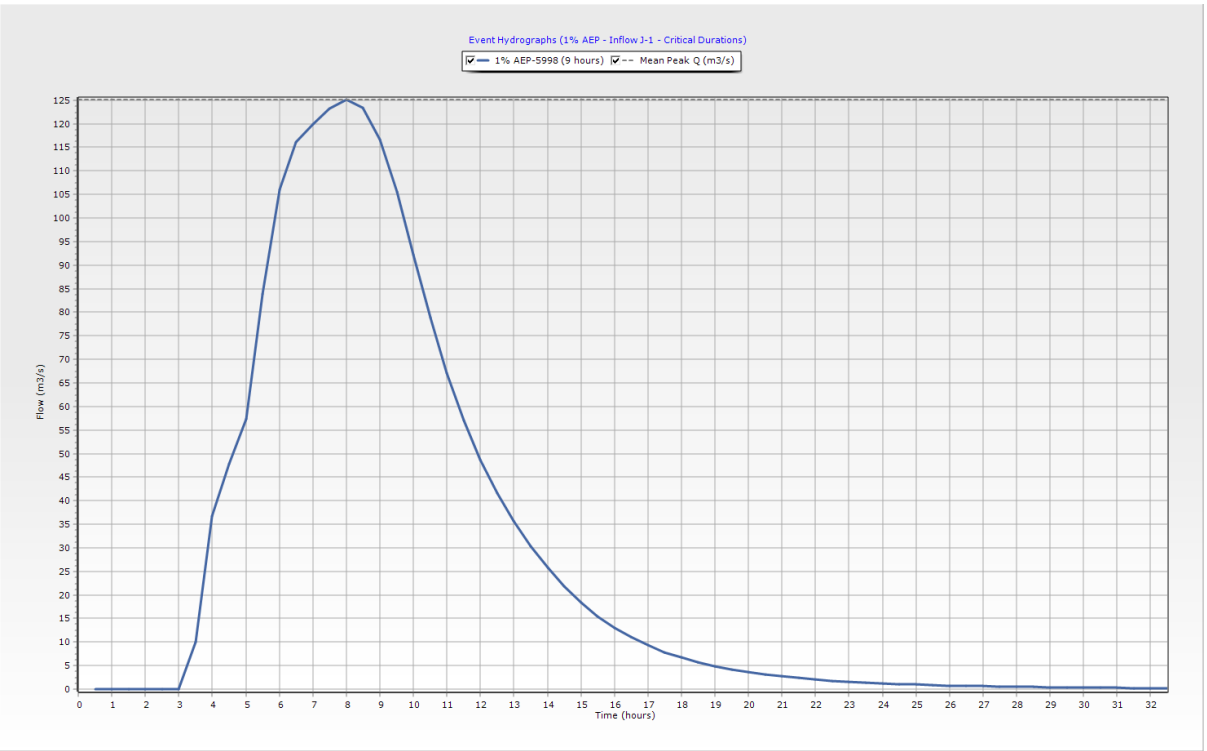


Figure 10. Hydrograph for critical duration (9hr) at 1% AEP.

Appendix B - TUFLOW model setup and Quality Assurance

The following section summarises key aspects of the TUFLOW schematisation and Quality Assurance parameters and is included to provide confidence in the model's capability to replicate real world outcomes to assist in decision making, and includes:

Model setup showing flow into and out of the model, the model extent, existing buildings that may have been impacted by flood, existing bridge on Korumburra-Wonthaggi Rd (Figure 11). The hydrograph determined in Appendix A was input into the "Flow In" 2d_SA as shown in Figure 11.

Material roughness used in scenario modelling is shown in Figure 12, the remaining areas are set at Mannings roughness of 0.060 to represent Waterways/Channel with moderate vegetation.

Key input consideration in model schematisation, including model type, and location of key inputs is set out in Table 4:

Reported Quality Assurance parameters to assess model health. The QA table highlights where issues may occur and any explanations for corrective action or influence on the analysis and interpretation of results for the areas of interest (Table 5:).

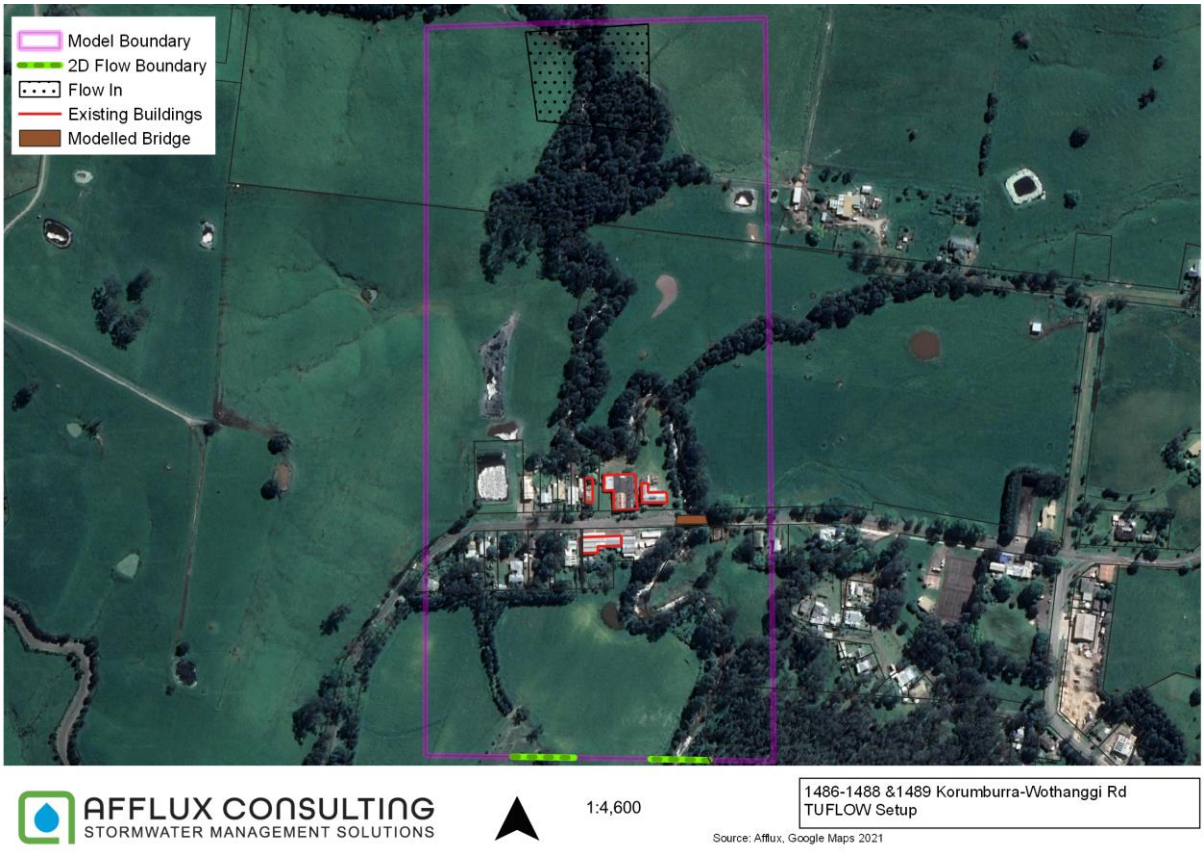


Figure 11. TUFLOW setup – schematisation.

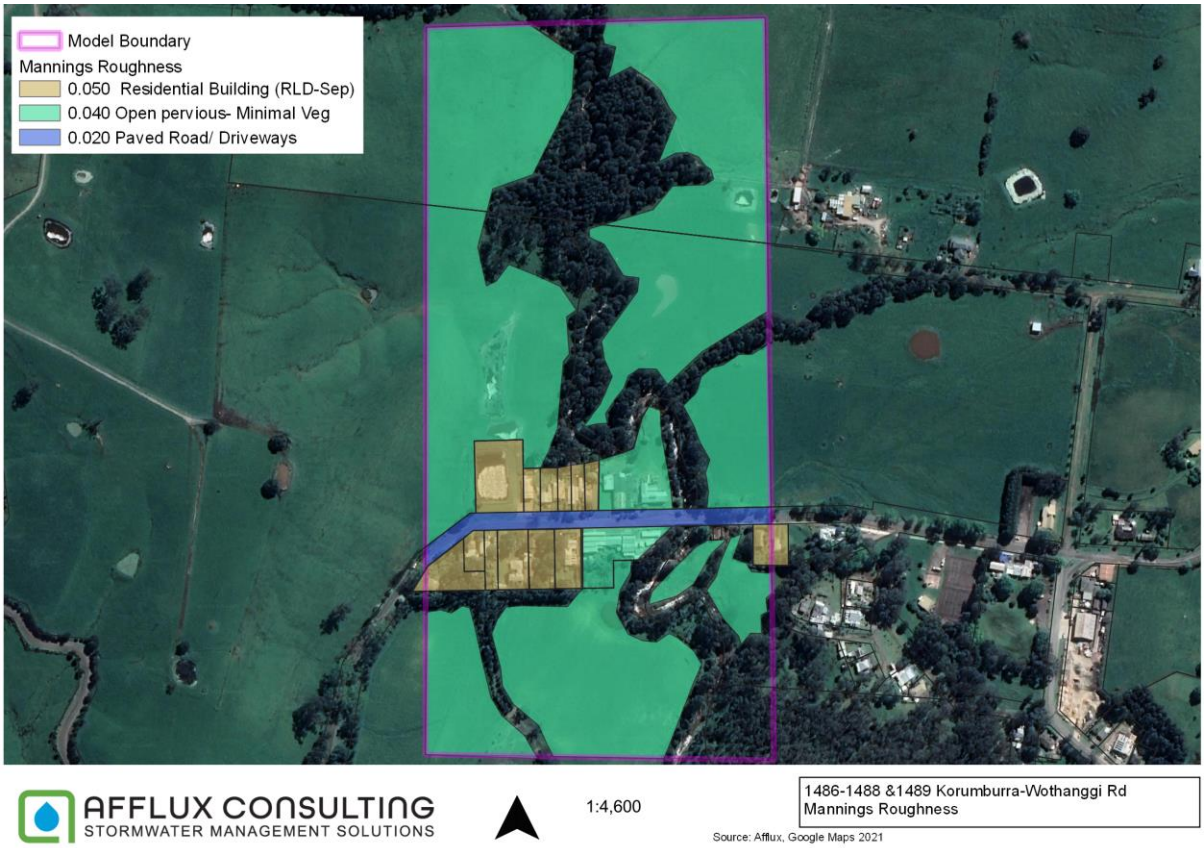


Figure 12. TUFLOW Setup - Mannings Roughness

Table 4: Model Input Parameters

Parameter	Scenarios	Description
Terrain	V01	Sourced from surveyed terrain provided by the client, Pete Wilson Landscape Architecture.
Buildings	V01	Buildings that would have been impacted by the floods was modelled with fill pads at 300mm.
Initial Water levels	V01	No IWL applied
Inflows	V01	2d_SA applied over the top of the catchment, applying design hydrograph.
Outfalls	V01	Two discharge points at the southern boundary to reflect Foster Creek and a farm channel. A standard slope of 0.005 was applied for a typical channel.

Table 5: Model QA Parameters

Scenario Name	Model Solver	Solution Inclusions	Simulation Time (hrs)	Model Timestep (secs)	Cell Size (m)	Volumetric Error (%)	Cumulative Mass Error (%)	WARNINGS Prior to simulation	WARNINGS During simulations	HCN Repeat Timesteps	NAN Warnings	NAN Repeat Timesteps
v01	2023-03-AA-iDP-w64	HPC Modeller	30.0 (1)	1 (2b)	3.0 (1)	-0.00 (1)	-0.00 (1)	17 (2)	2 (2)	6 (2)	8 (2)	0 (1)

**Additional QA undertaken in form of water level comparison. Differences in area of interest <1cm (abs).*

NOTES: TUFLOW modelling has been undertaken using the Afflux Quality Assurance framework. Model runs have been verified in Classic TUFLOW version and Mass Errors confirmed to be within acceptable limits relative to the interpretation of results. Additional runs have been completed in HPC versions where indicated with relevant parameters reported. For 'production runs' HPC is our preferred modelling engine to lower run times and improved model stability.
For model runs where all QA parameters report values of lees than (2) there can be confidence in interpreting results. In other instances results should be interpreted with caution, however an adverse QA parameter does not necessarily mean that the results are in error if the modelling issues are isolated, minor in nature or located away from areas of interest with sufficient hydraulic separation. If this is the case further explanation may be provided.
Key model run and QA Parameters are presented within the Table for reported scenarios.
QA Parameters are described below
Solution Inclusions- Describes particular TUFLOW modelling inclusions used (e.g. CLASSIC versus HPC, Quadtree processing and/or Sub Grid Sampling)
Simulation Time
(1) Model run allow sufficient time for the peak to pass through all areas of interest through to the model outfall.
(2) Model run duration allows sufficient time for the peak to pass through all areas of interest.
(3) Peak hasn't passed through areas of interest. Results should be interpreted with caution.
Model Timestep- Model timestep should be half selected cell size (for Classic simulation) or is adjusted within program for HPC versions
Model Timestep (Classic Runs)
(1) Timestep is appropriate for cell size (i.e. in Classic simulation this should be around 0.2 to 0.5 of the cell size) and Mass Error is below 1%.
(2) Timestep is appropriate for cell size and Mass Error is between 1% and 5%.
(3) Timestep is not ideal relative to cell size, however model runs to conclusion and influence of timestep unlikely to influence at areas of interest. Results should be interpreted with caution.
Model Timestep (HPC)
(1) Model timestep in HPC is within 0.02- 0.5 of the selected cell size.
(2a) Model timestep in HPC is outside 0.02- 0.5 of the selected cell size, however no significant Control Number violations have been reported. Separate checks of dt have been undertaken and confirm regions of small timestep are unlikely to influence interpretation of results.
(2b) In addition to (2a) an additional check has been performed by cross checking with Classic run.
Cell Size- Cell size should be selected based on a combination of model run time and ability to represent terrain likely to influence water flow in areas of interest.
(1) Selected cell size is able to pick up terrain influencers (such as channels and swale) in areas of interest.
(2) Cell size has been used with advanced solution methods (e.g. Quadtree or SGS) to ensure balance between model run time and selecting detail.
(3) Larger cell size relative to terrain. Usually selected to shorten run times, however results should be interpreted with caution.
Cumulative Mass Error, Volumetric Error- Volumetric and Mass errors indicate model stability and that calculations during run time sufficiently account for water into and out of the model. TUFLOW modelling guidelines recommend this should be less than 3%. These errors are reported from the scenario tlf.
(1) Mass Error is below 1% and is acceptable.
(2) Mass Error is between 1% and 3%. Error sources have been checked and are remote from areas of interest and unlikely to affect results interpretation or conclusions.
(3) Mass Error above 3%. Results should be interpreted with caution.
HCN Repeat Timesteps, NAN Warnings, NAN Repeat Timesteps- Repeat timesteps and NaN warnings are generated using HPC versions based on model stability during simulation
(1) No Warnings or repeated timesteps.

(2) Less than 1% of calculated steps. Run time adjustments have been made to maintain model stability and are acceptable.
(3) Greater than 1% of calculated steps, but locations away from areas of interest. Results can be interpreted with care.
(4) Greater than 1% of calculated steps and locations near areas of interest. Results should be interpreted with caution.

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