AFFLUX CONSULTING
STORMWATER MANAGEMENT SOLUTIONS

DRAINAGE AND FLOOD INVESTIGATION

72 Golf Course Road, Euroa

Date	29 June 2022
Version	03
Author	TCF
Client	Urban Terrain Pty Ltd

Document History

Revision:

Version	03
Author/s	TCF
Checked	CMB
Approved	CMB

Distribution:

Issue date	29 June 2022
Issued to	Urban Terrain Pty Ltd
Description	Drainage Investigation and Preliminary SWMP

Document History

Version	Date	Description
01	05-05-2021	Draft to inform development plan
02	10-09-2021	Stormwater Management Strategy
02a	25-10-2021	Amendment to images
03	29-06-2022	Updated development plan dated 17-05-2022

Climate Change Statement

A wide range of sources, including but not limited to the IPCC, CSIRO and BoM, unanimously agree that the global climate is changing. Unless otherwise stated, the information provided in this report does not take into consideration the varying nature of climate change and its consequences on our current engineering practices. The results presented may be significantly underestimated; flood characteristics shown (e.g. flood depths, extents and hazards) are may be different once climate change is taken into account.

Disclaimer

This report is prepared by Afflux Consulting Pty Ltd for its clients' purposes only. The contents of this report are provided expressly for the named client for its own use. No responsibility is accepted for the use of or reliance upon this report in whole or in part by any third party. This report is prepared with information supplied by the client and possibly other stakeholders. While care is taken to ensure the veracity of information sources, no responsibility is accepted for information that is withheld, incorrect or that is inaccurate. This report has been compiled at the level of detail specified in the report and no responsibility is accepted for interpretations made at more detailed levels than so indicated.

Contents

Tables

Figures

1. Introduction

Afflux have been engaged to conduct a flood assessment and complete a stormwater management strategy at 72 Golf Course Road, Euroa (Figure 1). This report will explore the influence of regional rainfall events on the site as well as flooding associated with the Castle Creek system.

This will cover the major drainage, flooding and water quality associated with the development. If necessary, it will include an assessment of associated stormwater drainage assets, regional overland flow paths/creek systems and stormwater conditions within neighbouring properties. The intention of this report is to:

- Provide an assessment of major drainage and flooding associated with site;
- Ensure flooding of the site, or potential off-site impacts are reduced or eliminated;
- Ensure safe conveyance of existing overland flow regimes;
- Meet the EPA best practice environmental management (BPEM) water quality requirements;
- Inclusion and consideration of guidelines and advice for stormwater management in line with Strathbogie Council and Goulburn Broken Catchment Management Authority (GB CMA) requirements; and
- Identification of mitigation and treatment options, if required.

To meet these requirements a range of hydrological, hydraulic and water quality modelling has been undertaken.

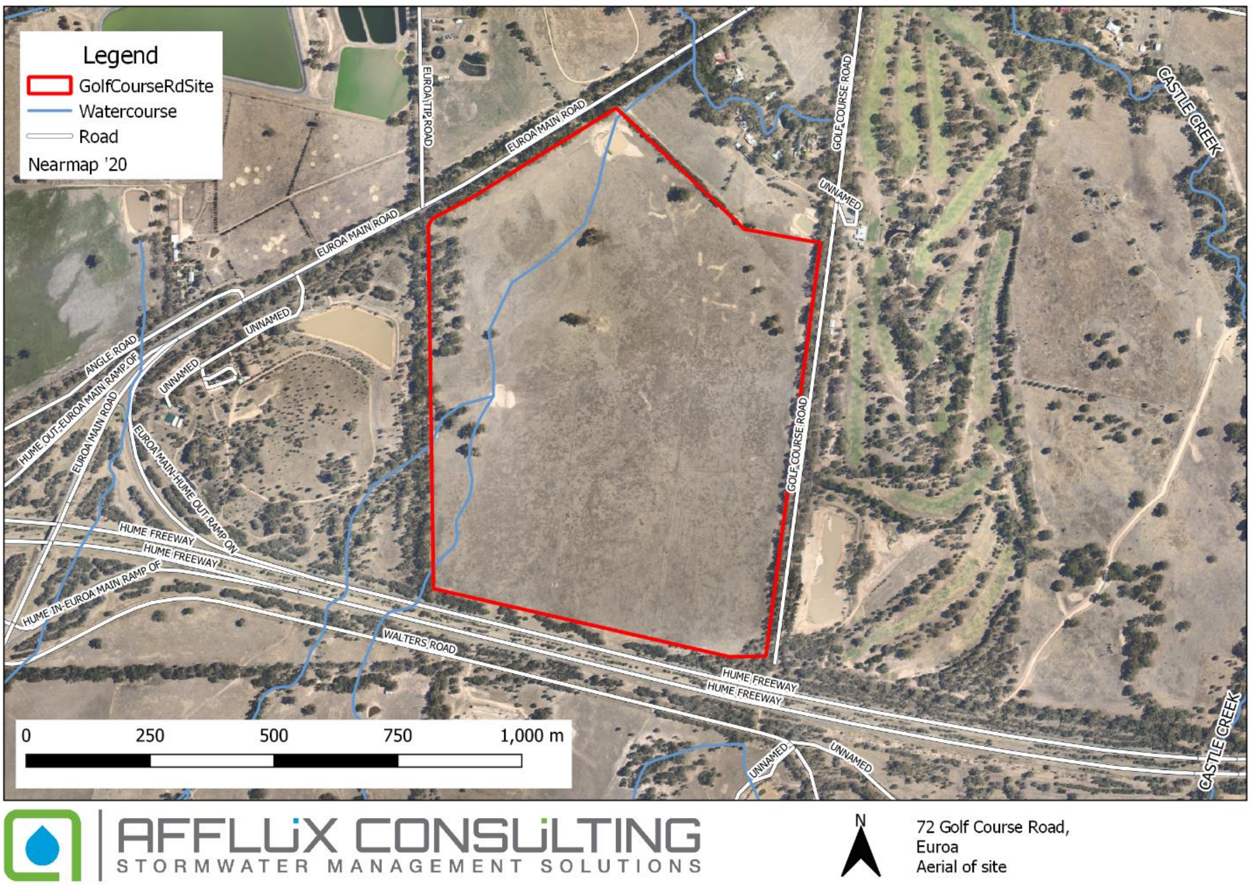


Figure 1. Aerial of site

1.1. Information Sources

A number of information sources have been used in the formation of this report; these include but are not limited to:

- Site inspection
- Aerial imagery
- DELWP planning scheme and cadastral information as accessed online September 2020
- Discussions and information as provided by GB CMA (including flood contours and extents)
- Euroa Post Flood Mapping and Intelligence Project, Final Report (Cardino, 2015)
- Site survey received from client
- Development Plan Report (CPG, April 2010)
- Required Lidar data sourced commercially
- Design Guidelines and Guidelines for Development
- Various Environmental Planning instruments and Planning Frameworks

1.2. Preliminary Design

A preliminary design was provided by the client on commencement of project which can be seen in Figure 2 indicating almost 170 Lots. Various updates to this plan have been undertaken in collaboration with Afflux, with the current iteration is shown in Figure 3.

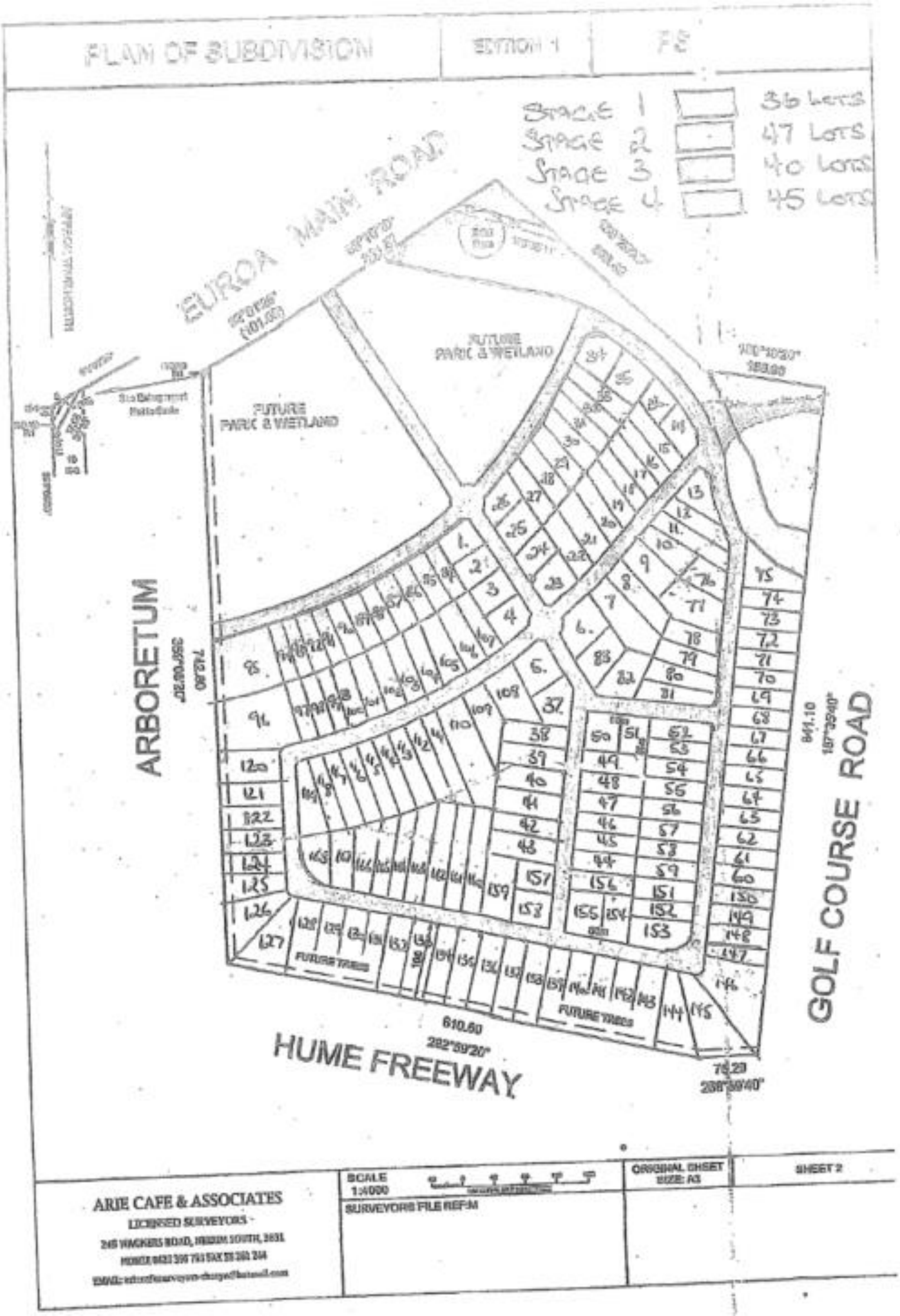
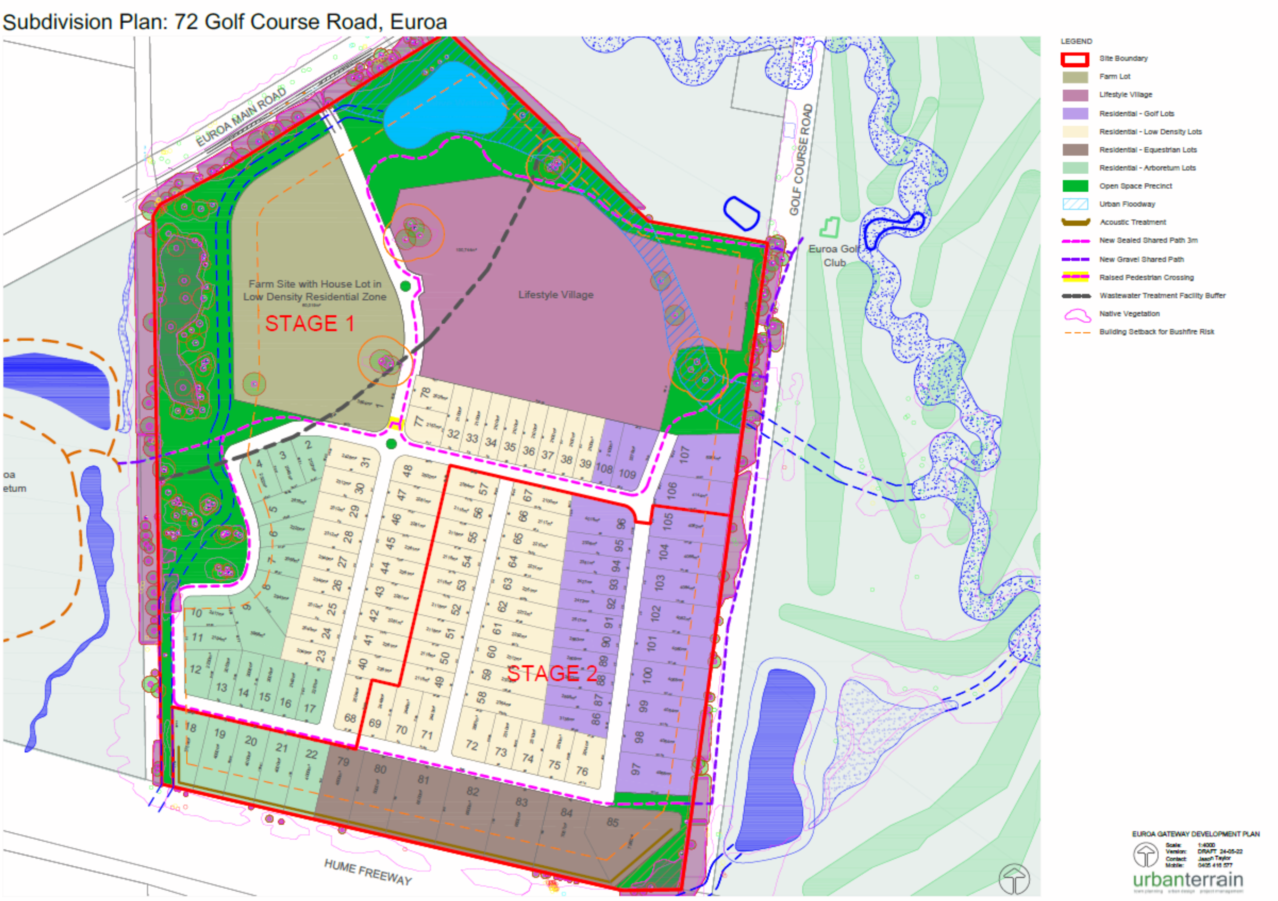


Figure 2. Initial Proposed Development Plan



Source: Urban Terrain, Dated 24-05-22

Figure 3. Updated Proposed Development Plan with Drainage Concept

2. Existing Catchment

The site is located approximately 130 km northeast of Melbourne within the Strathbogie Council. It is bounded to the south by the Hume Freeway, to the west by Euroa Arboretum (a Public Conservation and Resource Zone), to the north by Euroa Main Road and a farm zoned property, and to the east by Golf Course Road.

The existing catchment has highlighted below. Assessment of catchment flows through the site includes consideration of both "Immediate Catchment Code Boundary" (shown in Legend of Figure 4) which is delineated for assessment of upstream and on-site rainfall, and "Greater Regional Code Boundary" to assess the regional impacts from Castle Creek flood events. This is discussed in greater detail within section 6 Flood Modelling.

The catchment drains north towards Euroa Main Road, and consists primarily of farm grasslands and minimal shrubby vegetation. The subject site is approximately 67 ha with an approximate slope of 1 %, as shown in Figure 4.

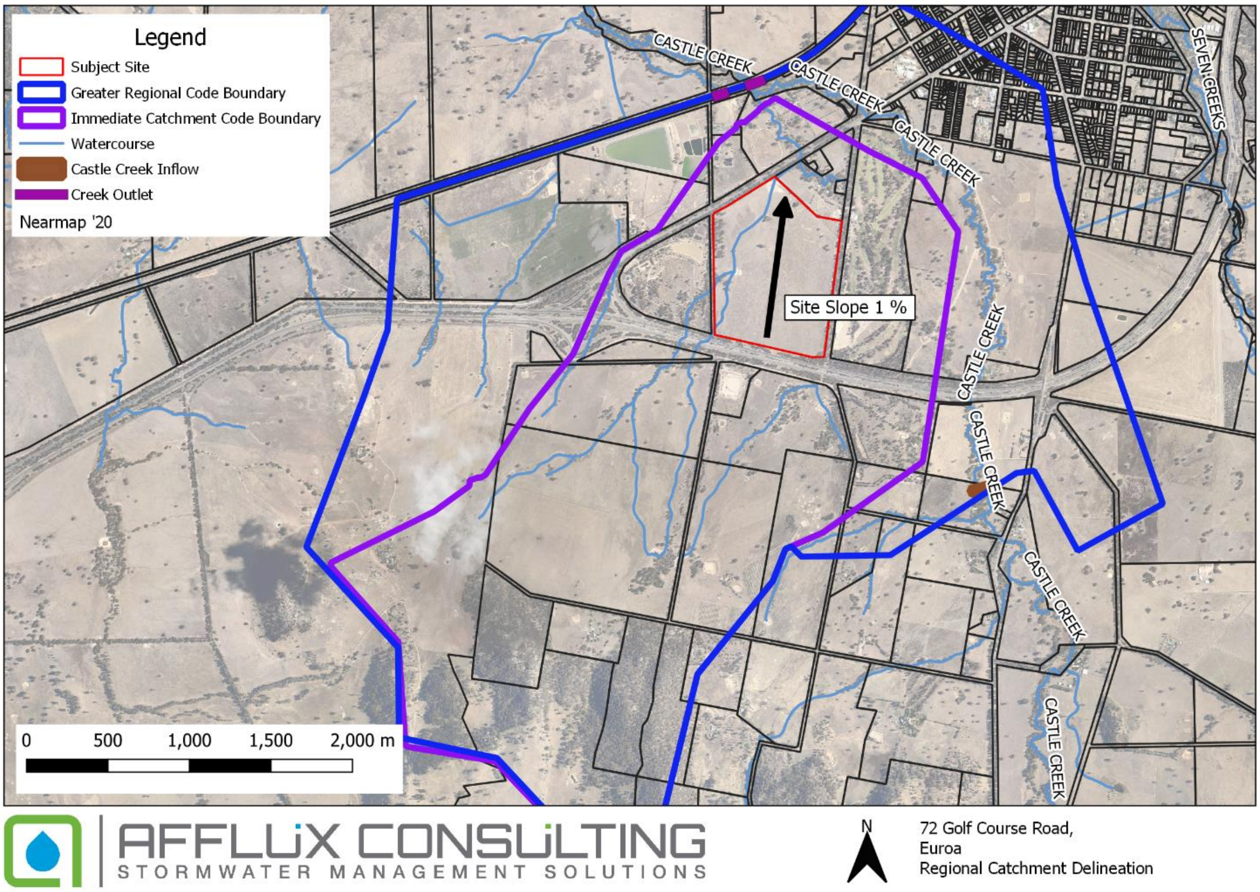


Figure 4. Existing catchment

2.1. Topographic Data

The LiDAR data acquired commercially was used as the base information to generate the Digital Elevation Models (DEM), informing surface elevations required for the model. Figure 5 shows the data over the catchment area for the site. LiDAR survey information is shown in Table 1.

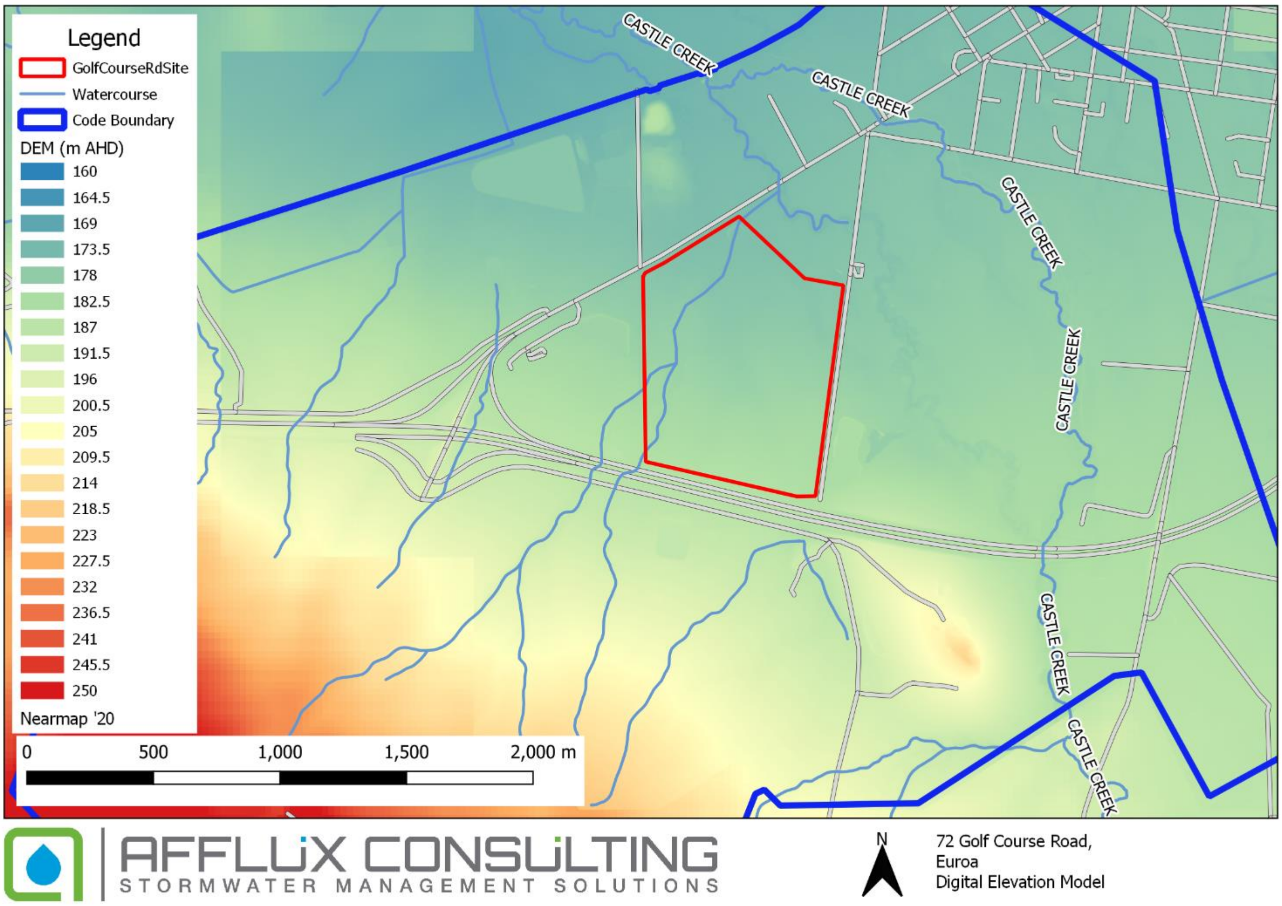


Figure 5. Digital elevation model

Table 1. LiDAR survey metadata

LiDAR survey metadata	
Acquisition Start Date	2 December 2010
Acquisition End Date	17 January 2011
Horizontal datum	GDA 94
Vertical datum	AHD
Map projection	MGA zone 55
Horizontal accuracy	0.2 m
Vertical Accuracy	0.1 m

2.2. Site Visit

A site investigation was undertaken to understand site conditions, catchment characteristics and hydraulic controls of the contributing catchment. General site conditions are shown in Figure 6, Figure 6 and Figure 8 showcasing clear green, relatively flat land with minimal vegetation. The sections following outlines key features reviewed, with 9 key sites being photo documented for the purpose of this report, these can be seen in Figure 9

Figure 6. Site conditions (the site from eastern boundary facing west)

Figure 7. Site condition (the site from western boundary facing east)

Figure 8. Western property boundary condition (tributary running along the western boundary just outside of site; last photo looking south down the boundary towards the Freeway)

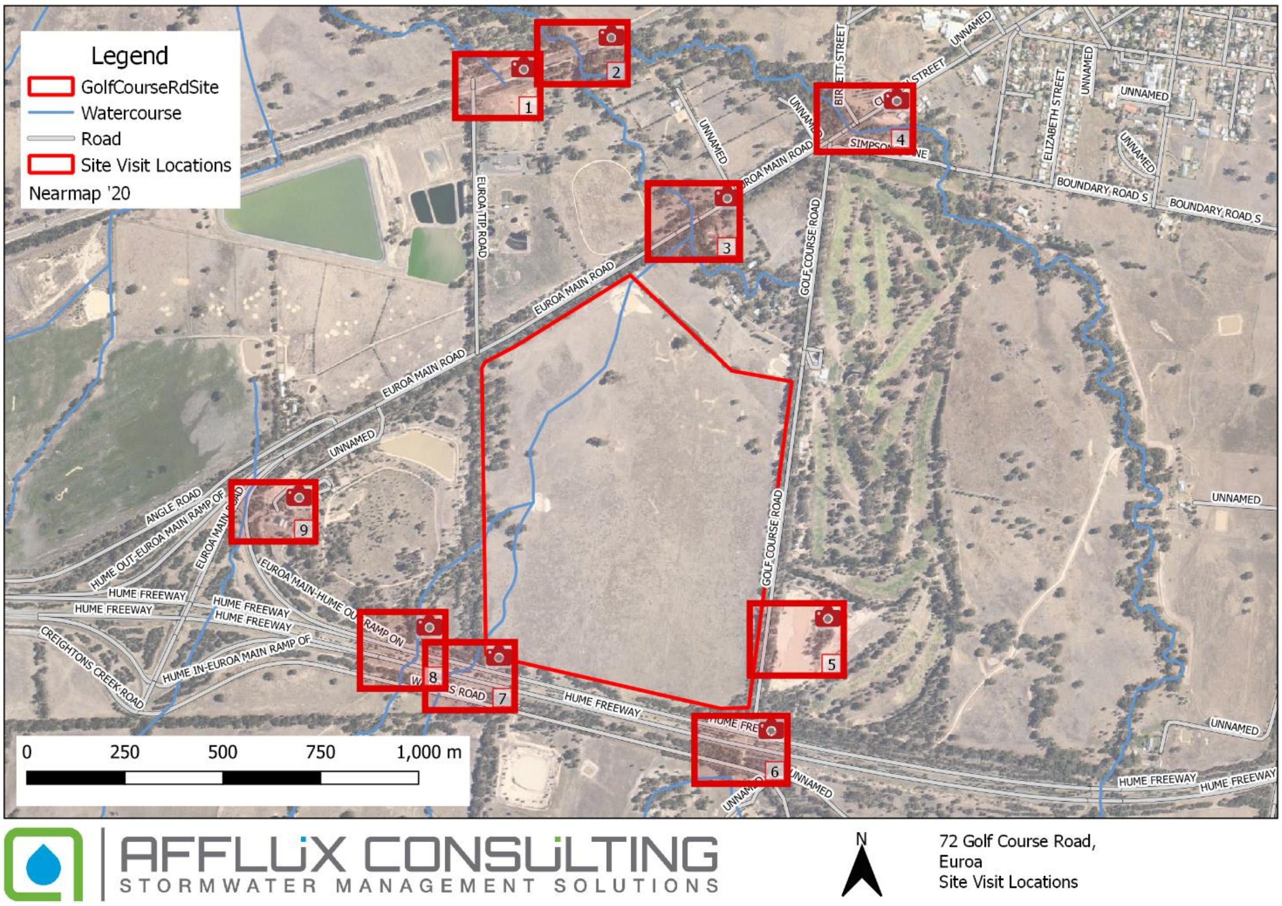


Figure 9. Key sites inspected as part of this report

Location 1 and 2 depict the outfall for the greater catchment outlet as represented within the modelling set at the railway crossing.

Figure 10. Photo location 1 and 2: Railway crossings representing hydraulic model outlet.

Photo Location 3 depicts the culvert crossing for castle creek tributary (Euroa Main Road). The images highlight the two sets of culverts (one higher set - circled in image). This area represents a complex hydraulic control with two sets of different sized culverts. The swamp area (middle picture) at culvert inlet indicates regular wetting of the area. It is a well vegetated area which has the capacity to slow flows at culvert inlets, protect banks and potentially provide water quality benefit (if water is regularly turned over). Slightly downstream of this area forms the outlet for the local model.

Figure 11. Photo Location 3: culvert crossing for tributary at Euroa Main Road

Location 4: Castle Creek Bridge (Euroa Main Road crossing). Images show conveyance of the major Castle Creek tributary. The bridge is approximately 16 m across the top and suggests a large cross-section traversing Euroa Main Road. The creek looks well established and appears to align approximately with historic flood information, where the bank (shown in the image on right) is relatively flat and close to creek level as expected for areas experiencing inundation.

Figure 12. Photo Location 4: Castle Creek Bridge crossing Euroa Main Road

Photo location 5 highlights the area to the south east of the site. This highlights the vegetated surface with a small watercourse leading towards the dam on the property abutting the site to the east. Importantly, this is the area with the Erosion Management Overlay.

Figure 13. Photo Location 5: Dam on property to east of site and surrounding vegetation.

Photo Location 6 shows the culverts at the Hume Freeway at south eastern corner of the site. The culvert photos are taken facing south, showing the four culverts. The final image shows the embankment to the south eastern corner of the site that directs flows towards the dam and inhibits flows going onto the site from the highway culverts.

Figure 14. Photo location 6: Hume Freeway culverts at south eastern corner of site

Photo Location 7 shows the culvert at the south western corner of the property. The culvert collects flows from under Hume Freeway and outlets into a small tributary running along the southern boundary of the property. The tributary appears to run along the outer property boundary then flows onto the site at the south western boundary. The culvert is well vegetated and located within a swale collecting surrounding flows or highway runoff.

Figure 15. Photo location 7 (looking towards culvert at south western corner of property; last picture looking east from culvert)

Figure 16. Photo location 7 (looking north towards site from culvert, small trib/creek running along site boundary; last picture tributary further north (downstream) from culvert)

Photo location 8 is split into south (culvert inlet) and north (culvert outlet), split by the freeway.

Photo location 8 "SOUTH" shows four rectangular culverts passing under the Hume Freeway. Figure 17 shows culvert inlet on southern side of Freeway, there is a concrete lined drop from the roadside swale (shoulder) into the culvert indicating flows into culvert would not be impeded. The second image is the swale on the southern side of the Freeway, it is well vegetated and highlights the clear low flow path from the culverts from the southern portion of the catchment.

Figure 17. Photo location 8 (south): Hume freeway culverts to the west of the site

Photo location 8 "NORTH" shows the downstream culvert outlet on the northern side of the Hume Freeway. The first image highlights how well vegetated the outlet is with some rock work, grass and bushy shrubs. Other images show the surrounding vegetation and trees, with the final image showing the swale along the highway for collection of road runoff. The level of vegetation ensures flow velocity can be slowed and flows can be somewhat dispersed across Euroa arboretum and the site.

Figure 18. Photo location 8 (north): Hume freeway culverts to the west of the site (downstream)

Photo location 9 shows the culvert at the freeway entrance ramp, this appears to provide a small inflow from the freeway runoff and drainage to prevent pooling in the road reserve.

Figure 19. Photo location 9 (culvert at freeway ramp)

3. Catchment Design Objectives

All development has the potential to adversely affect downstream environments through the effects of stormwater runoff. Increased impervious areas resulting in increased volumetric and peak flows have been extensively researched and linked to downstream environmental degradation. Contaminants contained in the runoff have also been linked with adverse changes to both water quality and stream ecology. Finally, the contribution of increased runoff can be linked to downstream flooding and capacity constraints.
To combat these affects a range hydrological and water quality mitigation measures have been researched and legislated in Victorian planning schemes. The design objectives for this catchment are considered below.

3.1. General Considerations

The Victorian State Planning Policy Framework includes provisions incorporating the provisions for stormwater management in its integrated water management clauses. The Strathbogie Council, as part of its planning requirements, incorporates BPEM water quality targets, setting out objectives for stormwater runoff.

3.2. Water Quality Requirements

Current water quality requirements as listed by the Victorian EPA Best Practice Environmental Management (BPEM) Guidelines are:

- 80% Total Suspended Solids (TSS) reduction
- 45% Total Nitrogen reduction
- 45% Total Phosphorus reduction
- 70% Gross Pollutant capture

These water quality requirements will be met in as part of this development.

3.3. Integrated Water Management

Water quality and re-use have interactions relevant to stormwater management requirements. In attempt to reduce potable water consumption and ensure volumetric flow reductions within waterways, stormwater management incorporates consideration of integrated water management strategies as appropriate to site. Generally, when implementation is appropriate, flows from site will be reduced due to reuse and provision of alternative water sources. Recommended water saving and reuse targets must be explored alongside water quality requirements as reuse results in an improved capacity to meet nutrients removal. Thereby, allowing opportunities to reduce treatment downstream. Provision of water quality requirements alongside reuse opportunities and current planning provisions have been analysed within this report as a part of stormwater management.

3.4. Flood Storage Requirements

The development shall be designed to ensure that flows are not to increase above the pre-development levels. Generally, this would be applied to the 100 year Average Recurrence Interval (ARI) storm only and checked at each of the site discharge points. Attenuation, if required, will be applied at the basin and reductions in flow peak will be determined at the outlet of the basin.

3.5. Flood Protection Requirements

All lots within the development will be provided at least 300mm freeboard above any predicted 1% AEP flood level (with floors a further 300mm higher). Building envelopes will not be placed in areas without this level of protection. Natural overland flow paths will be retained in principle. All retardation infrastructure will be designed to be cut into the natural surface avoiding any potential dam wall construction issues. Local stormwater protection may have a lower level of freeboard (300mm). Appropriate building/infrastructure setbacks (a minimum of 30 metres) to water features will be recommended within this report.

3.6. Ecological Objectives

This site eventually discharges into Castle Creek. The protection of downstream environs through the provision of water quality and quantity control devices is an important aspect of this site's development. The proposed development should be developed in such a way as to minimise its impact on the surrounding environment and improve ecological values where reasonably practicable.

Vegetation and vulnerable species are impacted by activities related to development. Elimination and mitigation of these impacts are an important consideration in this process. Vulnerable species may be impacted by the following activities (Invert-Eco, 2019):

- Changes to ground water drainage patterns or stream channels which affect the water table (e.g. dam construction, stream diversion);
- Clearing of riparian vegetation, changing hydrology and causing drying out of sites;
- General road and drainage activities impacting on seepage, wetland and stream bank habitat and any activities that may degrade stream bank integrity, increase siltation and enhance erosion;
- Soil disturbance and compaction due to vehicles, stock trampling and inhibit burrow formation. Compaction also impairs soil permeability and water holding capacity;
- Water contamination, especially through application of chemical sprays, pesticides, excess nutrients or toxic leaching; and
- Drainage of swamps and conversion to pasture.

Ecological survey is not within the scope of this project however if the presence of any specimens is detected, drainage activities should be located outside of these zones where possible. If required, ecological studies should be completed for this area and referred to for comprehensive coverage of issues.

3.7. Additional Planning Controls

Approximately two thirds of the lot is zoned Low Density Residential, while the remainder of the site is Farming zone. The development parcel has several complex pieces of water related infrastructure to consider including:

- Land Subject to Inundation Overlay (LSIO);
- Urban Floodway Zone (UFZ); and
- minor waterways/tributaries moving from the south-western boundaries to the north.

These can be seen in Figure 20 and Figure 21. The minor waterways appear to be tributaries of Castle Creek which join the primary creek line just over the railway line to the North.

Portions of the site are also encumbered with:

- Environmental Significance Overlay (ESO) (Figure 22); and
- Vegetation Protection Overlay (VPO) (Figure 23).

Additional consideration must be made to the nearby overlay:

- Erosion Management Overlay (EMO) (Figure 24)

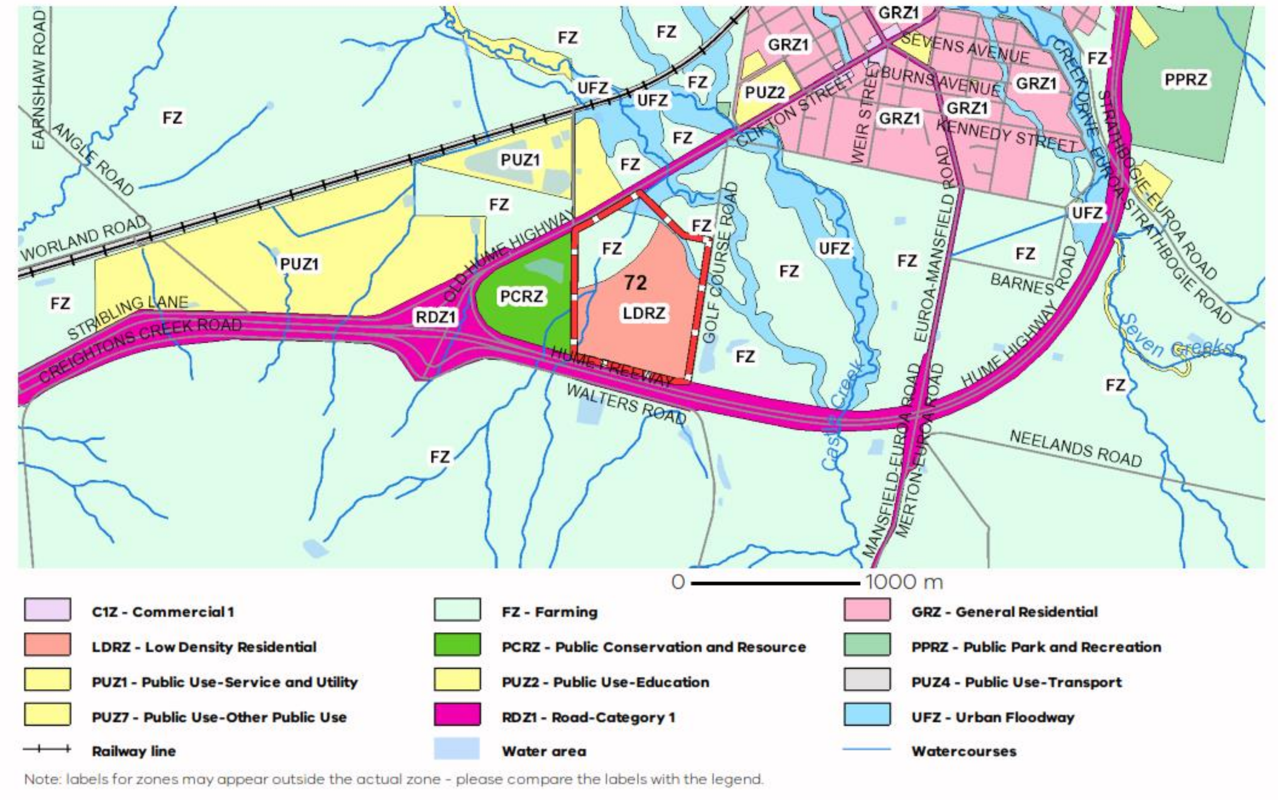


Figure 20. Planning Zones (Excerpt from the Victoria Environmental, Land, Water and Planning Property Report

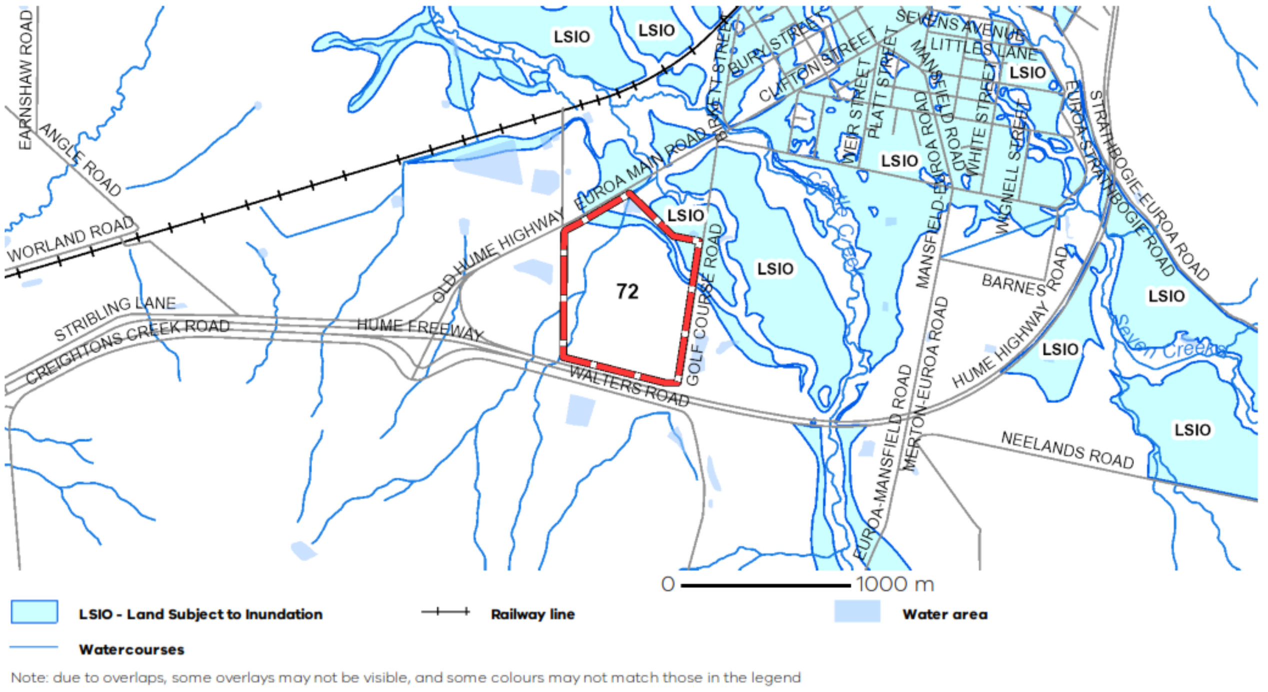


Figure 21. Planning Overlays Indicating LSIO (Excerpt from the Victoria Environmental, Land, Water and Planning Property Report)

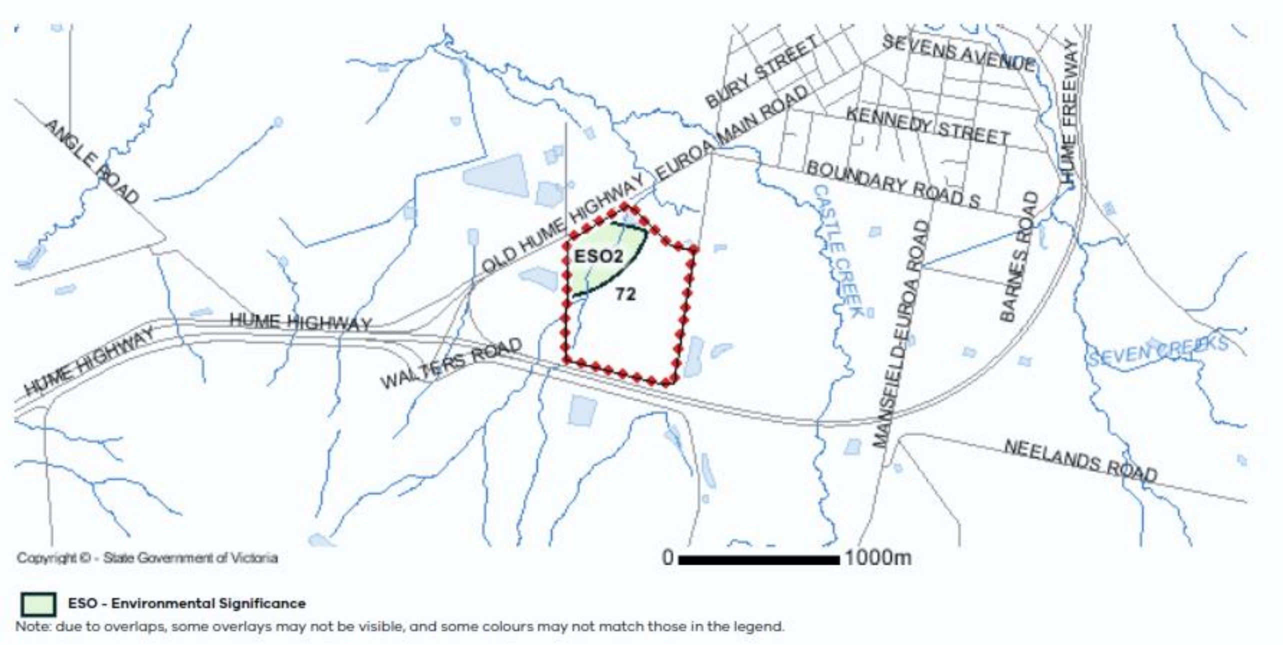


Figure 22. Planning Overlays Indicating Environmental Significance (Excerpt from the Victoria Environmental, Land, Water and Planning Property Report)

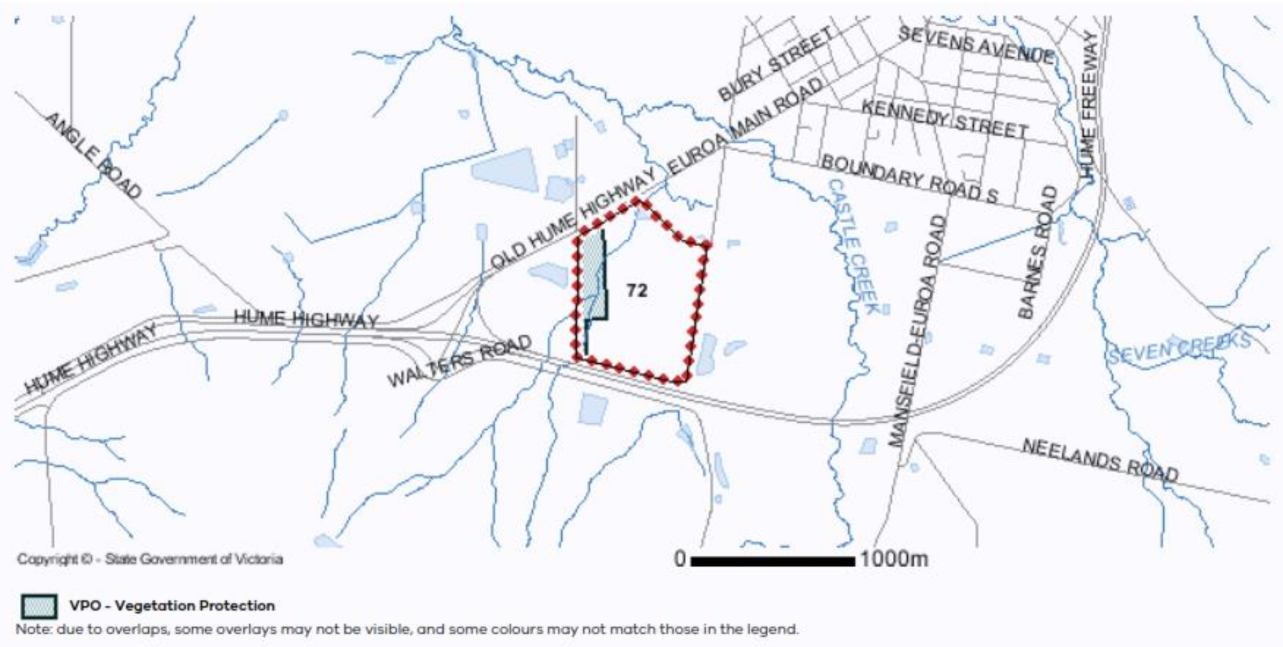


Figure 23. Planning Overlays Indicating Vegetation Protection (Excerpt from the Victoria Environmental, Land, Water and Planning Property Report)

Figure 24. Planning Overlays Indicating Erosion Management (Excerpt from the Victoria Environmental, Land, Water and Planning Property Report)

Land Subject to Inundation/Urban Flood Zone (LSIO/UFZ)

The site is located in Strathbogie Council with a LSIO/UFZ from the Castle Creek system extending over the north section of the parcel. This triggers the expectations of Strathbogie Local Floodplain Development Plan Precinct of Castle Creek and Seven Creeks, December 2003.

This study will use a standardised approach to flood reporting within a LSIO/UFZ, including:

- Assessment of major drainage and flooding associated with the relevant greater regional catchment
- Assess immediate catchment influence to mitigate flooding risk to the proposed development and flood impacts to neighbouring properties
- Ensure flooding of the site, or potential off-site impacts are reduced or eliminated
- Ensure developed site conditions are compatible with the flood hazard and local drainage conditions and will not cause any significant rise in flood level or flow velocity
- Ensure that the development maintains the free passage and temporary storage of floodwaters
- Meet the EPA best practice environmental management (BPEM) water quality requirements, particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).

Additional site-specific requirements have been included within this report, as follows:

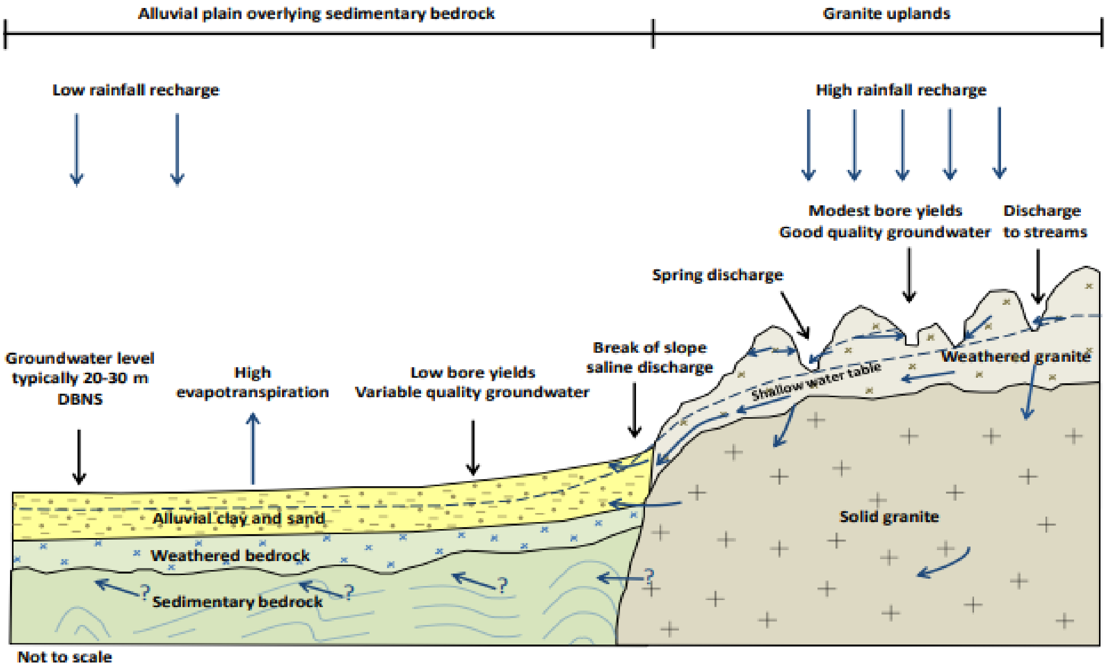
- Inclusion of the Castle Creek and the Castle Creek anabranch's influence on the major drainage and flooding
- Assessment of the minor waterway (Castle Creek tributary) and the overland flow path requirements associated with the subject site
- Inclusion and consideration of any comments from the relevant floodplain management authority (GB CMA)

To meet these requirements a range of hydrological, hydraulic and water quality modelling have been undertaken.

Erosion Management Overlay (EMO)

While the overlay is not directly on the site it indicates erosion potential for soil types present in the area with the potential to impact earthworks, increased asset risk and additional stabilisation requirements for drainage assets. Geology in this catchment is known to consist of primarily alluvial clay and sand, however it may also have some granite floaters or boulders due to the proximity to the granite fields to the east This can be seen in Figure 25.

In areas with erosion susceptible soils, the exposure of the deeper dispersive soils (due to construction and clearing activities) is the primary driver for erosion, and in particular tunnel erosion. Construction of drainage assets should take into consideration the impacts of interactions between stormwater and soils. Geomorphic studies of the catchment and proposed drainage features should be undertaken in the next phase of design development and used to further inform drainage asset designs.



Source: Excerpt Strathbogie Groundwater Management Area Local Management Plan 2013

Figure 25. Expected Soil profile of the site

3.8. Specific Concerns For This Site

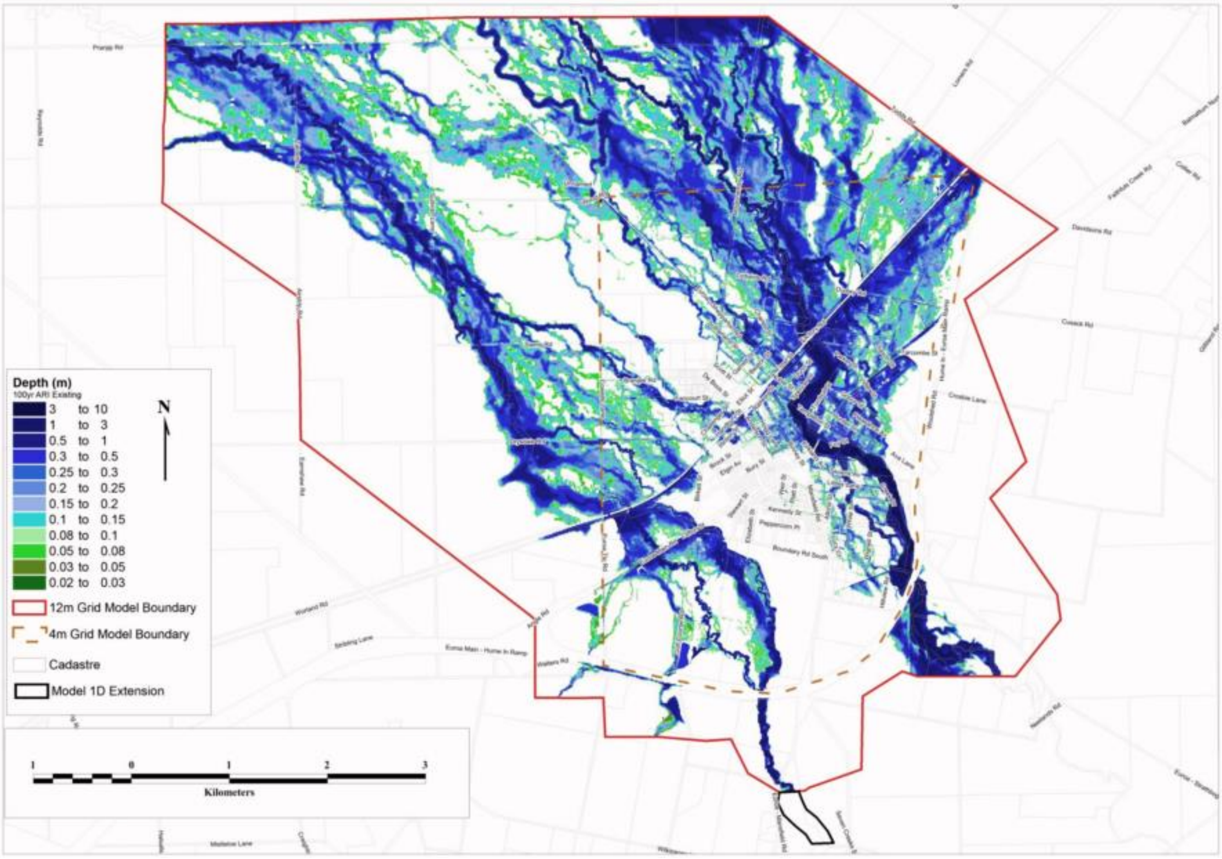
Based on the review of the catchment, listed objectives and requirements the following stormwater elements should be considered for this site:

- Managing flood extents and ensuring no worsening conditions on adjacent properties
- Fill requirements and waterway offsets
- Existing drainage infrastructure capacity
- Surrounding existing development constraints
- Site topography and geomorphological interactions with drainage asset locations
- Climate and rainfall conditions
- Interactions with regional waterway systems (Castle Creek and Castle Creek anabranch)
- Interactions between drainage features and local soil types.

4. Historic Flood Information

The regional flood study for the area was provided by the Goulburn Broken Catchment Management Authority (GBCMA). The information provided by GBCMA provided sound hydrological information for creek inflows into regional flood model and flood shapes for comparison. The report confirmed significant existing flooding within the study area.

Relevant excerpts from the report are shown below (Figure 26). The report also provides a reference point for catchment flows corresponding to the relevant catchment area for this site. The design peaks and critical storm durations for Castle Creek are shown in Figure 27 and Figure 28.



Source: Excerpt from Euroa Post Flood Mapping and Intelligence Project, Cardno, 2015

Figure 26. Design event peak depths - 1 % AEP

AEP	Design Peak (m^3/s)	Duration	Initial Loss	Continuing Loss
20%	25.5	9h	20.0	1.88
10%	39.8	9h	20.0	1.65
5%	54.9	9h	20.0	1.70
2%	73.4	9h	20.0	1.90
1%	89.7	9h	20.0	2.00
0.5%	106.9	9h	20.0	2.10
0.2%	130.8	6h	20.0	2.30

Source: Euroa Post Flood Mapping and Intelligence Project, Cardno, 2015

Figure 27. Design events generated for the Castle Creek catchment

AEP	Design Peak (m^3/s)	SKM (1997)	Difference (SKM to current)
20%	**26**		
10%	**40**	36	11%
5%	**55**	54	2%
2%	**73**	73	1%
1%	**90**	97	-8%
0.50%	**107**	122	-12%
0.20%	**131**	159	-18%

Source: Euroa Post Flood Mapping and Intelligence Project, Cardno, 2015

Figure 28. Design events generated for the Castle Creek catchment as compared to SKM study in 1997

5. Hydrology

To evaluate the hydrology of the proposed development a number of hydrological models have been formed and compared. This method has been chosen to best represent hydraulic influences and hydrologic

5.1. Hydrological Modelling - Regional Model

The 1 % AEP peak flow information for the regional model was provided by Goulburn Broken CMA within the Cardno Flood Model. The relevant design event (Figure 28) was converted into a triangle hydrograph as shown in Figure 29. This flow hydrograph is introduced into the regional hydraulic model to assess the 1% AEP regional flood levels (section 6.1 Regional Catchment).

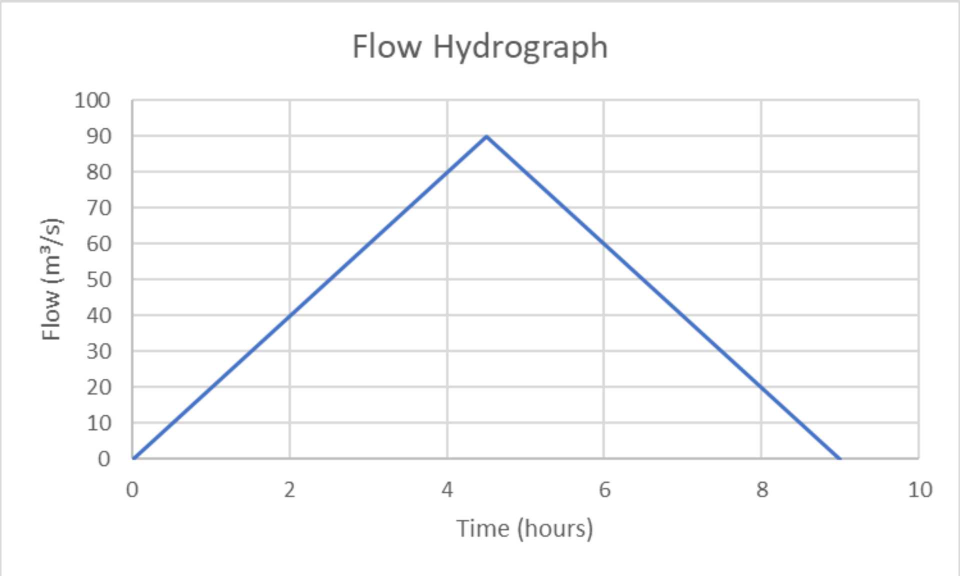


Figure 29. Flow Hydrograph

5.2. Hydrological modelling - Immediate Site Catchment

The 1% AEP (Annual Exceedance Probability) flood discharge for the site was estimated following ARR 2019 (Australian Rainfall and Runoff, 2019) processes. The ARR19 tool for TUFLOW and QGIS was used to process the information from the online ARR Data Hub. Table 2 summarises key inputs to the hydrological model.

Table 2. Site specific hydrology assumptions

Input Data	Value
Region	Southern Slopes
Impervious Losses	IL: 1 mm CL: 0 mm/h
Pervious Losses	IL: 28 mm CL: 4.2 mm/h

Rainfall depths were extracted from the BoM IFD database. The temporal rainfall patterns were taken from the ARR Data Hub as per guidelines, and as shown in Figure 30 below, "Murray Basin" data set was applicable for this site.

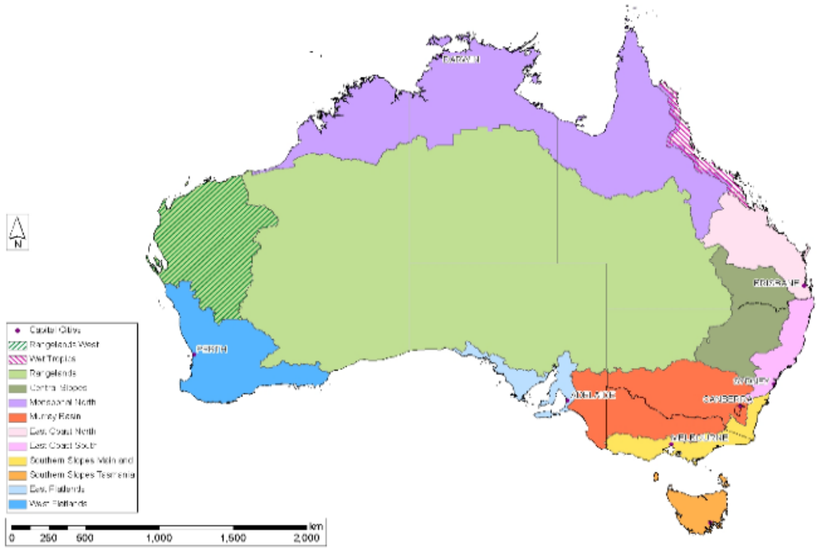


Figure 30. Map of temporal pattern regions

In addition, the ARR Data Hub provides recommendations for losses as shown below in Figure 31 and Figure 32. The ARR19 tool estimates losses and reduction factors using the information from Data Hub. The supplied loss file was found to be suitable with loss factors appropriate to the catchment given the predominantly rural catchment. Once the estimated rainfall magnitudes were decided upon, a Rainfall on Grid (ROG) method was used to distribute the flows in the local catchment model (section 6.3 Local catchment).

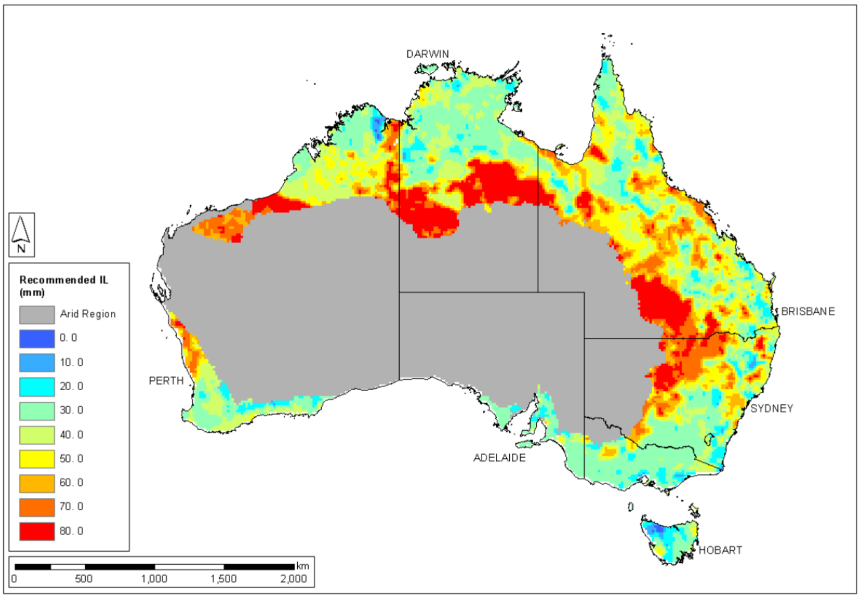


Figure 31. ARR 2016 recommended Initial Loss

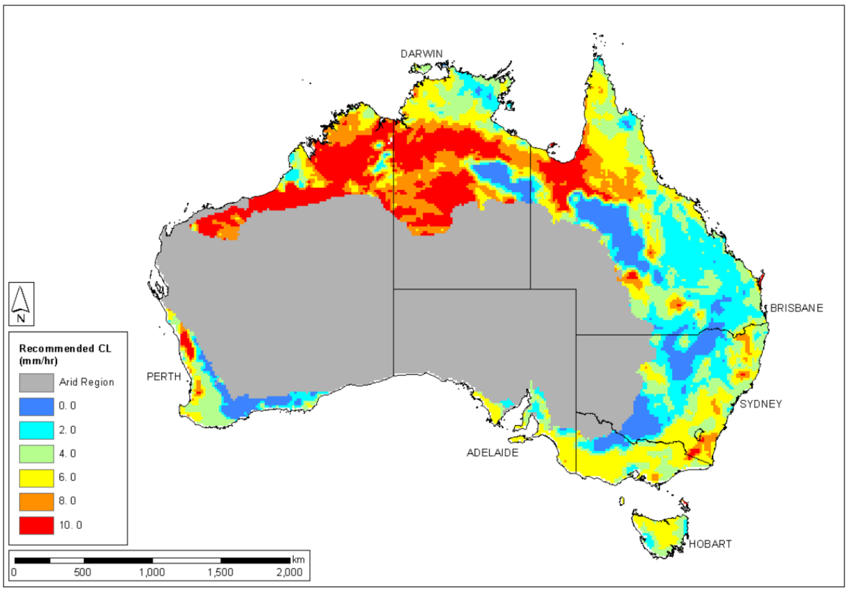


Figure 32. ARR 2016 recommended Initial Loss

6. Flood Modelling

Two major factors influencing flooding on the site and relevant catchment include:

- interactions with Castle Creek and Castle Creek tributaries due to large upstream events; and
- the impact of flooding from rainfall on the immediate catchment.

As a result, two methodologies were used to assess flood outcomes:

- The creek system was assessed using flow inputs provided by GBCMA (discussed in section 6.1 Regional Catchment).
- The impact of flooding from rainfall on the immediate catchment was assessed using the rainfall magnitudes determined in the hydrological modelling. The Rain on Grid (ROG) methodology was then used within Tuflow to distribute the flows (discussed in section 6.3 Local catchment)

6.1. Regional Catchment

The impact of the creek system was assessed using a regional greater catchment model with inputs based on the flood information provided by GBCMA. The regional catchment has been delineated as shown below (Figure 33). The flow hydrograph was introduced into the regional hydraulic model at an upstream source area boundary. Downstream boundary conditions have been established based on an examination of topography. This has been set a considerable distance downstream of the site to ensure no undue model boundary influence.

6.2. Model Parameters

Initial model setup for the catchment models involved the accessing a survey surface, setup of existing drainage networks and assumptions of Manning's roughness parameters for the model area (Figure 33). These assumptions can be seen in Figure 5 and Figure 34.

Model extent is based on topographical catchment boundaries. Land use in the model has been determined based on inspection of aerial imagery and visual inspection and has been used to inform Manning's roughness factors in the model. Downstream boundary conditions have been established based on an examination of topography. This has been set a considerable distance downstream of the proposed assets to ensure no undue model boundary influence. Parameters for the model area are included in the Table 3 below. These assumptions and Manning's roughness values can be seen in Figure 33 below.

Table 3. Model parameters

Model Parameters		
Grid Size	3m	Appropriate for regional model
Time Step	1.5 seconds (2D)	Reasonable time step for selected grid size
Model Run Duration	15 hours	Allows sufficient time for peak flows to pass through the site
Model Topography	Commercially supplied LiDAR (Feb, 2017) adopted as basis of model	
Inflow Boundaries	Flow over time hydrograph inflow upstream of the site	

Outflow Boundaries (2D)	Located approximately 700m downstream of the site	
Mass Balance	<1%	Mass balance indicates model stability and representativeness of physical conditions. As per Melbourne Water modelling guidelines this should ideally be less than 1%.
Manning's Roughness	Manning's Roughness applied to cells not covered by materials layer set to a value of 0.02	

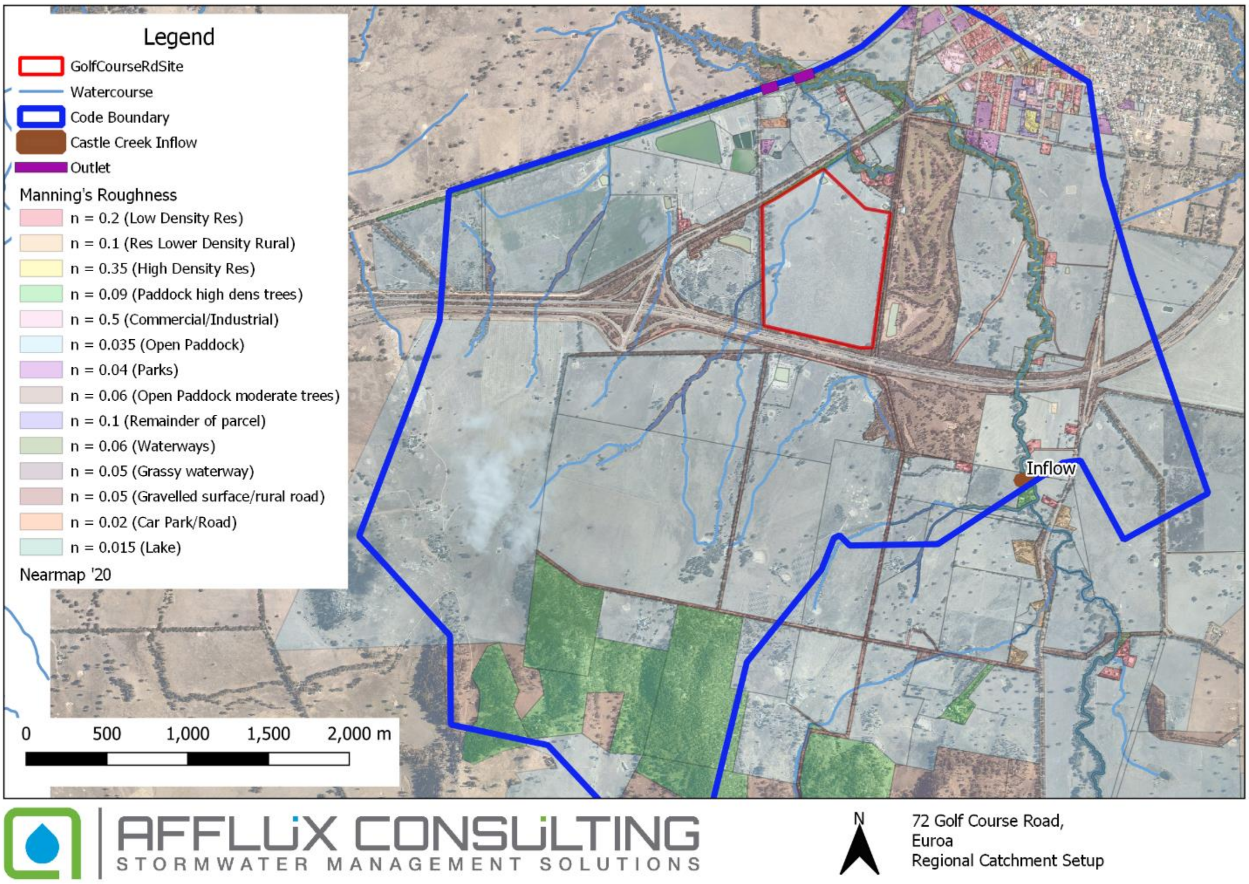


Figure 33. Regional catchment

6.3. Local catchment

Once the estimated rainfall magnitudes were decided upon (discussed within Hydrology section), a high-definition model was constructed to understand flood mechanisms during a 1% AEP storm event. The model was built and run in TUFLOW using a linked 1d/2d approach, parameters and data sources.

The Immediate catchment model extent is based on topographical catchment boundaries as shown in Figure 34.

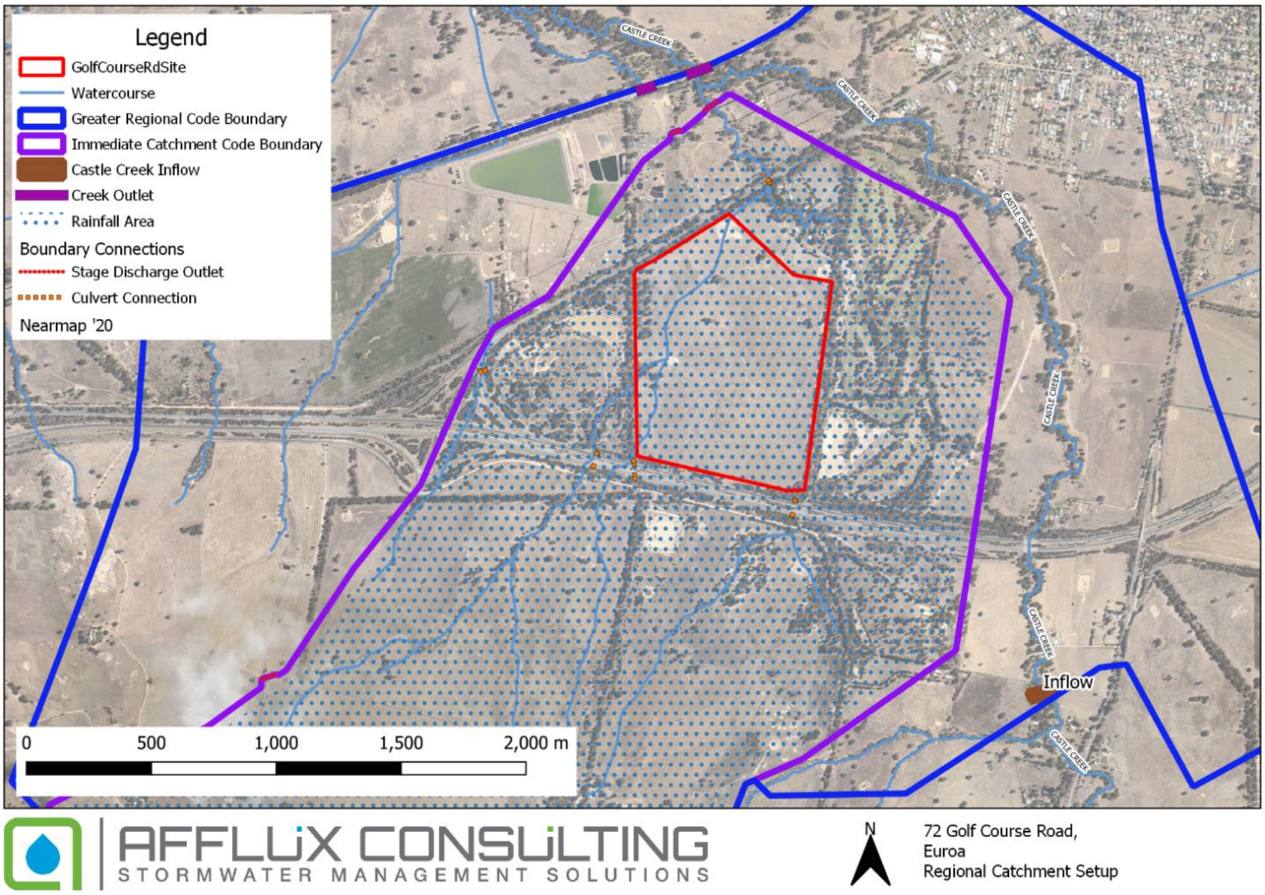


Figure 34. Model parameters and setup for Greater Regional and Immediate Catchment boundaries

The Ensemble Event approach was adopted involving the use of a set of 10 temporal rainfall patterns from gauged local catchments to derive a set of hydrographs for each event AEP and critical duration (Table 4). Each hydrograph was run through the hydrologic model providing a critical maximum depth plot for all temporal patterns and storm durations (Figure 35).

As recommended within ARR19 methodology, only the mean for the critical duration storm results are selected for design. The max critical storm durations map is shown in Figure 36 with the 360 min storm duration selected for design. Figure 37 shows the storm temporal pattern (TP) map for the Critical (360 min) 1 % AEP storm duration. The resulting critical rainfall hyetograph (1 % AEP, 360 min, temporal pattern 3) is shown in Figure 38.

Importantly, a visual check was undertaken at various key locations to verify critical event selection confidence. That is, the results from the selected critical event were compared to the mean depths identified from ensemble analysis at all locations. The depths varied by only a few millimetres. As such, the critical design storm provides a good representative model for the 1 % AEP.

Table 4. Storm duration and temporal pattern run suite

		Temporal Pattern No.									
Storm Duration		TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8	TP9	TP10
	20min	X	X	X	X	X	X	X	X	X	X
	25min	X	X	X	X	X	X	X	X	X	X
	45min	X	X	X	X	X	X	X	X	X	X
	1hr	X	X	X	X	X	X	X	X	X	X
	1.5hr	X	X	X	X	X	X	X	X	X	X

	2hr	X	X	X	X	X	X	X	X	X	X
	3hr	X	X	X	X	X	X	X	X	X	X
	4.5hr	X	X	X	X	X	X	X	X	X	X
	6hr	X	X	X	X	X	X	X	X	X	X
	9hr	X	X	X	X	X	X	X	X	X	X
	12hr	X	X	X	X	X	X	X	X	X	X
	18hr	X	X	X	X	X	X	X	X	X	X
	24hr	X	X	X	X	X	X	X	X	X	X
	30hr	X	X	X	X	X	X	X	X	X	X
	36hr	X	X	X	X	X	X	X	X	X	X
	48hr	X	X	X	X	X	X	X	X	X	X
	72hr	X	X	X	X	X	X	X	X	X	X

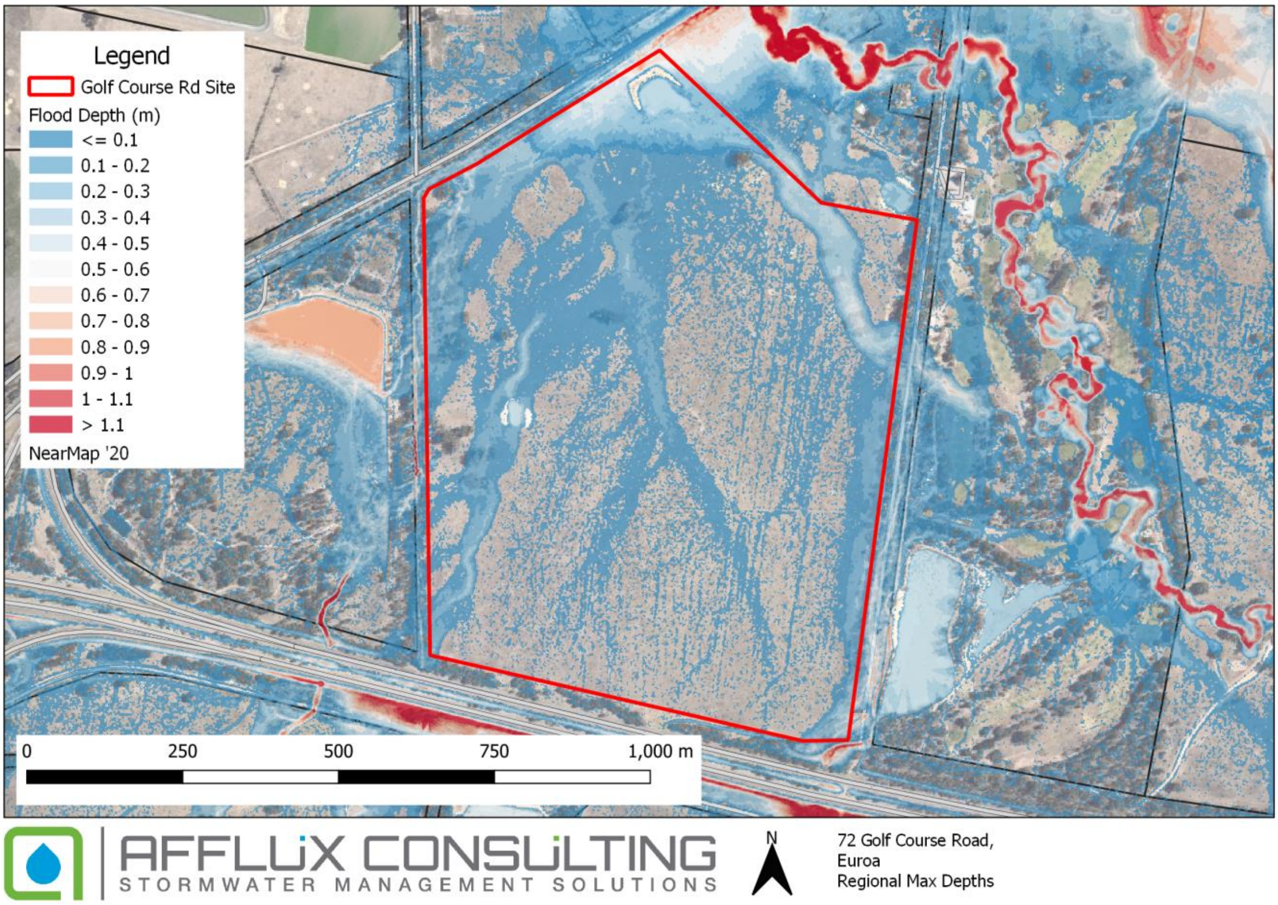


Figure 35. Existing conditions flood depth

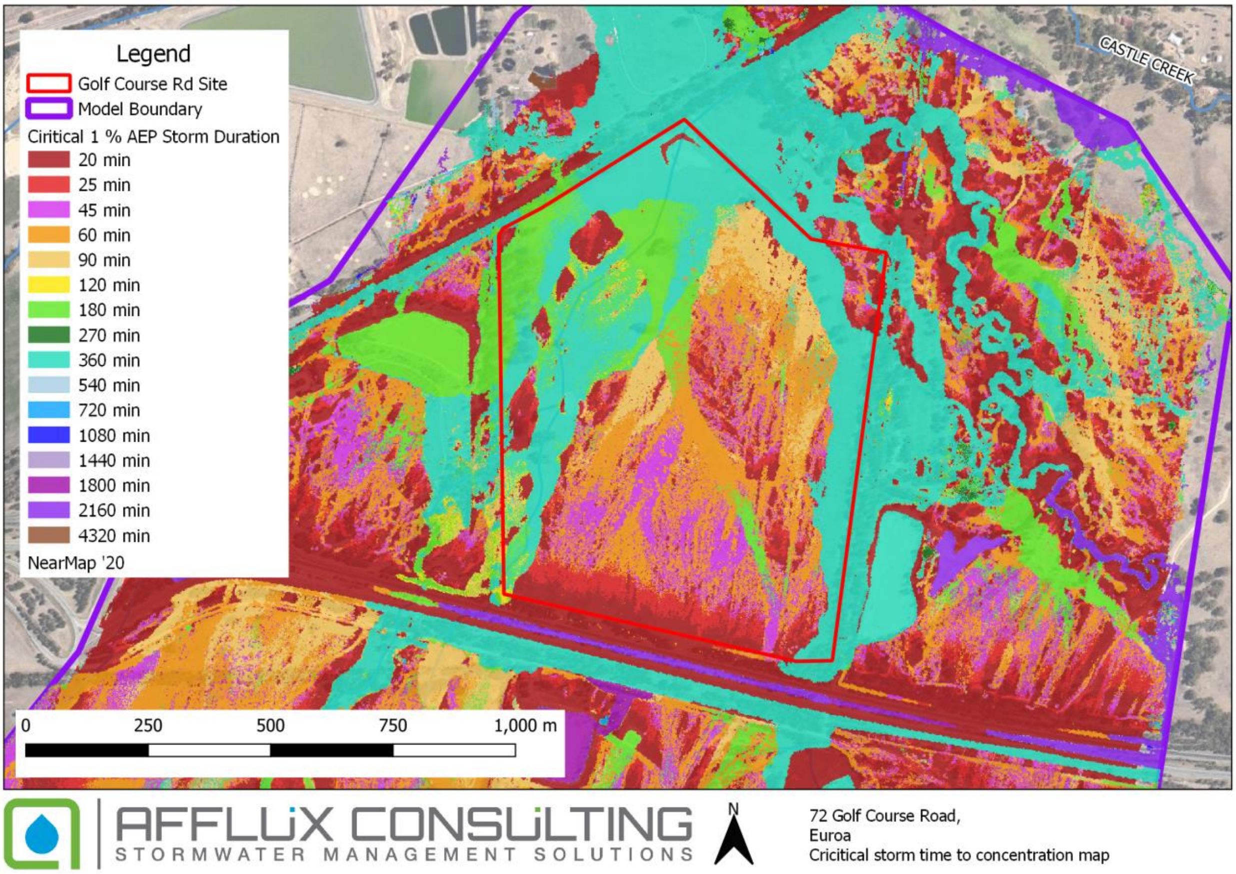


Figure 36. Critical storm time to concentration catchment map

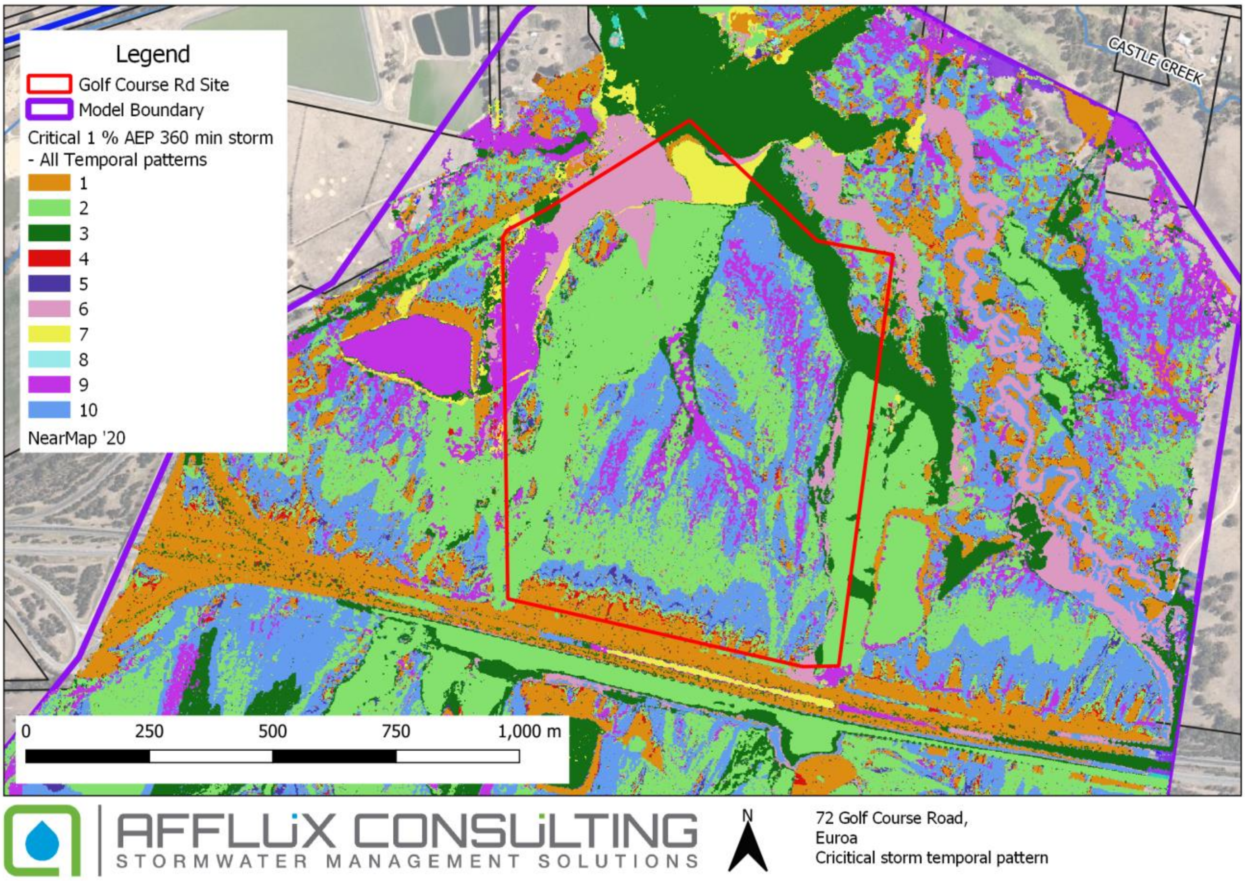


Figure 37. Critical storm temporal patterns over the catchment

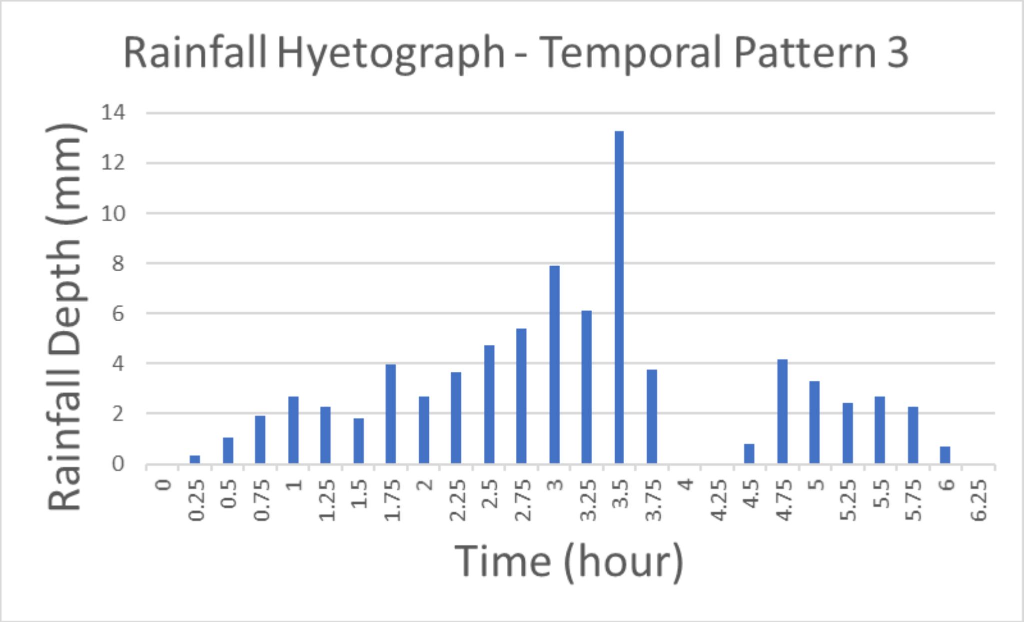


Figure 38. Example Rainfall Hyetograph – 1 % AEP 360 min TP3

7. Flood Assessment

The main considerations for both the regional and immediate/local catchment flood assessment includes the need for unobstructed overland flow conveyance, availability of flood plain storage, water surface levels in relation to proposed developed floor levels and any possible changes impacting neighbouring properties.

7.1. Model Reporting and Analysis

The model has been set up to report the following key indicators:

- Water Surface Elevation (WSE) showing the water level relative to a datum (m AHD) at each model grid cell.
- Maximum water depths for each model grid cell.
- Maximum water depths at defined reporting cross sections immediately onto and off the site.

Analysis of results will show WSE and water depth based on flood conditions and will be used to establish flood extents on the property. Water Level Difference maps will be provided to show afflux changes between existing and developed conditions. Additional maps will be produced to provide an assessment of the proposed development against safety criteria. Based on the assessment of these results recommendations for floor levels, site access and treatments will be made.

7.2. Existing Conditions

The impact of flooding from rainfall on the relevant regional catchment was assessed using a whole catchment model. This was overlayed with the immediate catchment model as shown in Figure 35 and Figure 39.

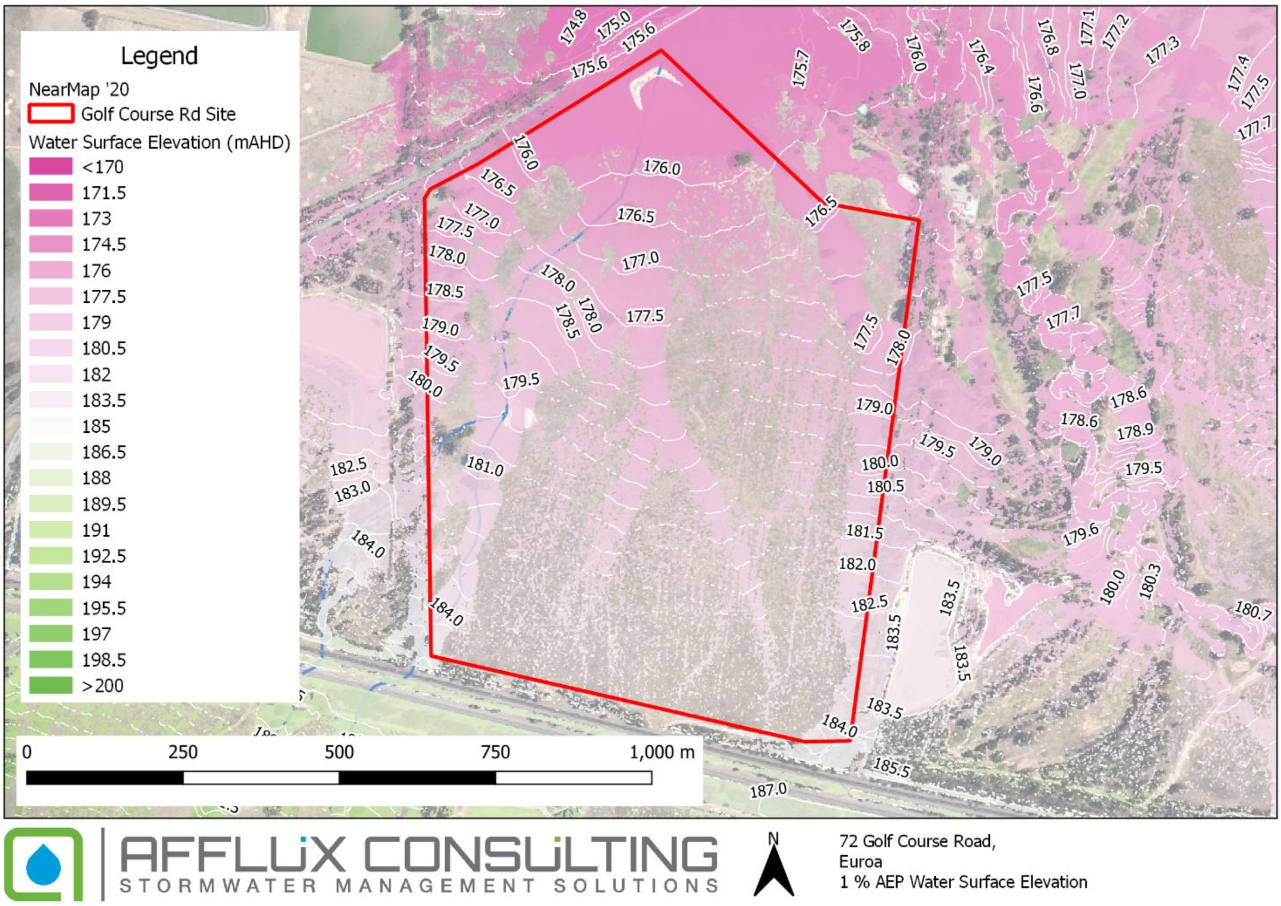


Figure 39. Existing conditions water surface elevation

The key points from this analysis are:

- The peak flow through the site for the 1% AEP are associated with the 6 hour (360 min) TP 3 storm event; and
- A few significant overland flow paths (OFP) occur through the site, these should be considered within development plans.

Importantly, adequate OFP arrangements should be maintained to ensure development minimises offsite afflux.

7.3. Reconciling Regional Results

To check that modelled flood extents provide reasonably consistent results the modelled extents (and WSE contours) were compared to the Cardno/GBCMA flood mapping outputs. The model extents were also compared to the LSIO overlay and the UFZ zone map. These are shown in Figure 40 and Figure 41 respectively.

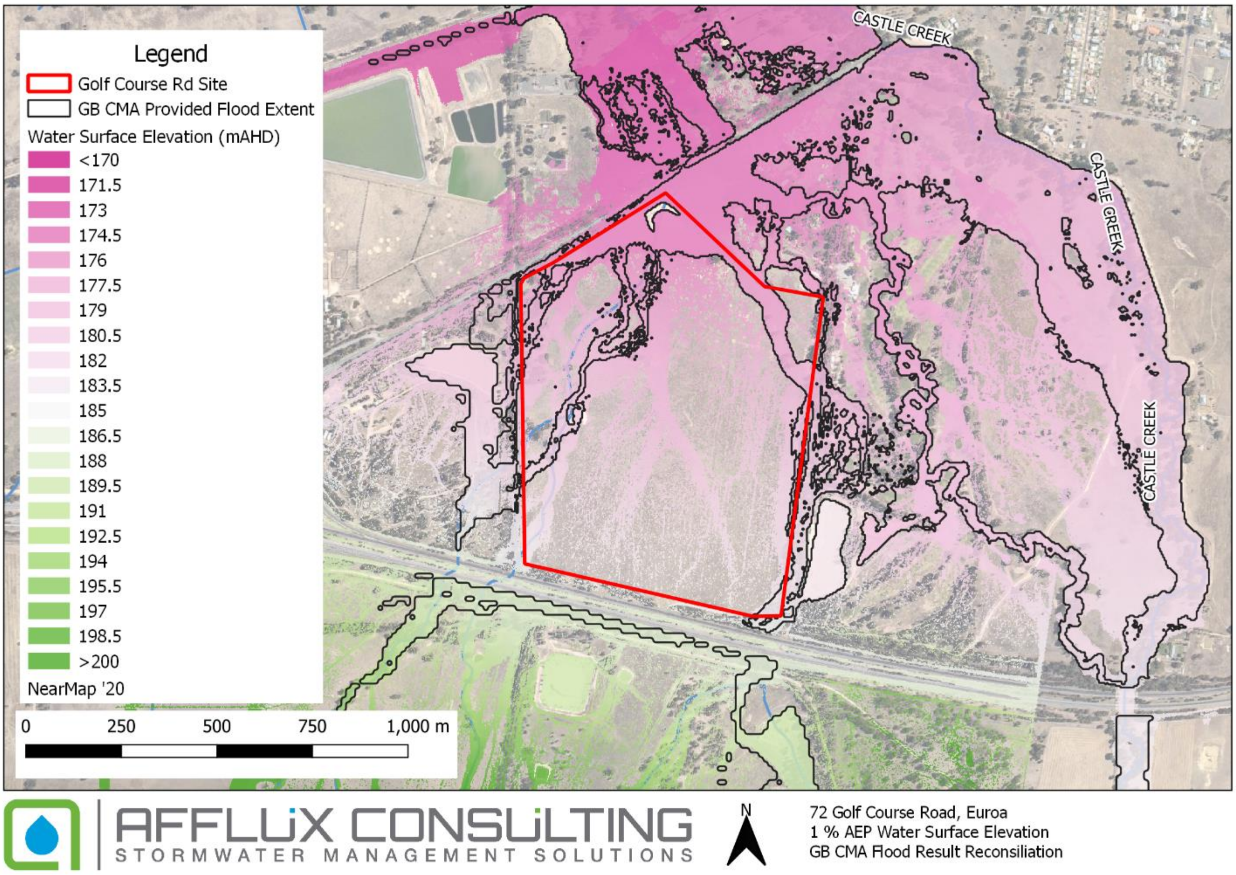


Figure 40. 1 % AEP WSE with GM CMA (Cardno) mapping overlaid

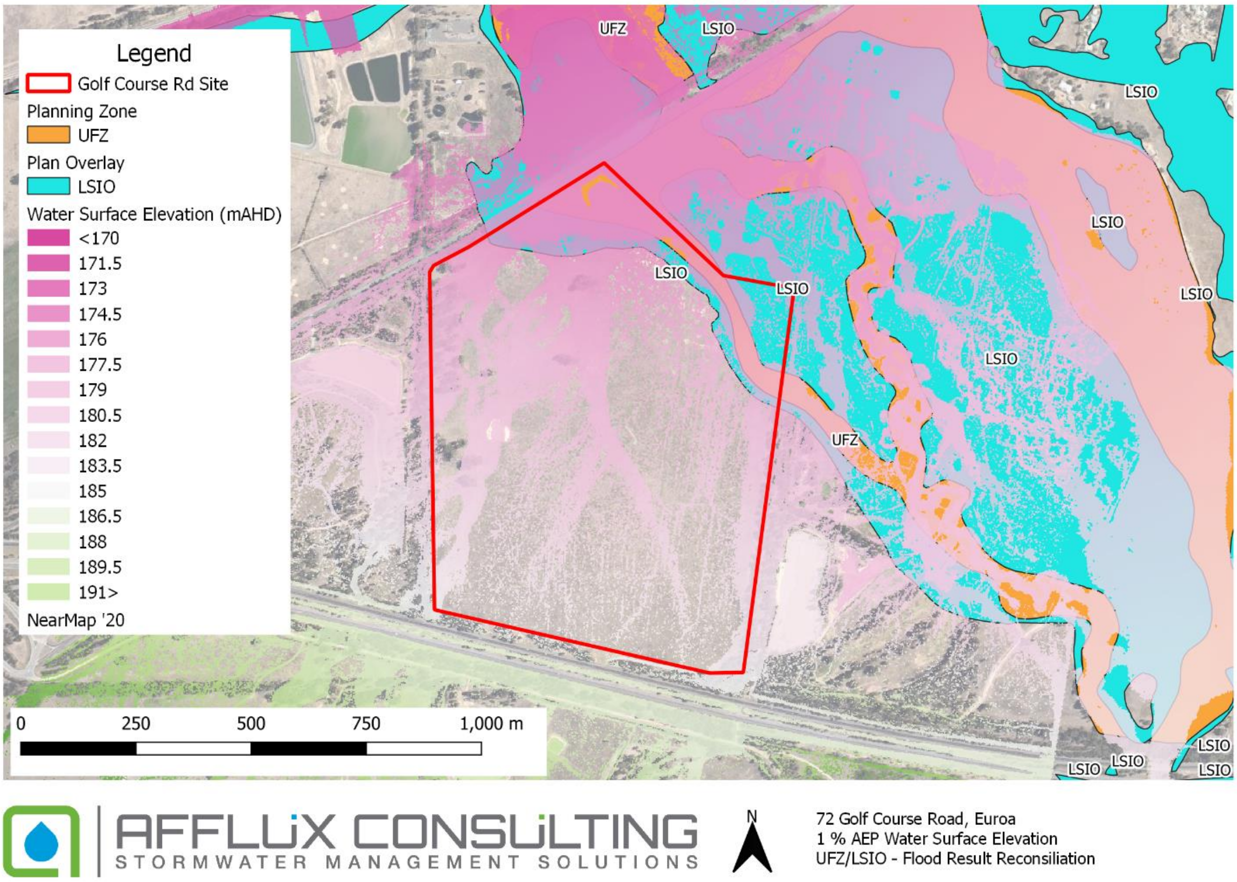


Figure 41. 1 % AEP WSE with LSIO/UFZ mapping overlaid

Key conclusions:

- The mapped results provide reasonably reconciled flood results;
- The LSIO/UFZ doesn't outline the important overland flow paths on the site;
- The LSIO/UFZ provides good indications of the Castle Creek flood extents; and
- The Afflux modelled results align reasonably with the GB MA flood mapping and LSIO/UFZ

7.4. Developed Unmitigated Conditions

The initial developed model was based on the initial proposed development plan (provided with the job proposal) and development planning information. The altered model assumed full development potential for the site to provide an indication on flood impact on adjacent properties. The assumptions made for this model were similar to those for the existing conditions catchment model, with additional assumptions including:

- Only the 1% Annual Exceedance Probability (AEP) critical duration storm presented;
- An altered DEM was derived designed to emulate fill above WSE for entire development for impact assessment;
- No improvements/alterations were made to overland flow conveyance within DEM; and
- Rainfall was not modelled on the site.

Importantly, in this scenario rainfall was not modelled on the site, therefore the site flows are not shown. This was not an oversight, rather this model was developed to assess impact to adjacent properties as a priority for consideration in overall lot development potential. This still assumes the development would cater to its own site runoff within road networks, etc. and considers the impact of development without consideration for conveyance of flows from the broader catchment through the site. This provides information on the magnitude of the external flows (of 1% AEP events) and can form as a basis for negotiations with adjoining landowners to divert catchment flows if desired.

Figure 42 shown below was then used to inform further alterations to the development plan and conveyance configurations. Figure 43 shows the flood difference plot indicating increases in flood depths on adjoining properties.

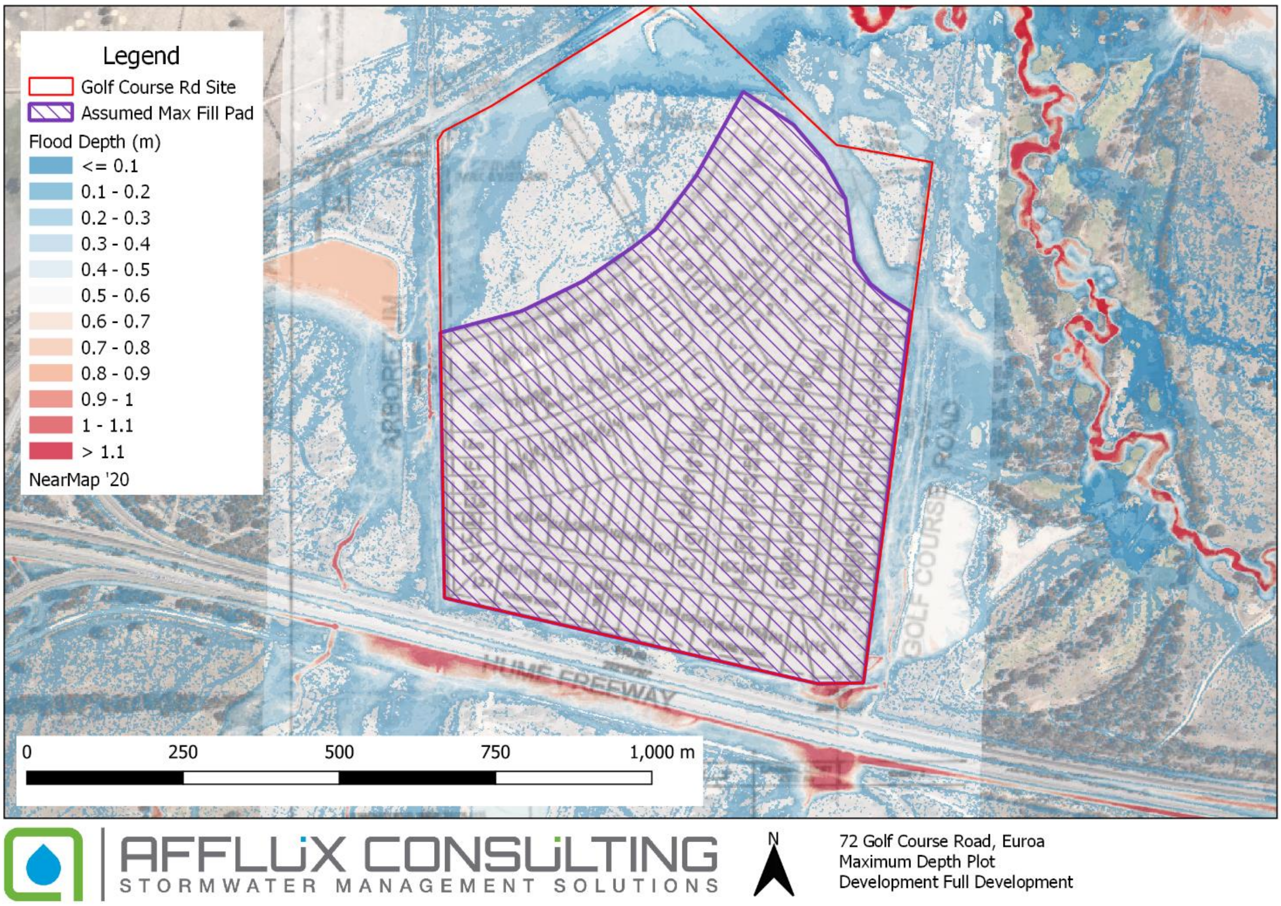


Figure 42. Developed conditions – full development scenario with no consideration for conveyance of flows from broader catchment

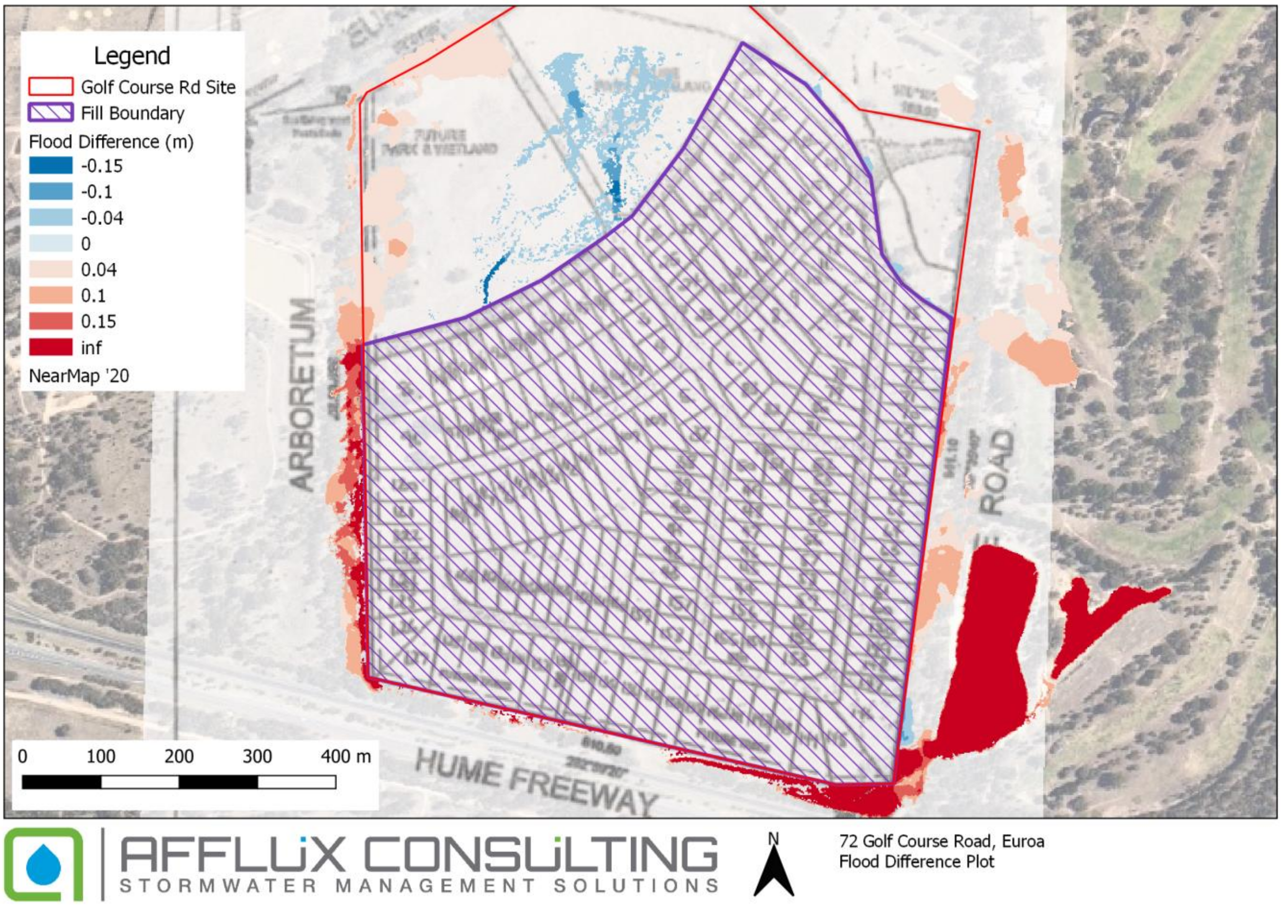


Figure 43. Flood Difference Plot - Developed conditions – full development scenario with no consideration for conveyance of flows from broader catchment

7.5. Developed Scenarios

Various scenarios were mapped to assess development impact on regional flows. This included variations of:

- Flows from Hwy culverts formalised within channels and diversion towards arboretum lake (west of site) and golf course (east); or
- arboretum does not want flow path through site and flood difference must be contained on site; and/or
- golf course does not want flow path through site and flood difference must be contained on site.

Ultimately the following development conditions were resolved, alongside a head of agreement (HOA) with the golf course.

Note: If golf course management alter HOA, minor alterations to eastern lots are possible and scenario where flood difference must be contained on site has been modelled, shown within Appendix.

Therefore, developed conditions assumes:

- arboretum does not want additional flows and flood difference must be contained on site; and
- golf course is happy to receive additional flows and a formalised flow path.

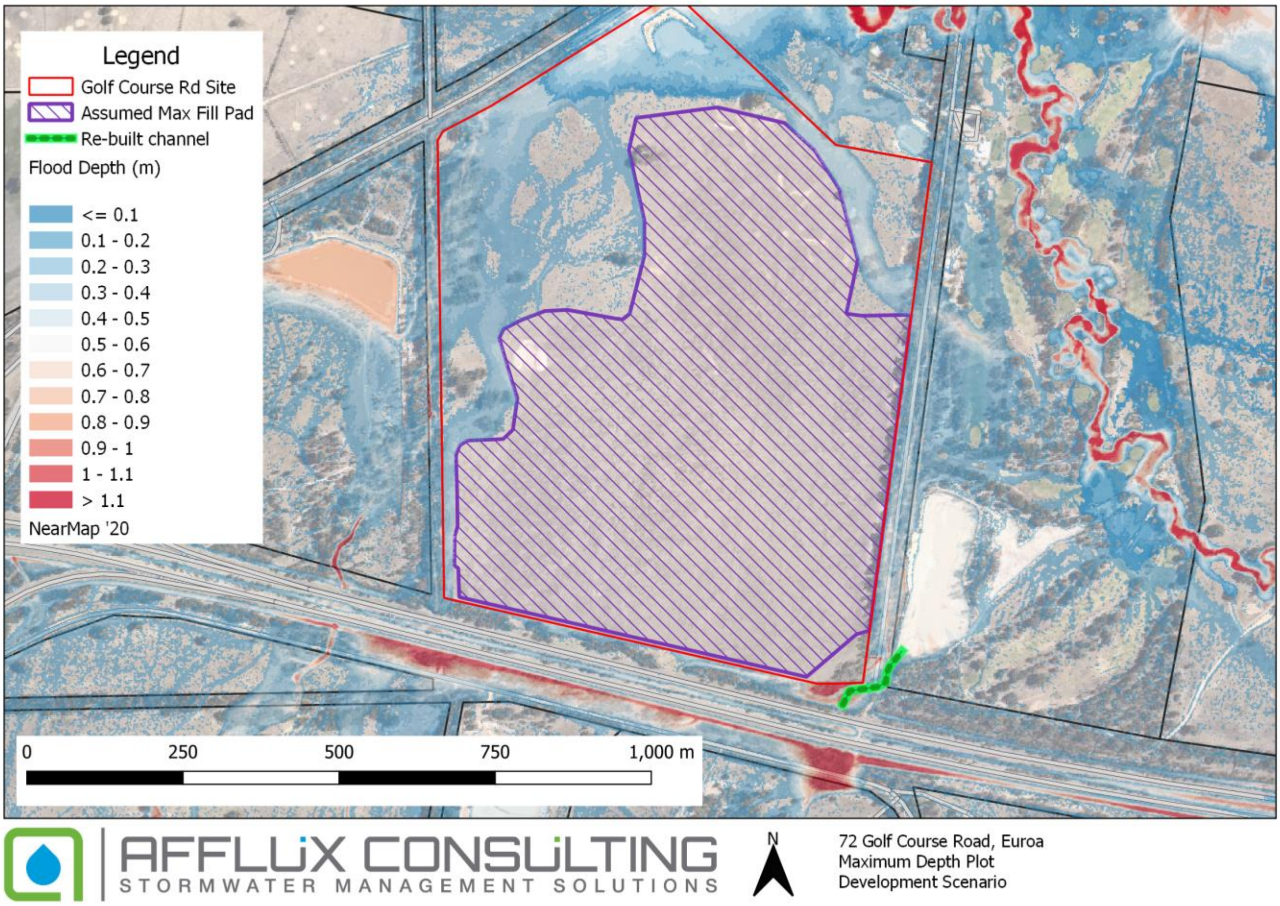
Model alterations:

- Building envelopes (i.e. fill pad) moved 20m away from western boundary to ensure broader catchment flows from west conveyed on site (as per revised Figure 3 concept (May, 2022);

- No rebuilding of channel on western boundary (surface remains existing), and
- Eastern channel from culverts rebuilt to convey flows towards golf course.

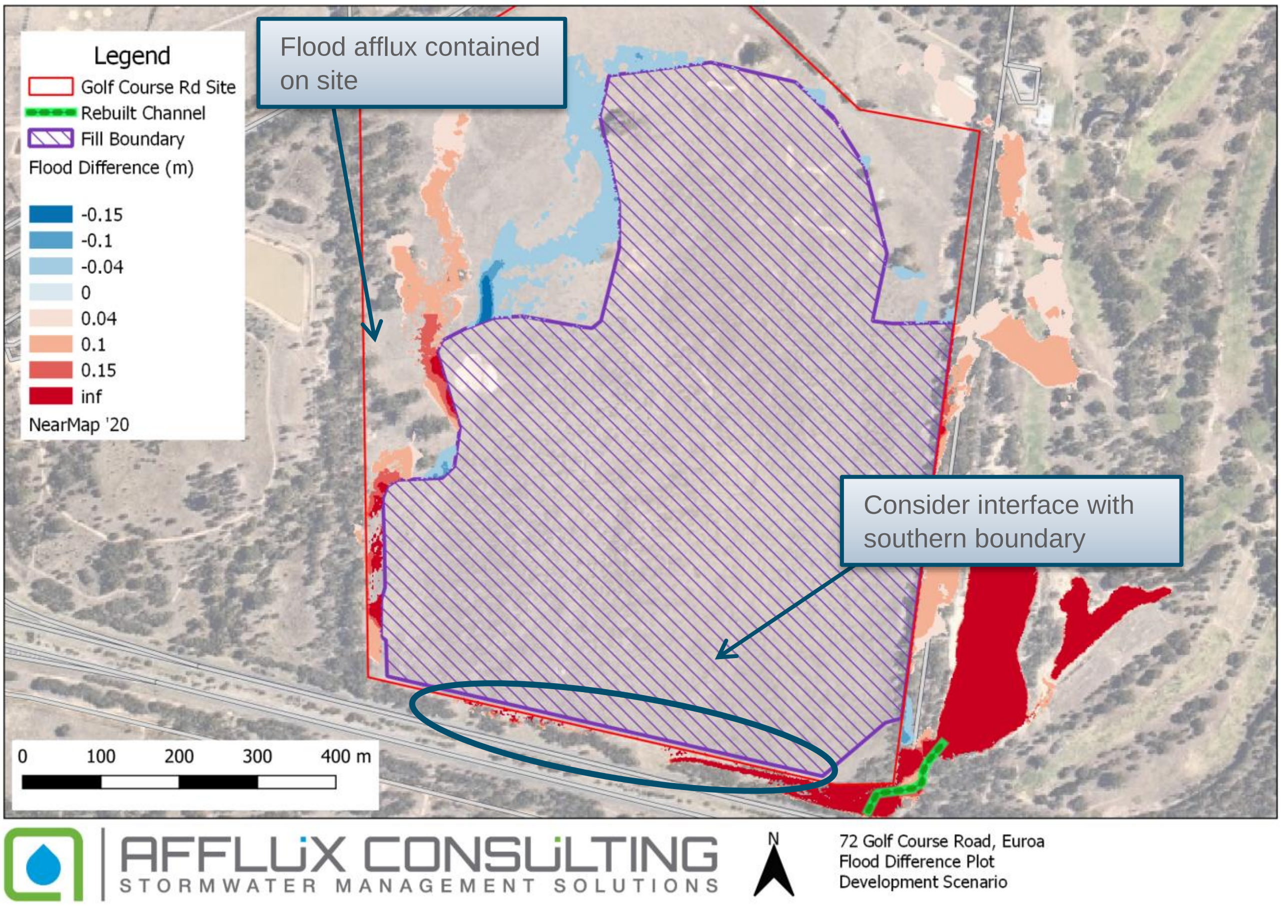
Water Surface Elevation plots not provided for brevity but available on request.

Figure 44 and Figure 45 below show depth and flood difference results.



Source: Euro_1p_0360m_tp03_v06_d_Max.flt

Figure 44. Development Scenario 1 Flood Depth Plot



Source: EuroV6-2_Diff.flt

Figure 45. Development Scenario 1 Flood Difference Plot

Key considerations:

- Flood conditions at western boundary could be improved with earthworks in the 20m OFP/channel;
- Earthworks/construction of re-built OFP/channel on western boundary requires consideration of vegetation (located within Vegetation Protection Overlay);
- Construction of re-built channel on golf course property requires consideration of erosion (located within Erosion Management Overlay);
- Construction of re-built channel on golf course property requires detailed design for more appropriate channel size and shape;
- Diversion of additional flows towards golf course dam requires consideration of dam conditions and safety implications;
- Design does not consider any upgrades to dam and overflow bypass arrangements;
- Fill interface with flows from southern boundary resulting in afflux within Hume Fwy road reserve; and
- Interface with any mounding or acoustic walls at south of site

8. Waterway Requirements

The required hydraulic widths for the channels and overland flow paths have been assessed using PC-Convey flood level calculation analysis tool for open channels. The indicative cross sections, velocities and V*d ratio checks are assessed within the PC-Convey tool and outputs are discussed in sections following.

Cross sections show required hydraulic width for 100-year (1 %) events, further freeboard should be incorporated within vegetated buffers.

Eastern Waterway (golf course side)

Eastern waterway cross section is based on estimated culvert flows exiting the culvert as shown in Figure 46. Any upgrades to a channel on this side should be designed to convey ~12.5 m³/s.

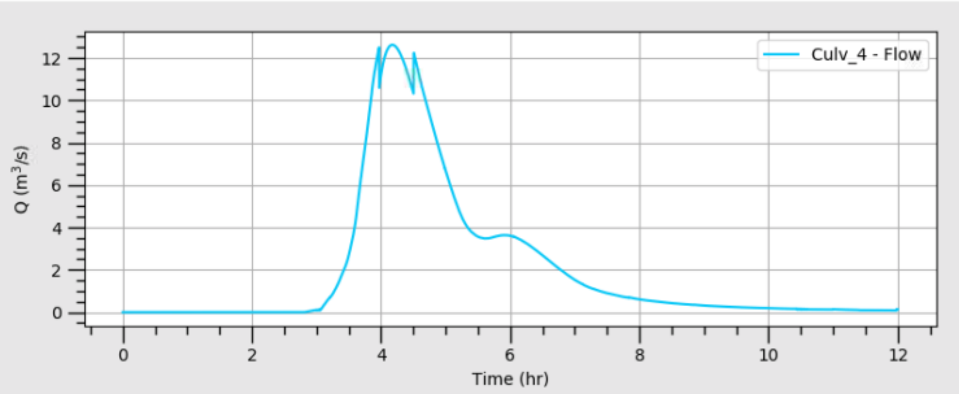


Figure 46. Eastern culvert (golf course side) ~12.5 m³/s

Cross section and outputs generated by PC-Convey are shown in Figure 47 and Figure 48.

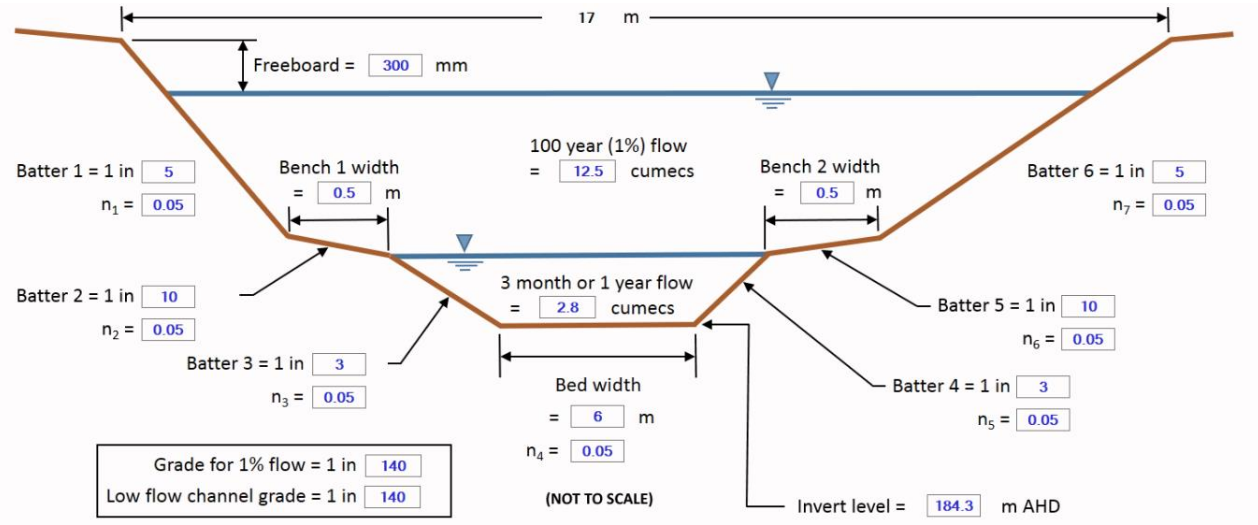
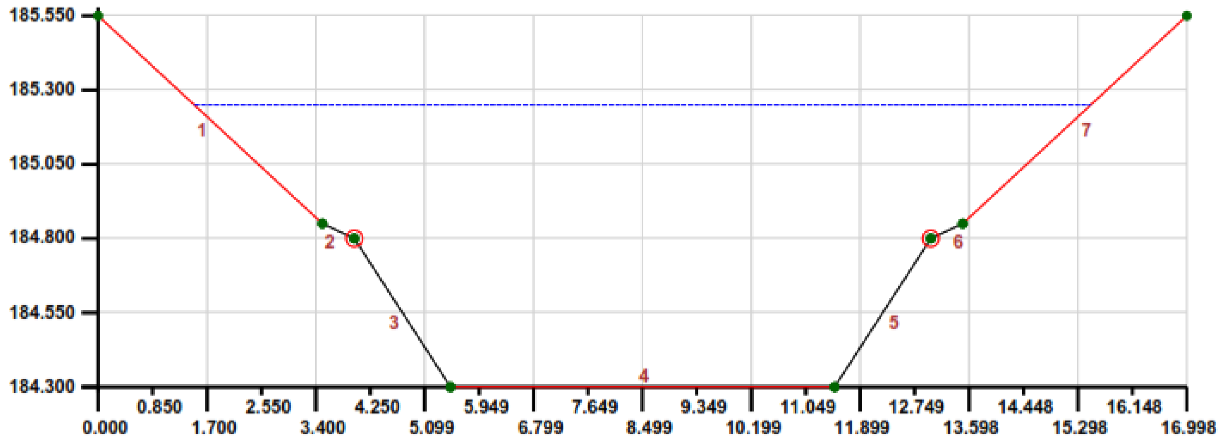


Figure 47. Conceptual cross section inputs – eastern channel (culvert to golf course dam)

PROJECT: Euroa_Golf
Print-out date: 08/04/2021 - Time: 1:48
Data File: EuroaGolf.dat

1. CROSS-SECTION:



2. RESULTS SUMMARY:

Results for water surface level = 185.250 m. Water density = 1000.0 kg/m3. Gravity = 9.80 m/s2.
1% waterway (High Flow Channel) grade = 1 in 140, Main/Low Flow Channel grade = 1 in 140.
Reporting average shear stresses. Red Segments on graph show maximum FACTORED average shear stresses.
Unfactored shear stresses are calculated using du Boys' equation (1879), and then factored up using bank (side) and bed factors in accordance with Melbourne Water's Constructed Waterway Design Manual (December 2019).
The cross-section is not on a bend.

2.1 Discharges and Velocities
Left Overbank (LOB) discharge = 0.401 cumecs. LOB average velocity = 0.655 m/s.
Main/Low Flow Channel (M/LFC) discharge = 11.843 cumecs. M/LFC average velocity = 1.518 m/s.
Right Overbank (ROB) discharge = 0.401 cumecs. ROB average velocity = 0.655 m/s.
Total discharge = 12.644 cumecs. Cross-section average velocity = 1.401 m/s.

2.2 Shear Stresses
Maximum (factored) average shear stress = 81.470 N/m2 in Segment 4.
Maximum (factored) average Left Overbank shear stress = 28.557 N/m2 in Segment 1.
Maximum (factored) average Main/Low Flow Channel shear stress = 81.470 N/m2 in Segment 4.
Maximum (factored) average Right Overbank shear stress = 28.556 N/m2 in Segment 7.

Figure 48. PC-Convey results summary - eastern channel (culvert to golf course dam)

Key considerations:

- A channel upgrade from Hume Freeway culverts allows a clearer flow path, diverting flows towards their dam;
- The channel would be approximately 17m (top width);
- Velocity and sheer stress limits are based on standard limits and should be reassessed with any updated geological information;
- More information on in-situ soil types should be sourced as this channel falls within the EMO;
- Review design when more information regarding soil types becomes available;
- Any recommended erosion treatments should be included within revised designs, this may include (but not limited to) rockwork, flatter side batters, vegetation, geofabrics and/or soil treatments;
- If preferred outcome requires re-built overland flow path from culvert to dam designers must ensure interactions with Golf Course Road are minimised;
- If excavation works are required to divert dam overflows towards Castle Creek the overflow channel should be sized within the next stage of design; and

- Dam upgrade and outfall arrangements should be assessed within the next stage of design.

Western Overland Flow Path

Western flow path cross section is based on estimated culvert flows exiting the culvert as shown in Figure 49. Any alterations to a channel on this side should be designed to convey 3-4 m³/s.

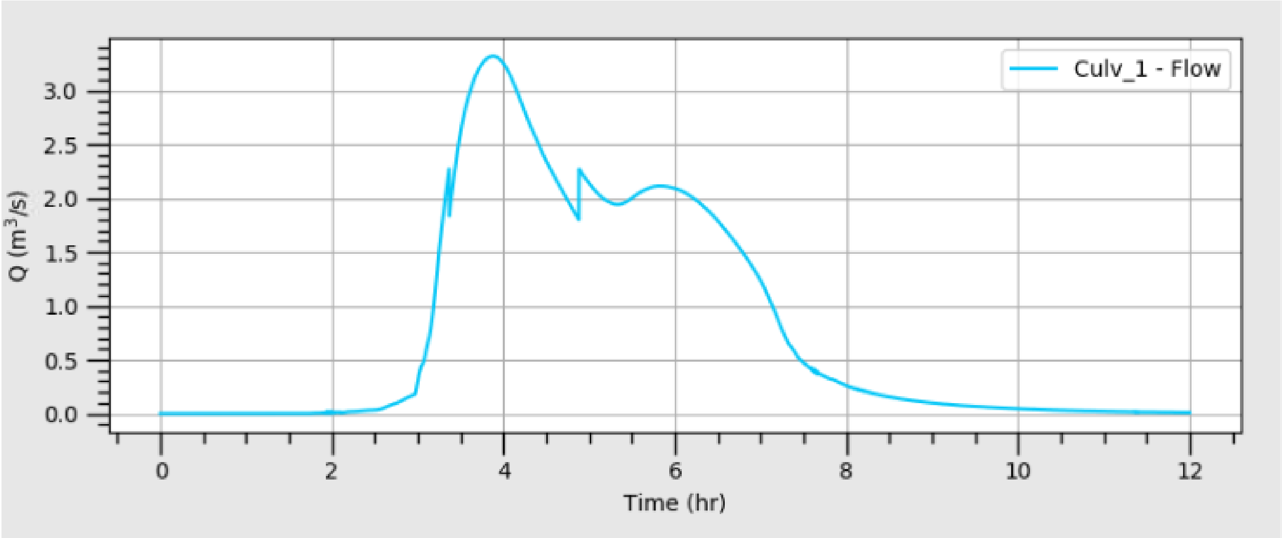


Figure 49. Western culvert (arboretum side) ~3-4 m³/s

Cross section and outputs generated by PC-Convey are shown in Figure 50 and Figure 51

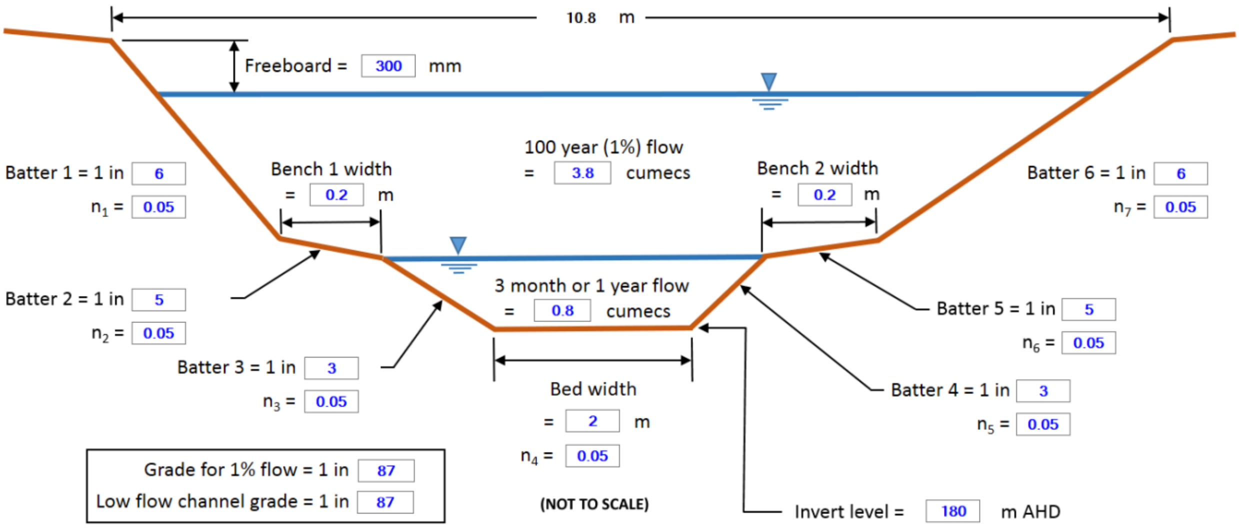
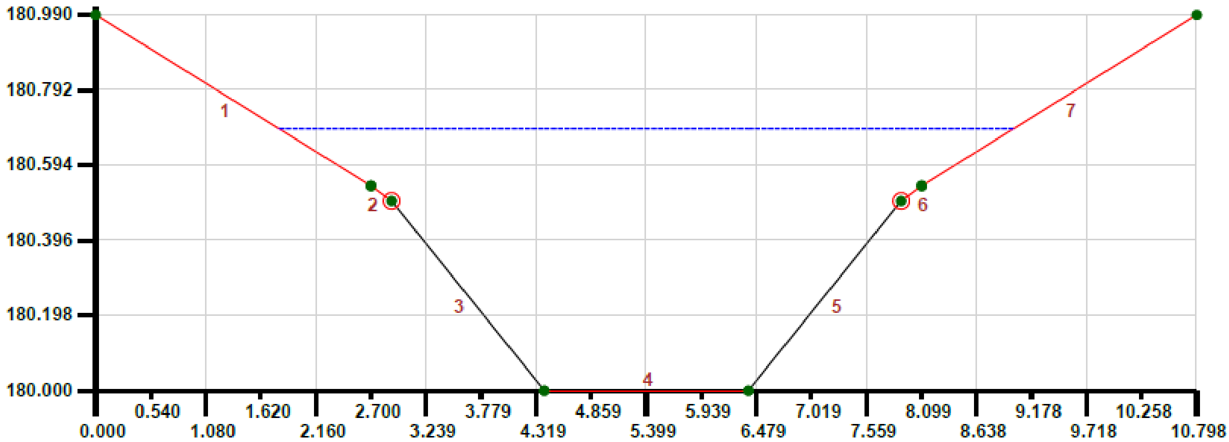


Figure 50. Conceptual cross section inputs – western channel

PROJECT: RoadWestchannel
Print-out date: 13/09/2021 - Time: 10:41
Data File: roadwest.dat

1. CROSS-SECTION:



2. RESULTS SUMMARY:

Results for water surface level = 180.690 m. Water density = 1000.0 kg/m3. Gravity = 9.80 m/s2.
1% waterway (High Flow Channel) grade = 1 in 87, Main/Low Flow Channel grade = 1 in 87.
Reporting average shear stresses. Red Segments on graph show maximum FACTORED average shear stresses.
Unfactored shear stresses are calculated using du Boys' equation (1879), and then factored up using bank (side) and bed factors in accordance with Melbourne Water's Constructed Waterway Design Manual (December 2019).
The cross-section is not on a bend.

2.1 Discharges and Velocities
Left Overbank (LOB) discharge = 0.044 cumecs. LOB average velocity = 0.434 m/s.
Main/Low Flow Channel (M/LFC) discharge = 3.758 cumecs. M/LFC average velocity = 1.392 m/s.
Right Overbank (ROB) discharge = 0.044 cumecs. ROB average velocity = 0.434 m/s.
Total discharge = 3.846 cumecs. Cross-section average velocity = 1.325 m/s.

2.2 Shear Stresses
Maximum (factored) average shear stress = 87.945 N/m2 in Segment 4.
2 Segments have the maximum (factored) average Left Overbank shear stress of 19.253 N/m2.
Maximum (factored) average Main/Low Flow Channel shear stress = 87.945 N/m2 in Segment 4.
2 Segments have the maximum (factored) average Right Overbank shear stress of 19.253 N/m2.

Figure 51. PC-Convey results summary - western channel (culvert to arboretum waterbody)

Key considerations:

- Flows from culverts can be conveyed within a channel approximately 10-11m (top width);
- Alternative channel arrangement could include conveyance through development with larger roadways;
- Velocity and sheer stress limits are based on standard limits and should be reassessed with any updated geological information;
- Channel alignment should consider sensitive vegetation;
- This design is conceptual to indicate size only; and
- Any recommended erosion or ecological treatments should be included within revised designs.

Northern Waterway (within farm zone)

The northern waterway (within farm zone) is an extension of the western overland flow path. The overland flow path/channel continues north from the roadway through the farm zone and collects sheet flows from the arboretum to the west. The northern waterway cross section is based on total estimated culvert flows to the south of the site combined with the flows from the arboretum. This is an indicative estimation and should be reconsidered with updated information on arboretum outlet configuration.

This channel is a conceptual design to convey 16 m³/s.

Cross section and outputs generated by PC-Convey are shown in Figure 52 and Figure 53.

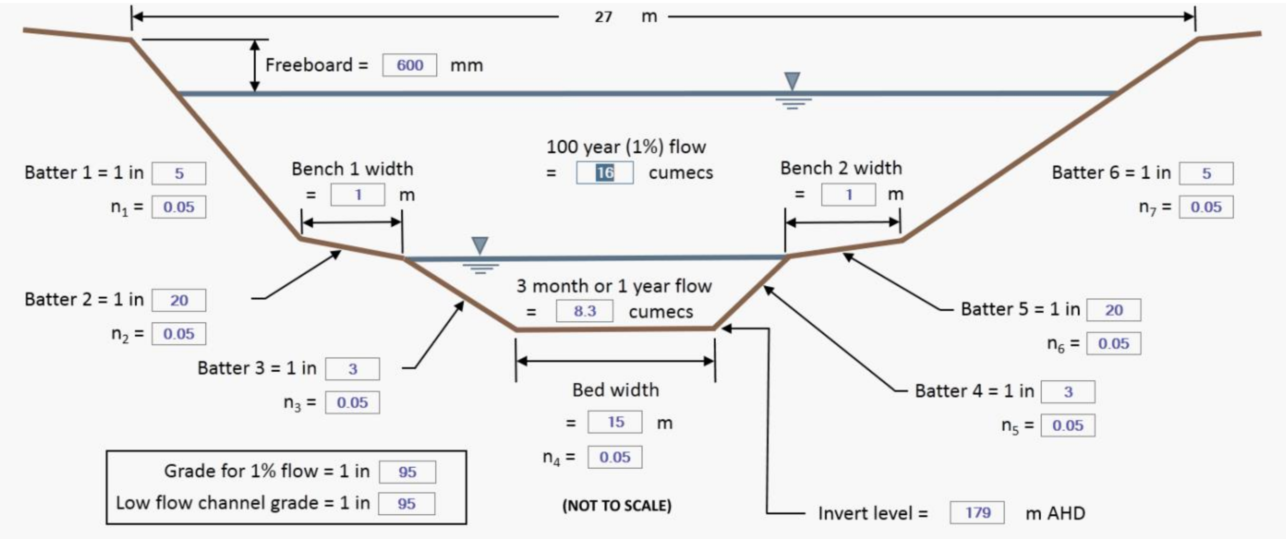
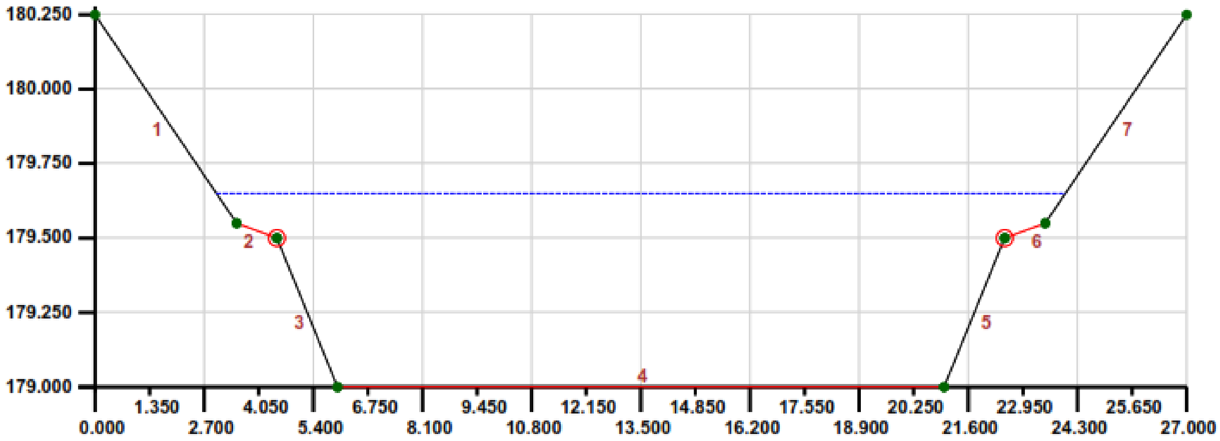


Figure 52. Conceptual cross section inputs – northern channel (from arboretum outlet)

PROJECT: ArbComb
Print-out date: 08/04/2021 - Time: 2:03
Data File: EuroaArbCOMB.dat

1. CROSS-SECTION:



2. RESULTS SUMMARY:

Results for water surface level = 179.650 m. Water density = 1000.0 kg/m3. Gravity = 9.80 m/s2.
1% waterway (High Flow Channel) grade = 1 in 95, Main/Low Flow Channel grade = 1 in 95.
Reporting average shear stresses. Red Segments on graph show maximum FACTORED average shear stresses.
Unfactored shear stresses are calculated using du Boys' equation (1879), and then factored up using bank (side) and bed factors in accordance with Melbourne Water's Constructed Waterway Design Manual (December 2019).
The cross-section is not on a bend.

2.1 Discharges and Velocities
Left Overbank (LOB) discharge = 0.066 cumecs. LOB average velocity = 0.440 m/s.
Main/Low Flow Channel (M/LFC) discharge = 16.035 cumecs. M/LFC average velocity = 1.464 m/s.
Right Overbank (ROB) discharge = 0.066 cumecs. ROB average velocity = 0.440 m/s.
Total discharge = 16.167 cumecs. Cross-section average velocity = 1.437 m/s.

2.2 Shear Stresses
Maximum (factored) average shear stress = 80.852 N/m2 in Segment 4.
Maximum (factored) average Left Overbank shear stress = 14.898 N/m2 in Segment 2.
Maximum (factored) average Main/Low Flow Channel shear stress = 80.852 N/m2 in Segment 4.
Maximum (factored) average Right Overbank shear stress = 14.898 N/m2 in Segment 6.

Figure 53. PC-Convey results summary - northern channel (from arboretum outlet)

Key considerations:

- Fully constructed channel approximately 27m (top width) can divert flows from arboretum outlet across site towards site outlet;
- Channel arrangement can be modified/altered and is subject to detailed design;
- Channel arrangement can be modified to convey only the low flow events with approximately 17-18m top width and remaining flows up to the 1% AEP event conveyed overland within the farm zoned area;
- Velocity and sheer stress limits are based on standard limits and should be reassessed with any updated geological information;
- Channel alignment should consider sensitive vegetation and requirements of ESO;
- This design is conceptual to indicate approximate size only; and
- Arboretum lake outfall arrangements should be assessed within the next stage of design.

8.1. Bank Protection Requirements

Waterways and culvert outlets are often prone to higher levels of erosion due to localised turbidity. Sheer stresses will be assessed following soil and erosion assessment. Treatments may include bank protection in the form of rock beaching or soil stabilisation, as recommended following erosion assessment.

Recommended maximum shear stress resistance thresholds for vegetation within drain are based on Figure 54. To be considered alongside erosion advisory report.

Title **Maximum shear stress resistance thresholds for herbaceous vegetation in gully initiation studies**

Vegetation type	Threshold erosion data (N/m^2)
Aquatic (swampy) vegetation	105
Tussock and sedge	240
Disturbed tussock and sedge	180
Bunch grass 20-25 cm high	184
Bunch grass 2-4 cm high	104
Bunch grass	80-170*
Bermuda grass	110-200*
Buffalo grass, Kentucky bluegrass	110-200*

Notes * These ranges summarise data for a variety of soil types/hillslopes.

Source: Excerpt from Vic Waterway Guidelines

Figure 54. Bank protection from shear stress

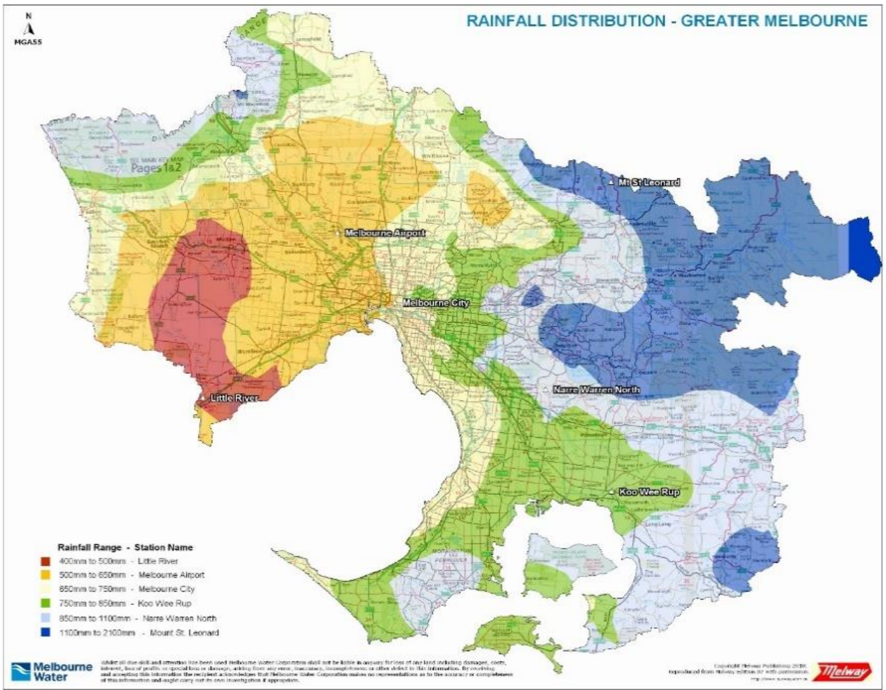
9. Water Quality

The water quality for this site has been assessed for the development. Treatment is modelled to ensure water quality for the site meets best practice load-based reduction requirements. The water quality works must coincide with proposed development to ensure runoff does not directly discharge into existing drainage system to the detriment of downstream water quality.

9.1. Rainfall Information

The mean annual rainfall for this site was identified as ~ 649.6 mm and therefore within the Melbourne City Template rainfall range. As such the Melbourne City template was used for conceptual treatment asset sizing and volumes.

Rainfall was run at a 6 minute interval to match the lowest Time of Concentration of the catchment.



Source: Melbourne Water MUSIC Guidelines

Figure 55. Greater Melbourne rainfall distribution

9.2. MUSIC Model Setup

To ensure that the development meets the BPEM requirements of Clause 56-7.04 a MUSIC model (v6) has been created for the catchment. MUSIC modelling is an industry standard approach to determine water quality treatment and sequencing. Guidance for model inputs was sourced from the IDM as well as Melbourne Water's MUSIC guidelines.

In order to reach BPEM Guidelines the model has been set up with the following notes:

- The model has been designed in alignment with proposed layout (Figure 56);
- The model is built using the most recent guidelines including soil losses field capacity;

- The model is built with an assumed 350mm EDD;
- The model is built using rainfall templates that include 10-year periods of rainfall data;
- The measured catchments are in alignment with hydrological models; and
- Source node sub-catchment areas for the development are separated by impervious fraction as per Table 5, in alignment with MUSIC guidelines.

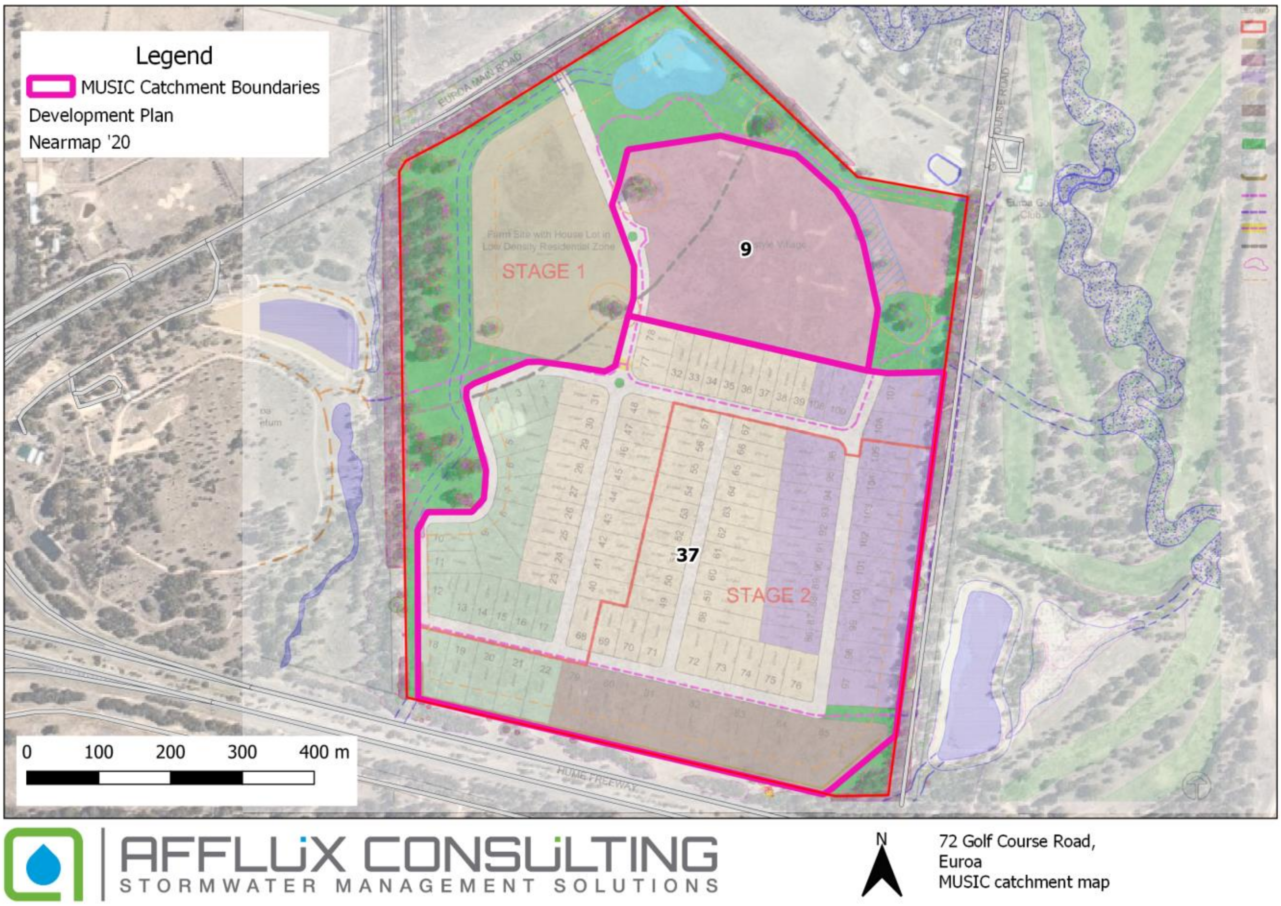


Figure 56. Music catchment map

Table 5. Sub-catchment areas and impervious fraction (Updated May 2022)

Housing Density Equivalent	Area (ha)	FI
GRZ	9	75 %
LDRZ	37	20 %
Remainder of parcel (treatment not required)	23	5%

9.3. Proposed Treatment

Runoff from the developed catchment will be treated by a treatment train system to ensure the development does not result in significant degradation of downstream waterways and optimum stormwater treatment at site outlet. It is recommended that the development is treated by an on-site WSUD system. The results of the MUSIC simulation provide an estimation of the expected nutrient reduction performance as shown in Figure 58.

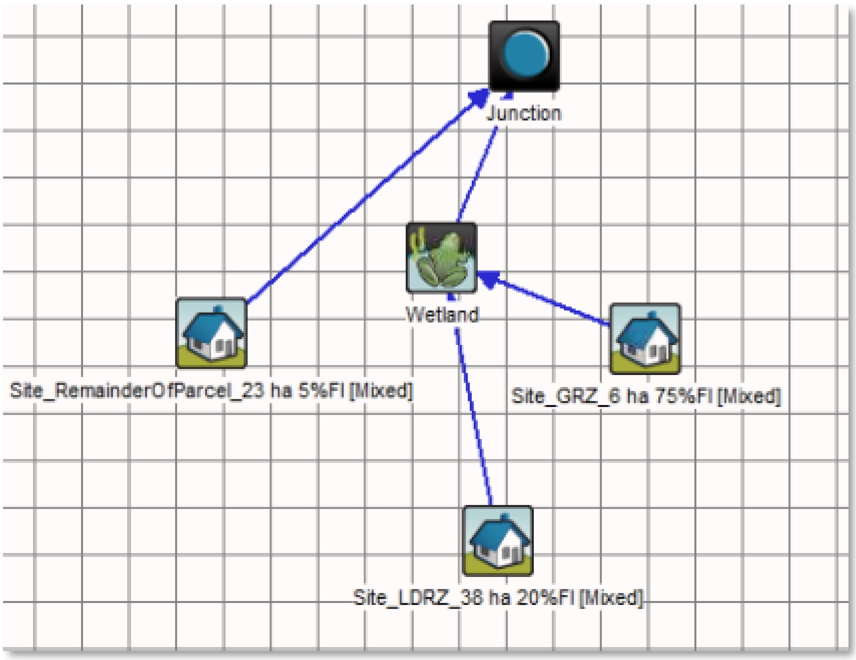


Figure 57. Catchment MUSIC model layout

	Sources	Residual Load	% Reduction
Flow (ML/yr)	112	108	3.9
Total Suspended Solids (kg/yr)	15300	3160	79.4
Total Phosphorus (kg/yr)	37.1	13	65
Total Nitrogen (kg/yr)	296	164	44.7
Gross Pollutants (kg/yr)	3250	0	100

Figure 58. MUSIC model results - Treatment Efficiencies

9.4. Wetlands

Biological treatment of stormwater reduces the loads of nutrients entering receiving waters, an important aspect of best practice guidelines. The general philosophy is to construct wetlands in preference to other water quality measures due to their robustness in long term survival, reduced maintenance, and ability to store greater amounts of water above the Normal Water Level (NWL) in a retarding basin situation. Wetland surface area dictates the potential effectiveness of these treatments, with plant selection and density being limited by available treatment area. Wetlands are designed to service the three month flow or equivalent from the site.

Sediment ponds were modelled as 'Inlet Ponds' when in the same drainage reserve as the wetland nodes as per MUSIC guidelines. Sediment basins are capable of reducing the sediment load into the wetlands themselves, hence increasing life expectancy. The sedimentation basin was sized using the Fair and Geyer equations, with the results summarised below (Figure 59).

Calculations

Euroa

Target = very fine sand

Vs =	0.011	m/s
d_e =	0.4	m
d_p =	1.2	m
d* =	1.0	m
$\frac{(d_e+d_p)}{(d_e+d^*)}$ =	1.1	
Q =	2.1	m^3/s use rational method to obtain 1 Year ARI flow for sub catchment
A =	1800	m^2 Area of basin
$\frac{V_s}{Q/A}$ =	9.43	
λ =	0.26	pond shape assumption
n =	1.35	

Fraction of Initial Solids Removed

R = 95%

Requirement: Melbourne Water Requires R = 95% for a 125 micrometer particle

Cleanout Frequency

Catchment Area =	44	ha	Just urban catchment concidered
Sediment load =	1.60	m^3/ha/yr	(Willing and Partners 1992)
Gross Pollutant Load =	0.40	m^3/ha/yr	(Alison et al 1998)
Actual basin depth =	1.5	m	
Actual Basin area =	1800	m^2	

Therefore, cleanout frequency required = $\frac{(1.6+0.4)A_{catchment}}{0.5d_{basin}*A_{basin}}$ = 0.07 per year   Clean out every 15.3 years

Assumes cleanout when basin 50% full

Figure 59. Sedimentation Basin Sizing - Fair and Geyer

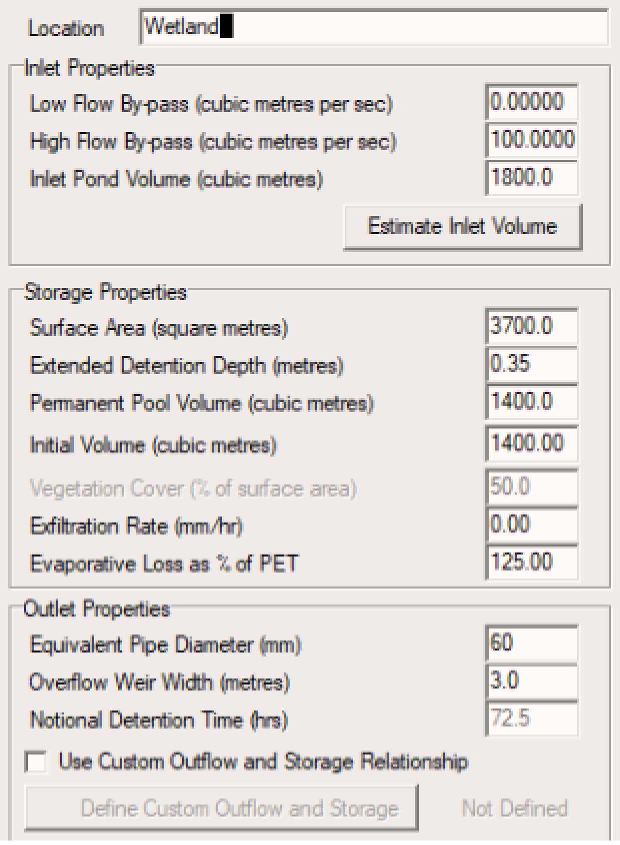


Figure 60. MUSIC Wetland Design Inputs

Key conclusions:

- The water quality for the site can be met through a treatment train involving a sediment and wetland treatment system.

Expected water treatment area:

- Sediment basin (wet area only): 1800 m^2
- Wetland (wet area only): 3700 m^2

Total wet area: 5,500 m^2

Therefore, total required for water quality asset including batters, dry out areas, maintenance tracks and bypass configurations etc. would be approx. 1-1.2 ha. Shown below in Figure 61 at recommended location.

Additional consideration:

- in the future an agreement could be made for golf course to accept low flows from developed area, pumped from wetland, in addition to the large events;
- any reuse arrangements reduces site runoff volumes and therefore required treatment.

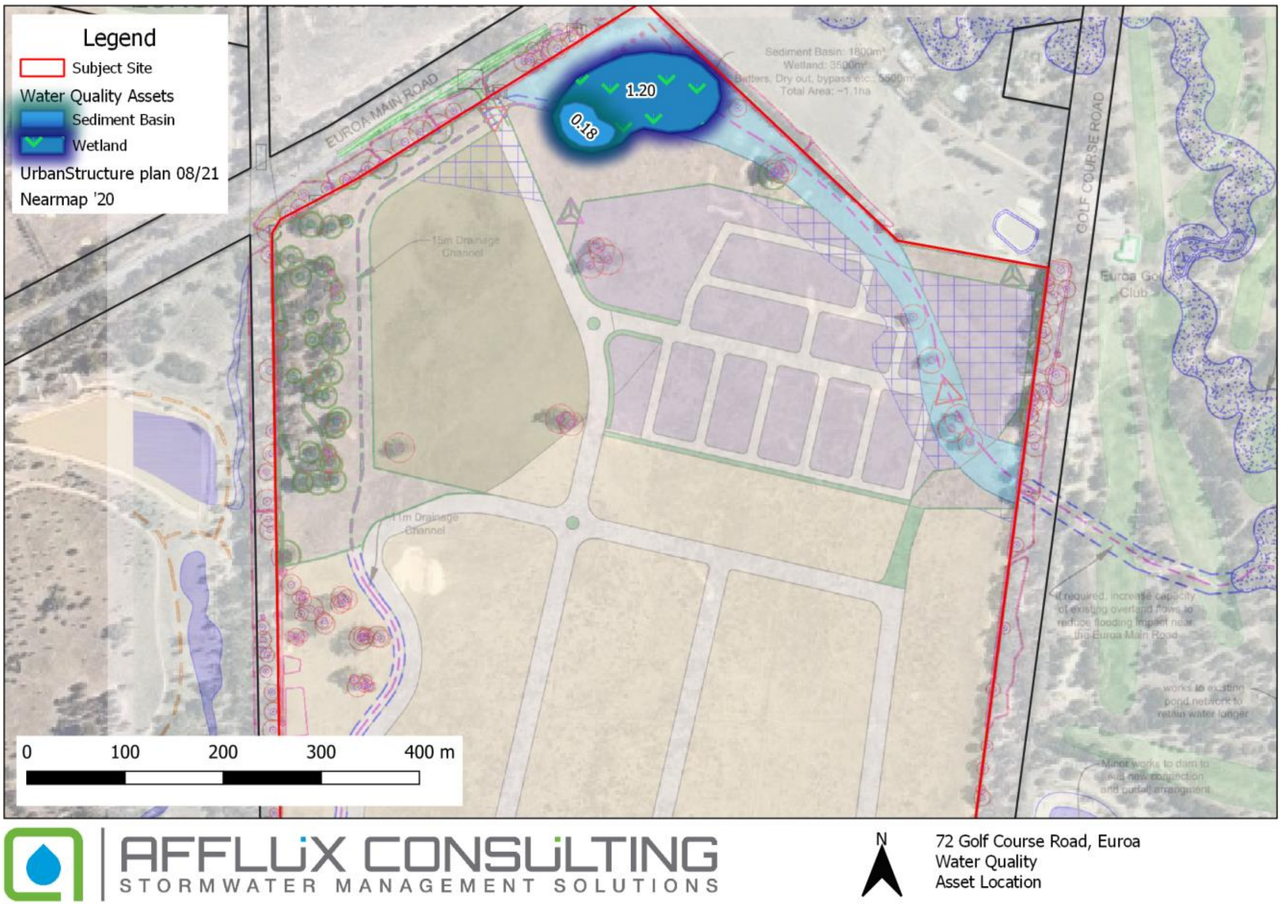


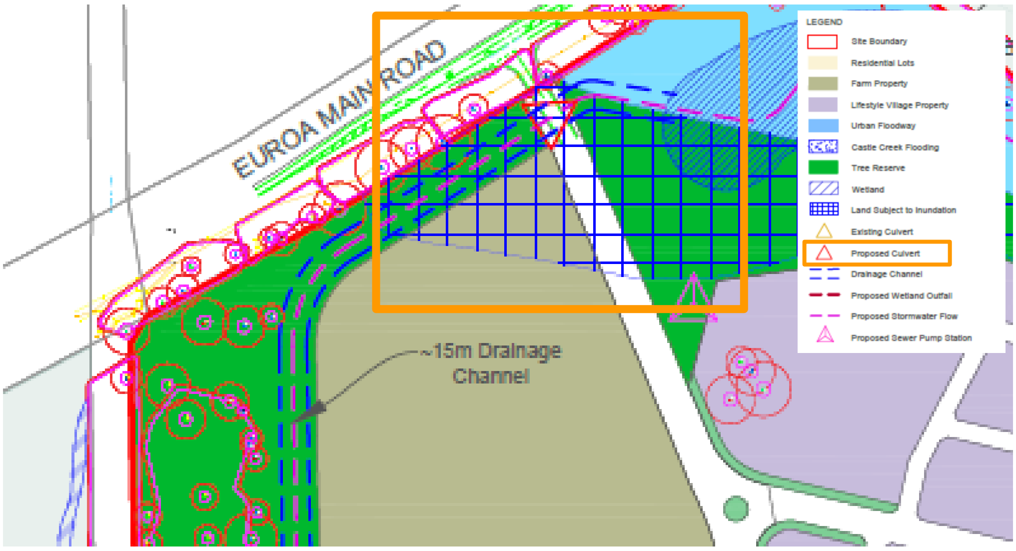
Figure 61. Water quality asset location

10. Additional Design Requirements

10.1. Site Egress

A natural ground level access route to flood free land will be required to develop this parcel. The access route to the Euroa Main Road must have access to the Hume Freeway to the west of the site in a 1 % AEP.

It is expected that the road will be at a height that ensures flood levels are not more than 300mm over the road and complies with flood hazard requirements. The proposed culvert (Figure 62). will be designed to allow conveyance of drainage channel towards castle creek (Figure 11). As there is adequate undevelopable area at the north of this site it is expected that all afflux (as a result of road level) will be contained on site.



Source: Urban Terrain, Dated 19-08-21

Figure 62. Closeup of Proposed Development Plan – Egress

It is noted that any access to the Lifestyle Village community Center will require a flood free access, located at least 300mm above the 1% AEP flood depth, or as otherwise negotiated.

10.2. Site Storage

The regional flood plain dominates flood storage within this area, therefore providing additional storage in this area is redundant and counter to current flow behaviours. Minor event storage (1.5y ARI) will be provided within the wetlands.

10.3. Flow Path Assessment

Minor drainage network has been assessed based on current topography. The general flow path and road network directs flows towards treatment wetland (north), as shown in Figure 63 below. Overland flow paths will not be altered significantly from current topographical conditions.

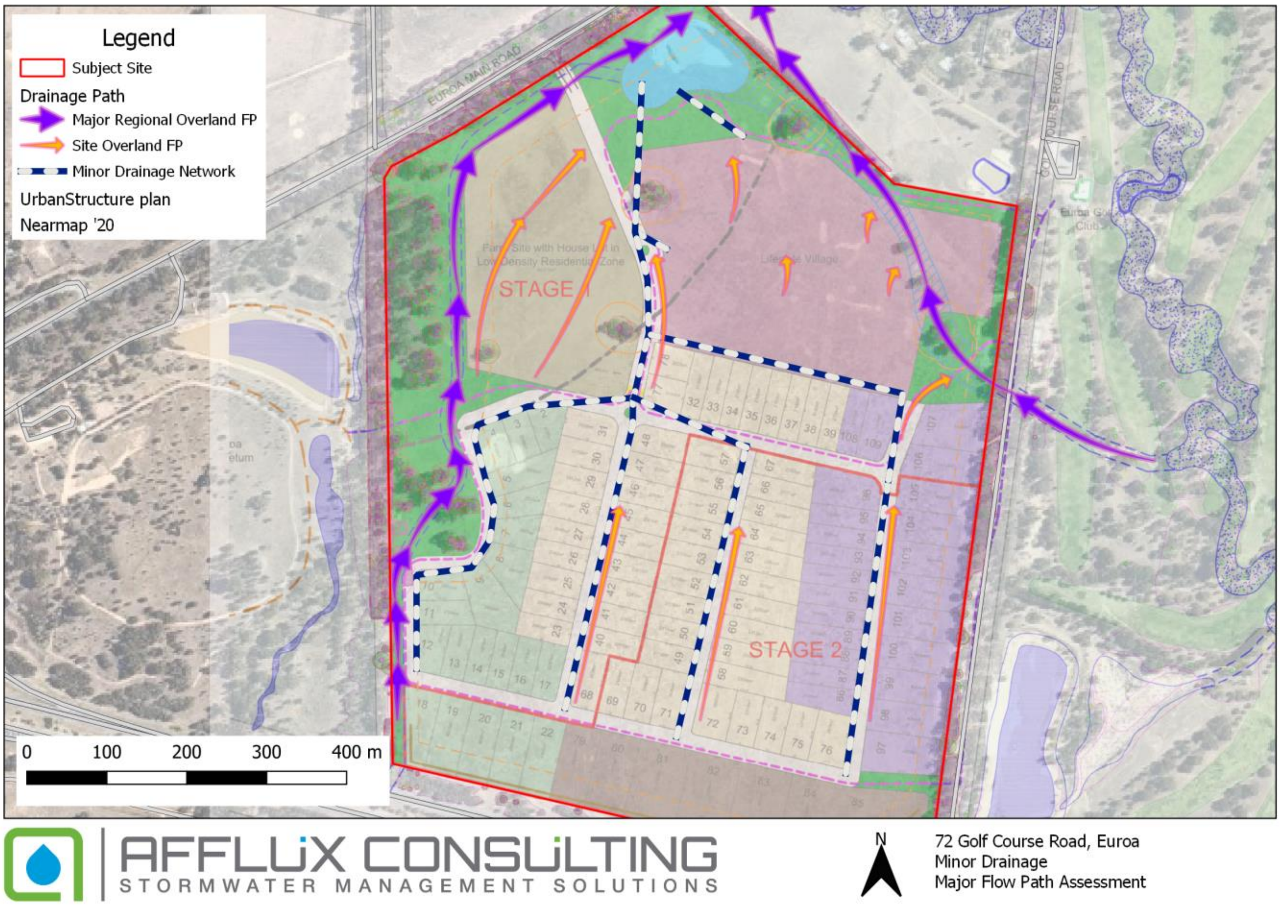


Figure 63. Major and minor drainage assessment

Note: Drainage layout is indicative and remains subject to final lot layout and detail design

11. Conclusions

This report presents a stormwater management strategy for the proposed development at 72 Golf Course Road, Euroa. The site has important interactions with the Castle Creek system, as well as its immediate catchment, and these interactions have been considered in this report. In order to maintain the behaviour of the hydraulic systems, including flood plain storage and water quality requirements, this report presents the following requirements:

- A channel upgrade from Hume Freeway culverts at southeast of site, allows a clearer flow path;
- Formalising this flow path diverts sheet flows towards the golf course dam;
- More information on in-situ soil types should be sourced as this channel falls within the EMO;
- Review design requirements when more information regarding soil types becomes available;
- Flows from culverts to the southwest of site can be conveyed within a channel approximately 10-11m (top width);
- The channel continues through the farm zone and collects sheet flows from arboretum to the west;
- Fully constructed channel approximately 27m (top width) can divert combined flows across farm zone towards site outlet;
- Channel arrangement can be modified to convey only the low flow events with approximately 17-18m top width and remaining flows up to the 1% AEP event conveyed overland within the farm zoned area;
- Channel alignment should consider sensitive vegetation and requirements of ESO;
- The water quality for the site can be met through a treatment train involving a sediment and wetland treatment system.
- Total required for water quality asset including batters, dry out areas, maintenance tracks and bypass configurations etc. would be approx. 1-1.2 ha.
- The regional flood plain dominates flood storage within this area, therefore providing additional storage in this area is redundant

12. Appendix

Alternative Scenario

Minor alterations to lots within eastern boundary is possible within current development plan if final arrangement with golf course is altered. Therefore, alternative conditions trialled assumes:

- arboretum does not want additional flows and flood difference must be contained on site; and
- golf course does not want additional flows and flood difference must be contained on site.

Model alterations:

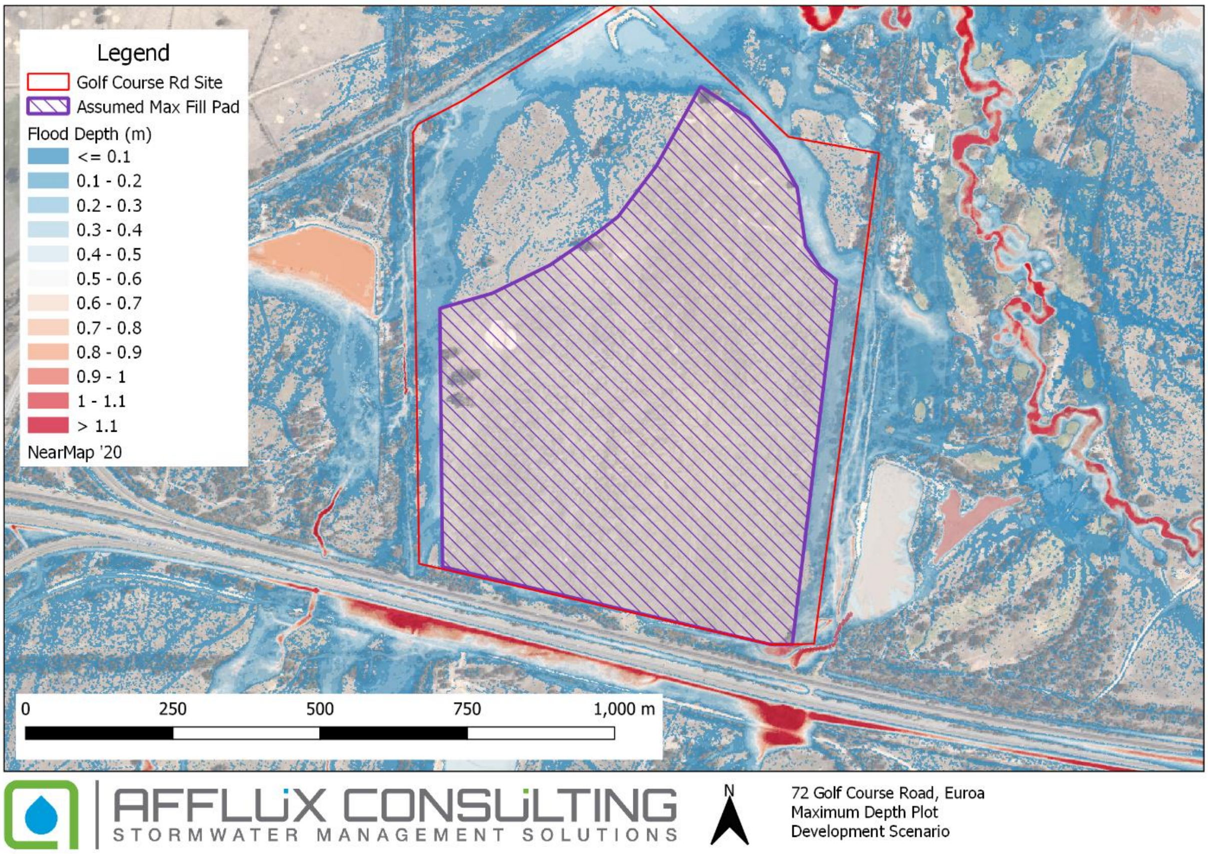
- Building envelopes (i.e. fill pad) moved 40m away from eastern boundary to ensure broader catchment flows from east conveyed on site.

Key considerations:

- 40 m could be reduced with formalisation of channel/OFP along both boundaries;
- Construction of re-built channel on western boundary requires consideration of vegetation (located within Vegetation Protection Overlay);
- Interface with flows from culvert on south eastern boundary (i.e. may require small cut drain); and
- Interface with any mounding or acoustic walls at south of site

Option to be refined if necessary. WSE plots not provided for brevity but available on request.

Figure 64 and Figure 65 below show depth and flood difference results.



Source: *Euro_1p_0360m_tp03_v05_d_Max.flt*

Figure 64. Development Scenario 2 Flood Depth Plot

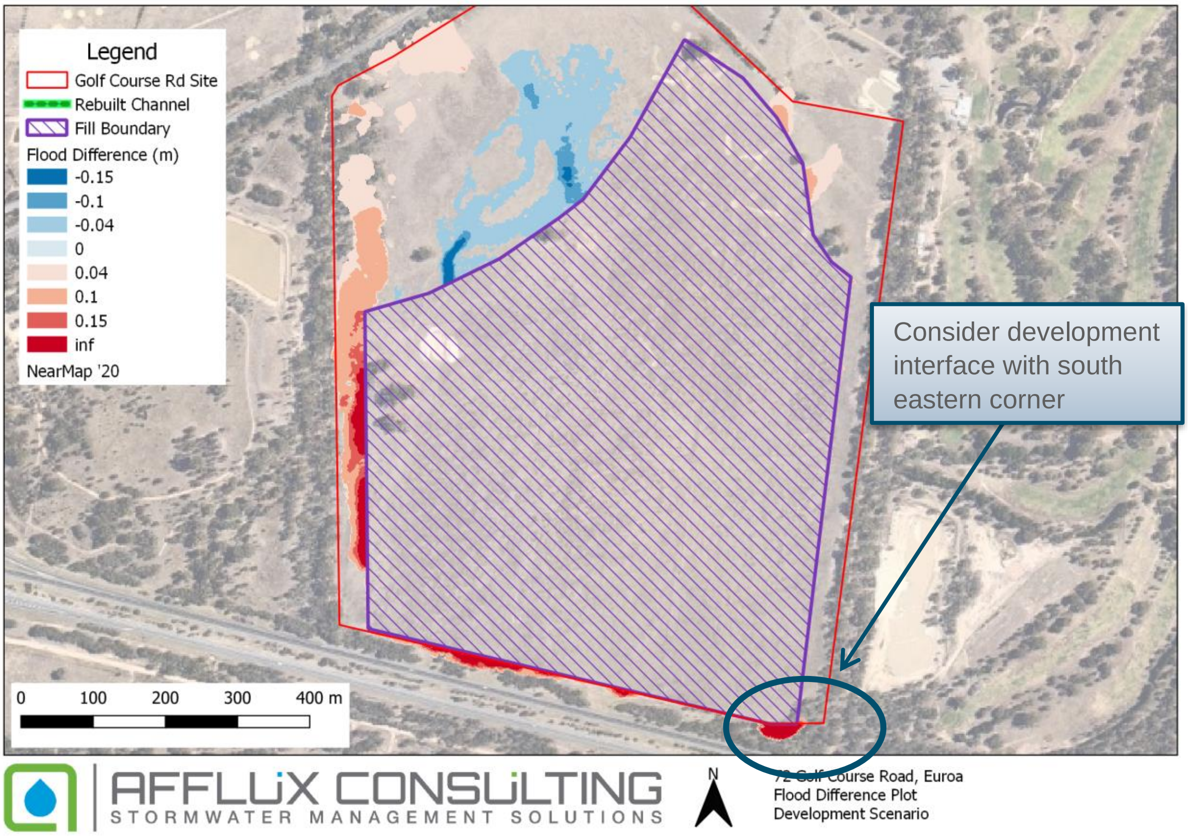


Figure 65. Development Scenario 2 Flood Difference Plot

13. References

Euroa Flood Study, Euroa Post Flood Mapping and Intelligence Project, Final Report Cardino, 2015

Land subject to inundation overlay, Victoria Planning Provisions

Strathbogie Local Floodplain Development Plan Precinct of Castle Creek and Seven Creeks, December 2003.

Urban Floodway Zone schedule, Schedule 4 to the development plan overlay, Strathbogie Planning Scheme

For information on this report:

Tess Fuhrmann

Engineer

03 9036 2530

tess@afflux.com.au

linkedin.com/in/t-fuhrmann

www.afflux.com.au

Afflux Consulting Pty Ltd
PO Box 457 Emerald VIC 3782

03 9036 2530

info@afflux.com.au

afflux.com.au