Exhibition Document – Functional Design Report

East of Aberline PSP – Stormwater Drainage

Prepared for: Victorian Planning Authority
31 August 2025
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Executive Summary

SMEC has been engaged by the Victorian Planning Authority (VPA) to refine the stormwater drainage strategy based on the Integrated Water Management (IWM) Plan previously developed by Spiire (2022) and prepare the functional designs for the East of Aberline Precinct Structure Plan (PSP). The outcomes of the stormwater drainage strategy will be used to inform the PSP land budget and the associated costing to deliver the drainage infrastructure works in the form of a Development Contributions Plan (DCP).

A literature review and contextual analysis (Stage 1) were conducted to understand the background work undertaken by the VPA and various consultants. The findings from this review helped inform the design basis. Subsequently, a preliminary drainage concept was developed and presented to the key stakeholders for initial feedback and support.

As part of the preliminary drainage strategy (Stage 1) outlined in this report, SMEC has undertaken additional technical analysis (including hydrological, and hydraulic modelling) to corroborate the preliminary drainage strategy and provide confidence in the land budget allocated for stormwater drainage assets. The stormwater drainage strategy has been further refined with input from the VPA, and the required stormwater infrastructure has been identified and conceptually sized.

The concept proofing phase (Stage 2) culminated in the completion of a concept report. Following this, a functional design (Stage 3) has been developed for the proposed retarding basins, stormwater wetlands, and sediment basins, incorporating 3D surface modelling and additional flood and water balance modelling to validate and refine the stormwater strategy.

Site Context

East of Aberline PSP area is located within the major river catchment of Merri River and within the sub catchment of Russell Creek. The PSP area is predominantly surrounded by residential, farming and industrial land. It is bounded by Wangoom Road to the north, Dales Road to the south, and Aberline Road to the west. The total site area is approximately 408 ha and identified by the Warrnambool City Council as a “future corridor extension” in the Great South Coast Regional Growth Plan (2014) and the Warrnambool City-Wide Housing Strategy (2013). East of Aberline PSP area has a gentle undulating topography. There is fall towards Russell Creek that traverses the precinct. The land also has a 1:60 fall to the north towards Wangoom Road. There is a minimal east-west cross-fall.

The East of Aberline PSP area is generally split into seven major catchments. A large external catchment (Russell Creek) traverses the PSP boundary from east to west.

Some of the key features of the PSP area include a high-quality rural environment that is characterised by Russell Creek and Tozer Reserve. Russell Creek is a prominent feature within the PSP area and is subject to a range of planning, engineering and environmental considerations. The Tozer Memorial Reserve is approximately 20 ha and located centrally to the PSP area. The site constraints including existing flooding, and biodiversity assessments have been identified to assist in developing the strategy.

Stormwater Drainage Strategy

A stormwater drainage strategy has been developed to address stormwater management requirements, including flood protection, IWM objectives where possible, compliance with relevant drainage authority design standards, and stormwater quality management. Identified assets include retarding basins, wetlands and sediment ponds, along with provisions for supporting stormwater infrastructure such as pipelines, culverts and overland flow paths to manage and control runoff before it is discharged into Russell Creek.

The proposed locations of the stormwater infrastructure, waterways and outlet points are shown in the figure below.

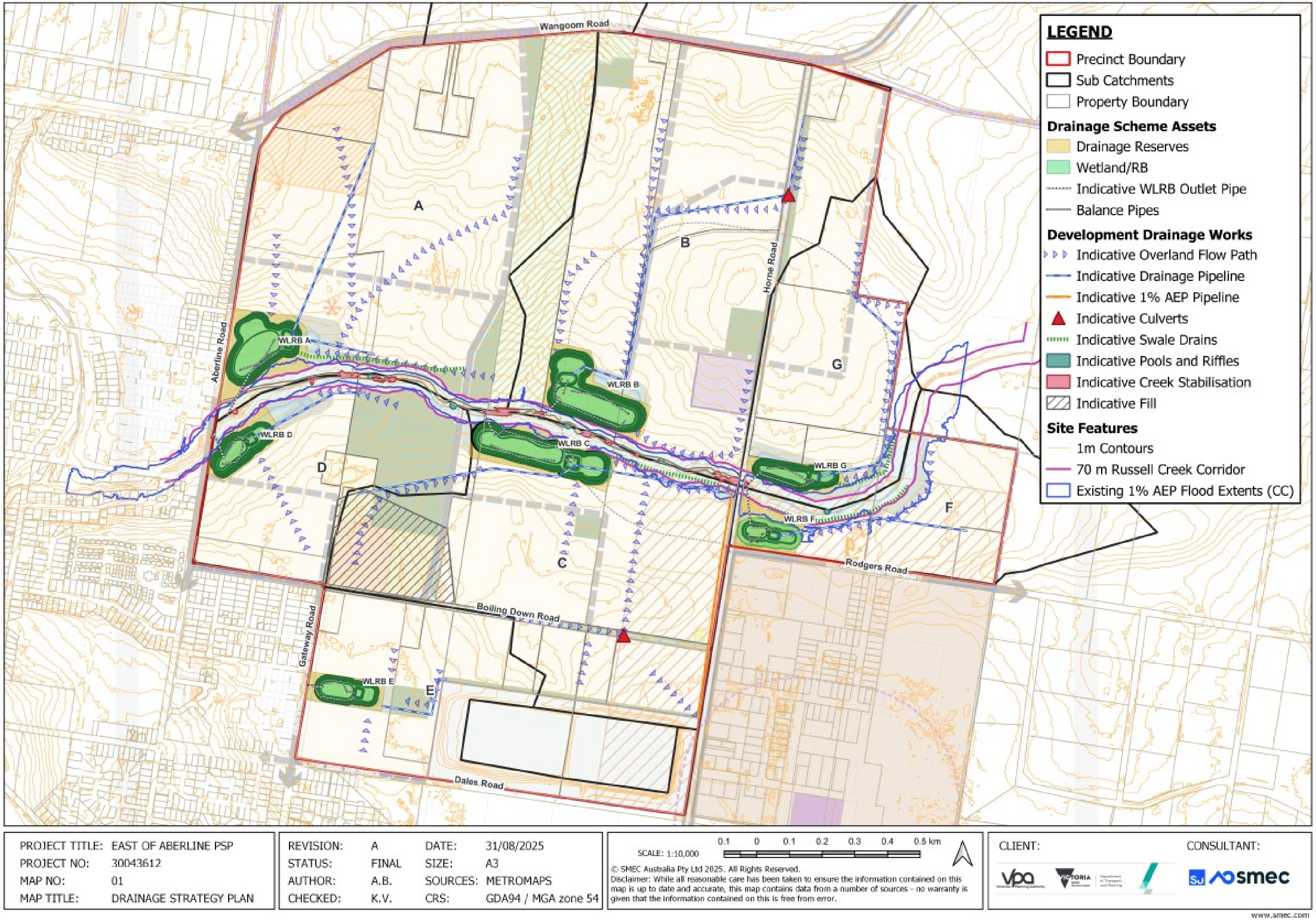

Figure 0-1-1 East of Aberline PSP Stormwater Drainage Strategy

Integrated Water Management Strategy

The IWM Plan (Spiire, 2022) proposed a number of end-of-line retarding basin and wetland systems to treat and control the runoff prior to discharging into the Russell Creek. In addition, recommendations for stormwater harvesting from wetland to irrigate active open spaces were mentioned.

One of the key opportunities identified in the PSP at the time was to extend the existing roof water harvesting scheme (RWHS) by Wannon Water to the new developments in East of Aberline PSP. The Scheme collects roof runoff which is distributed to the potable water supply. The RWHS is an existing system with infrastructure already in place at Aberline Road. Water balance modelling completed by Spiire estimates that the PSP could contribute around 680 ML annually, increasing RWHS's share of Warrnambool's supply to 7% and reducing stormwater runoff by 53%.

This report investigates the provision of traditional lot-scale rainwater tanks and precinct-scale WSUD wetlands, with the objective of harvesting stormwater for reuse in the irrigation of local open spaces. Water balance modelling shows that 34% of the non-potable water demand is supplied by a 2kL rainwater tank installed in every household within the PSP area, operating with approximately 73% reliability. The water balance modelling conducted to date also suggests that 67% of the total runoff volume can potentially be harvested from wetland system for stormwater reuse when rainwater tanks are in place. However, this outcome is contingent upon the availability of an equivalent water demand within the area.

Flood Impact Assessment

East of Aberline PSP is situated within the Glenelg Hopkins Catchment Management Authority (GHCMA) regions. East of Aberline is subject to flooding along the Russell Creek floodplain in the 1% Annual Exceedance Probability (AEP). A hydrologic and hydraulic assessments have been completed in accordance with Australian Rainfall and Runoff (AR&R) (Ball et al., 2019) and GHCMA Guidelines. Specifically, climate change scenario modelling have been undertaken to define the 1% AEP flood extent. This has been used as the basis for the flood impact assessment.

The hydraulic modelling assessment has incorporated the proposed retarding basins to assess the impacts on the floodplain under the developed conditions. The outcomes demonstrates that the PSP development with the proposed infrastructure does not result in any worsening of flood conditions in the 1% and 10 % AEP events under climate change scenario. In addition, the outputs from the flood assessment has informed the planning flood controls to be applied for Russell Creek in terms of Floodway Overland and Land Subject to Inundation Overlay.

Conclusion and Recommendation

The stormwater drainage strategy outcomes has demonstrated that the proposed drainage infrastructure and mitigation works are technically feasible and meet the relevant requirements suitable for the purposes of the PSP and DCP. Key recommendations include:

- Present the strategy during the PSP public exhibition to seek feedback and build support for sustainable drainage infrastructure that enables responsible development in Warrnambool.
- Continue collaboration with stakeholders, including Warrnambool City Council, Glenelg Hopkins CMA and Wannon Water, to ensure agreed understanding of flooding requirements in particular impacts of climate change and explore integrated water management opportunities beyond the PSP framework.
- Investigate opportunity for a comprehensive rehabilitation program for Russell Creek, including geomorphological and eco-hydrological assessments to restore geomorphology, riparian vegetation, creek form and ecological health.
- Expand the hydraulic assessment to include the effects of the new bridge crossing Russell Creek to ensure there are no adverse changes to the floodplain and to the broader waterway health.
- As part of the development process. detailed site investigations to refine overland flow paths, pipe alignments, and confirm conveyance needs, especially near Russell Creek.

1. Introduction

SMEC has been engaged by the Victorian Planning Authority (VPA) to refine the stormwater drainage strategy prepared by Spiire in 2022 and prepare the functional designs for the East of Aberline Precinct Structure Plan (PSP). The outcomes of the stormwater drainage strategy will be used to inform the PSP and the associated costing to deliver the drainage infrastructure works in the form of a Development Contributions Plan (DCP).

East of Aberline PSP boundary has been expanded since 2022 to include additional areas to the east. The expanded area is shown in **Figure 1-1** below.

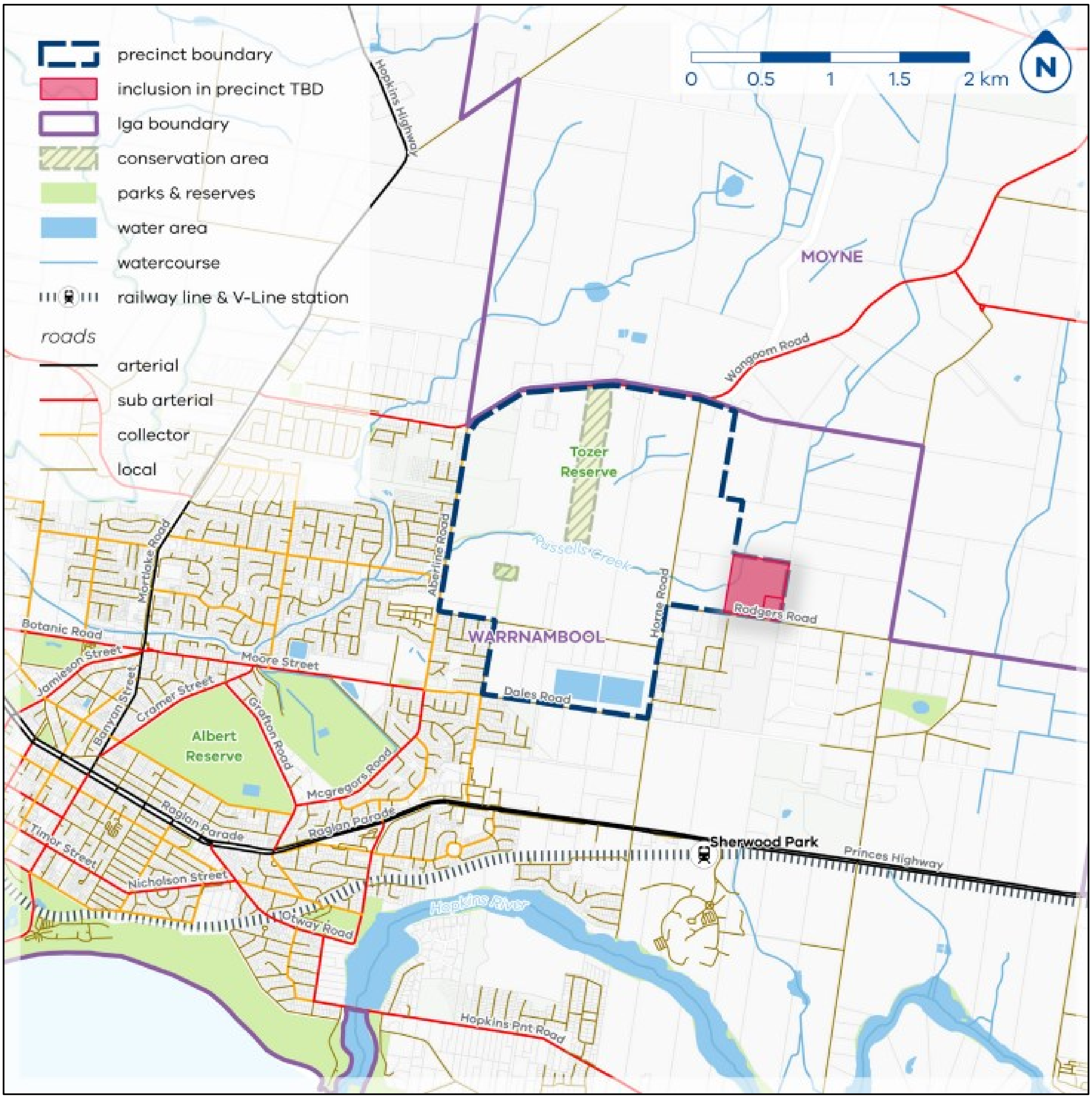

Figure 1-1 East of Aberline PSP Boundary (source: Metromap)

The PSP area covers approximately 408 hectares of land and is located between Wangoom Road to the north, Dales Road to the south, and Aberline Road to the west.

The scope of works encompasses a number of stages:

- Stage 1 - Literature Review, Site Visit and Preliminary Drainage Concept
- Stage 2 – Stakeholder Workshops and Exhibition Documents
- Stage 3 – Functional Design and Costing

A literature review was conducted to understand the background works undertaken by the VPA and various consultants. The findings from this review helped inform the design basis. Subsequently, a site visit was completed, and a preliminary drainage concept was developed and presented to the key stakeholders for initial feedback and support.

This report describes the key outcomes and methodology related to various aspects of the drainage strategy development from concept to functional design. The following report sections detail the key components:

- Key outcomes of the literature review and site visit (Section 3 & 4)
- Waterway health (Section 5)
- Stormwater management objectives (Section 5)
- Existing conditions hydrology (Section 6)
- Outcomes of the stormwater drainage strategy design for the developed conditions – infrastructure sizing (Section 7)
- Stormwater quality analysis and Integrated water management (Section 8 & 9)
- Russell Creek Waterway Corridor (Section 10)
- Flood impact assessment (Section 11)
- The detailed modelling methodology and results of the RORB, TUFLOW and MUSIC modelling are provided in the Appendices.

The outcomes of Stage 2 (proof of concept report submitted on 04/08/2025) was required to verify the drainage assets sizing and land allocation at a conceptual level. Further assessments, hydraulic modelling and 3d surface design have been completed in this functional design (Stage 3, this report) for the purposes of Exhibition for the East of Aberline PSP and costing of the Development Contributions Plan.

2. Available Data

The following reports and digital data have been supplied by the VPA.

2.1 Reports

List of reports is presented in **Table 2-1**.

Table 2-1 Input Reports

Author	Year	Document Title
Cardno	2010	Design of North Warrnambool Floodplain Management Plan Implementation Works, RM2208 v1.0 FINAL, Prepared for City of Warrnambool, October 2010
Water Technology	2017	Russell Creek Flood Mitigation - As Constructed Flood Modelling, Warrnambool City Council, November 2017
Ecology and Heritage Partners	2018	Flora and Fauna Assessment: Aberline to Horne Growth Corridor
Engeny	2018	Aberline to Horne Growth Corridor, Stormwater Management Report
Landtech Consulting	2019	Growling Grass Frog Study – Aberline to Horne Road – Future Urban Growth Area
Spiire	2020	Existing Situational Analysis Report East of Aberline PSP Stormwater Drainage Concept and Functional Design, September 2020
Spiire	2022	East of Aberline PSP Stormwater Drainage Concept Design & Integrated Water Management, October 2022
Victorian Planning Authority	2023	East of Aberline PSP, Pitching Sessions, Summary Report, June 2023
Glenelg Hopkins Catchment Management Authority (GHCMA)	2024	Flood Modelling Guidelines and Specifications
Victorian Planning Authority	2024	East of Aberline PSP, Vision & Purpose Survey Summary Report, February 2024
Victorian Planning Authority	2024	East of Aberline Precinct Structure Plan, September 2024
Victorian Planning Authority	2024	Ballarat North Precinct Structure Plan - Co -Design Summary Report, November 2024

2.2 Digital Data

List of available digital data is presented in **Table 2-2**.

Table 2-2 Digital Data

Source	Year	Description
Department of Environment, Land, Water and Planning	2017	LiDAR, 1m DEM, Provided by VPA
Spiire	2024	MUSIC – East of Aberline PSP IWM
Spiire	2024	RORB Model – East of Aberline PSP
Spiire	2024	TUFLOW Model of Russell Creek
VPA	2025	GIS Shapefiles, Locality, Precinct Boundary, Existing Utilities, Landfill Site Shapefiles from Datashare
VPA	2025	Place-based plan (PBP) 22/08/2025

3. Literature Review

3.1 Site Context

East of Aberline PSP area is located approximately 4 km to the east of the centre of the Warrnambool. The PSP area is predominantly surrounded by residential, farming and industrial land.

It is bounded by Wangoom Road to the north, Dales Road to the south, and Aberline Road to the west. A key feature of the PSP is Russell Creek which traverses the precinct, meeting the Merri River approximately 3.5 km west of the PSP area. Refer to **Figure 3-1**.

The total site area is approximately 408 ha and identified by the Warrnambool City Council as a “future corridor extension” in the Great South Coast Regional Growth Plan (2014) and the Warrnambool City-Wide Housing Strategy (2013).

The precinct is located within a high-quality rural environment that is characterised by Russell Creek and Tozer Reserve. The Tozer Memorial Reserve is approximately 20 ha and located central to the PSP area and is owned by the Minister for Education.

East of Aberline PSP area has a gentle undulating topography. There is fall towards Russell Creek that traverses the precinct. The land also has a 1:60 fall to the north towards Wangoom Road. There is a minimal east-west cross-fall.

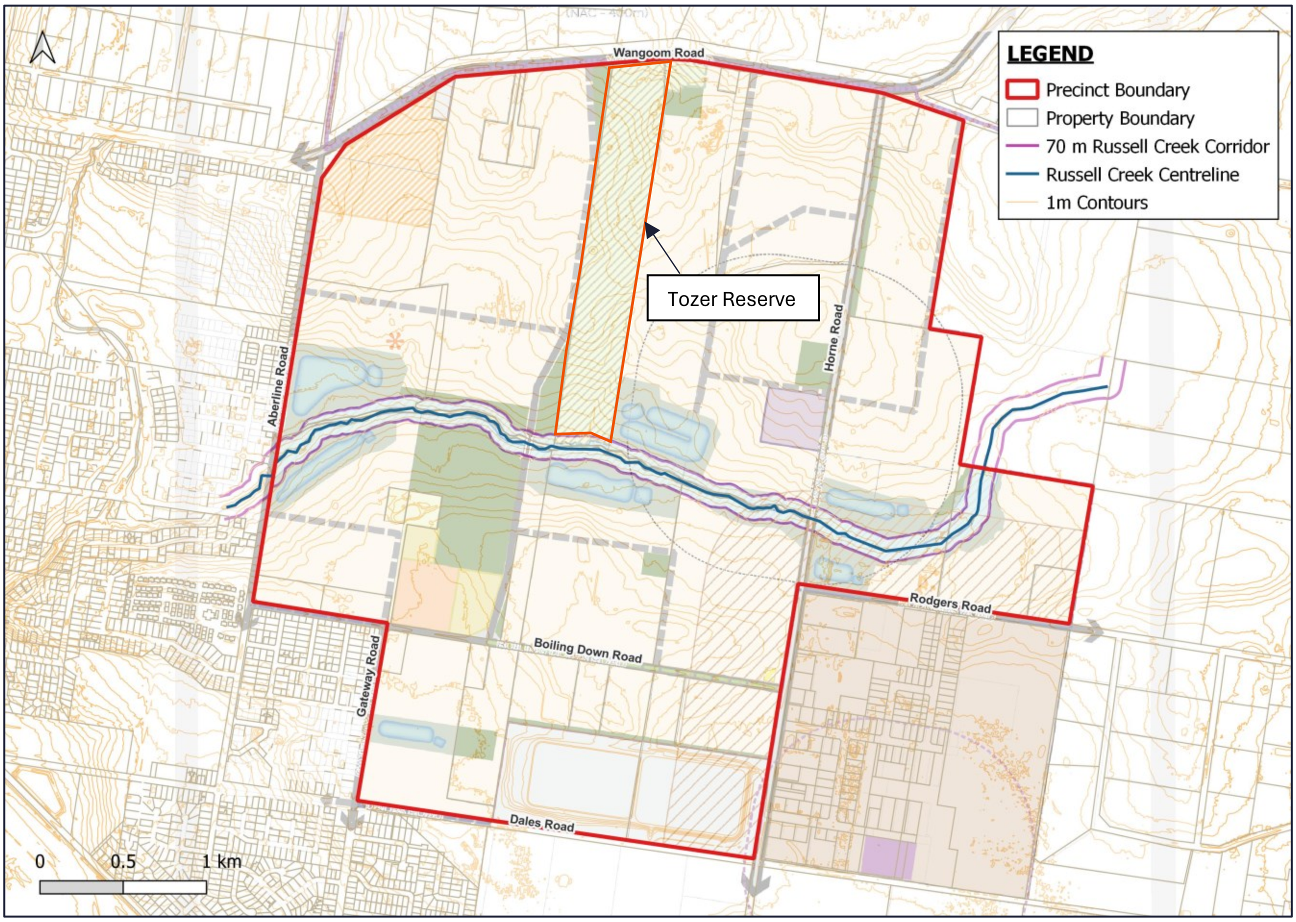

Figure 3-1 East of Aberline PSP Site Overview

3.2 Catchments

The East of Aberline PSP area is generally split into seven major catchments with a large external catchment coming from Russell Creek and the existing industrial development to the south east of the PSP. These catchments are described below and shown in **Figure 3-2**.

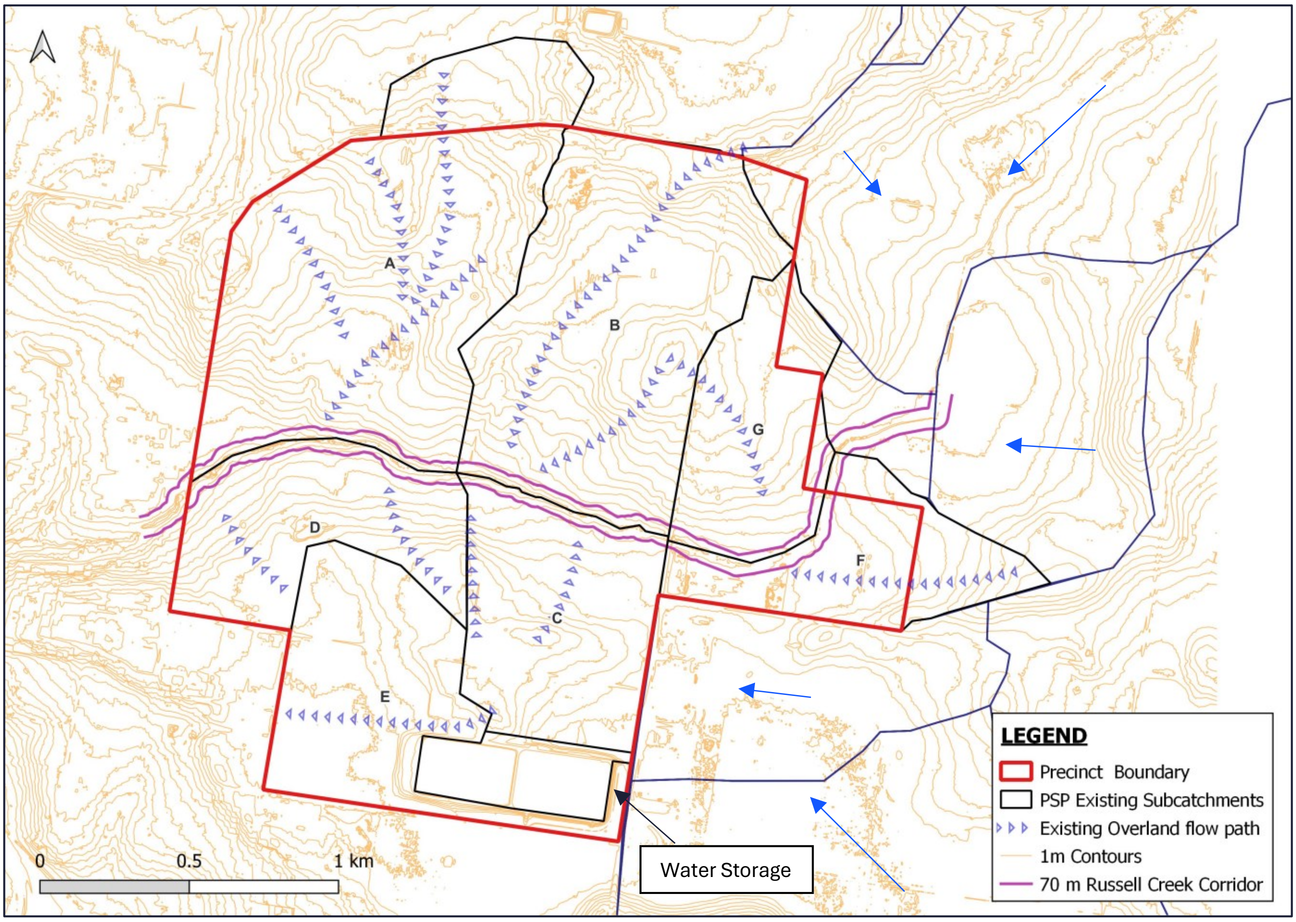

Figure 3-2 Catchment Split based upon Existing Overland Flow Paths

3.2.1 Catchment A

Catchment A is approximately 114 ha of which 18 ha is external catchment outside of the PSP boundary. The majority of the catchment is mainly large open paddocks which accommodates livestock grazing or otherwise underutilised rural land use. The majority of Tozer Memorial reserve is located at the eastern boundary of this catchment. The direction of runoff is generally from north to south west of the boundary. The highest point of the catchment is north of Wangoom Road with the runoff draining towards south into the Russell Creek. Catchment A elevation is varied from 52 m Australian Height Datum (AHD) to 23 m AHD.

3.2.2 Catchment B

Catchment B is approximately 93 ha. The majority of the external catchment is south of the Dixons Ln. Catchment B is mainly open rural lands and slopes from north east to south and south west of the boundary towards Russell Creek. Part of Tozer Memorial reserve is located at the south west boundary of this catchment. It has an elevation ranging from 49 m AHD to 28 m AHD. This catchment has multiple outlet locations along the creek interface.

3.2.3 Catchment C

Catchment C is approximately 49 ha which drains north into the Russell Creek. This catchment constitutes large open paddocks and rural land. It has an elevation ranging from 38 m AHD to 25 m AHD. This catchment has multiple outlet locations along the creek interface.

3.2.4 Catchment D

The small part of the PSP area is catchment D. The land use type is largely open space which is being used for livestock grazing and is approximately 43 ha in size. This catchment generally slopes towards western boundary of the site where it drains into the Russell Creek. The highest point elevation is 33 m AHD and lowest point is at 22 m AHD at the Russell Creek outlet (considered as the outlet of the entire PSP area)

3.2.5 Catchment E

Catchment E is approximately 51 ha. It is located south of the Boiling Down Rd with the dominated land use type of open spaces. This catchment generally slopes from east to south western boundary of the site. This catchment is the only catchment which drains to the separate outlet as opposed to other ones which are discharged to the Russel Creek. The highest point elevation is 38 m AHD and lowest point is at 30 m AHD. The water storages shown in **Figure 3-2** have been excluded from catchment delineation as well as future modelling.

3.2.6 Catchment F

Catchment F is approximately 37 ha of which 14 ha is external catchment north of the Rodgers Rd. The catchment is mainly large open paddocks which accommodates livestock grazing or otherwise underutilised rural land use. The direction of runoff is generally from east to west which finally drains into the Russell Creek. Catchment F elevation is varied from 43 m AHD to 30 m AHD.

3.2.7 Catchment G

Catchment G is approximately 39 ha and located east of Horne Rd. Approximately 6 ha of the total catchment area is external catchment. Similar to other catchments, this catchment constitutes large open paddocks and rural land. The direction of runoff is generally from north to south and drains to the Russell Creek. Catchment G elevation is varied from 45 m AHD to 30 m AHD.

3.2.8 External Catchment - Russell Creek

The Russell Creek external catchment of approximately 1,688 ha flows to the PSP boundary. Flows coming from this external catchment will not impact the WLRB sizing. However, this external catchment has been included in the RORB model. The full extent of the external catchment in the north, east, and southeast of the PSP area is shown in **Figure 3-3** below.

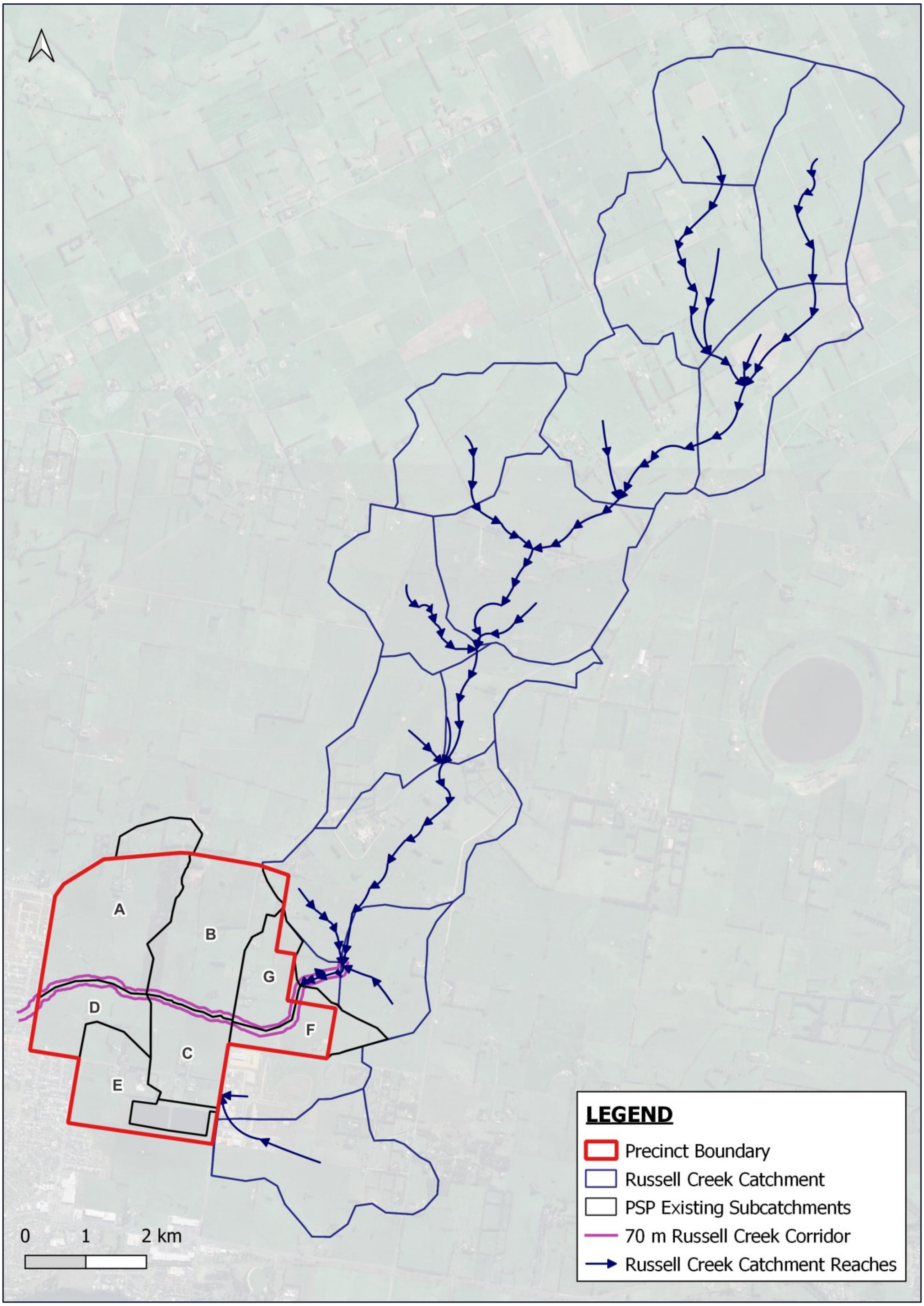

Figure 3-3 External Catchment

3.3 Planning Zones and Overlays

Land within the PSP area is currently predominantly zoned Farming Zone. The Wannon Water storage ponds located in the south-east corner of the PSP are zoned Public Use Zone (PUZ1).

Land immediately west and south-west of the PSP is zoned General Residential Zone. Land within Horne Road Industrial Precinct is zoned Industrial 3 Zone (INZ3). Key roads framing and within the PSP area (Aberline Road, Wangoom Road and Horne Road) are zoned Road Zone (RDZ2). Planning zones are illustrated in **Figure 3-4**.

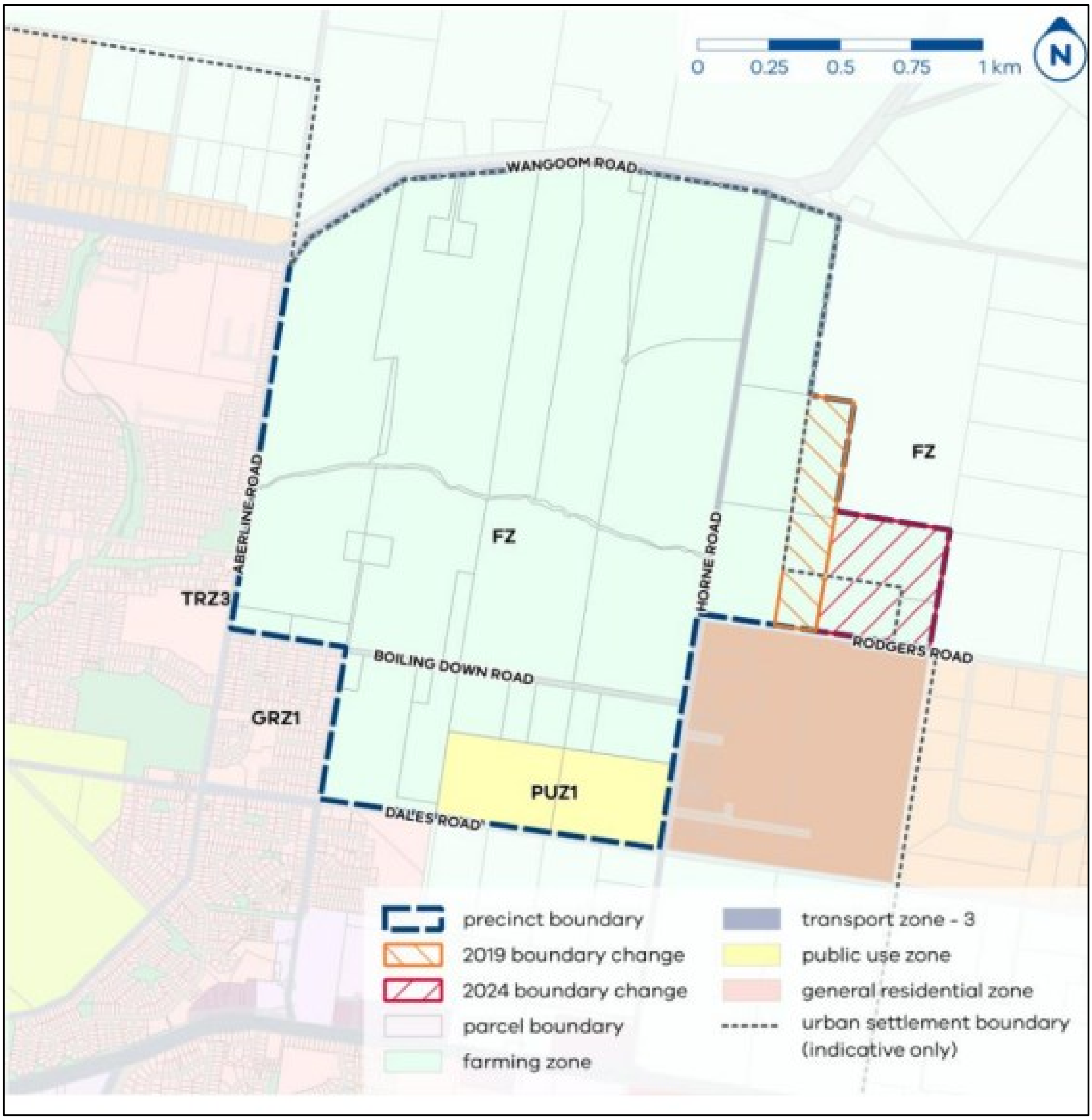

Figure 3-4 Planning Zones for East of Aberline PSP (Urban Enterprise, 2024)

The only overlay that impacts the PSP area is the Bushfire Management Overlay (BMO) which was introduced to the land as part of (VC140 12/12/2017). The management of bushfire will be addressed and the necessity of this overlay within an urban context will be considered through the planning scheme amendment for the PSP.

Development of the land surrounding the PSP area has largely been planned using Development Plan Overlays (DPO1, DPO7 and DPO11). Planning overlays are shown in **Figure 3-5**.

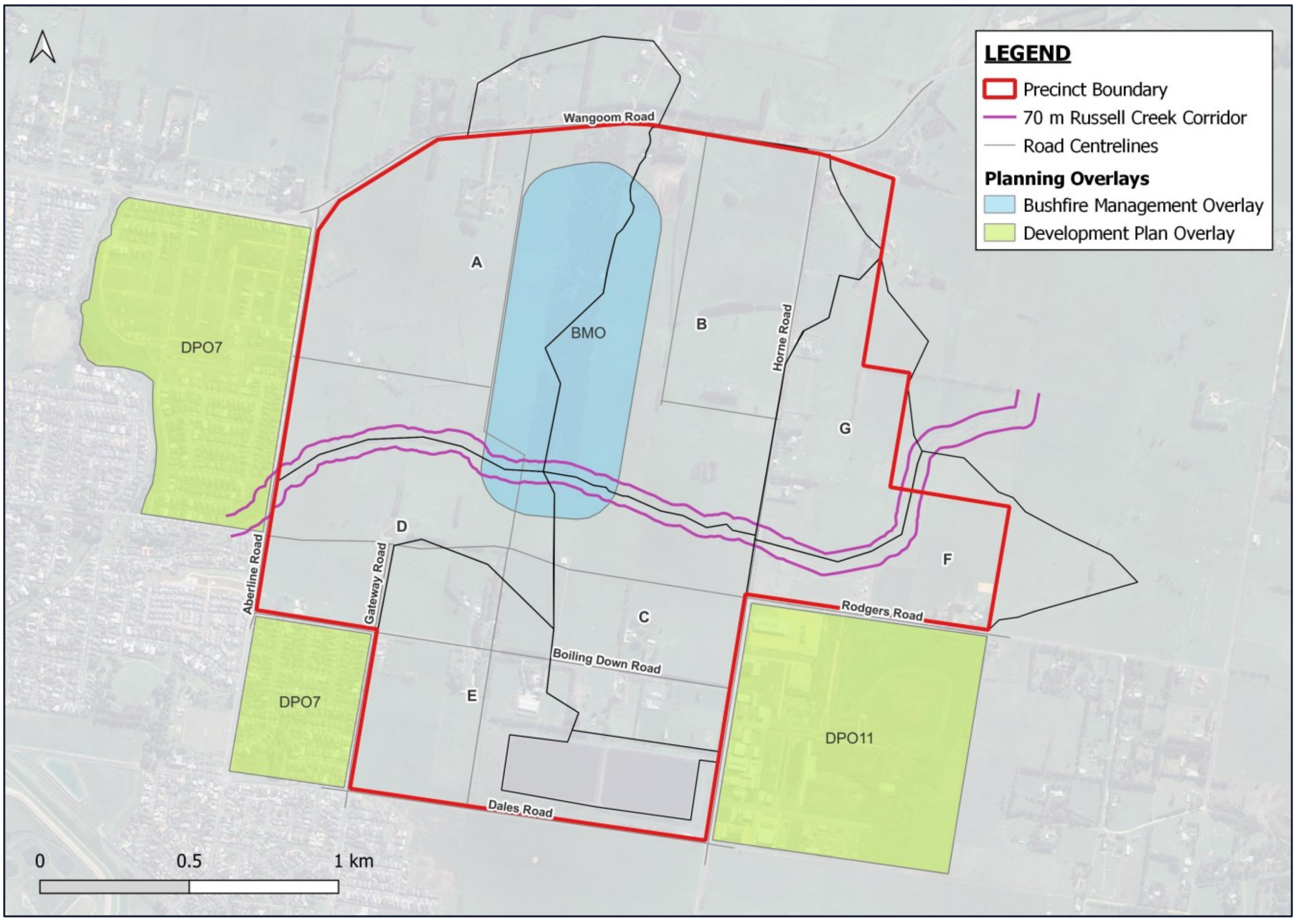

Figure 3-5 Planning Overlays for East of Aberline PSP (source: mapshare.vic.gov.au)

3.4 Site Visit

SMEC attended the site on 14 January 2025. The primary objectives of the visit were to:

- Comprehend the site condition and constraints.
- Inspect the locations of the five wetland and detention basins identified in the previous Stormwater Drainage Concept & IWM Report (Spiire, 2022), to check the suitability of these areas for the proposed assets.
- Inspect where accessible the Russell Creek condition to assess the waterway health and any geomorphological change.
- Meet with Wannon Water on site to witness how the roof water harvesting scheme currently in place is designed and operated.

Refer **Figure 3-6** for the inspected locations on the site visit day. Access to private properties were not available at the time of the site visit.

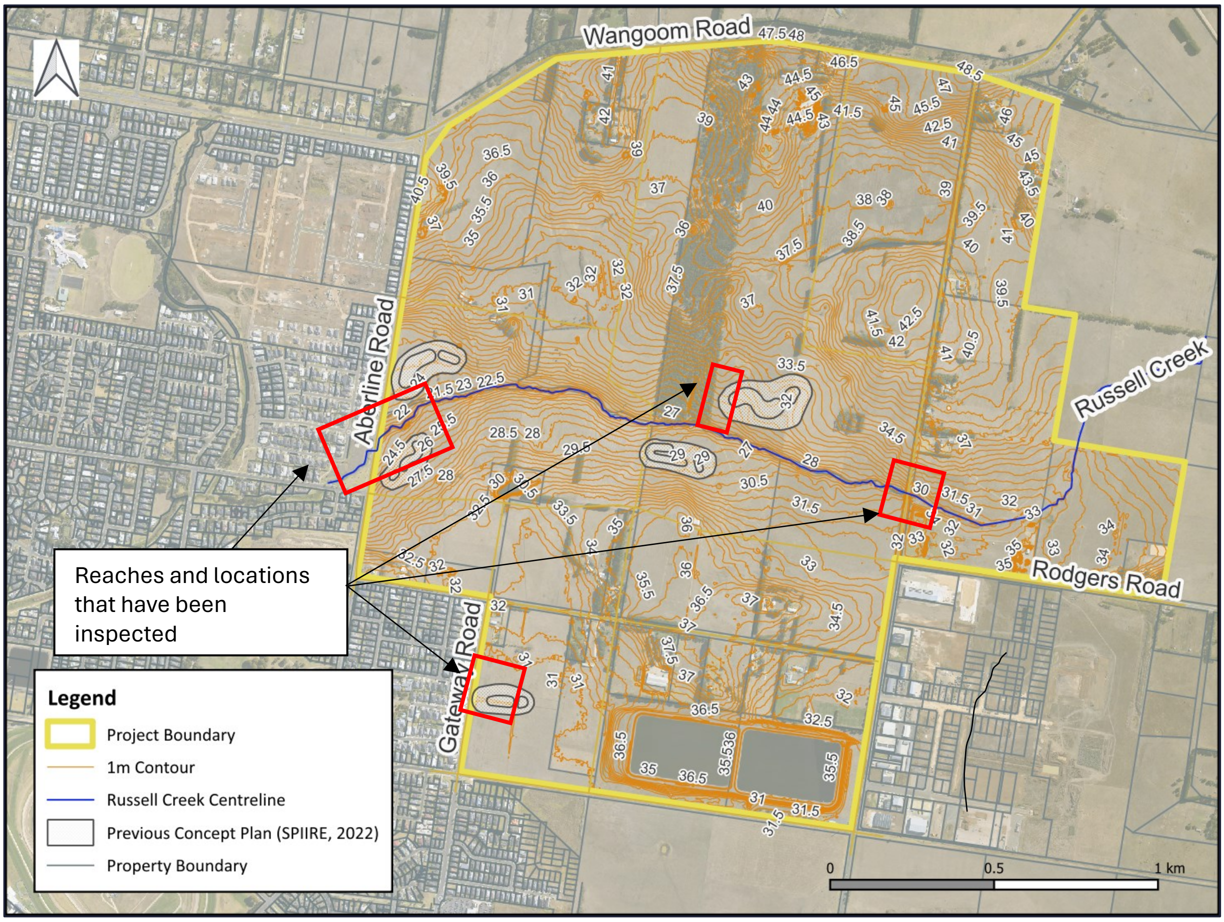

Figure 3-6 Site Visit Locations

The inspected locations of the detention basins proposed by Spiire (2024) are shown in **Figure 3-7** below.

Figure 3-7 East of Tozer Reserve where Detention Basin B is proposed north of Russell Creek (looking east from Tozer Reserve)

Location of Detention Basin E east of Gateway Road (looking east from an existing junction pit at Gateway Road)

Location of Detention Basin C at a distance adjacent Russell Creek (looking west from Horne Road)

Location of Detention Basin A and B on both side of Russell Creek (looking southeast from Aberline Road)

There are two existing road culverts along Russell Creek within the PSP boundary. The culverts at Horne Road consist of four (4) box culverts (approx. 3.6m (W) × 1.5m (H)). The Aberline Road culverts consist of five (5) box culverts (approx. 1.5m (W) x 1.5m (H). Refer to **Figure 3-8**.

Figure 3-8 Horne Road culverts on the left (downstream looking north) and Aberline Road culverts on the right (downstream looking southeast)

Russell Creek between Aberline Road and Horne Road can be described as a well-defined valley and relatively straight with a low longitudinal slope (average 0.005m/m). The upper Creek between Horne Road and Tozer reserve (approx. 740m) has little to no presence of native species such as trees, understory plants, or grasses, which are essential for stabilising the banks and supporting the ecosystem. **Figure 3-9** illustrates two images of the Creek's lack of vegetation cover.

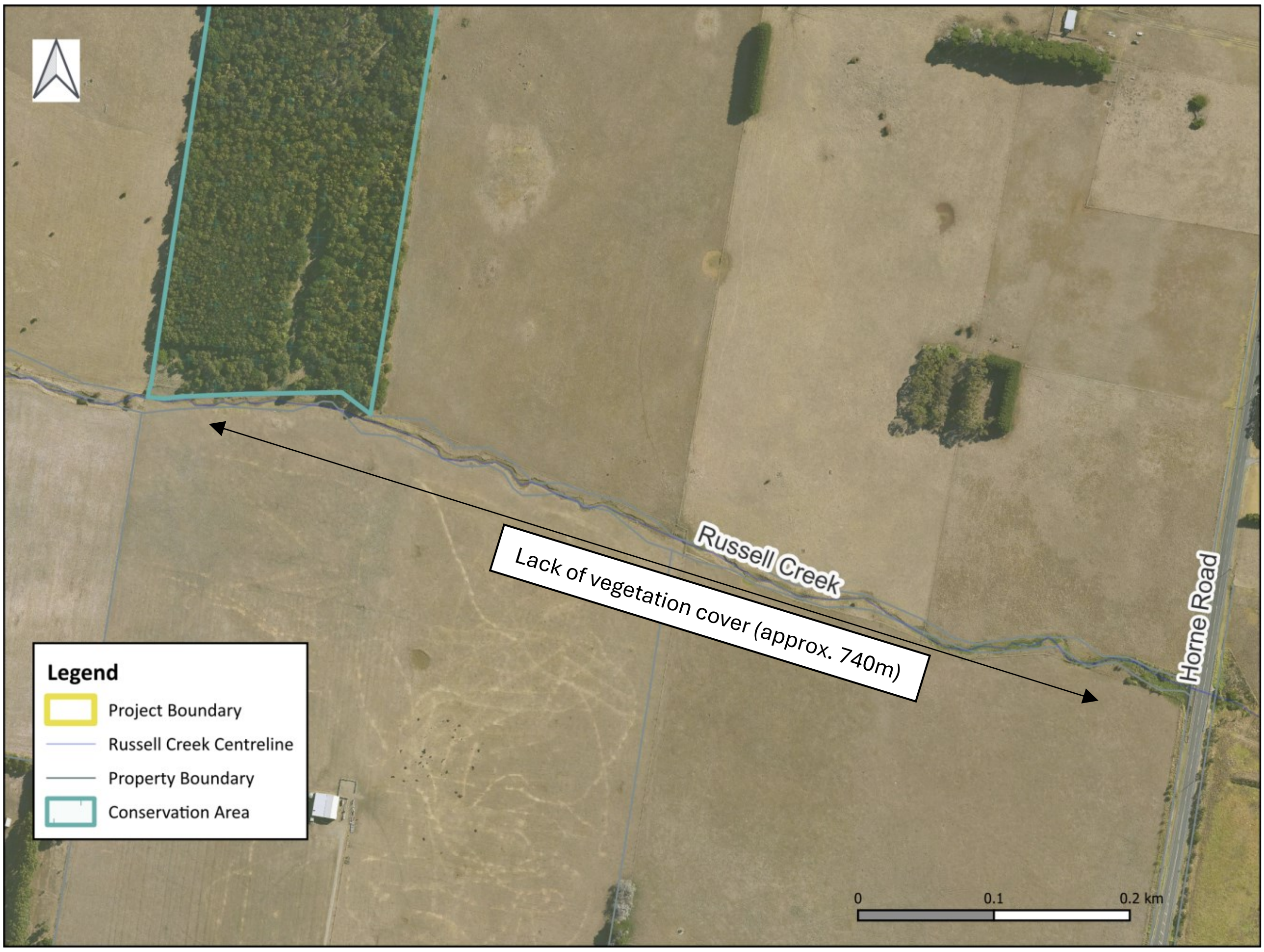

Figure 3-9 Russell Creek lack of vegetation cover (source: Metromap above and site photo below)

Further west of Russell Creek, some scattered trees along the Creek banks are evident. The aerial imagery in **Figure 3-10** also shows some evidence of erosion due to lack of vegetation on the river banks as a protective layer.

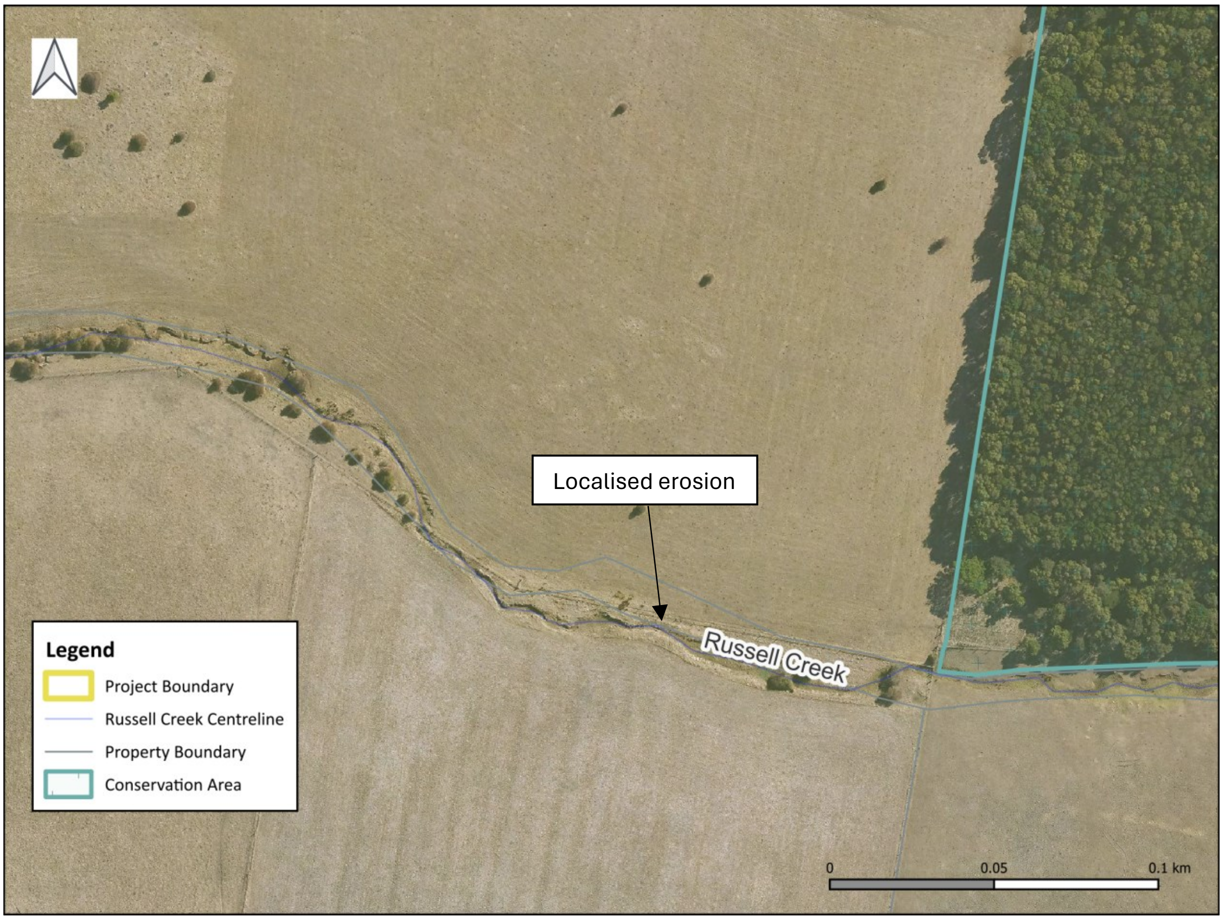

Figure 3-10 Russell Creek from west of Tozer Reserve showing some evidence of erosion (Metromap, 2025)

3.5 Integrated Water Management

A review of the Integrated Water Management (IWM), Water Sensitive Urban Design (WSUD) elements completed in the earlier study by Spiire (2022), are discussed below.

3.5.1 Review of the Spiire (2022) Draft IWM Strategy

- The IWM Plan report proposed a number of end-of-line retarding basin and wetlands systems to treat and control the runoff prior to discharging into Russell Creek. In addition, recommendations for stormwater harvesting from wetland to irrigate active open spaces were mentioned.
- A series of GGF ponds within Russell Creek corridor were identified.
- Preservation of Tozer Reserve was a key feature of the IWM strategy which included a vegetated swale to provide stormwater management.

Refer **Figure 3-11** below for the IWM plan by Spiire.

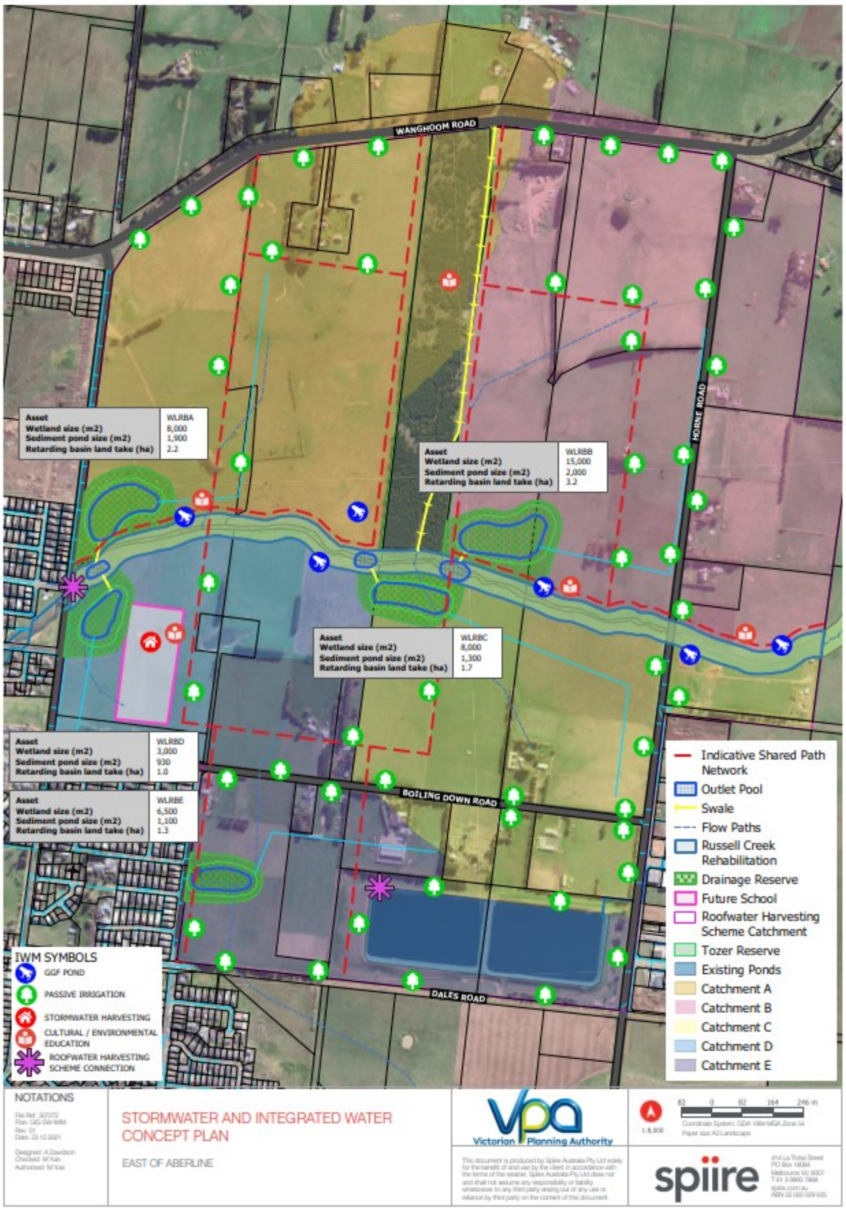

Figure 3-11 IWM Plan (Spiire, 2022)

- One of the key opportunities identified in the PSP at the time was to extend the existing roof water harvesting scheme (RWHS) by Wannon Water to the new developments in East of Aberline PSP. The Scheme collects roof runoff which is distributed to the potable water supply. The RWHS is an existing system with infrastructure already in place at Aberline Road. Water balance modelling completed by Spiire estimates that the PSP could contribute around 680 ML annually, increasing RWHS's share of Warrnambool's supply to 7% and reducing stormwater runoff by 53%.
- A review of the initial drainage layout suggests that terrain considerations have been appropriately addressed. The proposed locations and overall concept were found to be suitable, taking into account both the terrain characteristics and the development staging.
- A RORB rainfall runoff model was used to represent the developed conditions based on the draft Place Based Plan at the time. Based on the review of the model a number of aspects can be refined in the proof-of-concept stage. Some of these are as follows:
    - Refinement of the fraction of impervious area to reflect the latest land zonings in the developed conditions.
    - Reach length and slopes are to be recalculated based on the revised drainage layout.
- A uniform climate change upscaling factor of 19% in the rainfall depth was adopted in the Spiire model run. This factor was based on the climate temperature increase of 3.57 °C (RCP 8.5) for 2100 and was consistent with practices at the time. The recent update to climate change guidance, as mentioned above, means that the hydrology was required to be update.
- Hydraulic modelling (TUFLOW) has been undertaken to define the flood depths, levels, velocities and extents through the PSP and surrounds.

3.5.2 PSP 2.0 Process

East of Aberline PSP has been chosen as one of the projects for the VPA to implement the PSP 2.0 Process initiative. This process introduces a new Innovation Pathway for preparing structure plans. A number of background work have been done by the VPA which are described in a number of reports including Pitching Sessions (VPA, 2023), Vision & Purpose Survey (VPA, 2024a) and Co-Design Summary Report (VPA, 2024b).

The Vision and Purpose Survey Summary has been prepared by the VPA with input from survey responses and is described in VPA (2024a). The document describes the aspirations for the future community and the environment. The six key themes identified in the Vision & Purpose Survey are as follows:

- Theme 1: Housing
- Theme 2: Transport
- Theme 3: Water and Drainage
- Theme 4: Community Infrastructure
- Theme 5: Biodiversity and the Environment
- Theme 6: Sustainability

Specifically in relation to Theme 3: Water and Drainage, the PSP purpose states that the plan will protect the Russell Creek corridor, enhance biodiversity, and include conservation areas for habitat creation. It will use innovative drainage solutions and roof water harvesting where possible.

The strategic land use context, design aspirations and how these can be implemented in the PSP are culminated in the East of Aberline PSP report (VPA, 2024c). This report provides guidelines with respect to the IWM initiatives that would be expected from the PSP infrastructure delivery.

One of the objectives outlined is to plan for an integrated water management system that reduces reliance on reticulated potable water, increases the reuse of alternative water through stormwater harvesting and water recycling contributing towards a sustainable and greed urban environment.

The document states that where practical, integrated water management systems should be designed to:

- Enable future harvesting and/or treatment and re-use of stormwater.
- Maximise habitat values for local flora and fauna species.
- Protect and manage habitat for Matters of National Environmental Significance, particularly within conservation areas, in relation to water quality and sustainable hydrological regimes (both surface and groundwater).
- Enable any potential supply of treated stormwater for existing and future Growling Grass Frog and Swamp Skink wetlands to be gravity-fed.
- Recognise and respond to Aboriginal cultural heritage significance.

3.6 Russell Creek Health

Russell Creek runs at the centre of the East of Aberline Precinct Structure Plan (PSP) from east to west. This creek is a shallow creek with an average base width of 1 to 2 m, small steep banks and a longitudinal slope of the creek is 0.005 m/m.

At the time of the site inspection, SMEC's team were not able to walk along the creek to assess the condition of the creek due to the limited access to the creek and surrounding agricultural lands. Therefore, SMEC has utilised the following sources of information for this creek's existing condition assessment.

- Aerial photos such as Metro Map
- One-meter LiDAR data
- Photos from site visit

Russell Creek is currently surrounded by agricultural land with no clear corridor to provide a suitable environment for the riparian vegetation. For an approximate length of 350 m upstream of Aberline Road, the fence lines on both sides of the creek form a corridor for the waterway with an approximate width of 15 m at the narrowest point to 27 m at the widest point. The waterway corridor at the section of the creek is narrower than the minimum required waterway corridor width recommended in Victorian urban waterway guidelines, such as Melbourne Water Waterway Corridors for greenfield development areas.

Upstream of this section, there is a fence line on one side of the creek or no fence line at all, which enables farming activities to encroach on the creek bank, loosening the soil structure and exacerbating the risk of bank erosion for the creek. **Figure 3-12** and **Figure 3-13** show two sections of the creek where fencing appears on one or both sides of the creek.

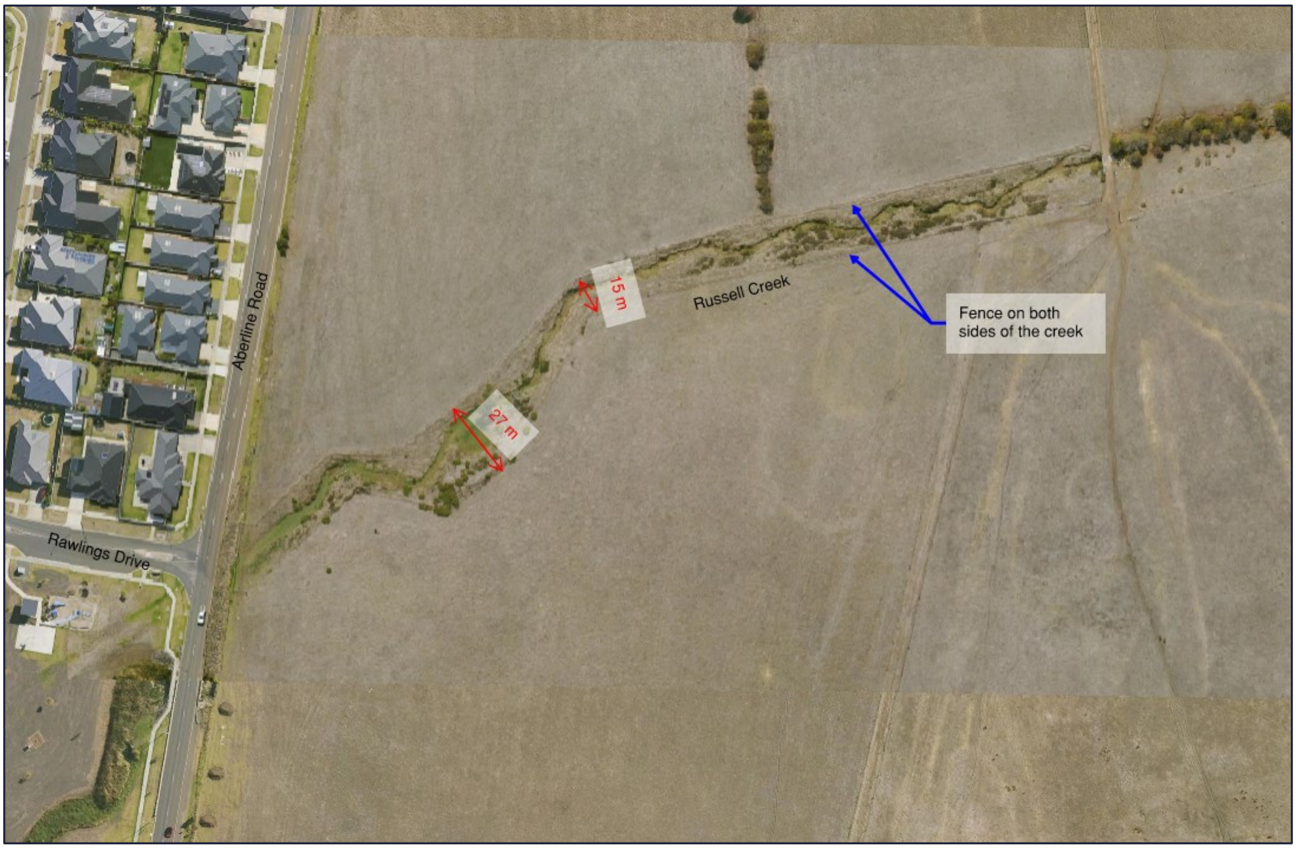

Figure 3-12 Russell Creek Corridor upstream of Aberline Road

Figure 3-13 Fence line on one side of the Russell Creek, with no clear corridor for the creek

Due to historical human activities, native vegetation has been cleared, and in the absence of a defined waterway corridor, riparian vegetation has been unable to recover and protect the waterway. Farming practices leave the catchment largely unvegetated after the harvest season, resulting in high-velocity surface runoff flowing toward the creek. When this runoff reaches the steep riverbanks, it initiates localised erosion, which is subsequently exacerbated by ongoing riverine processes. The resulting surface erosion is evident in **Figure 3-14** to **Figure 3-16**.

Figure 3-14 Lack of riparian vegetation and agricultural activities resulting in surface erosion, approximately chainage 660 from Aberline Road

Figure 3-15 Lack of riparian vegetation and agricultural activities resulting in surface erosion, near the upstream end of the PSP area

Figure 3-16 Lack of riparian vegetation and agricultural activities resulting in surface erosion, approximately chainage 1220 from Aberline Road

There is limited in-stream vegetation predominantly downstream of culverts under the Horne Road and approximately from chainage 350 to 640 m upstream of Aberline Road. Exotic short trees and long grass cover the river bed in two stretches of the river. **Figure 3-17** and **Figure 3-18** show the condition of in-stream vegetation in the existing condition.

Figure 3-17 In-stream vegetation downstream of Horne Road

Figure 3-18 In-stream and riparian vegetation condition

Russell Creek tends to create a meandering form with pools and riffles downstream of Horne Road. The meandering alignment of the creek with limited pools and riffles downstream of Horne Road is illustrated in **Figure 3-19**. Evidence of lateral movement in the creek channel indicates ongoing geomorphological change under current conditions. Without intervention, these changes are likely to intensify following urbanisation of the catchment, driven by increases in flow rates, stormwater volumes, and the extended duration of flood hydrographs.

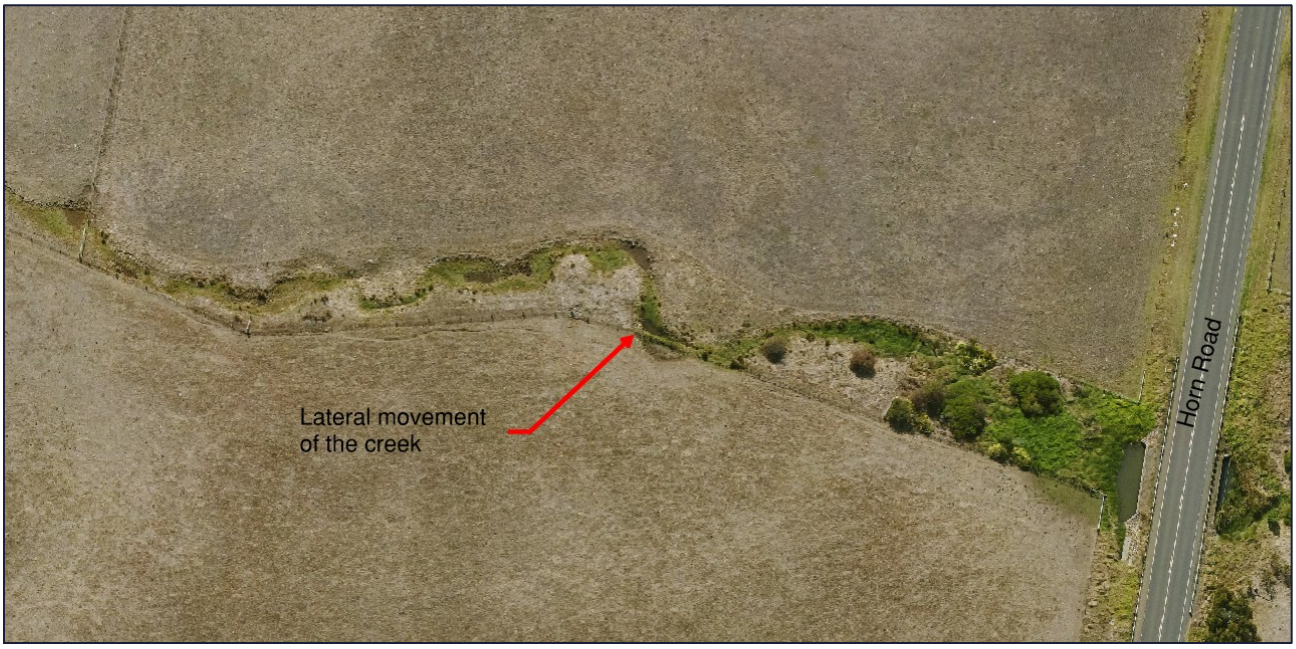

Figure 3-19 Lateral movement of the creek and the formation of pools and riffles downstream of Horne Road

Overall, Russell Creek suffers from the absence of a defined waterway corridor and a lack of riparian vegetation. As a result, the creek displays minimal ecological value and shows clear signs of bank erosion in several sections.

Urbanisation alters catchment hydrology by increasing peak flows and stormwater volumes, while reducing stormwater quality. Although current Victorian stormwater regulations require that peak flows and water quality be maintained at pre-development levels, the management of stormwater volume should not be neglected.

Beyond catchment-wide stormwater management, a comprehensive rehabilitation program is required for Russell Creek. Such a program should aim to restore the creek's geomorphological form, re-establish riparian vegetation, and support the recovery of its ecological health.

4. Site Constraints

4.1 Flooding

A high-level review has been completed of the available flood modelling information. Russell Creek is the main drainage outfall for the PSP area providing flood conveyance, amenity and a biodiversity corridor. It has also been identified as one of the main opportunities for enhancement and rehabilitation. The current Floodway Overlay (FO) and Land Subject to Inundation Overlay (LSIO) are limited to Aberline Road and outside the PSP boundary. Refer to **Figure 4-1** of the planning scheme.

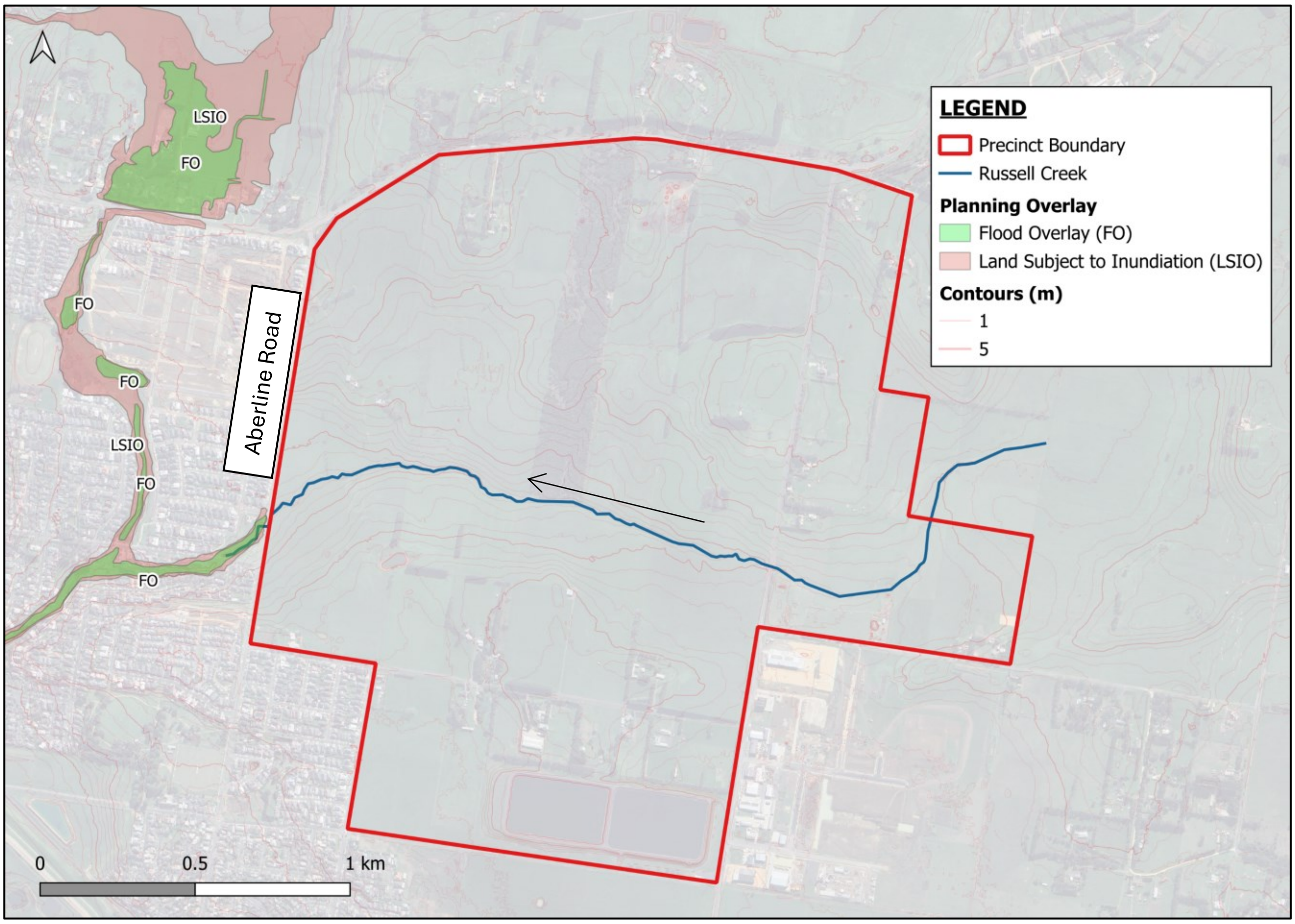

Figure 4-1 Floodway Overlay and Land Subject to Inundation

Numerous flood investigations have been undertaken for Russell Creek and the wider Merri River catchment. The most recent flood study relevant to the PSP is the Russell Creek Flood Mitigation Report (Water Technology, 2017) commissioned by the Glenelg Hopkins Catchment Management Authority (GHCMA). The flood outputs are shown in **Figure 4-2** covering East of Aberline to the east.

Figure 4-2 Water Technology 2017 1% AEP Flood Modelling Outcomes for Design Conditions

4.1.1 2024 Climate Change Consideration Update

GHCMA has advised the VPA that the flood extents documented in the report should be reviewed since they were based on the AR&R guidelines at the time. Updates to Australian Rainfall & Runoff Guidelines (AR&R) (Ball et al., 2019) was released in September 2024 which provides the latest guideline to climate change modelling. The new guidelines recommends increasing the uplift factors for all design storms depending on the adopted time horizon and climate condition.

A desktop assessment has been undertaken to identify any catchment changes since 2017 that may influence the hydrological modelling. Recent industrial development has occurred east of Horne Road, between Rodgers and Dales Road, and is understood to drain north into the Russell Creek catchment. This will contribute additional runoff to the catchment.

The currency of the defined 1% Annual Exceedance Probability (AEP) flood extent impacts the East of Aberline PSP scope of works as it defines the development exclusion zone. As such, an update to the existing conditions flood modelling has been completed to reflect the recent changes and is described in Section 6 of this report.

4.1.2 Aberline to Horne Growth Corridor

Warrnambool City Council commissioned Engeny to investigate the same future growth corridor and to identify the required stormwater drainage infrastructure. The outcome of this study is described in Aberline to Horne Growth Corridor report (Engeny, 2018). The study looked at a number of design scenarios ranging from centralised and distributed assets. Ultimately, the recommended drainage strategy identified five wetland and retarding basins along the Russell Creek corridor. Refer to **Figure 4-3**. The Spiire (2022) and Engeny (2018) strategies have proposed assets at similar locations.

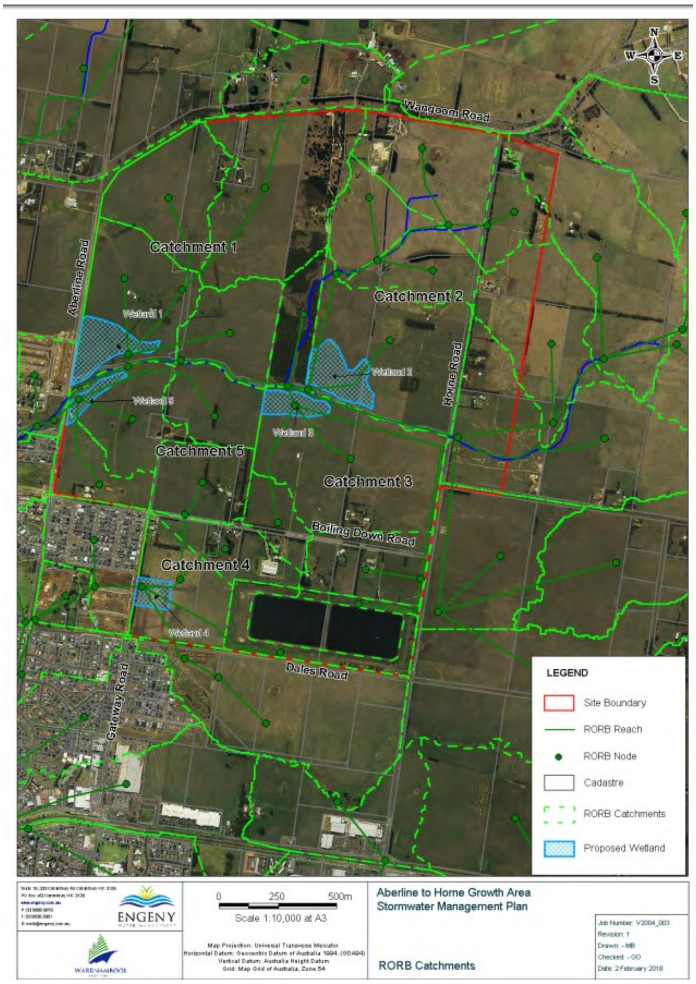

Figure 4-3 Aberline to Horne Growth Area Stormwater Management Plan (Engeny, 2018)

4.2 Biodiversity

Several studies, including the Existing Situational Analysis Report (Spiire, 2020), Flora and Fauna Assessment: Aberline to Horne Growth Corridor (Ecology and Heritage Partners, 2018), and the Growling Grass Frog Study – Aberline to Horne Road – Future Urban Growth Area (Landtech Consulting, 2019), have been undertaken to assess and report on the biodiversity considerations within the proposed PSP boundary. Key findings from the studies are as follows:

- Key findings from Spiire (2020) indicate that Tozer Reserve (southward from Wangoom Road) will remain due to its “high ecological value and [an] important habitat provision”.
- The Flora and Fauna Assessment: Aberline to Horne Growth Corridor report (Ecology and Heritage Partners, 2018) indicate that the key ecological value within the area consists of mainly the Tozer Reserve and Russell Creek corridor. The report suggests that “the study area can accommodate the medium- and longer-term growth of Warrnambool whilst maintaining and enhancing the key ecological values present”.
- A targeted survey of the Growling Grass Frog (*Litoria raniformis)* by Landtech Consulting (2019) indicates that the Growling Grass Frog may only be present within Tozer Reserve, and that “a GGF Management Strategy should form part of future study area planning and include the key issue regarding GGF; potential and future habitat protection and linkage”.

To summarise, various biodiversity studies indicate that development within the proposed PSP boundary have to be limited to area outside of Tozer Reserve and the Russell Creek corridor to limit any negative impact towards local biodiversity.

5. Stormwater Management Objectives

5.1 Drainage Requirements

The Warrnambool City Council requires that all new developments be designed to meet the standards and guidelines set forth in the Australian Rainfall and Runoff (AR&R) Guidelines (Ball et al., 2019) and the Infrastructure Design Manual (IDM) (LGIDA, 2019). Additionally, the design outcomes must comply with the provisions of the *Planning and Environment Act 1987*.

The IDM requires new developments to:

- Provide drainage capacity equivalent to 20% AEP for minor drainage system in residential areas for Council drainage systems
- Be protected from major flooding equivalent to the 1% AEP event, where all new lots shall be above the 1% AEP flood level, and buildings are at least 300mm above the 1%AEP flood level.

In developing the precinct, it is a requirement to ensure there is no adverse change to the stormwater peak discharges from the site outfall boundaries for critical storms up to the 1% AEP event and ultimately prevent any adverse impacts to downstream properties. To meet this requirement, it is typical to manage the stormwater flows as follows:

- Collect and control stormwater flows via provisions of underground drainage systems, overland flow paths and drainage channels or waterways.
- Retain the peak flow from developed conditions to match the existing conditions within the catchment, before discharging to the catchment outlet, through the provision of retarding basin infrastructure.

5.2 Stormwater Quality

The minimum requirements for urban stormwater quality treatment is set out in the *Best Practice Environmental Management Guidelines for Urban Stormwater* (BPEMG) document (CSIRO, 1999). The requirement is stipulated in the Victorian Planning Provisions under Clause 56.07 Integrated Water Management. The guideline document sets a minimum target of stormwater pollutant reduction as follows:

- 80% Total Suspended Solids
- 45% Total Phosphorus
- 45% Total Nitrogen
- 70% Gross Pollutants or Litter

Water Sensitive Urban Design (WSUD) principles are applied to the development in order to meet these requirements which generally involves provision of sedimentation basins, bioretention systems and constructed urban wetlands.

5.3 Stormwater Volume Management

The EPA Publications - Urban Stormwater Management Guidance (1739.1) (EPA, 2021) provides the guidance on the management of urban stormwater which includes guidelines on volume reduction targets. The aim of the document is to set minimum and aspirational targets for stormwater runoff volume reduction by infiltration and stormwater harvesting and reuse where possible. It also provides guidance on the areas with higher priority to the rest of the urban catchments. For East of Aberline PSP, where the average annual rainfall is around 700 mm the target is 27% harvesting and evapotranspiration, and 9% infiltration.

5.3.1 Precinct Structure Plan 2.0 Guidance

- The VPA has prepared PSP guidance with the aim to 'lift the bar' by encouraging higher standards of design and development. With respect to IWM, the following targets were included.
    - T14– All streets containing canopy trees should use stormwater to service their watering needs.
    - T17– IWM solutions should meaningfully contribute towards the actions and targets of the relevant Catchment Scale Public Realm & Water Plans and any relevant water-related strategy, plan, or guideline.
- National Construction Code (NCC) 2022 in Schedule 2. There are no specific requirements for provision of rainwater tanks. However, there is a strong push by the State Government to improve the water efficiency of all buildings subject to regulatory impact statement and stakeholder and community consultation.

6. Existing Condition

6.1 Hydrology

The catchment hydrologic model, RORB, was employed to estimate runoff hydrographs for the catchment. RORB (Laurenson et al., 2010) is a nonlinear rainfall runoff and stream flow routing model for calculation of flow hydrographs in drainage and stream networks. The model requires catchments to be subdivided into subareas, connected by conceptual flow reaches.

The latest RORB model (Spiire, 2020) was adapted as a base case model and modified to represent the PSP catchment at a smaller scale. Two models for the existing condition have been generated for the PSP area based upon the two points of discharge. All catchments (except for E in the south) are discharged into the Russell Creek at Aberline Rd while Catchment E has its own point of discharge at Gateway Rd.

The RORB model k_c parameter was adopted based on the previous studies for the catchment. The peak flow of the model just downstream of the East of Aberline PSP (at Aberline Road) were compared against the peak flow at the same location of the Spiire model. **Appendix A-1** details the RORB model parameters and verification methodology.

Figure 6-1 below shows the existing condition RORB model setup for the East of Aberline PSP. By definition the existing conditions represent the catchment as it currently is without any new developments. The PSP area has been subdivided into seven sub catchments A-G. The sub catchment characteristics such as areas and fraction imperviousness are presented in **Appendix A-1**.

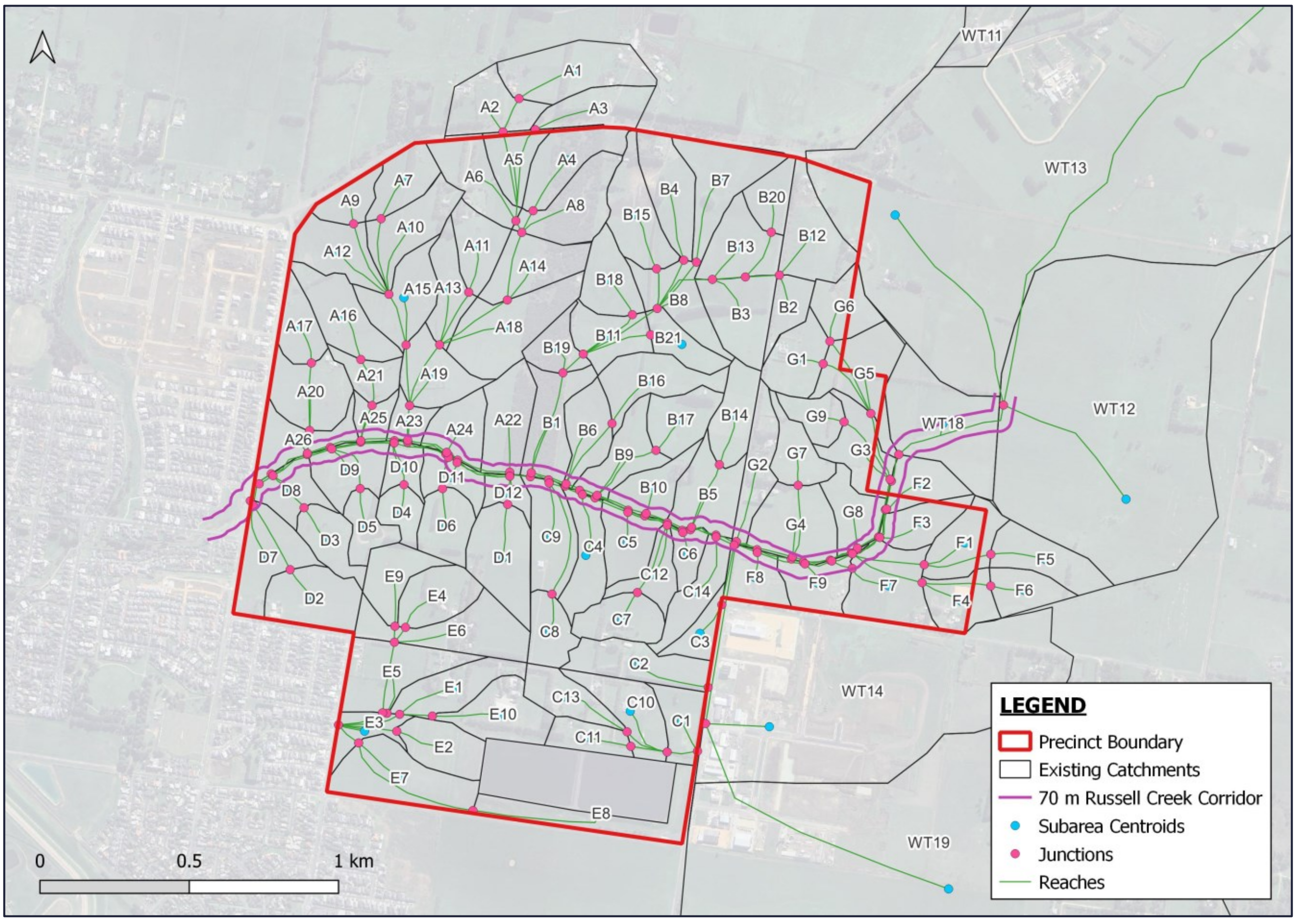

Figure 6-1 East of Aberline PSP Existing Condition RORB Model Setup

The RORB model was simulated for the 10% AEP and 1% AEP, and the peak flows are outlined in **Table 6-1** and **Table 6-2**.

Table 6-1 Existing Condition 10% AEP Results

Flow Estimate Location	Peak Flow (m^3/s)	Critical Duration
Catchment A Interstation	1.7	6 hrs
Catchment B Interstation	1.3	6 hrs
Catchment C Interstation	0.9	3 hrs
Catchment D Interstation	1.1	3 hrs
Catchment E Interstation	1.2	3 hrs
Catchment F Interstation	0.8	3 hrs
Catchment G Interstation	0.9	3 hrs
Aberline Rd Outlet	11.3	9 hrs

Table 6-2 Existing Condition 1% AEP Results

Flow Estimate Location	Peak Flow (m^3/s)	Critical Duration
Catchment A Interstation	5.0	1.5 hrs
Catchment B Interstation	3.8	3 hrs
Catchment C Interstation	2.6	2 hrs
Catchment D Interstation	3.7	1 hr
Catchment E Interstation	3.8	1.5 hrs
Catchment F Interstation	2.6	1.5 hrs
Catchment G Interstation	2.7	1.5 hrs
Aberline Rd Outlet	38.4	9 hrs

6.1.1 Climate Change Scenario

A scenario where climate change factors are taken into consideration have been modelled. Ball et al. (2019) defines the industry standard for completing design event rainfall runoff estimation and associated flood modelling. Guidance in climate change consideration has recently been updated in September 2024 (AR&R Version 4.2). The updates incorporate changes the uplift factors to be adopted for rainfall runoff model procedures. The uplift factors are dependent on the global temperature increase and future horizon being assessed.

The climate change scenario modelling adopted for this project is based on an increase in global temperature of 4.5 °C in the year 2100 horizon. This is consistent with the Glenelg Hopkins CMA guidelines (GHCMA, 2024) which is supported by Warrnambool City Council for the purposes of the East of Aberline PSP drainage strategy.

The climate change uplift factors vary depending on the storm duration and AEP. A summary table of the uplift factors applicable to the site location is illustrated in **Table 6-3**. Detailed climate change factors are included in **Appendix A-2**.

Table 6-3 Data hub Climate Change Consideration Uplift Factors (AR&R v4.2, 2019)

SSP5-8.5										
Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	**1.2**	**1.18**	**1.17**	**1.16**	**1.14**	**1.13**	**1.13**	**1.12**	**1.11**	**1.11**
2040	1.26	1.24	1.22	1.2	1.18	1.17	1.16	1.15	1.14	1.14
2050	**1.34**	**1.31**	**1.29**	**1.26**	**1.24**	**1.23**	**1.21**	**1.2**	**1.18**	**1.18**
2060	1.42	1.38	1.35	1.32	1.29	1.28	1.26	1.24	1.22	1.21
2070	1.52	1.47	1.43	1.4	1.36	1.34	1.31	1.29	1.27	1.26
2080	1.63	1.57	1.52	1.48	1.43	1.4	1.37	1.35	1.33	1.31
2090	**1.77**	**1.69**	**1.64**	**1.58**	**1.52**	**1.49**	**1.45**	**1.42**	**1.39**	**1.37**
2100	1.86	1.77	1.71	1.64	1.58	1.54	1.5	1.47	1.43	1.41

The outcome of this scenario for the 10% AEP and 1% AEP storm events is presented in **Table 6-4** and **Table 6-5**.

Table 6-4 10% AEP Existing Flow Estimates Comparison with the Impact of Climate Change

Flow Estimate Location	Peak Flow (m^3/s)	Critical Duration
Catchment A Interstation	4.8	1.5 hrs
Catchment B Interstation	3.7	1.5 hrs
Catchment C Interstation	2.7	1.5 hrs
Catchment D Interstation	3.9	1.5 hrs
Catchment E Interstation	3.5	1.5 hrs
Catchment F Interstation	2.7	1.5 hrs
Catchment G Interstation	2.8	1.5 hrs
Aberline Rd Outlet	27.3	1.5 hrs

Table 6-5 1% AEP Existing Flow Estimates Comparison with the Impact of Climate Change

Flow Estimate Location	Peak Flow (m^3/s)	Critical Duration
Catchment A Interstation	12.8	1.5 hrs
Catchment B Interstation	9.7	1.5 hrs
Catchment C Interstation	6.8	1 hr
Catchment D Interstation	9.3	45 mins
Catchment E Interstation	9.5	45 mins
Catchment F Interstation	6.7	45 mins
Catchment G Interstation	6.9	45 mins
Aberline Rd Outlet	79.9	1.5 hrs

The values outlined in tables above provide the basis of the allowable peak discharge in the developed conditions to mitigate the increased peak flows from the catchment as a result of the PSP development. This assessment will be covered in Section 7 and 10 of the report where the retarding basin sizing and flood impacts are assessed for current climate conditions and the future climate change conditions.

7. Stormwater Drainage Strategy

7.1 General

The stormwater drainage strategy has been further refined, considering various constraints, site context analysis, IWM objectives, and the strategic vision for the Russell Creek. The strategy maintains the concept of centralised assets positioned alongside the waterway corridor. A major/minor drainage system is proposed to manage the flow conveyance of the PSP which is consistent with the Infrastructure Design Manual (LGIDA, 2019).

It is noted that the future internal road network and subdivision layout is not yet known at the PSP level and will ultimately determine the direction of flows. However, the strategy as discussed below provides the overarching plan on how to direct the stormwater runoff into the proposed drainage infrastructure.

The Russell Creek provide opportunity to interface the water sensitive urban design (WSUD) features together with active open spaces.

Section 7.2 discusses the proposed strategy for each sub-catchment while the details of the retarding basin and wetland sizing are discussed in Section 7.4 and Section 8.2.2 respectively.

7.1.1 Overland flow Assessment

An overland flow assessment has been completed for each sub catchments to identify flow paths which may require additional conveyance above the capacity of the future road reserves. In locations where gap flows cannot be contained within the reserve, a conceptual grassed swale has been sized. The calculations are provided in **Appendix B**.

It is important to note that gap flows are expected to increase under the climate change scenario, which may necessitate additional overland flow conveyance measures. The specific approach to managing these gap flows will be determined in accordance with Warrnambool City Council's requirements at the time of development. The assessment undertaken by SMEC is conceptual in nature, reflecting the high level of uncertainty at this stage. The assessment is based on assumed road layout; the final determination will be subject to the subdivisional road and drainage design.

Any additional works or land required to accommodate gap flows, whether designed for climate change or not, are considered outside the scope of the proposed stormwater drainage cost estimates.

7.2 Strategy Basis

The PSP area can be split into seven sub catchments A to G. Each catchment outfalls to the Russell Creek with exception to catchment E which drains to the Council drainage network. A combined wetland/retarding basin system (WLRB) are proposed to capture flows up to and including the 1% AEP event prior to discharging to the Russel Creek.

The overall drainage strategy layout plan is illustrated in **Figure 7-1**.

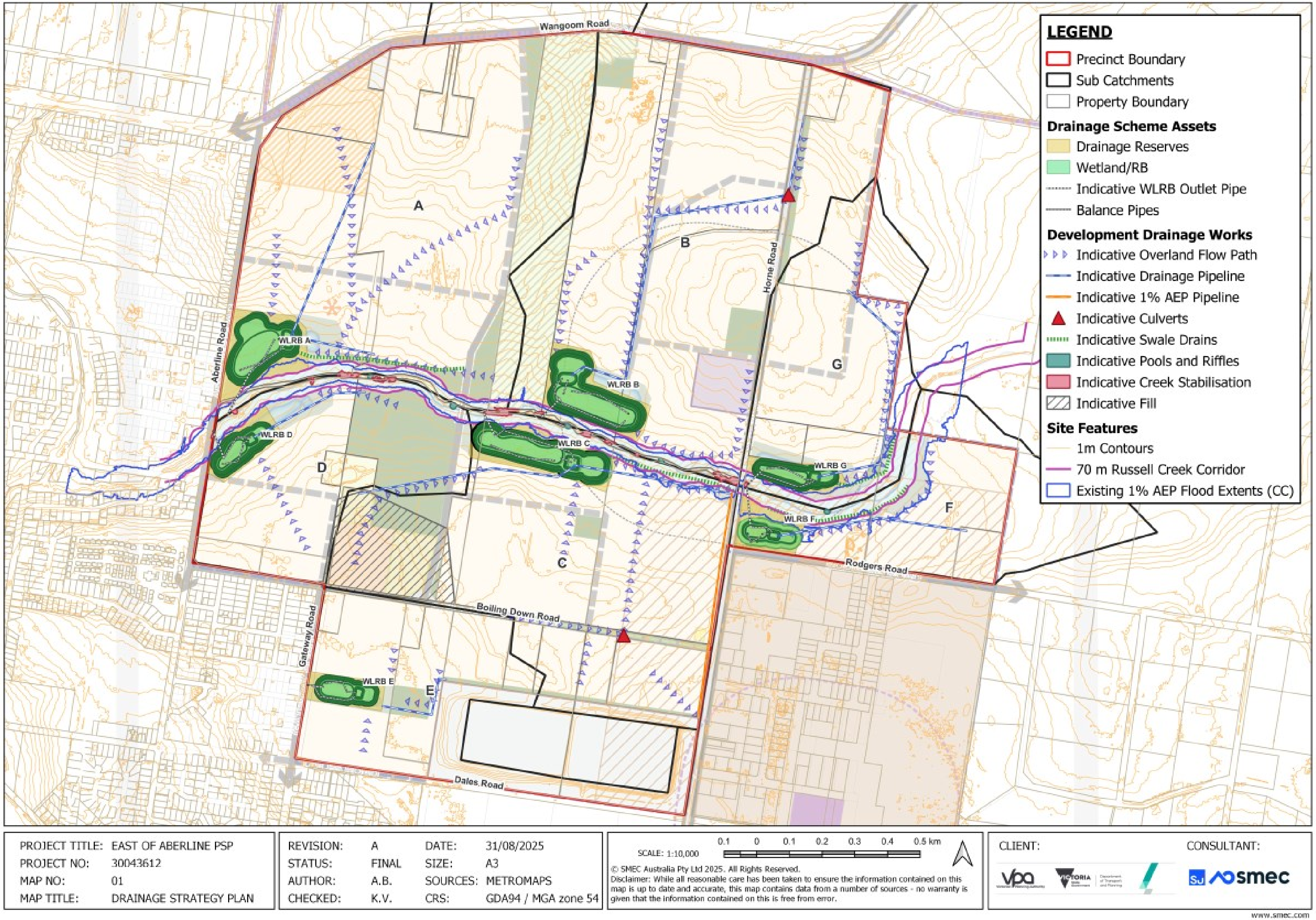

Figure 7-1 Proposed Stormwater Drainage Strategy

The proposed drainage strategy for each of the sub catchments are explained below:

7.2.1 Sub Catchment A

7.2.1.1 WLRB A

- One WLRB is proposed for sub-catchment A. This retarding basin is located north of the Russell Creek on the western boundary of the precinct. The retarding basin is sized to attenuate no more than the existing conditions peak flow at the same location. Once the flows have been attenuated, it is intended to convey this flow to the Russell Creek.
- WLRB A will provide stormwater treatment via combination of a wetland and a sediment basin before being discharged into the Russell Creek. Gross Pollutant Traps are included prior to the sediment basin.
- Runoff from majority of sub catchment A is proposed to be conveyed via drainage pipes into the sediment basin for primary treatment.
- It is known that Tozer Reserve is a key consideration for the precinct to support Grassy Eucalypt Woodland of the Victorian Volcanic Plain ecological community and Growling Grass Frog. As such no development is proposed for this parcel.
- Along the northern side of Russell Creek corridor and a future north south road within the catchment, an overland flow road and grassed swale are potentially required to convey the flows into the RB. Overland flow capacity assessment for sub catchment A is detailed in **Appendix B**.

Summary of the drainage and WSUD details within the sub catchment A is presented in **Table 7-1**.

Table 7-1 Sub Catchment A Drainage and WLRB Details

Asset ID	Upstream Catchment Area (ha)	Asset Type	Drainage Reserve (ha)	Description
WLRB A	114	Retarding Basin/Wetland	5.2	Located next to the Russell Creek

7.2.2 Sub Catchment B

7.2.2.1 WLRB B

- One WLRB is proposed for sub-catchment B. This asset is located in the central of the PSP area along the northside of Russell Creek corridor. The location has been selected based on the site's topography to minimise excavation and reduce the extent of cut batters. As a result of this optimisation, it was necessary for the WLRB to traverse a property boundary.
- WLRB B will provide stormwater treatment via combination of a wetland and a sediment basin before being discharged into the Russell Creek. Gross Pollutant Traps are included prior to the sediment basin.
- Runoff from majority of sub catchment B is proposed to be transferred via drainage pipes into the sediment basin for primary treatment. One sediment pond has been proposed at the location where the majority of catchment is flowing into. The catchment southeast of B will have to be piped towards the proposed sediment basin location or bypassed if it is not feasible to do so. This will be subject to detailed drainage design.
- Tozer Reserve is earmarked to remain as a conservation area for the Grassy Eucalypt Woodland and the GGF. As such no development is proposed within this area.
- A major culvert is required to cross Horne Rd to convey the north east catchment.
- Minor flows within this catchment will be piped underground to the WLRB B with proposed overland gap flows to be contained within the road reserves and directed to the retarding basin. Additional grassed swale is assessed to be required in the climate change condition. Overland flow capacity within the road reserves within sub catchment B is estimated in **Appendix B**.

Summary of the WSUD details within the sub catchment B is presented in **Table 7-2**.

Table 7-2 Sub Catchment B Drainage and WLRB Details

Asset ID	Upstream Catchment Area (ha)	Asset Type	Drainage Reserve (ha)	Description
WLRB B	98	Retarding Basin/Wetland	5.0	Located next to the Russell Creek

7.2.3 Sub Catchment C

7.2.3.1 WLRB C

- One WLRB is proposed for sub-catchment C. This retarding basin is located along the Russell Creek floodplain at the centre of the PSP area and south of the Russell Creek corridor.
- WLRB C will provide stormwater treatment via combination of a wetland and a sediment basin before being discharged into the Russell Creek. Gross Pollutant Traps are included prior to the sediment basin.
- A major culvert is required to cross Boiling Down Rd.
- Opportunities for irrigation of the Active Open Space (AOS) adjacent to the WLRB C has been investigated. The analysis suggest that stormwater harvesting from the treatment wetland with inclusion of a storage tank has the potential to reduce the reliance on potable water. Refer to Section 9.3.4.
- Minor flows will be piped underground to the WLRB C with proposed overland gap flows to be contained within the road reserves and directed to the retarding basins. An assessment of the typical capacity of the road reserve to carry the gap flows is presented in **Appendix B**. The assessment identified that a local access road has limited capacity for the gap flow and that a grassed swale is required to carry the excess gap flows. It is envisaged that the grassed swale can be located within the Russell Creek waterway corridor at this location. A conceptual sizing suggest a swale with top width of 11m is required. The details of the gap flow conveyance will be confirmed during the development design phase.
- Runoff from western parcels of sub catchment C (that are government school, carpark and part of the sports reserve) is proposed to discharge towards north along the border of sub catchments C and D and piped on the north-easterly direction to the sediment basin for primary treatment. This portion of the catchment naturally drains south, and it is proposed to divert this catchment towards north into WLRB C. For this to occur, some filling up to 0.5-1.0 m in depth is required. This catchment diversion eliminates any culverts required at Boiling Down Rd and suits the anticipated development staging based on current landownership. Warrnambool City Council supports this strategy based on stakeholder consultation. This will reduce the catchment area of E as a result. Refer **Figure 7-2** below.
- Runoff from parcels 39, 40 and part of 38 south of the Boiling Down Rd is proposed to be diverted north via a major culvert crossing Boiling Down Rd, through subdivisional areas towards the waterway corridor, and eventually west to WLRB C. This is while runoff from parcel 41 will be directed towards south east of the catchment boundary and captured by the proposed south-north 1050 mm diameter 1% AEP pipe (shown in orange in **Figure 7-2**) adjacent of Horne Rd and eventually flowed overland (road reserve and grassed swale) along the waterway corridor to the WLRB system. This pipe is intended to capture the PSP development area and is considered a DCP cost item. A separate pipeline currently caters for the existing industrial development east of Horne Rd to the south.

Summary of the WSUD details within the sub catchment C is presented in **Table 7-3**.

Table 7-3 Sub Catchment C Drainage and WLRB Details

Asset ID	Upstream Catchment Area (ha)	Asset Type	Drainage Reserve (ha)	Description
WLRB C	74	Retarding Basin/Wetland	5.2	Located next to the Russell Creek
C1	5.7	Pipeline	n/a	Q100 pipe to convey the small catchment naturally draining south east at the corner of the Water Storage

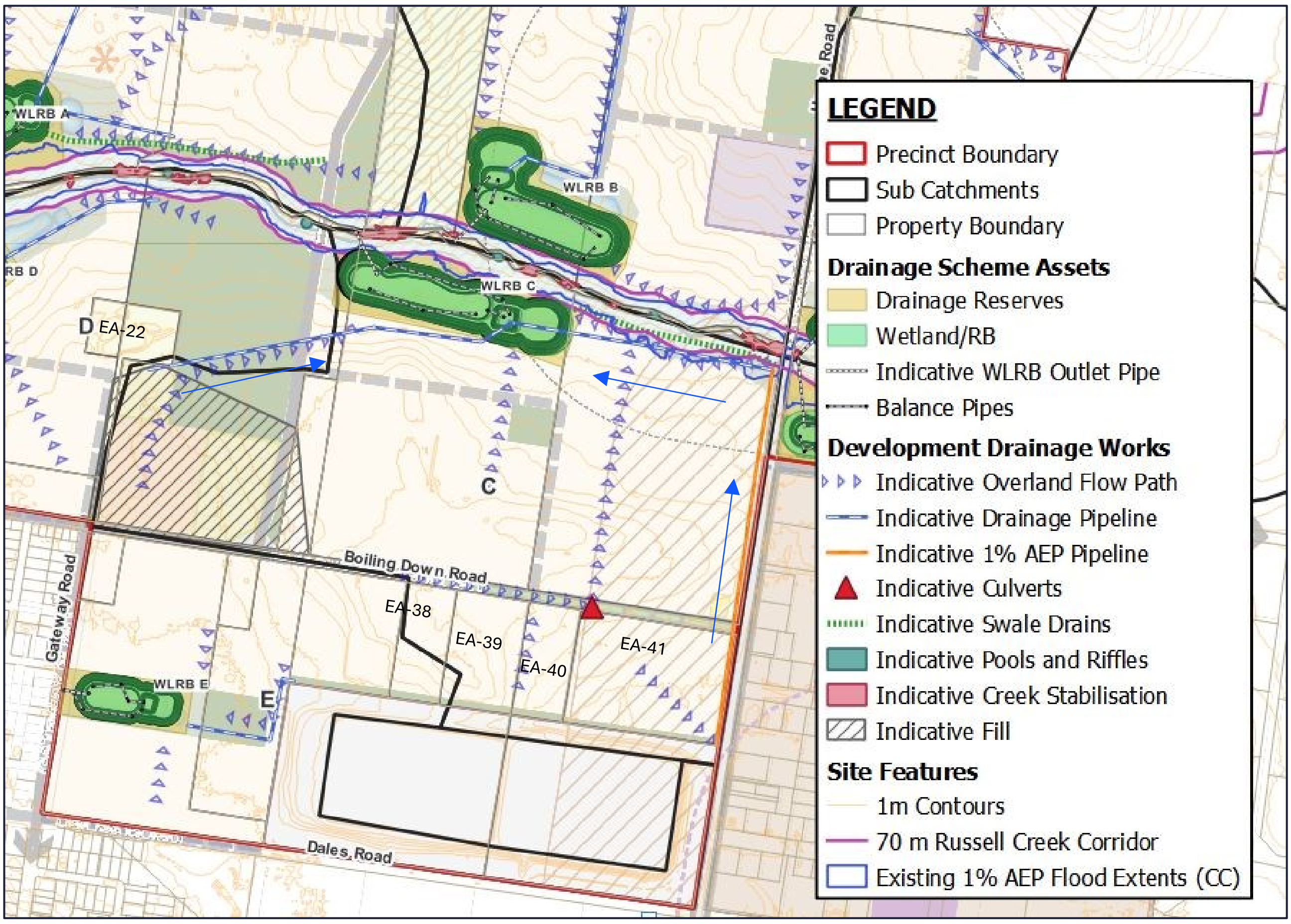

Figure 7-2 Sub Catchment C Runoff

7.2.4 Sub Catchment D

7.2.4.1 WLRB D

- One WLRB is proposed for sub-catchment D. This retarding basin is located south of the Russell Creek on the western boundary of the precinct.
- WLRB D will provide stormwater treatment via combination of a wetland and a sediment basin before being discharged into the Russell Creek and the Aberline Rd discharge point. Gross Pollutant Traps are included prior to the sediment basin.

- Parcel 22 is currently earmarked to remain as a conservation area for the Growling Grass Frog. No development is proposed for this parcel. As such, no drainage works are required to manage the existing runoff.
- Minor flows from residential areas will be piped underground to the WLRB E with proposed overland gap flows to be contained within the road reserves and directed to the retarding basins.

Summary of the WSUD details within the sub catchment D is presented in **Table 7-4**.

Table 7-4 Sub Catchment D Drainage and WLRB Details

Asset ID	Upstream Catchment Area (ha)	Asset Type	Drainage Reserve (ha)	Description
WLRB D	34	Retarding Basin/Wetland	2.6	Located next to the Russell Creek

7.2.5 Sub Catchment E

7.2.5.1 WLRB E

- One WLRB is proposed for sub-catchment E. This asset is located in the south of the PSP area with a separate discharge point at the Gateway Rd.
- WLRB E will provide stormwater treatment via combination of a wetland and a sediment basin before being discharged into the Russell Creek. Gross Pollutant Traps are included prior to the sediment basin.
- Minor flows from residential areas will be piped underground to the WLRB E with proposed overland gap flows to be contained within the road reserves and directed to the retarding basins. Summary of the WSUD details within the E catchment is presented in **Table 7-5**.

Table 7-5 Sub Catchment E Drainage and WLRB Details

Asset ID	Upstream Catchment Area (ha)	Asset Type	Drainage Reserve (ha)	Description
WLRB E	36	Retarding Basin/Wetland	2.0	Located in the south of the PSP area and discharged into the Gateway Rd

7.2.6 Sub Catchment F

7.2.6.1 WLRB F

- One WLRB is proposed for sub-catchment F. This asset is located south of the Russell Creek corridor and abutting Horne Road.
- WLRB F will provide stormwater treatment via combination of a wetland and a sediment basin before being discharged into the Russell Creek. Gross Pollutant Traps are included prior to the sediment basin.
- Minor flows will be piped underground to the WLRB F with proposed overland gap flows to be contained within the road reserves and potentially a grassed swale with a top width of 8.2 m in the climate change condition. Overland flow capacity within the road reserves within sub catchment F is estimated in **Appendix B**.
- There is currently some placed fill at the proposed location of the WLRB F. It is anticipated that this fill will be removed in the future as development occurs.

Summary of the WSUD details within the E catchment is presented in **Table 7-6**.

Table 7-6 Sub Catchment F Drainage and WLRB Details

Asset ID	Upstream Catchment Area (ha)	Asset Type	Drainage Reserve (ha)	Description
WLRB F	37	Retarding Basin/Wetland	2.5	Located next to the Russell Creek

7.2.7 Sub Catchment G

7.2.7.1 WLRB G

- One WLRB is proposed for sub-catchment E. This asset is located north of the Russell Creek corridor on the eastern boundary of the PSP area.
- WLRB C will provide stormwater treatment via combination of a wetland and a sediment basin before being discharged into the Russell Creek. Gross Pollutant Traps are included prior to the sediment basin.
- Minor flows will be piped underground to the WLRB G with proposed overland gap flows to be contained within the road reserves and potentially a grassed swale with a top width of 6 m in the climate change condition. Overland flow capacity within the road reserves within sub catchment G is estimated in **Appendix B**.

Summary of the WSUD details within the E catchment is presented in **Table 7-7**.

Table 7-7 Sub Catchment G Drainage and WLRB Details

Asset ID	Upstream Catchment Area (ha)	Asset Type	Drainage Reserve (ha)	Description
WLRB G	39	Retarding Basin/Wetland	2.2	Located next to the Russell Creek

7.3 Developed Condition

A developed condition catchment RORB models have been created for the entire PSP area to represent the increase in peak runoff resulting in increased impervious areas from the development. Subsequently, the retarding basin size and storage were determined to ensure the resulting outflow is no more than the existing conditions. This model encapsulates all the seven sub-catchments and the external catchments of the Russell Creek system. The extent of the developed conditions RORB models for the East of Aberline PSP area is shown in **Figure 7-3**.

Note that similar to existing condition, two RORB models have been generated: one for the catchments discharging into the Russell Creek and eventually to the Aberline Rd and one for Catchment E which is draining to the Gateway Rd to the south.

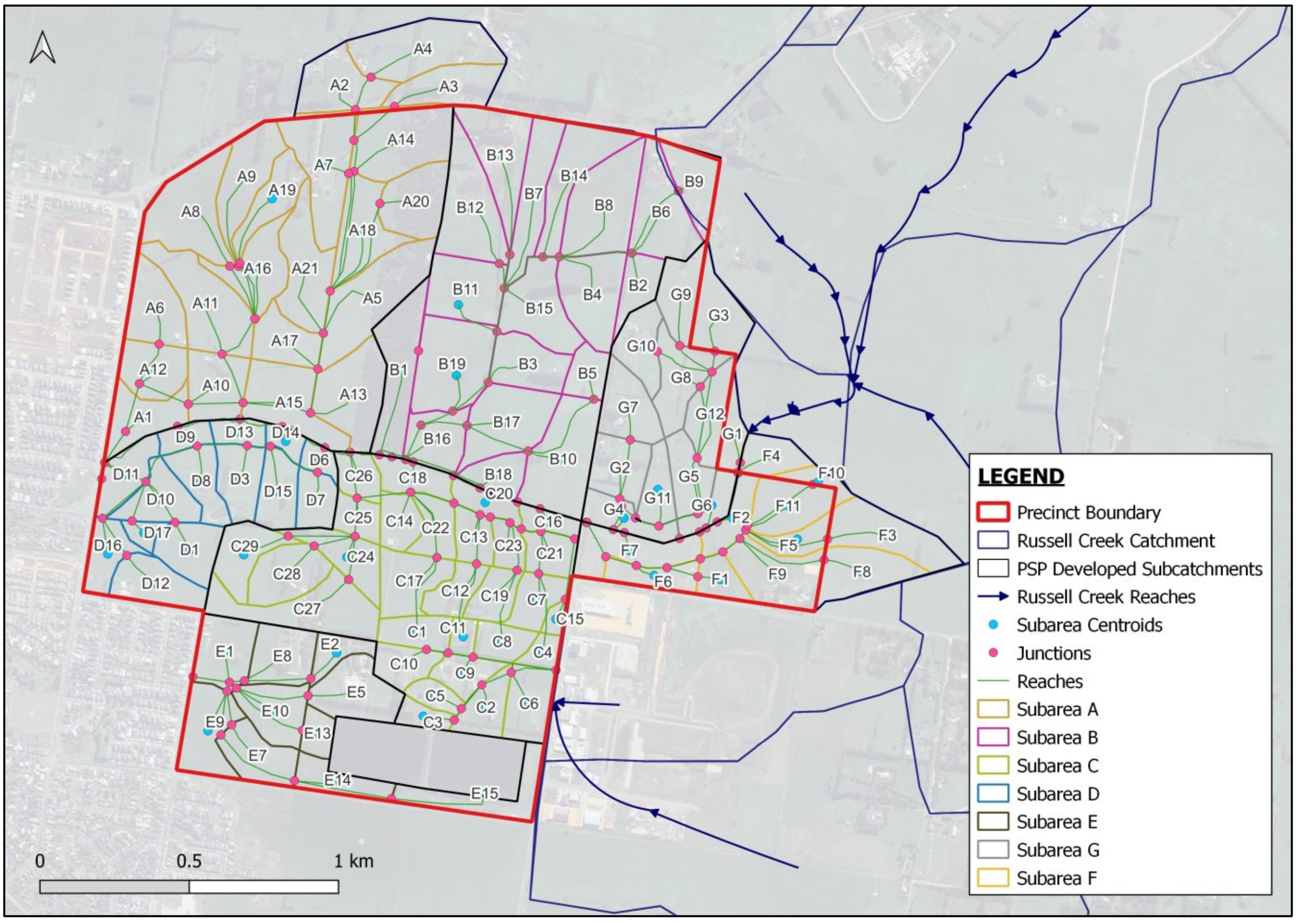

Figure 7-3 East of Aberline PSP Developed Condition RORB Model Setup

The RORB model was simulated for the 10% AEP and 1% AEP, and the peak inflows are outlined in **Table 7-8** and **Table 7-9**.

Table 7-8 10% AEP Developed Condition Inflow Estimates

Flow Estimate Location	Peak Inflow (m^3/s)	Critical Duration
Catchment A Interstation	4.5	1.5 hrs
Catchment B Interstation	4.2	2 hrs
Catchment C Interstation	4.0	45 mins
Catchment D Interstation	1.7	1.5 hrs
Catchment E Interstation	2.1	45 mins
Catchment F Interstation	1.5	30 mins
Catchment G Interstation	2.1	45 mins

Table 7-9 1% AEP Developed Condition Inflow Estimates

Flow Estimate Location	Peak Inflow (m^3/s)	Critical Duration
Catch A Interstation	9.5	45 mins
Catch B Interstation	8.5	1 hr
Catch C Interstation	7.9	25 mins
Catch D Interstation	3.3	20mins
Catch E Interstation	4.6	20 mins
Catch F Interstation	2.9	20 mins
Catch G Interstation	4.0	25 mins

A scenario where climate change factors are taken into consideration as per the AR&R guidelines (Ball et al., 2019) has been modelled. The inflows for the 10% AEP and 1% AEP events are shown in **Table 7-10** and **Table 7-11.**

Table 7-10 10% AEP Developed Inflow Estimates with Climate Change

Flow Estimate Location	Peak Inflow (m^3/s)	Critical Duration
Catch A Interstation	10.1	1 hr
Catch B Interstation	9.3	1 hr
Catch C Interstation	8.6	30 mins
Catch D Interstation	3.6	45 mins
Catch E Interstation	4.7	30 mins
Catch F Interstation	3.1	45 mins
Catch G Interstation	4.3	45 mins

Table 7-11 1% AEP Developed Inflow Estimates with Climate Change

Flow Estimate Location	Peak Inflow (m^3/s)	Critical Duration
Catch A Interstation	22.4	30 mins
Catch B Interstation	17.9	30 mins
Catch C Interstation	17.0	20 mins
Catch D Interstation	7.9	20 mins
Catch E Interstation	10.2	20 mins
Catch F Interstation	7.0	30 mins
Catch G Interstation	8.8	30 mins

The details of the developed conditions RORB modelling methodology and parameters are provided in **Appendix A**. The storage and retardation modelling outcomes are discussed in the following section.

7.4 Retarding Basin Sizing

The retarding basin (RB) areas were determined by initially adopting the area required for wetland and sediment basin (including access tracks) as the base area of the RB and utilising the depth above this space for the storage volume. The current locations of the WLRBs have been optimised based on the site inspection and site topography constraints. A 3d surface design (using a design software 12d) have been developed to optimise the cut and fill balance and account for batter slopes to determine a more accurate footprint for the functional design. A

1 in 5 safety batter slope has been assumed for the RB side profile to ensure safe access and maintenance requirements. Refer to **Appendix G** for functional design drawings.

The design footprints have been refined in this functional design report and are now smaller in comparison to the concept design footprints. The height, storage volume and outlet configuration (pipe and spillway) of the RBs were iterated in RORB until the critical peak outflow is less than the existing conditions. The RB sizing has been completed and assessed for the 1% AEP and 10% AEP with and without climate change uplifts.

The outcomes of the retarding basin (RB) sizing for each sub-catchment is summarised in **Table 7-12**.

Table 7-12 Retarding Basin Outcomes (1% AEP)

Asset ID	Existing Flow (m^3/s)	Inflow (m^3/s)	Outflow (m^3/s) and Duration	Peak Storage (m^3)	Outlet Configuration	Reserve Area (ha)
WLRB A	5.0	9.5	2.9 (3 hrs)	24,500	1 ∅ 1800 mm	5.2
WLRB B	3.8	8.5	1.8 (4.5 hrs)	27,000	1 ∅ 1200 mm	5.0
WLRB C	2.6	7.9	1.4 (4.5 hrs)	20,600	1 ∅ 1200 mm	5.2
WLRB D	3.7	3.3	1.3 (1.5 hrs)	4,930	2 ∅ 900 mm	2.6
WLRB E	3.8	4.6	1.4 (2 hrs)	7,470	1 ∅ 1200 mm	2.0
WLRB F	2.6	2.9	2.3 (45 mins)	1,820	1 ∅ 1200 mm	2.5
WLRB G	2.7	4.0	1.2 (1.5 hrs)	6,940	1 ∅ 1200 mm	2.2

The assessment was repeated for the climate change scenario as shown in **Table 7-13**.

Table 7-13 Retarding Basin Outcomes with Climate Change Impact (1% AEP)

Asset ID	Existing Flow (m^3/s)	Inflow (m^3/s)	Outflow (m^3/s) and Duration	Peak Storage (m^3)	Outlet Configuration	Reserve Area (ha)
WLRB A	12.8	22.4	6.0 (1.5 hrs)	42,000	1 ∅ 1800 mm	5.2
WLRB B	9.7	17.9	3.2 (4.5 hrs)	42,200	1 ∅ 1200 mm	5.0
WLRB C	6.8	17.0	2.5 (3 hrs)	32,600	1 ∅ 1200 mm	5.2
WLRB D	9.3	7.9	2.9 (1 hr)	9,080	2 ∅ 900 mm	2.6
WLRB E	9.5	10.2	2.9 (1.5 hr)	13,700	1 ∅ 1200 mm	2.0
WLRB F	6.7	7.0	5.5 (30 mins)	3,220	1 ∅ 1200 mm	2.5
WLRB G	7.0	8.8	2.5 (1 hr)	12,500	1 ∅ 1200 mm	2.2

The outcome of the analysis confirms the requirements to retard the flows back to existing conditions can be met by the retarding basins proposed for each sub catchment and the combination of these does not increase the peak flows along Russell Creek. The flows at Aberline Road are provided in **Appendix A.**

8. Stormwater Quality Analysis

The combined WLRBs were designed in accordance with Melbourne Water (2020) including sediment basins, wetlands, and dewatering areas components. Refer **Appendix C-1** for Water Quality Analysis and MUSIC modelling details and following section about sediment basins and wetlands sizing.

Figure 8-1 below shows the locations and names of the sediment basins and wetlands and the internal catchment that are flowing into these assets. These catchment areas have been used for water quality modelling. It is noted that external catchments are excluded in the contributing catchment area for treatment.

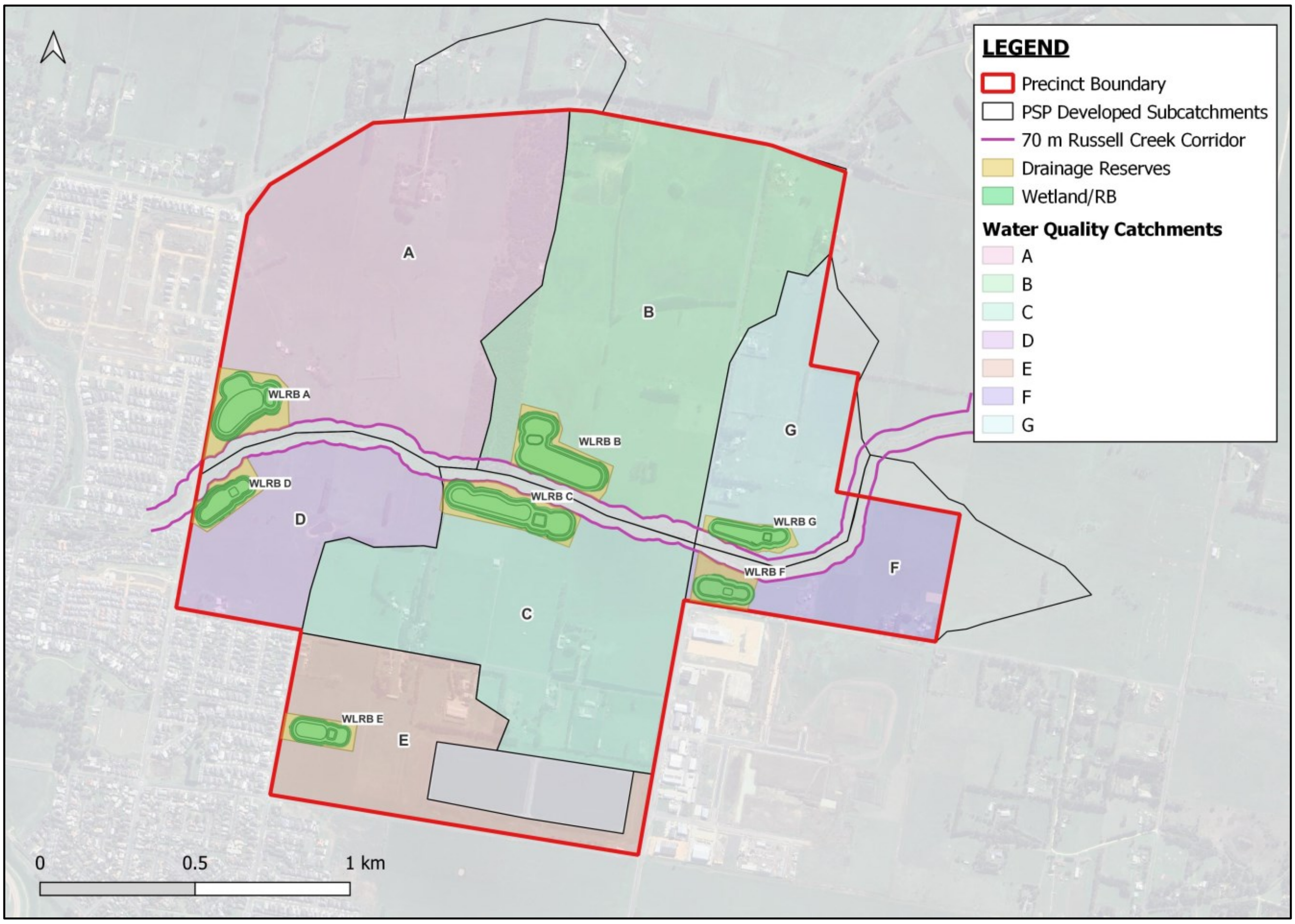

Figure 8-1 Layouts of the Wetlands and Sediment Basins

Tables below show the treatment effectiveness for each wetland.

Table 8-1 Wetland A Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	66,400	10,600	84.0
Total Phosphorus (TP)	142	41.9	70.5
Total Nitrogen (TN)	979	559	42.9
Gross Pollutants	16,600	0	100

Table 8-2 Wetland B Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	74,500	11,500	84.6
Total Phosphorus (TP)	161	45.9	71.6
Total Nitrogen (TN)	1,120	615	45.1
Gross Pollutants	18,700	0	100

Table 8-3 Wetland C Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	55,300	7,210	87.0
Total Phosphorus (TP)	121	31.6	73.8
Total Nitrogen (TN)	815	427	47.6
Gross Pollutants	13,900	0	100

Table 8-4 Wetland D Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	20,900	2,600	87.6
Total Phosphorus (TP)	46	11.9	74.1
Total Nitrogen (TN)	311	160	48.6
Gross Pollutants	5,520	0	100

Table 8-5 Wetland E Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	23,400	3,120	86.7
Total Phosphorus (TP)	50.2	13.3	73.6
Total Nitrogen (TN)	346	182	47.5
Gross Pollutants	5,880	0	100

Table 8-6 Wetland F Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	18,000	2,510	86.0
Total Phosphorus (TP)	35.2	10.4	70.5
Total Nitrogen (TN)	251	142	43.4
Gross Pollutants	4,280	0	100

Table 8-7 Wetland G Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	27,000	3,700	86.3
Total Phosphorus (TP)	52.8	14.9	71.8
Total Nitrogen (TN)	367	204	45.7
Gross Pollutants	6,350	0	100

8.1.1 Treatment Train Effectiveness

As per the MUSIC modelling results, the removal efficiency of proposed treatment nodes in the PSP area is shown in **Table 8-8**. The results demonstrates that BPEMG can be achieved by the proposed wetland and sediment basin assets for the entire PSP area.

Table 8-8 Reduction in Pollutant Loads

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	286,000	41,200	85.6
Total Phosphorus (TP)	609	170	72.1
Total Nitrogen (TN)	4,200	2,290	45.5
Gross Pollutants	71,200	0	100

8.2 Functional Design

The design refinement of the wetland and sediment basins are described below. The detailed modelling inputs, assumptions and results are further described in **Appendix C**.

8.2.1 Sediment Basins Design

The initial size of the sediment basins was estimated based on the Fair and Geyer equation to meet the guideline requirements of adequate sediment storage volume to store 5 years of sediment. The following sections outline the design principles and adopted parameters for functional design. Refer to **Appendix G** for design drawings.

8.2.1.1 Sediment Basins Geometry

According to Melbourne Water (2020), a batter slope of 1:5 should be adopted for the area between Normal Water Level (NWL) to Top of Extended Detention Depth (TEDD) and to the base of the retarding basin. A safety bench was designed with a batter slope of 1:8 to 350 mm below NWL. The batter of the sediment basins was extended with a 1:3 slope to the base of the sediment basins, 1.5 m below NWL.

8.2.1.2 Sediment Basins Sizing

The sediment basins were sized to ensure a minimum 95% capture efficiency for suspended solids is achieved at the design flow. The design flows (4EY) were estimated using RORB model. Two scenarios of the sediment basins being empty and full were considered and the minimum areas of the sediment basins at NWL that satisfy this requirement were adopted.

The procedure involves the use of the Fair and Geyer equation to size the sediment basins. The design sediment loading of 1.6 m^3/ha/year and gross pollutant loading rate of 0.4 m^3/ha/year were applied for developed conditions**. Table 8-9** details input parameters used for sizing the basins.

Table 8-9 Sediment Basins Design Parameters

Parameters	A	B	C	D	E	F	G
4EY Design Flow (m^3/s)	0.8	0.8	0.9	0.4	0.4	0.3	0.5
Surface Area at NWL (m2)	1,800	1,908	1,707	1,028	911	903	1,019
Extended Detention Depth (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Permanent Pool Volume (m^3)	1,800	1,908	1,707	1,028	911	903	1,019
Fraction of Solids Removed (%)	99	99	98	99	99	99	99
Sediment Storage Volume (m^3)	1,124	1,215	1,042	542	455	455	530
Drying Area (m^2) as per design	2,306	2,400	2,290	690	660	644	830
Normal Water Level (m AHD)	23.45	27.95	26.55	22.20	28.40	31.10	31.00
Extended Detention Depth (m AHD)	23.80	28.30	26.90	22.55	28.75	31.45	31.35

8.2.1.3 Sediment Basins Flow Velocity

The maximum flow velocity was checked for the 1% AEP flow rate directly entering the sediment basins from the upstream development. A flow depth was adopted based on the 10% AEP water level determined using RORB modelling. The method described in the Wetland Design Manual (Melbourne Water, 2020) was followed to calculate the flow velocity. Velocities were calculated for 1% AEP and smaller than the maximum velocity of 0.5 m/s proposed by Melbourne Water. See **Table 8-10** below for detailed calculations.

Table 8-10 Sediment Basins 1% AEP Flow Velocity Check

Parameters	SB A	SB B	SB C	SB D	SB E	SB F	SB G
10% AEP WSE (m AHD)	24.13	28.63	27.11	22.56	28.92	31.34	31.53
NWL (m AHD)	23.45	27.95	26.55	22.20	28.40	31.10	31.00
Flow Depth (m)	0.68	0.68	0.56	0.36	0.52	0.24	0.53
Min Width at NWL (m)	28	35	40	31	27	27	31
Min Width at 10% AEP (m)	48	51	57	51	41	53	40
Average Flow Width (m)	38	43	48.5	41	34	40	35.5
Flow Area (m^2)	25.84	29.24	27.16	14.76	17.68	9.6	18.81
1% AEP Flow (m^3/s)	9.5	8.4	7.9	3.4	4.5	2.8	4.0
1% AEP Flow Velocity (m/s)	0.37	0.29	0.29	0.23	0.25	0.29	0.21

8.2.1.4 Sediment Basins Maintenance

A 4 m minimum base width has been adopted to provide access to the sediment basins during the clean out maintenance period. The actual storage volumes of sediment basins were calculated from 12d from the base of the sediment ponds to 0.5 m below NWL, including the volumes that the access ramps add to the sediment basins. The storage volumes of the sediment basins are greater than the minimum required storages for a 5-year maintenance period, however the basins must be cleaned every 5 years. to meet the target requirement cleanout frequency.

Sediment dewatering areas have been sized for a placed depth of 500 mm. The sediment basins are to be hydraulically separated from the wetlands by a grated outlet set at NWL. This will allow for dewatering of the sediment basin without affecting the wetland macrophyte zones.

8.2.1.5 Sediment Basins Transfer Pipes to Wetlands

Flows are transferred from the sediment basins to wetlands via a pit and pipe connection. The top of the outlet pit will be located at sediment basin NWLs. A transfer pipe at the bottom of the pit will convey 4EY flows to the wetlands. This occurs when the water levels in the sediment basins are at TEDD and in the wetlands are at NWL. The sizes of transfer pipes between the sediment basins and wetlands are shown in **Table 8-11**. Detailed calculations of the pit and pipe connections sizing are presented in **Appendix C-2**.

Table 8-11 Sediment Basins to Wetlands Pipe Sizing

Parameter	RCP Pipe Diameter (mm)
Sediment Basin to Wetland A	825
Sediment Basin to Wetland B	825
Sediment Basin to Wetland C	825
Sediment Basin to Wetland D	600
Sediment Basin to Wetland E	600
Sediment Basin to Wetland F	525
Sediment Basin to Wetland G	600

8.2.2 Wetlands Design

The initial size of the wetlands was estimated based on the MUSIC model to meet best practice standards. The following sections outline the design principles and adopted parameters for functional design. Refer to **Appendix G** for design drawings.

8.2.2.1 Wetlands Geometry

A batter slope of 1V:5H should be adopted for the area between NWL to EDD and to the base of the retarding basin. The geometry of wetlands under NWL is similar to the sediment basins in inlet, intermediate and outlet pools. The internal pools were designed for the macrophyte zones. The inlet and outlet pools with 1.5 m depth below the macrophytes NWL were designed to receive water from the sediment basins and discharge the treated water to the end of the wetlands. The intermediate pool with a maximum depth of 1.2 m below NWL were designed at the middle of the western macrophyte zone to control the velocity of flow and distribute vegetation evenly.

For the purposes of the functional design drawings the wetland design bathymetry below NWL have not been designed at this stage. It is assumed it will follow the Wetland Design Manual (Melbourne Water, 2020).

8.2.2.2 Wetlands Sizing

The sizes of the wetlands were initially obtained from MUSIC model to ensure best practice water quality objectives have been met. **Appendix A-2** shows the snippet of the MUSIC model layout for the developed condition. Details of the wetlands are provided in **Table 8-12**.

Table 8-12 Wetlands Design Parameters

Parameters	WL A	WL B	WL C	WL D	WL E	WL F	WL G
Surface Area (m^2)	11,078	13,692	11,037	3,607	4,042	2,077	4,041
Extended Detention Depth (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Average Depth (m)	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Permanent Pool Volume (m^3)	2,973	3,369	2,837	1,302	1,207	1,005	1,326
Detention Time (hrs)	66	65	66	66	65	66	65
Normal Water Level (m AHD)	23.35	27.85	26.45	22.10	28.30	31.00	30.90
Extended Detention Depth (m AHD)	23.70	28.20	26.80	22.45	28.65	31.35	31.25

8.2.2.3 Wetlands Flow Velocity

The flow velocity during major events (1% AEP) is generally very low in the retarding basin as the basin is fully submerged in these events. Therefore, the maximum flow velocity was checked for the 1% AEP flow rate and the 4EY (3-month) flow rate directly entering the macrophyte zone from the upstream development.

A flow depth was adopted based on the 10% AEP water level determined using RORB modelling for the 1% AEP calculation and the EDD was adopted for the 4EY flow depth. The method described in the Melbourne Water Wetland Design Manual (2020) was followed to calculate the flow velocity.

Velocities were calculated for the 1% AEP and smaller than the targeted value of 0.5 m/s. 4EY velocities are either below or close to the targeted value of 0.05 m/s as per the guideline. The exact shape of the wetland will be subject to further design by others. It is expected that the width can be amended to meet the criteria. See **Table 8-13** and **Table 8-14** for detailed calculations of the 1% AEP and 4EY flow velocity checks.

Table 8-13 Wetlands 1% AEP Flow Velocity Check

Parameters	WL A	WL B	WL C	WL D	WL E	WL F	WL G
10% AEP WSE (m AHD)	24.13	28.63	27.11	22.56	28.92	31.34	31.53
NWL (m AHD)	23.35	27.85	26.45	22.10	28.30	31.00	30.90
Flow Depth (m)	0.78	0.78	0.66	0.46	0.62	0.34	0.63
Min Width at NWL (m)	38	43	35	20	38	30	16
Min Width at 10% AEP (m)	60	60	53	40	47	64	30
Average Flow Width (m)	49	51.5	44	30	42.5	47	23
Flow Area (m^2)	38.22	40.17	29.04	13.8	26.35	15.98	14.49
1% AEP Flow (m^3/s)	9.5	8.4	7.9	3.4	4.5	2.8	4.0
1% AEP Flow Velocity (m/s)	0.25	0.21	0.27	0.25	0.17	0.17	0.28

Table 8-14 Wetlands 4EY Flow Velocity Check

Parameters	WL A	WL B	WL C	WL D	WL E	WL F	WL G
EDD (m AHD)	23.70	28.20	26.80	22.45	28.65	31.35	31.25
NWL (m AHD)	23.35	27.85	26.45	22.10	28.30	31.00	30.90
Flow Depth (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Min Width at NWL (m)	38	43	35	20	38	30	16
Min Width at EDD (m)	41	46	38	23	41	33	19
Average Flow Width (m)	39.5	44.5	36.5	21.5	39.5	31.5	17.5
Flow Area (m^2)	13.82	15.57	12.77	7.52	13.82	11.02	6.12
4EY Flow (m^3/s)	0.9	0.8	0.9	0.4	0.4	0.3	0.5
4EY Flow Velocity (m/s)	0.06	0.05	0.07	0.05	0.03	0.03	0.08

8.2.2.4 Wetlands Detention Time and Inundation Frequency Analysis

An inundation frequency analysis was undertaken using the Melbourne Water Wetland Analysis Tool, incorporating daily flux data generated from the MUSIC model. The results indicate that for most plant species recommended by Melbourne Water, the frequency of inundation is below 20%. This suggests that the risk of plant drowning is minimal and within acceptable thresholds.

The average water depths were found to marginally exceed the 50th percentile, which may warrant further review during detailed design but is not expected to pose significant ecological or hydraulic concerns.

Wetlands are typically designed to achieve a 90th percentile detention time of 72 hours. However, the analysis shows that several wetlands achieves residence times closer to 48 hours, indicating that this design criterion is not met at this stage. It is important to note that the custom storage-discharge relationships for these wetlands have not yet been defined to a level consistent with detailed design. As such, it is anticipated that with refined bathymetry and outlet configuration in future design stages, the detention time criterion can be met. Refer **Appendix C-3** for the details.

9. Integrated Water Management Strategy

9.1 General

This section of the report describes the Integrated Water Management (IWM) water balance modelling completed for East of Aberline PSP. The intent of this IWM plan is to quantify the potential stormwater runoff volume that can be harvested and reused from the PSP development.

9.2 Roof Water Harvesting

The Spiire (2022) report investigated two scenarios with respect to harvesting: one incorporating roof water harvesting for the PSP residential areas and a scenario without it. The report concludes that incorporating roof water harvesting reduces the required size of wetland treatment areas needed to meet Best Practice stormwater quality targets.

SMEC further refined the water balance modelling based on the draft Place Based Plan and the outcomes were validated against the previous modelling.

As a result of the stakeholder engagement by the VPA with Wannon Water and Warrnambool City Council, it was decided that the PSP drainage strategy shall be formulated assuming no roof water harvesting are in place. This scenario results in larger wetland footprint areas.

Although the drainage strategy adopted for the East of Aberline PSP does not currently include roof water harvesting, the opportunity to implement the scheme in the future remains. Wannon Water and Warrnambool City Council may further investigate the scheme and, through future planning processes, consider requiring roof water harvesting as a condition of planning permits for new developments.

Other IWM initiatives that could be implemented include household raingardens, stormwater harvesting from wetlands to irrigate open spaces and passive irrigations of tree pits. The modelling of these features have not been quantified at this point but can be included in the functional design phase.

9.3 Adaptive Plan

SMEC recommends an alternative approach known as the 'Adaptive Plan' which involves installation of 2kL rainwater tanks in all residential dwellings as well as the provision of precinct-scale wetlands for stormwater harvesting for open space irrigation.

Additionally, Russell Creek corridor enhancement was identified to be a key recommendation of the IWM initiatives.

9.3.1 Water Demands

SMEC have used the latest Place Based Plan provided by VPA on 10th June 2025 to estimate the water demand within the PSP. The water demand calculation may subject to change if any changes made on this plan. To estimate the expected water demands for the PSP, the assumptions are outlined in **Table 9-1**. Note that there is no reference found in the supplementary guidelines and Wannon Water website to specify mandatory potable/non-potable water targets within the PSP. The water demand assumptions are based on the best judgment and typical figures reported in other projects.

Table 9-1 Water Demand Assumptions

Type	Water Demand	Unit
Residential Potable Water Demand	120	kL/hh/yr
Residential Non-Potable Water Demand (toilet flushing and garden irrigation)	40	kL/hh/yr
Active Open Space	5,000	kL/ha/yr
Passive Open Space	2,000	kL/ha/yr

The total water demand for residential lots and open spaces within PSP area has been estimated and is illustrated in **Figure 9-1**. The total water demand within the PSP area is estimated to be 3,447 kL/day (1,258 ML/year). The full list of analysis assumptions is provided in **Appendix D**.

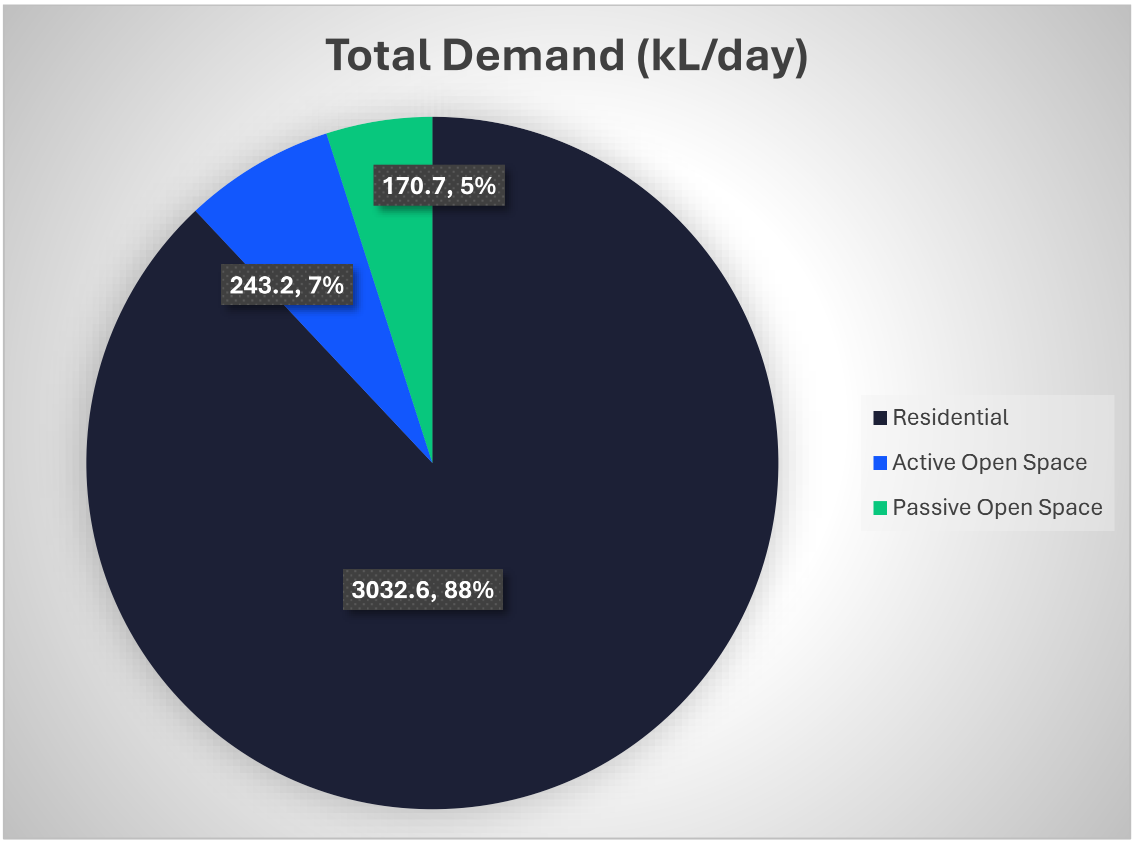

Figure 9-1 PSP Water Demand

9.3.2 Rainwater Harvesting

Rainwater can be collected from rooftops and directed into tanks for household use in meeting non-potable needs, such as toilet flushing, and outdoor irrigation. All new residential dwellings are proposed to install a minimum 2kL rainwater tank to help reduce dependence on potable water. A MUSIC model was developed to determine the magnitude of stormwater able to be generated and captured from residential roof areas within the PSP area. The snippet of the MUSIC model is shown in **Appendix D**. Additional information regarding assumptions and water demands are provided in the following sections.

9.3.2.1 Model Assumptions

The following assumptions have been made in setting up the MUSIC model.

- Impervious fraction values are taken from MW MUSIC Guidelines and estimated based on land use budget shapefile provided by VPA for the East of Aberline PSP.

- Rainwater is to be harvested only from residential roofs within the PSP area.
- 80% of the roof areas is assumed to be drained to a rainwater tank, and 20% would bypass.
- 2kL rainwater tanks are installed in every household, and that it will be reused for toilet flushing, and garden irrigation.
- Average number of people per household in East of Aberline area is 2.8 (ABS, 2021). This figure has been used for toilet flushing reuse demand calculations.
- Toilet flushing demand is assumed to be 20 L/person/day for residential lots.
- Irrigation reuse demand is assumed to be 2 ML/ha/yr for passive open spaces (residential gardens).

9.3.2.2 Reliance on Rainwater Harvesting

Water balance calculation shows that 34% of the non-potable water demand is supplied by a 2kL rainwater tank, operating with approximately 73% reliability.

9.3.3 Stormwater Harvesting from Wetlands

The objective of this approach is to harvest stormwater from wetlands for local open space irrigation purposes. The effectiveness of this measure to the volume reduction and infiltration targets is known to be much larger in comparison to smaller lot scale initiatives. The estimation of the stormwater runoff volume available from wetlands within the PSP area has been assessed when rainwater tanks are in place.

The water balance model (MUSIC) created to assist with sizing of the WSUD wetland treatment areas was utilised to estimate the stormwater runoff volume available from wetlands within the PSP area in the developed conditions.

9.3.3.1 Model assumptions

The following assumptions have been made in setting up the MUSIC model.

- The volume available for harvesting from wetlands is sensitive to the wetlands' configuration. It is assumed that only *excess flows* (bypass and weir overflow) can be harvested to ensure wetland planting is not compromised.
- Model calibration has not been employed in this assessment to validate the runoff volumes outcomes. It is judged likely that the runoff volumes produced by the model may not be accurate and further validation may be warranted should these proceed to design or cost benefit analysis study. For the purposes of this high-level assessment the model outcomes are considered appropriate.
- No storage has been included in the model. This would potentially overestimate the volumes being harvested.
- Water demand for each wetland system has not been determined at this stage.
- These assumptions can be refined once the functional design phase for each wetland has been completed.

9.3.3.2 Model Results

The stormwater runoff volume generated from the existing catchment and the increased runoff volume from the full development of the PSP area are shown in **Table 9-2**. This is a 289% increase from existing condition. The total volume of runoff that can be harvested from wetlands is estimated to be approximately 803 ML/yr which is 67% of the total runoff volume increase. This is above the target of 27% as per EPA (2021).

Table 9-2 Water Balance Model Results

Water Balance Metrics	Mean Annual Volume (ML/yr)
Existing Condition	629
Developed Condition	1,820
Increase in Runoff Volume	1,191
% Increase	289%
Stormwater Runoff available for Harvesting from Wetlands	803

The breakdown of the mean annual volume that can be extracted from each wetland is shown in **Table 9-3** below.

Table 9-3 Breakdown of Potential Harvested Runoff Volume from Wetlands

Wetlands	Mean Annual Volume Harvested (ML/yr)
A	208
B	182
C	135
D	68
E	98
F	49
G	63

9.3.4 Potential for Active Open Space Irrigation

There is an active open space (see **Figure 9-2**) within the PSP area that can be irrigated using the available runoff volume harvested from the adjacent wetlands, C and D. Results below show that there is an adequate amount of volume available from each of the wetlands to irrigate the adjacent active open space.

Percentage of harvested stormwater required for irrigation of the active open space is estimated as shown in **Table 9-4**.

Further evaluation of options will be required during the functional and detailed design phase to verify the water demand and storage needs. This will ensure that the harvested water can be appropriately stored for reuse and that the necessary infrastructure for transporting the water to support irrigation in the designated active open space, as outlined in the IWM plan, is properly planned.

Table 9-4 Harvested Stormwater required for Active Open Space Irrigation

Parameter	Value
Active Open Space Area (ha)	11.5
Total Irrigation Demand (ML/yr)	57
Available Harvested Stormwater (ML/yr) from Wetland C	135
% of Harvested Stormwater required for Irrigation from Wetland C	42%
Available Harvested Stormwater (ML/yr) from Wetland D	68
% of Harvested Stormwater required for Irrigation from Wetland D	84%

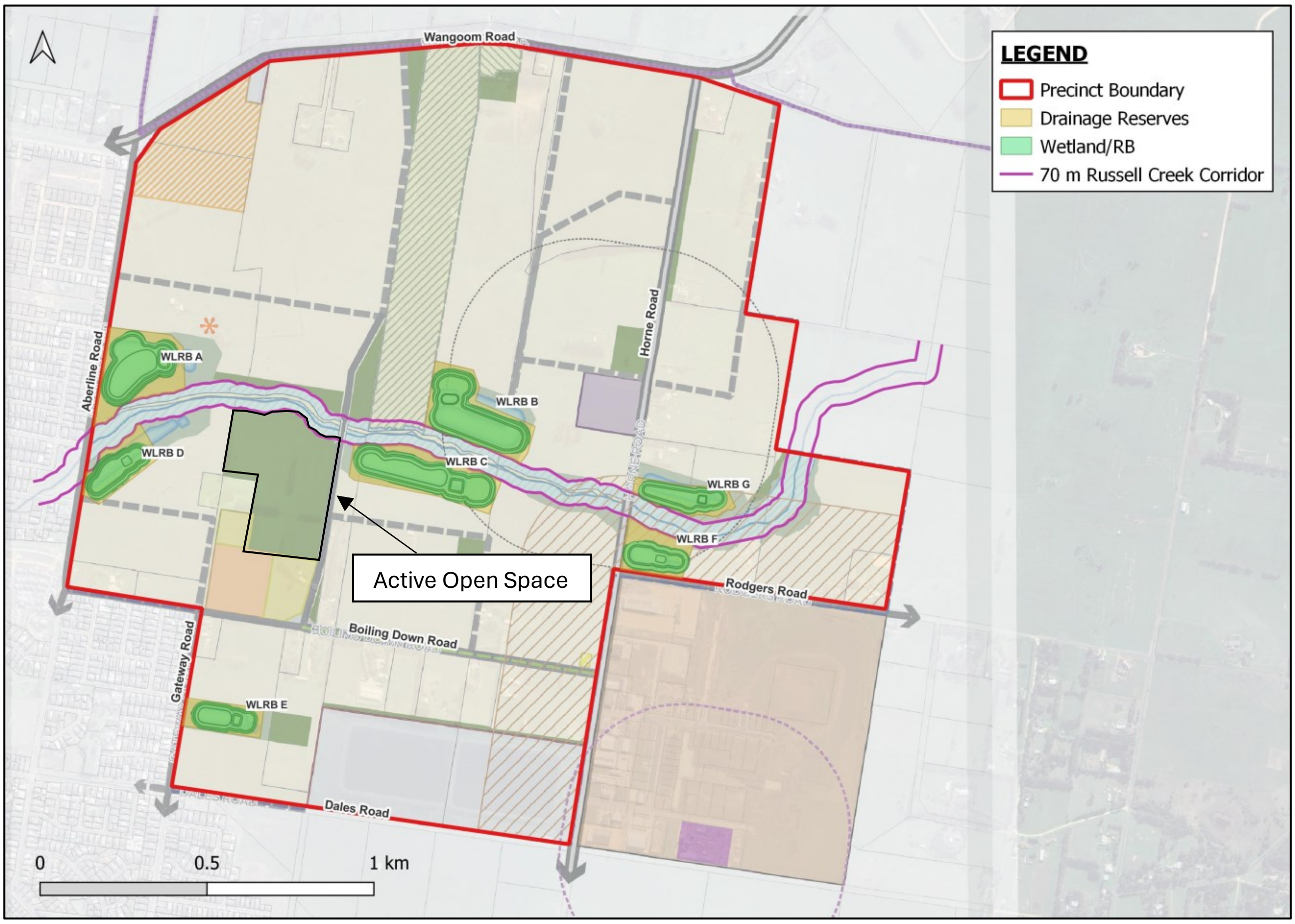

Figure 9-2 Location of the Active Open Space within the PSP area

10. Russell Creek Waterway

10.1 Corridor Width

As described previously, Russell Creek currently lacks a defined vegetated buffer and is surrounded by agricultural land, with existing corridor widths ranging from only 15 m to 27 m well below the minimum recommended in Victorian urban waterway guidelines.

The Warrnambool Planning Scheme (Clause 14.02-1S) specifies the following requirements to meet the various waterway objectives:

Retain natural drainage corridors with vegetated buffer zones at least 30 metres wide along each side of a waterway to:

- Maintain the natural drainage function, stream habitat and wildlife corridors and landscape values,
- Minimise erosion of stream banks and verges, and
- Reduce polluted surface runoff from adjacent land uses.
- Undertake measures to minimise the quantity and retard the flow of stormwater from developed areas.
- Require appropriate measures to filter sediment and wastes from stormwater prior to its discharge into waterways, including the preservation of floodplain or other land for wetlands and retention basins.
- Ensure that development at or near waterways provide for the protection and enhancement of the environmental qualities of waterways and their instream uses.

- Ensure land use and development minimises nutrient contributions to water bodies and the potential for the development of algal blooms.
- Require appropriate measures to restrict sediment discharges from construction sites.
- Ensure planning is coordinated with the activities of catchment management authorities.
- Ensure that water quality infrastructure is designed to minimise risk of harm to surface waters and groundwater.

Consistent with Glenelg Hopkins CMA requirements, and the strategic direction highlighted in previous studies (Spiire, 2020 and Engeny, 2018), the proposed 70 m corridor for Russell Creek is essential to meet both strategic planning goals and environmental protection standards. The corridor comprises a 30 m vegetated buffer zone on each side of the waterway, measured from the top of bank, with an additional 10 m allocated between the top of banks to accommodate the meandering centreline of the creek. This central zone supports hydraulic function during frequent flow events and allows for natural variability and future rehabilitation works.

In addition, active edges such as local roads are expected to be incorporated along the corridor to enhance accessibility, visibility, and integration with surrounding urban development. As outlined in Section 7.2 of the stormwater strategy, additional grassed swales are proposed adjacent to road reserves and within the corridor to convey gap flows under climate change scenarios. These features are consistent with the drainage corridor's objectives and reinforce the need for a wider corridor to accommodate multifunctional infrastructure.

10.2 Russell Creek Corridor Improvements

This report along with the previous IWM study has identified the risks of further erosion of Russell Creek under current conditions, a risk likely to be exacerbated by future conditions due to increased runoff volume, and increased frequency and duration from urban runoff despite a reduction in peak runoff rate during the 10% and 1% AEP flood event. To address this, it is recommended that sections of the Russell Creek waterway corridor is revitalise through stabilisation of the existing creek form, and the reintroduction of native vegetation and trees along the riparian zones.

Further studies such as hydro-ecological, geomorphological assessments, targeted flora and fauna survey will help identify and prioritise specific sections for enhancement. These items can be included in the DCP costs, as there is a clear nexus between the increased risk of creek deformation and future development within the PSP area, even though existing creek instabilities have already been caused by current land uses.

The responsibility of setting the requirements and acceptance of the proposed in stream works ultimately lies with GHCMA as the waterway authority. Consultation with the traditional owners are also recommended to achieve the best outcome.

10.2.1 Creek Stabilisation Extent

In the absence of detailed assessments, it is currently difficult to precisely define the extent of mitigation works required within Russell Creek. For the purposes of informing the PSP and making a reasonable allowance for the DCP, the extent of proposed works has been based on areas identified as having high shear stress from the hydraulic modelling outputs. Specifically, creek stabilisation works are proposed in locations where shear stress exceeds the threshold of 75 N/m^2. These areas are considered susceptible to stream erosion and require intervention to mitigate potential degradation and maintain hydraulic and ecological function. The nominal extent selected excluded any areas less than 100 square metres. A number of pools and riffles along the waterway have also been indicatively nominated to be included in the waterway works. Refer to the stormwater management strategy plan for the proposed locations.

10.3 Glenelg Hopkins CMA Requirements

As discussed with GHCMA, it is proposed that a flood related planning scheme control be included. Consistent with the *Guidelines for Development in Flood Affected Areas* (DELWP, 2019), a planning overlay is proposed to be applied in flood affected areas of the PSP specifically for the Russell Creek corridor. A Floodway Overlay (FO) is proposed to be used in the main watercourse. This zone is considered the most hazardous where the flood depth exceeds 0.5 m and the hazard criteria (depth x velocity product) equals or exceeds 0.4 m^2/s. These criteria are consistent with GHCMA principles and guidelines (GHCM, 2024). A LSIO planning control is proposed to be applied for the 1% AEP (with climate change) flood fringe (i.e. flood extent outside the Floodway Overlay). Refer to **Appendix F** for the proposed FO and LSIO overlay.

In addition, the following design requirements are applicable to the satisfaction of the responsible authority and/or GHCMA:

- GHCMA freeboard requirements for finished floor level of buildings to be set at least 300 millimetres above the 1% AEP (climate change), excluding garages, are met.
- GHCMA balanced cut and fill requirements to ensure lots are filled 300 millimetres above the applicable 1% AEP (climate change) flood level are met.
- GHCMA requirement for roads to be no lower than 300 millimetres below the 1%AEP (climate change) are met.

11. Flood Impact Assessment

11.1 Defining the Existing Conditions Extent

The proposed East of Aberline PSP boundary is located outside of the existing Flood Overlay (FO) and Land Subject to Inundation Overlay (LSIO) (VPA, 2025). **Figure 11-1** illustrated the location of the PSP boundary in relation to the existing FO and LSIO.

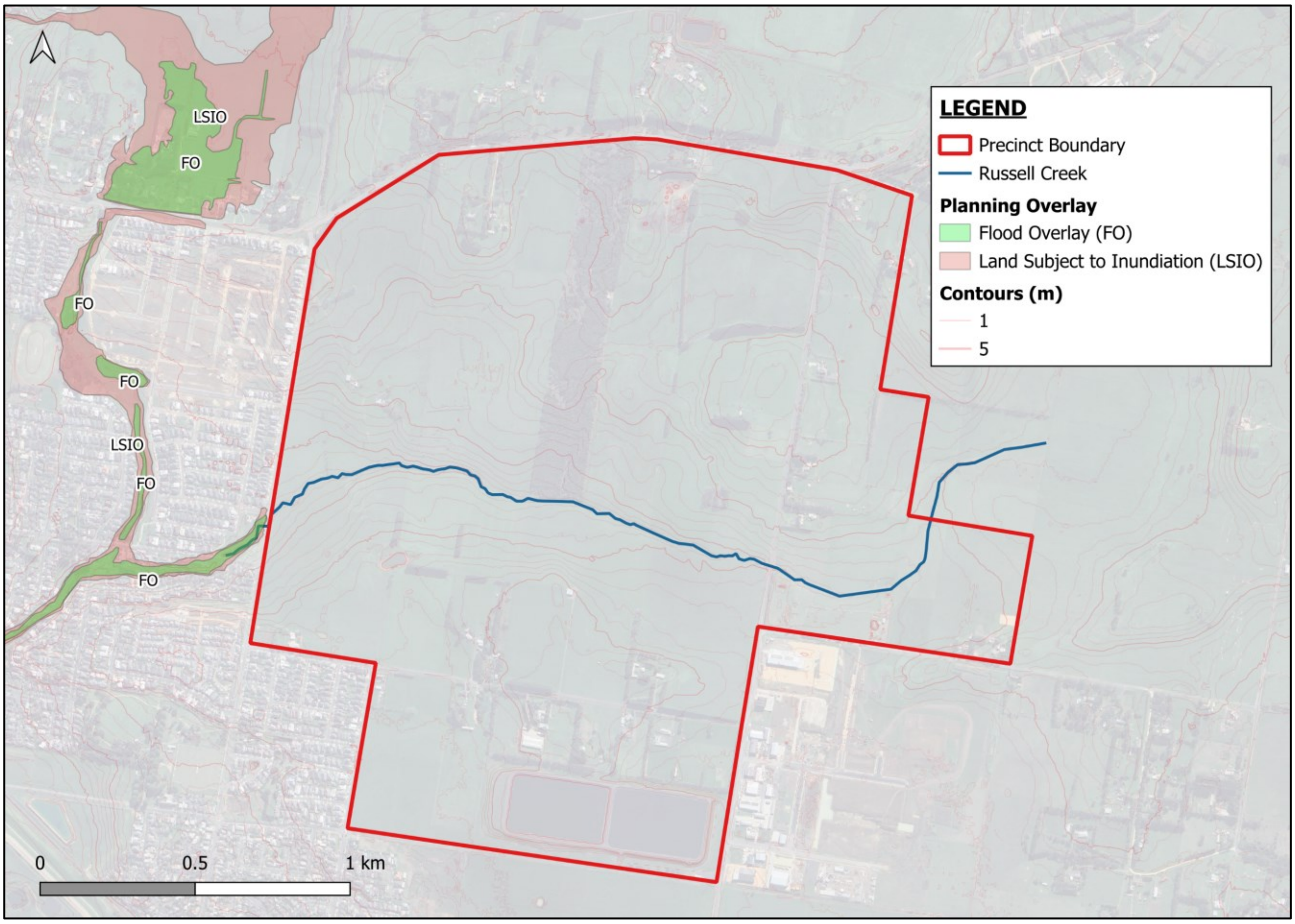

Figure 11-1 East of Aberline PSP and Russell Creek Flood Overlays

The flood extent defines the development exclusion zone, and an estimate of the updated zone is required to provide certainty for development planning purposes. Furthermore, defining the existing conditions base case is also necessary in order to assess the impact of the development conditions. The updated FO and LSIO based on flood modelling conducted in this report is provided in **Appendix F**.

11.1.1 Existing Conditions Flood Extent

SMEC was tasked with preparing a methodology to delineate the flood inundation extent of Russell Creek in advance of a more detailed future flood study to be completed at a later time. The methodology and outcomes were presented for in principal agreement to the Glenelg Hopkins Catchment Management Authority (GHCMA). The intent of the assessment is to define the existing conditions 1% AEP flood extent inclusive of climate change. The detail of this assessment is documented in a Technical Memo (30043612-181-TM-001) provided in **Appendix D**.

Subsequent to the existing conditions flood outcomes and development of the RORB models, the TUFLOW model was refined to be more accurate, and the methodology and outcomes are presented as below.

11.1.2 Methodology

11.1.2.1 Inputs

The preliminary flood model described in Spiire (2020) was supplied by the VPA, which were then modified by SMEC. These includes:

- Terrain (LiDAR) data (provided by VPA)
- Russell Creek – rainfall runoff model – RORB
- Russell Creek – 2d hydraulic model – TUFLOW
- RORB sub catchment and reaches in GIS format (shapefiles) (from Water Technology, 2017)

11.1.2.2 2024 Climate Change Consideration Update

Ball et al. (2019) defines the industry standard for completing design event rainfall runoff estimation and associated flood modelling. Subsequent to completion of the current flood study in 2013, Ball et al. (2019) has been updated in 2019 (Version 4.1) and more recently in September 2024 (Version 4.2). The updates incorporate changes to design rainfall and then, in 2024, changes to climate change impact estimation procedures.

For the purpose of the flood impact assessment, the existing conditions including climate change was simulated as it produces the critical and higher flood levels.

11.1.2.3 Limitations & Assumptions

- The model is limited to the main underground drainage on the west side of Gateway Road.
- The inflow hydrographs for each adjacent sub catchment were extracted from the RORB model and distributed at a few locations along Russell Creek and one external catchment inflow to represent the remaining upstream catchment of Russell Creek.
- The modelling does not include the flooding that may occur in the road reserves as overland flow paths since the development layout is not yet known.
- The model is limited to Russell Creek and the Gateway Road catchment to the south of Russell Creek.

11.1.3 Hydrology

The design rainfall and climate change conditions adopted for this assessment is consistent with the requirements of AR&R and GHCMA Flood Modelling Guidelines and Specifications (GHCMA, 2024). These are summarised in **Table 11-1**.

Table 11-1 Rainfall Depth and Climate Change Uplift factor

Scenario	Scenario Description	Design Rainfall Depth Source	Adopted Time Horizon	Global Climate Condition	Design Rainfall Depth Uplift Factor
Existing and Developed Conditions	Latest Climate Change Consideration	BoM IFD 2016 w/ uplift as per Ball et al. (2019)	2100	SSP8.5 4.5 degrees °C increase	1.47 to 1.86[1]

1. Uplift factor varies with storm duration

The future climate change scenario is based on an increase in global temperature of 4.5 °C in the year 2100 horizon. The climate change uplift factors vary depending on the storm duration and AEP. A summary table of the uplift factors applicable to the site location is illustrated in **Table 11-2**. Detailed climate change factors are included in **Appendix A-2**.

Table 11-2 Data hub Climate Change Consideration Uplift Factors (AR&R v4.2, 2019)

SSP5-8.5

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	**1.2**	**1.18**	**1.17**	**1.16**	**1.14**	**1.13**	**1.13**	**1.12**	**1.11**	**1.11**
2040	1.26	1.24	1.22	1.2	1.18	1.17	1.16	1.15	1.14	1.14
2050	**1.34**	**1.31**	**1.29**	**1.26**	**1.24**	**1.23**	**1.21**	**1.2**	**1.18**	**1.18**
2060	1.42	1.38	1.35	1.32	1.29	1.28	1.26	1.24	1.22	1.21
2070	1.52	1.47	1.43	1.4	1.36	1.34	1.31	1.29	1.27	1.26
2080	1.63	1.57	1.52	1.48	1.43	1.4	1.37	1.35	1.33	1.31
2090	**1.77**	**1.69**	**1.64**	**1.58**	**1.52**	**1.49**	**1.45**	**1.42**	**1.39**	**1.37**
2100	1.86	1.77	1.71	1.64	1.58	1.54	1.5	1.47	1.43	1.41

The RORB (Laurenson et al., 2010) model sub area and reaches and parameters (delay and losses) are described **Appendix A** of this report. A summary of the model parameters is shown in **Table 11-3**.

Table 11-3 RORB Model Parameters

Parameter	Value
Delay (k_c)[1]	5.71
Non-linearity (m)	0.80
Initial Loss (mm)	23.80
Continuing Loss (mm/hr)	6.62

1. The primary delay adopted. k_c was adjusted for smaller sub catchment using interstations.

11.1.3.1 Outcomes

The 1% AEP and 10% AEP peak flows were estimated at Russell Creek upstream of the PSP area (US EXT) and at the catchment outlet at Aberline Road are summarised in Error! Reference source not found..

Table 11-4 Existing Conditions Design Flows

Scenario	Existing Conditions Peak Flows (m3/s)	
	Upstream inflow (US EXT) (Duration)	Outlet at Aberline Road (Duration)
1% AEP	58.2 (4.5hr)	79.9 (1.5hr)
10% AEP	19.7 (1.5hr)	27.3 (1.5hr)

The RORB catchment model setup and locations of the reported peak flows are shown in **Figure 11-12**.

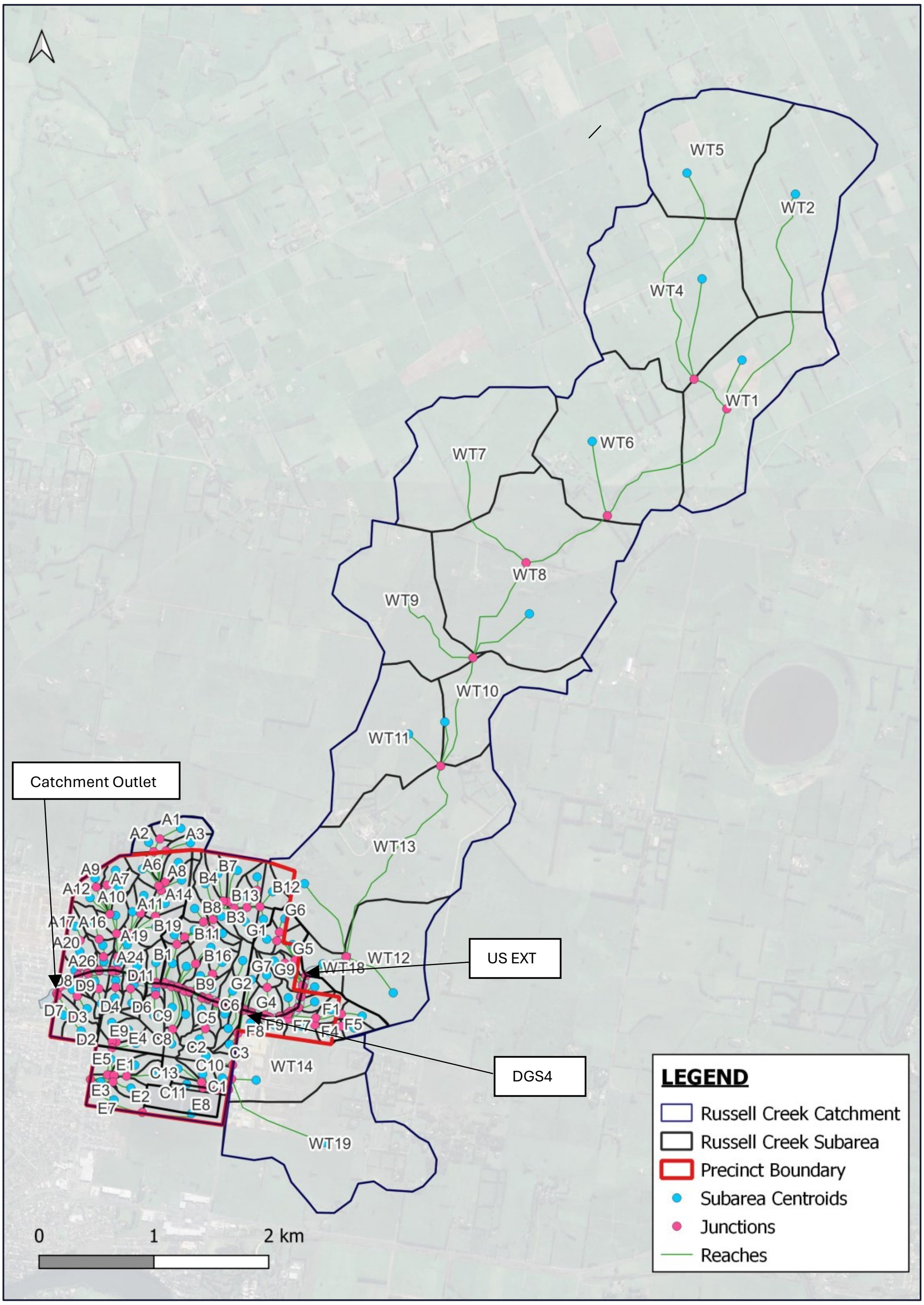

Figure 11-2 RORB Catchment Model

A range of storm durations and corresponding critical temporal pattern were selected for hydraulic simulation based on the peak flows at key locations including at each sub-catchment interstation, outlet at Aberline Rd, upstream inflow location outside of the PSP boundary (US EXT), and the external inflow from sub catchments WT14 and WT19 (DGS4).

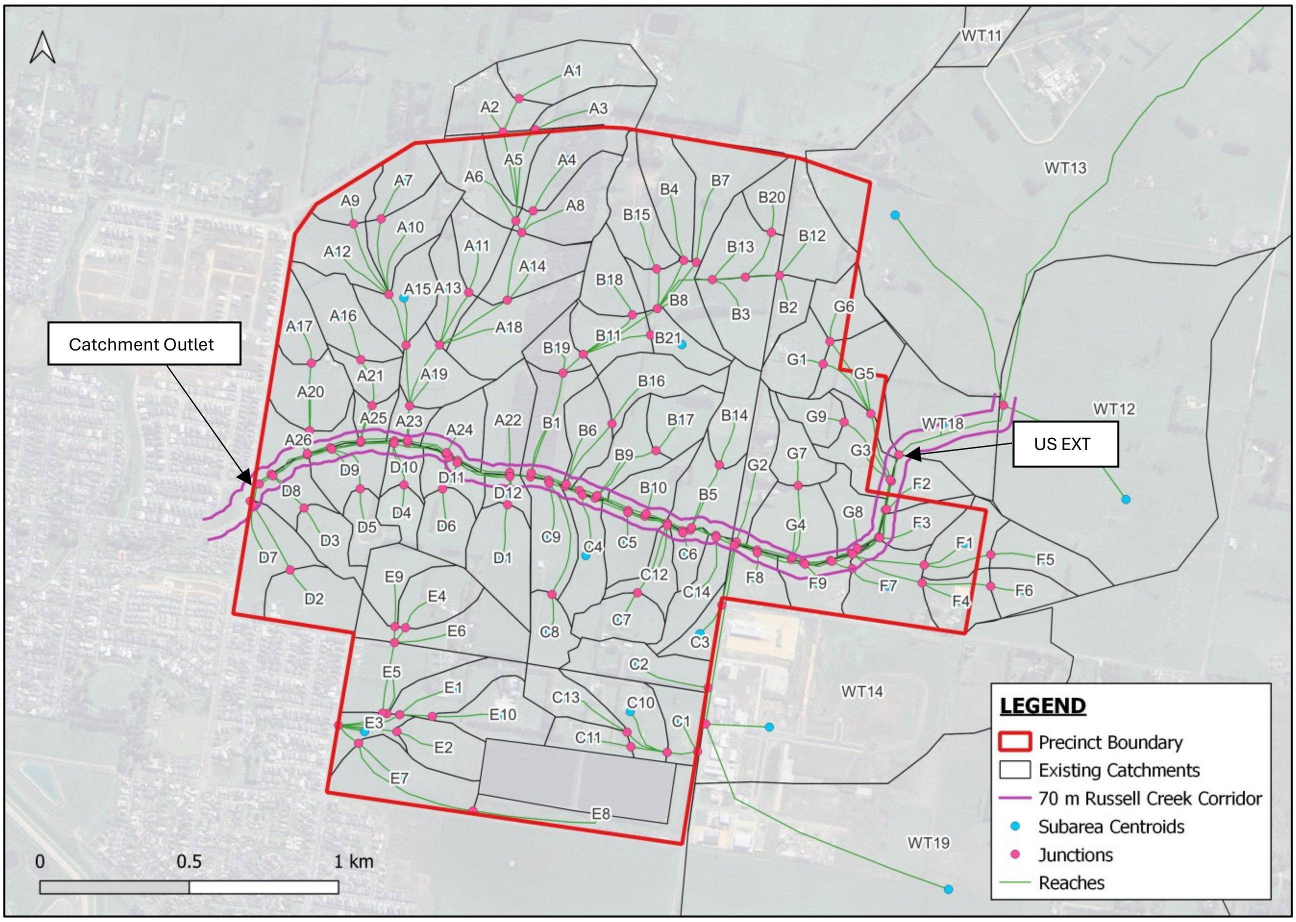

Figure 11-3 RORB Catchment model within the PSP boundary – Existing Condition

Error! Reference source not found. and Error! Reference source not found. outlines the storm events selected for the hydraulic simulation based on the RORB model critical events.

Table 11-5 Hydraulic Simulation Storm Events (1% AEP)

Storm Duration	Temporal Pattern
45 mins	TP22
	TP26
1 hr	TP27
1.5 hr	TP27
	TP29
4.5 hr	TP26
3 hr	TP28

Table 11-6 Hydraulic Simulation Storm Events (10% AEP)

Storm Duration	Temporal Pattern
5 hr	TP13
	TP15
	TP16
	TP18
3 hr	TP15
	TP17

11.1.4 Hydraulic Modelling

A 2d hydraulic model (TUFLOW) was setup to determine the maximum flood extents from various storm events for the 1% AEP and 10% AEP. The TUFLOW model was setup and ran as follows:

- Inflow hydrograph at the upstream end of the model domain and a number of adjacent catchment inflows
- Outflow boundary condition based on longitudinal slope.
- 2 m grid size based on 2017 LiDAR of 1 m resolution.
- HPC computation scheme with sub-grid-sampling (SGS) enabled.
- Roughness definition (materials file) were maintained as per the original model.
- Model extent is limited to the Russell Creek reach and a few hundred meters upstream and downstream of the PSP boundary (including downstream of Gateway Road).
- The inflow hydrograph to the hydraulic model was extracted from the hydrologic model at a location shown in Error! Reference source not found..
- Major culvert structures at road crossings that intersect Russell Creek, namely, Horne Road, Aberline Rd, and Whites Road, have been included in the TUFLOW model as layered flow constrictions.
- A network of 1d pits and pipes downstream of Gateway Road has been modelled as the outlet of subarea E.

The TUFLOW model domain is shown in **Figure 11-4**.

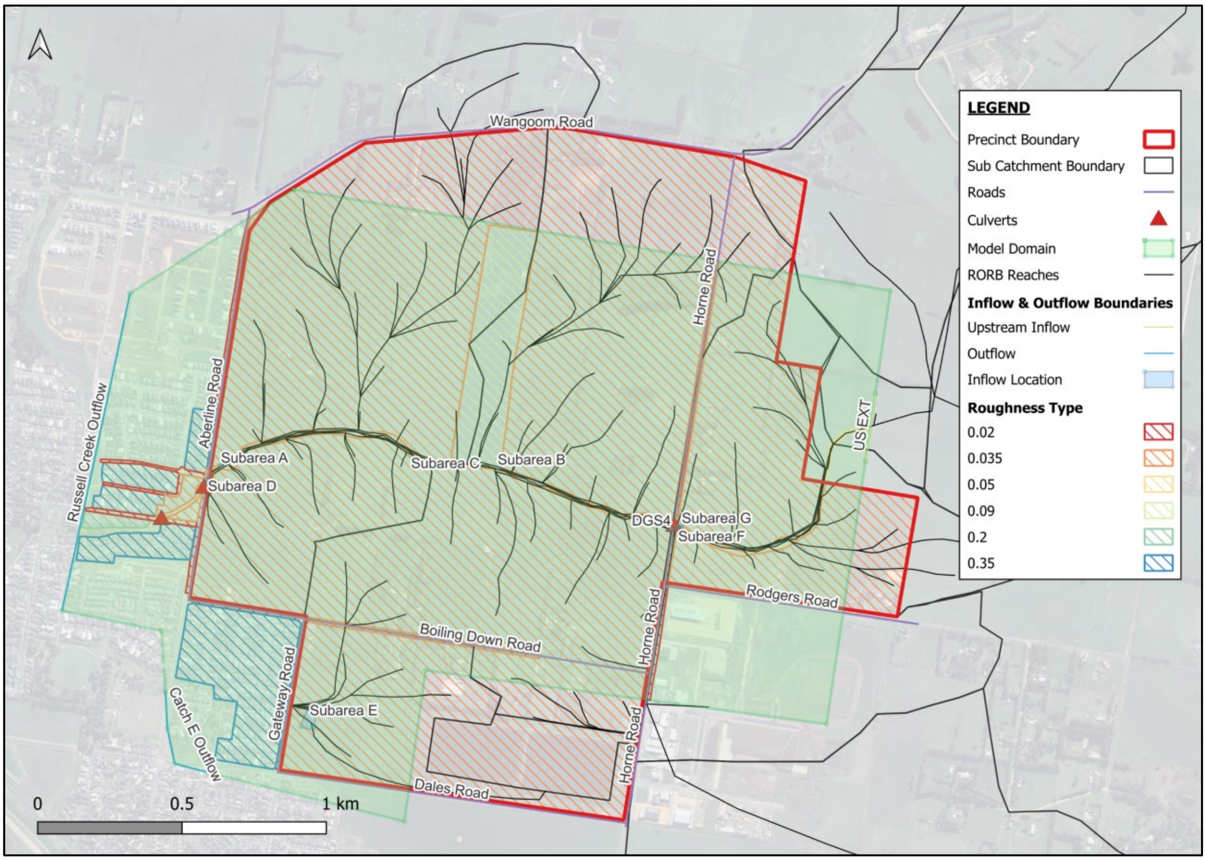

Figure 11-4 TUFLOW Model Setup Existing Conditions

11.1.5 Existing Conditions Extent Results

The results of the various storm events were combined to create the maximum flood extent. The 1% AEP and 10% AEP flood extent of the existing conditions scenarios are provided in Error! Reference source not found. and **Figure 11-6** respectively (included in **Appendix F**).

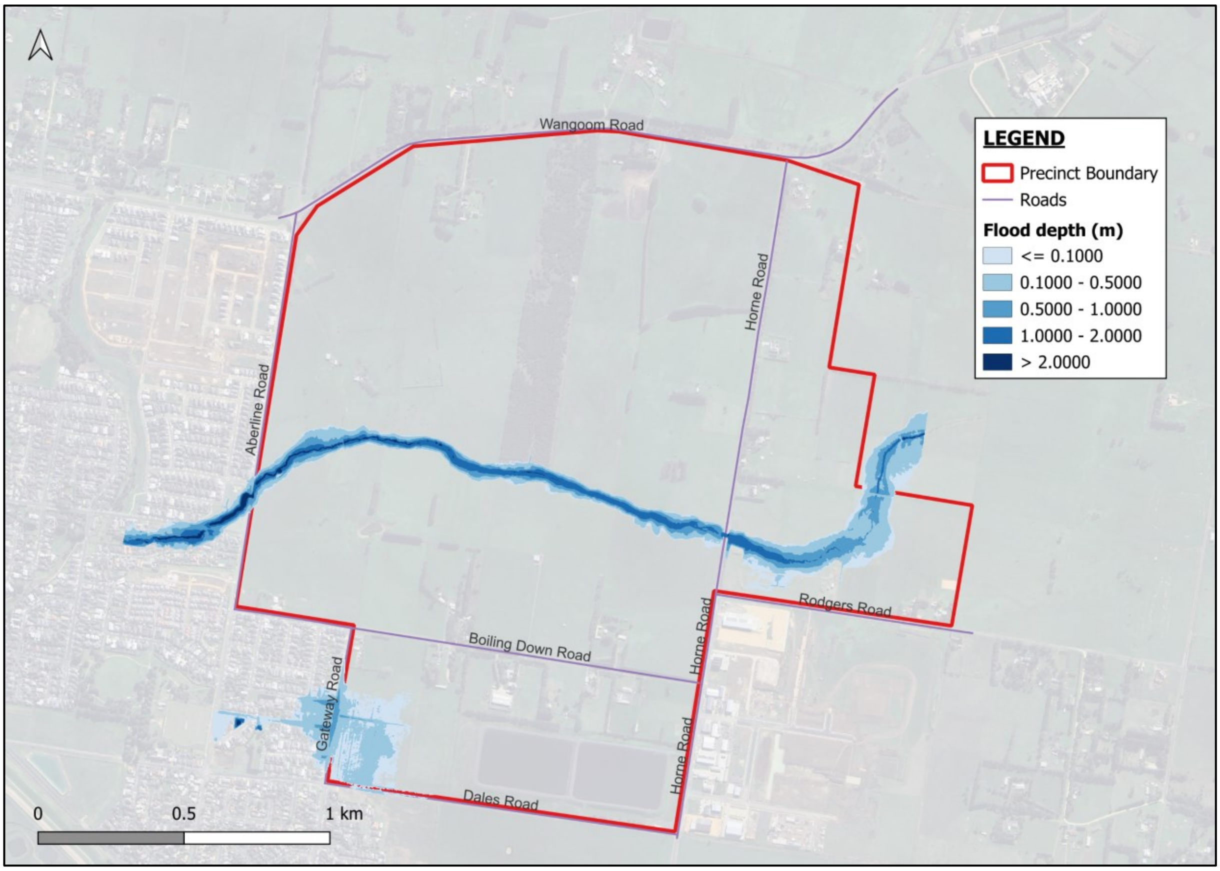

Figure 11-5 Existing Condition Flood Depth– 1% AEP

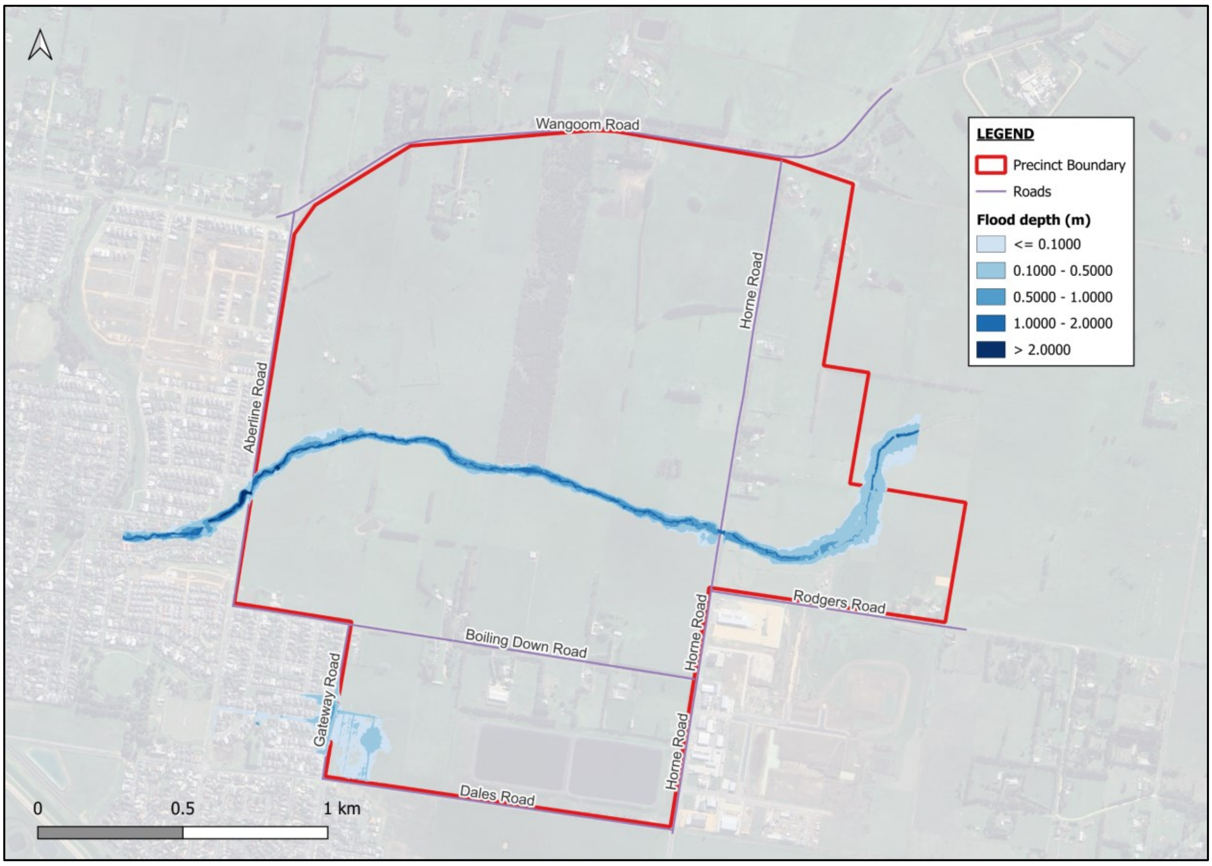

Figure 11-6 Existing Condition Flood Depth – 10% AEP

The outcomes of the existing conditions flood depth and extents are significantly greater that those documented in Spiire (2020) and Water Technology (2017), primarily attributed to the revised guidance on climate change modelling. Note that significant flooding occurs within the Russell Creek corridor east of Horne Rd and within the vicinity of Gateway Road.

11.2 Developed Conditions

The aim of the hydraulic model for the developed conditions is to assess the performance of the retarding basins in lowering the flooding impact due to future development within the PSP boundary. In order to perform this assessment, the hydraulic model from the existing conditions was modified to conform with the changes linked to the development conditions as explained in **Section 11.2.1.**

11.2.1 Methodology

11.2.1.1 Inputs

The hydraulic model for the developed conditions is modified from the existing conditions by including the following additional inputs:

- Developed conditions RB inflow hydrograph - RORB
- Retarding Basins surface design tin from 12d

11.2.1.2 2024 Climate Change Consideration Update

The climate change consideration adopted for the developed conditions is identical to the existing conditions (**Section** Error! Reference source not found.).

11.2.1.3 Limitations & Assumptions

Limitations and assumptions presented in the existing conditions (**Section 11.1.2.3)** remains the same for the developed conditions, with the addition of the following:

- The model does not include the spillways and the internal pits and pipes of the retarding basins.
- The model's roughness coefficient of the developed conditions is similar to the existing conditions with the exception of adding the retarding basin's (i.e. clay layer) roughness coefficient.
- The GHCMA has advised SMEC that an approx. 1 ha illegal fill exists within the current terrain, located east of Horne Rd between RB F and RB G. As such, SMEC has assumed that the illegal fill will be removed in the developed conditions and has made changes to the topography in the model.
- A new bridge crossing is planned for the PSP located on the west side of Tozer reserve. This structure has not been included in the hydraulic assessment. It is anticipated that the bridge will be designed to minimise hydraulic changes to Russell Creek.

11.2.2 Hydrology

The design rainfall, climate change conditions, and the RORB model parameters adopted for the developed conditions is identical to the existing conditions (see Error! Reference source not found. and Error! Reference source not found.). The detailed RORB model for the developed conditions including the model sub area is illustrated in **Figure 11-7** and **Appendix A** of this report.

11.2.2.1 Outcomes

The 1% AEP and 10% AEP peak flows were estimated at Russell Creek upstream of the PSP area (US DEV) and at the catchment outlet are summarised in **Table 11-7**.

Table 11-7 Developed Conditions Design Flows

Scenario	Developed Conditions Peak Flows (m^3/s)	
	Upstream inflow (US DEV) (Duration)	Outlet at Aberline Road (Duration)
1% AEP	57.7 (4.5hr)	75.4 (1.5hr)
10% AEP	19.4 (1.5hr)	27.6 (3hr)

The developed conditions RORB catchment model setup and locations of the reported peak flows are shown in **Figure 11-7**.

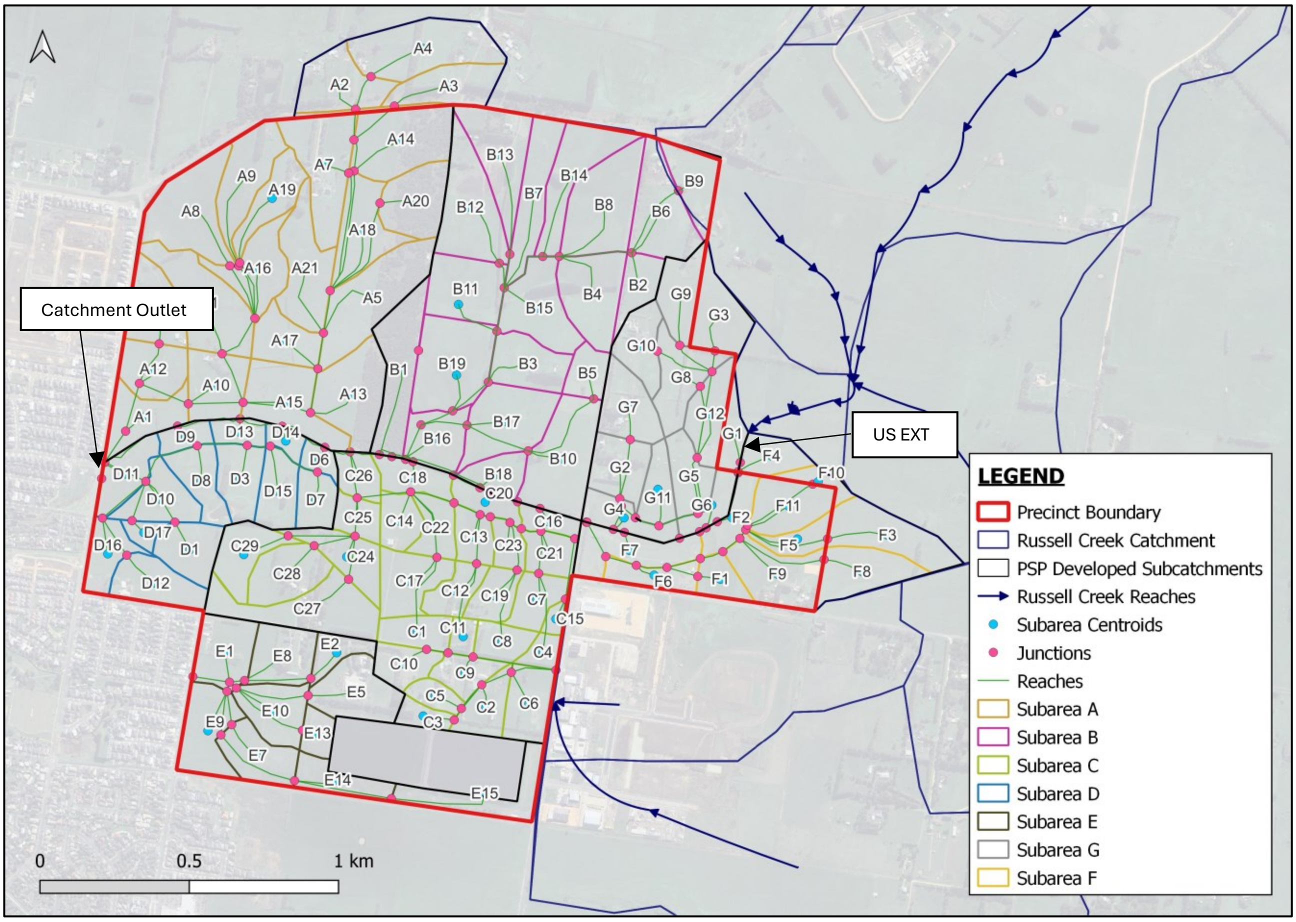

Figure 11-7 RORB Catchment model within the PSP boundary – Developed Condition

The storm events selected for the developed conditions hydraulic model are identical to the existing conditions (see **Table 11-5** and **Table 11-6).**

11.2.3 Hydraulic Modelling

A 2d hydraulic model (TUFLOW) was setup to determine the maximum flood extents from various storm events for the 1% AEP and 10% AEP. The TUFLOW model was setup and ran as follows:

- Inflow hydrograph at the upstream end of the model domain and a number of adjacent catchment inflows
- Outflow boundary condition based on longitudinal slope.
- 2 m grid size based on 2017 LiDAR of 1m resolution and Retarding Basins dimensions of 0.5 m resolution.
- HPC computation scheme with sub-grid-sampling (SGS) enabled.

- Roughness definition (materials file) were maintained as per the existing condition (except for the addition of the retarding basins' roughness coefficient).
- Model extent is the same as the existing conditions model domain.
- The inflow hydrograph to the hydraulic model was extracted from the hydrologic model at locations within the retarding basins as shown in **Figure 11-8**. Specifically, the RB storage inflows points were simulated in the model.
- Major culvert structures remains the same as existing conditions.
- A network of 1d pits and pipes downstream of Gateway Road has been modelled as the outlet of subarea E.
- Modifications to the topography include:
  - Included Retarding Basins into the model as can be seen in **Figure 11-8**.
  - Removed the illegal fill within the Catchment F boundary as per **Section 11.2.1.3.**
- A set of 1d outflow pipes have been modelled for each of the retarding basins as the main outlet of the retarding basins. The pipes are based on the RORB model pipe outlet diameters.

The TUFLOW model setup for the developed conditions is shown in **Figure 11-8.**

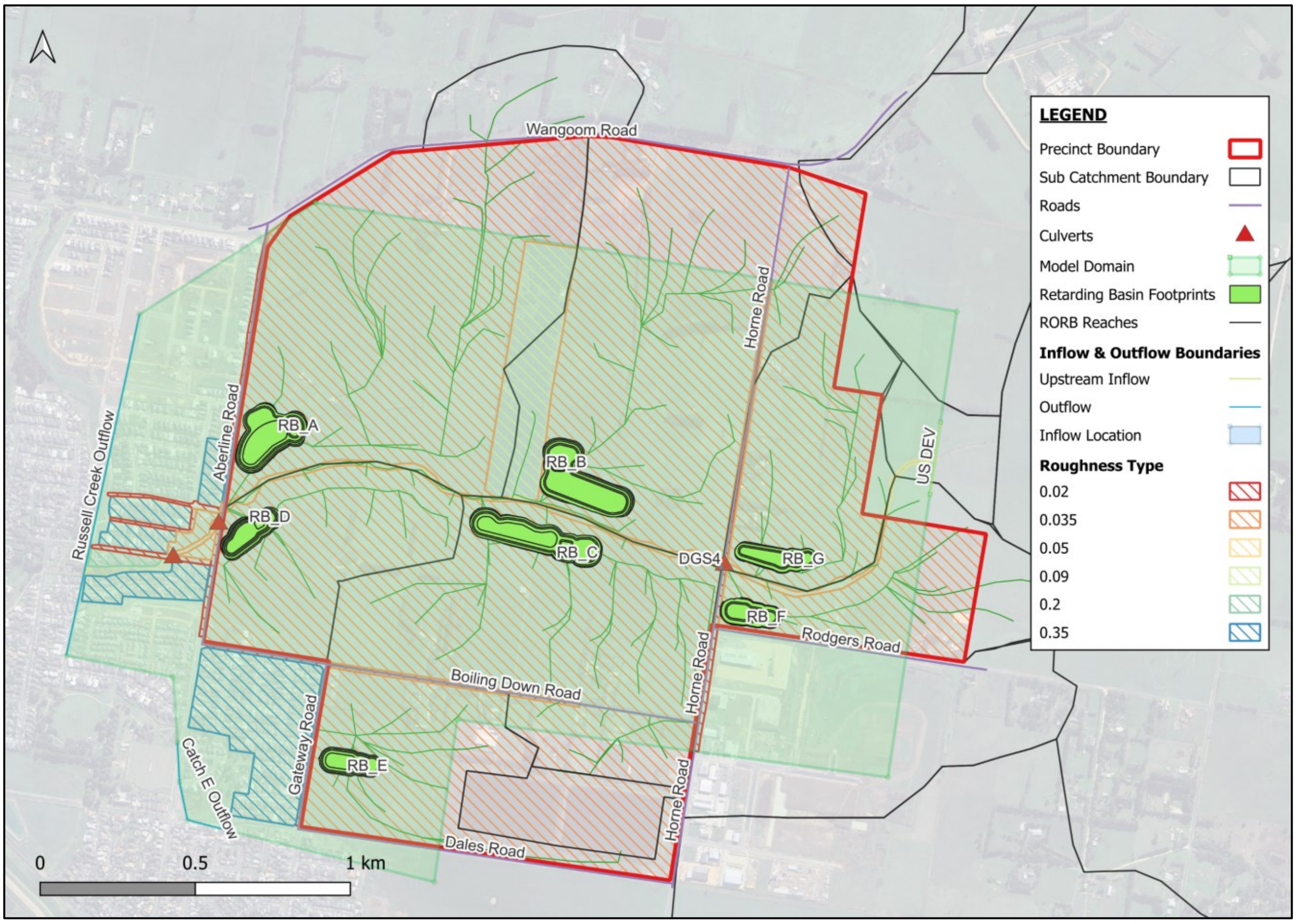

Figure 11-8 TUFLOW Model Inflow Locations - Developed Conditions

11.2.4 Results

The results of the same storm events modelled in the existing conditions were combined to create the maximum flood extent. The 1% AEP and 10% AEP flood extent of the developed conditions scenarios are provided in **Figure 11-9** and **Figure 11-10** (including in **Appendix F**).

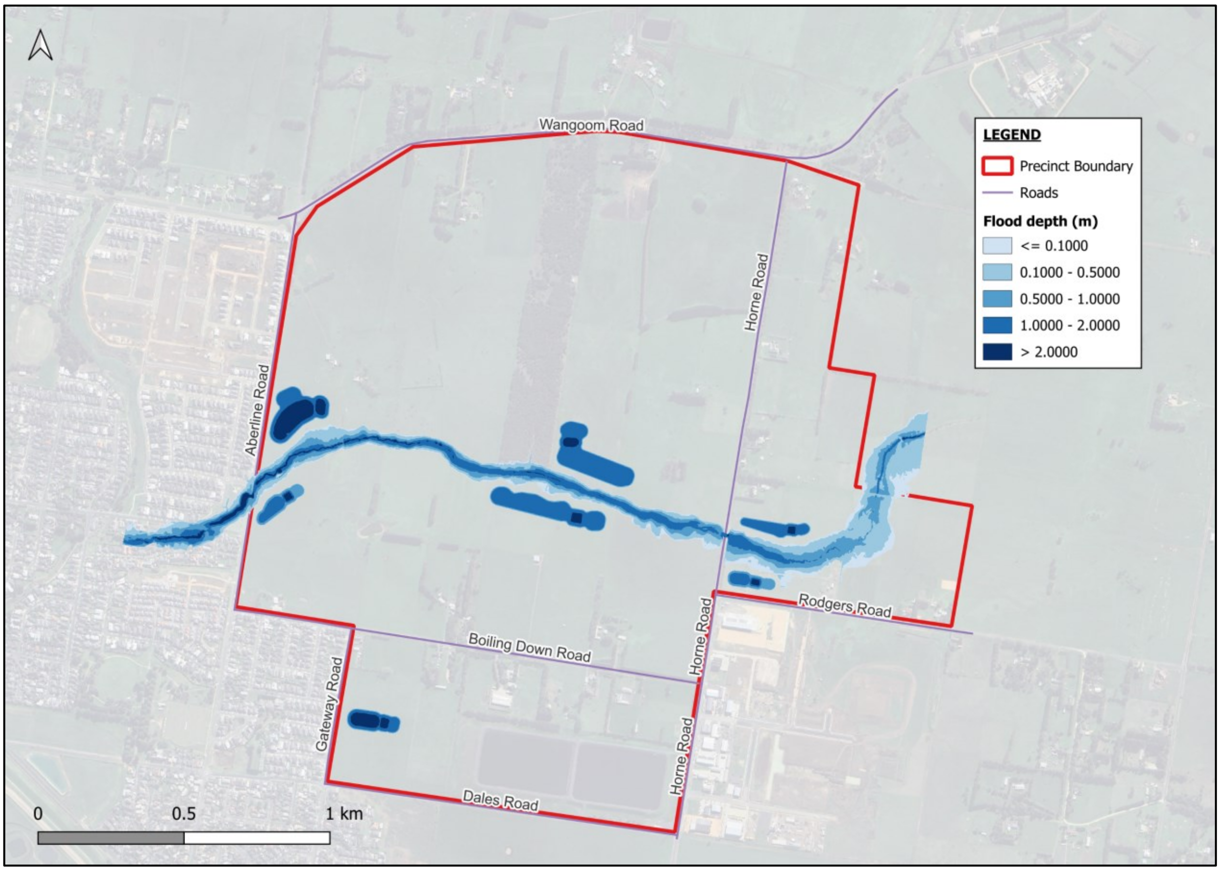

Figure 11-9 Developed Condition Flood depth – 1% AEP

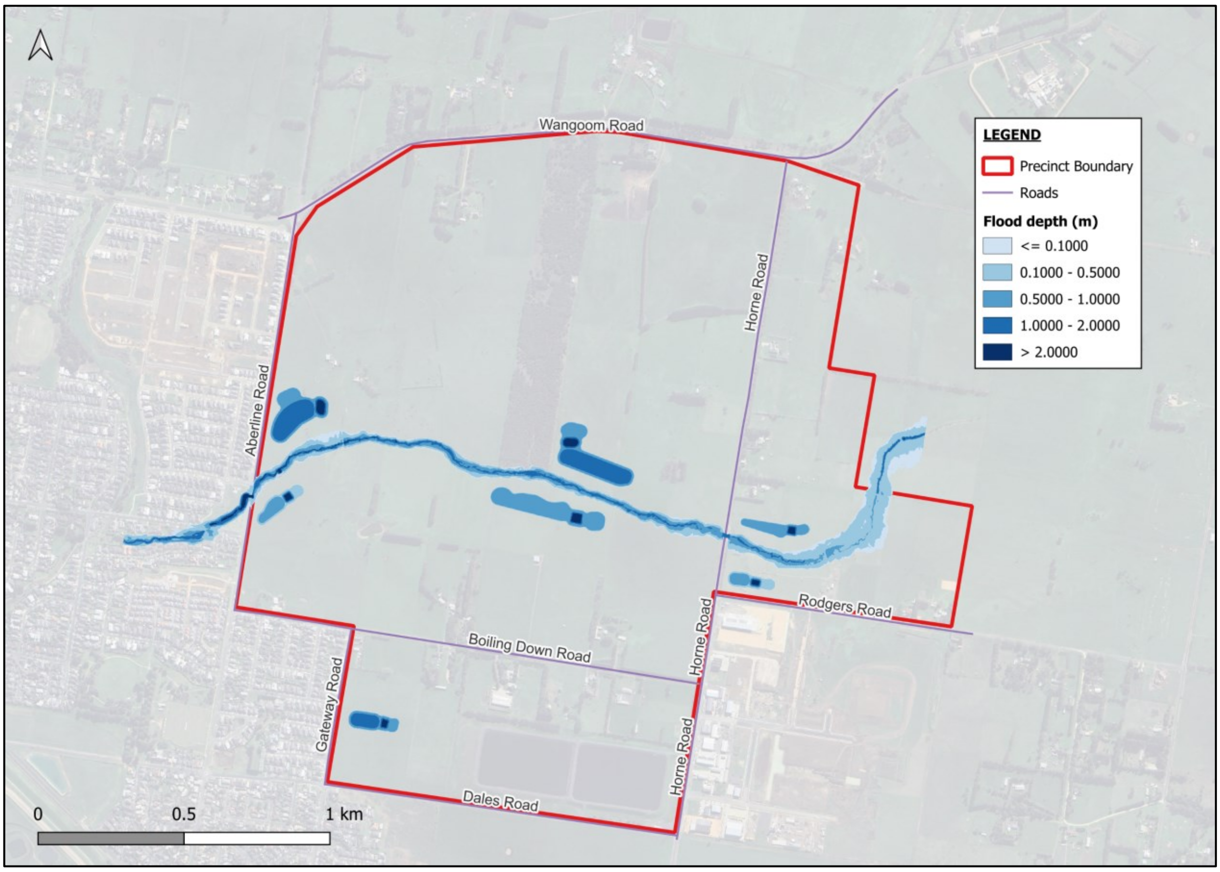

Figure 11-10 Developed Conditions Flood depth – 10% AEP

11.2.5 Impacts Assessment Result

The difference in flood levels for the 1% AEP and 10% AEP were compared between the existing and developed conditions which is presented in an afflux map. The results are provided in **Figure 11-11** and **Figure 11-12** (including in **Appendix F**).

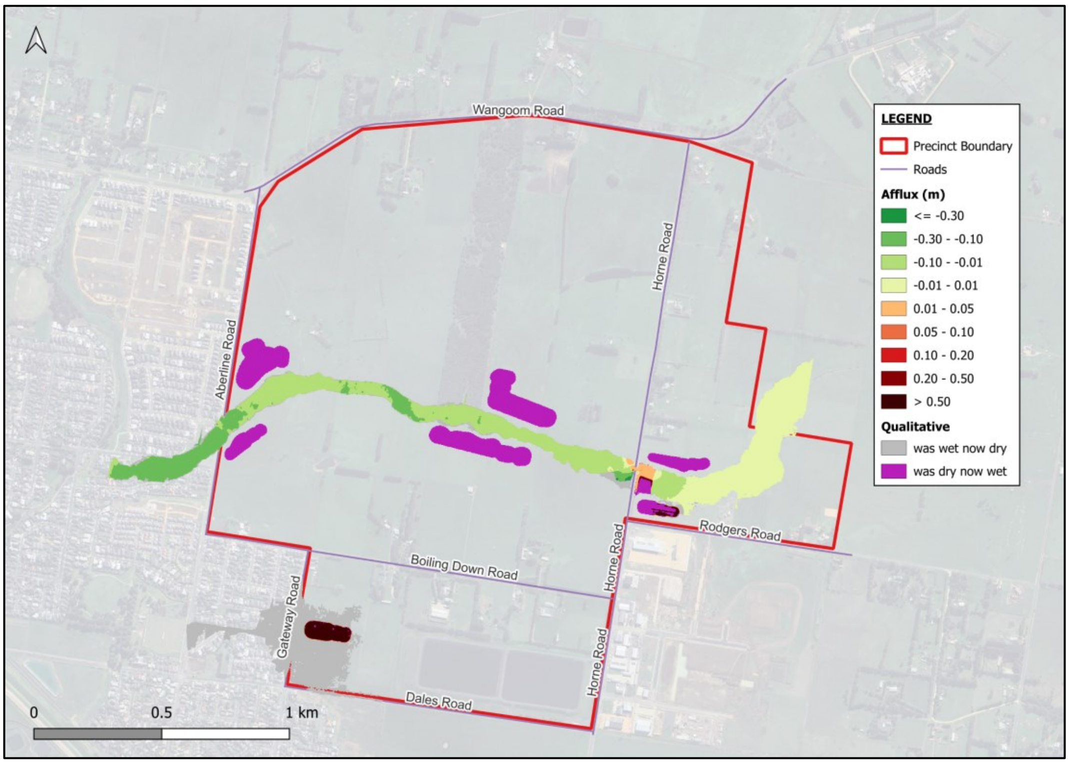

Figure 11-11 Flood Impact Assessment – 1% AEP Afflux

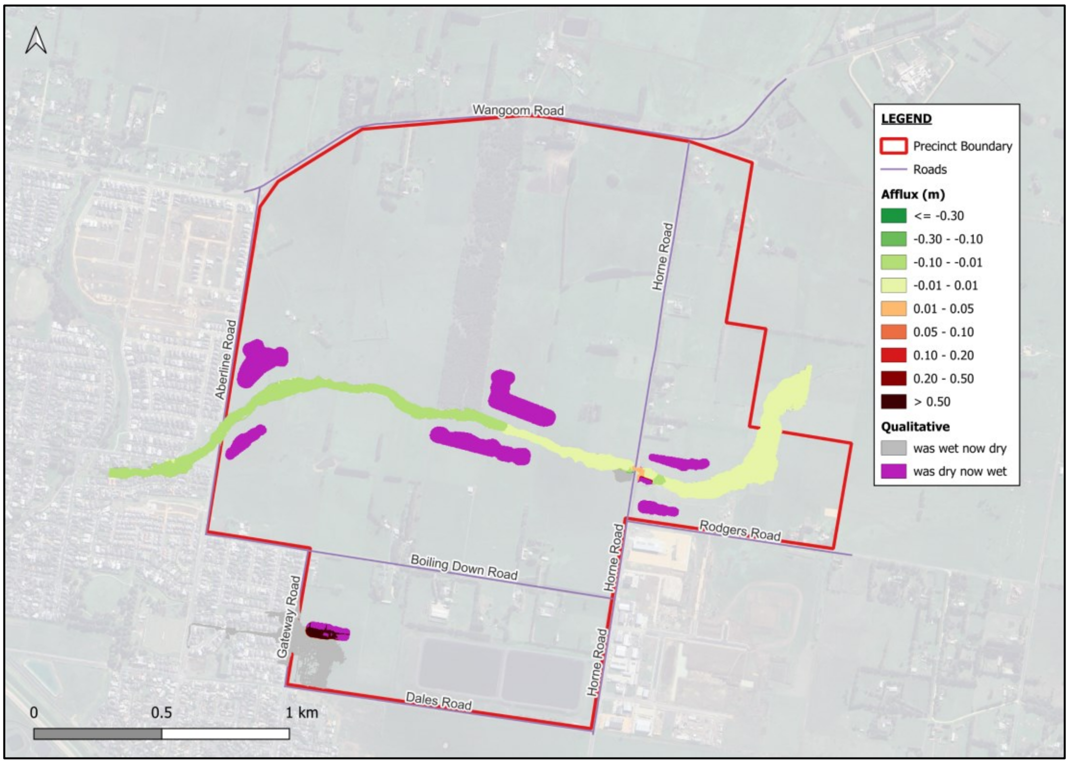

Figure 11-12 Flood Impact Assessment – 10% AEP Afflux

The 1% AEP and 10% AEP afflux maps show the developed conditions flood level within Russell Creek is generally lower than the existing conditions (by up to -0.3 m and -0.1 m respectively). Additionally, flooding within the vicinity of Gateway Rd is anticipated to significantly reduce by capturing the runoff from the catchment area E into a future retarding basin east of Gateway Rd (RB E).

It is important to note that the localised afflux at the intersect of Horne Rd and Russell Creek is believed to be caused by the outflow from RB F and G that are discharging upstream of the existing culvert at Horne Rd. This has created a retarding effect that resulted in an increased afflux of up to 0.03 m. However, such afflux is negligible and does not impact the overall outcomes.

The flood impact assessment outcomes demonstrates that there is no worsening of flood conditions in the 1% AEP with climate change as a result of the PSP development. The results provide proof that the provisions of flood mitigation measures (retarding basins and waterway realignment) can appropriately mitigate the impacts of the increased peak runoff from the PSP development.

12. Conclusion and Recommendations

The outcomes of the stormwater drainage strategy demonstrate that the proposed infrastructure and mitigation measures are technically feasible and align with the relevant authority's design requirements. A functional design has been completed for the proposed retarding basins, stormwater wetlands, and sediment basins, incorporating 3D surface modelling and additional flood modelling to validate and refine the strategy.

Construction cost estimates for the stormwater drainage design were derived from the functional design outputs to help inform the Development Contributions Plan. While the functional design and associated technical assessments are comprehensive and provide a high level of confidence for cost estimation and land allocation, the stormwater strategy is limited by the available data, including LiDAR and desktop-level assessments.

Due to uncertainties in the future development layout, assumptions have been made regarding overland flow paths and pipe alignments within the development scenarios. Detailed feature surveys during the subdivision design phase will confirm road and drainage layouts and identify any additional conveyance requirements for gap flows. A future road bridge crossing of Russell Creek near Tozer Reserve will require hydraulic validation, and it is recommended that the hydraulic assessment be expanded to simulate the bridge's impact on the floodplain.

While the desktop assessment has identified evidence of erosion affecting Russell Creek and the potential for exacerbation due to future development, a more detailed site investigation is warranted. This should include geomorphological and eco-hydrological assessments to better understand the creek's condition and inform appropriate management responses. Based on these findings, a comprehensive rehabilitation program is recommended. The program should aim to restore the creek's natural geomorphological form, re-establish riparian vegetation, and support the recovery of ecological health, contributing to a more resilient and sustainable waterway corridor.

Consultation with Glenelg Hopkins CMA has confirmed waterway corridor width, and flood control requirements for Russell Creek in relation to planning scheme overlays, including Floodway Overlay and Land Subject to Inundation Overlay. Discussions with Wannon Water have explored roof water harvesting opportunities and broader benefits for integrated water management, however, implementation of such scheme will require further investigation and continued collaboration with stakeholders which can be explored beyond the PSP framework.

It is recommended that the outcomes of the stormwater strategy be presented during the public exhibition stage of the PSP process to seek feedback and build support for resilient and sustainable drainage infrastructure. This will help ensure the PSP is serviced effectively while promoting environmentally responsible development in the Warrnambool area.

13. References

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Appendix A

Hydrology

A-1 RORB Modelling

A-1-1 General

In order to mitigate the impacts of increased runoff from the development, an existing condition design flow estimate is required to set the base case hydrology for the East of Aberline PSP area. The Russell Creek catchment is ungauged; therefore, the adopted design flows were validated against a range of other flow estimate methods including past studies, regional peak flow estimation equations and an existing RORB model developed as part of previous hydrological assessments.

The procedures set out in Australian Rainfall & Runoff (AR&R) guidelines (Ball et al., 2019) have been adopted to quantify a target peak flow. Water Technology (2017) and Spiire (2020) describes the most recent flood studies for the Russell Creek catchment and have been considered in setting the model parameters. The 2017 flood study is comprehensive and includes hydrologic and hydraulic validation to previous modelling of the catchment. The snippet of the Water Technology (2017) and Spiire (2020) existing conditions hydrologic model (RORB) model setup are illustrated in **Figure A-1-1** and below.

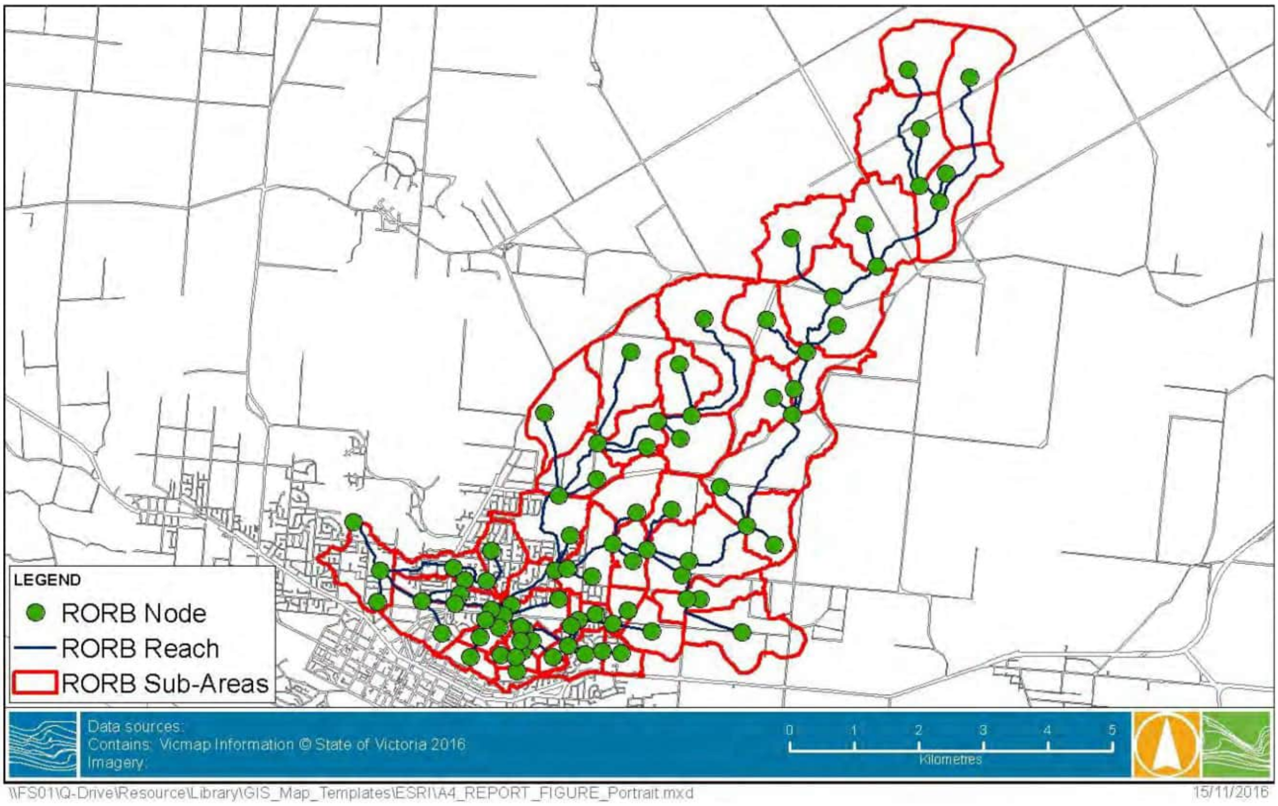


Figure A-1-1 Russell Creek RORB Setup (Water Technology, 2017)

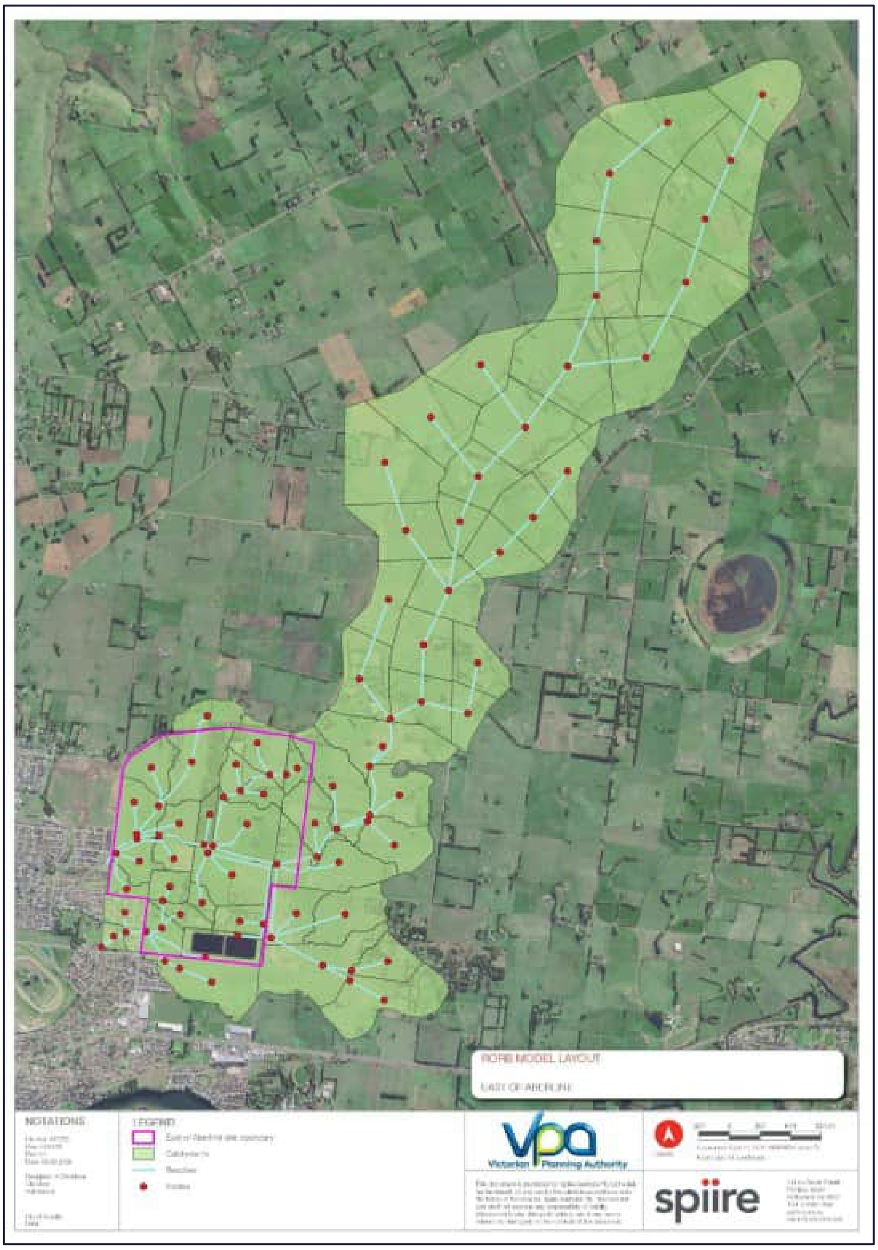


Figure A-1-2 East of Aberline PSP RORB Model Setup (Spiire, 2020)

A-1-2 Existing Condition

The runoff-routing model, RORB (Version 6.45) was used to determine the magnitude of design flows in accordance with the latest version of AR&R (Ball et al., 2019). A new RORB model was created with smaller subareas representing the East of Aberline PSP area at a scale appropriate for the PSP. For the external catchment of the PSP, the Water Technology (2017) subarea and reaches setup were adopted. The PSP area has been subdivided into seven subareas A-G with the outlets at Aberline Road and Gateway Road. The graphical representation of the existing condition RORB model setup is shown in **Figure A-1-2**.

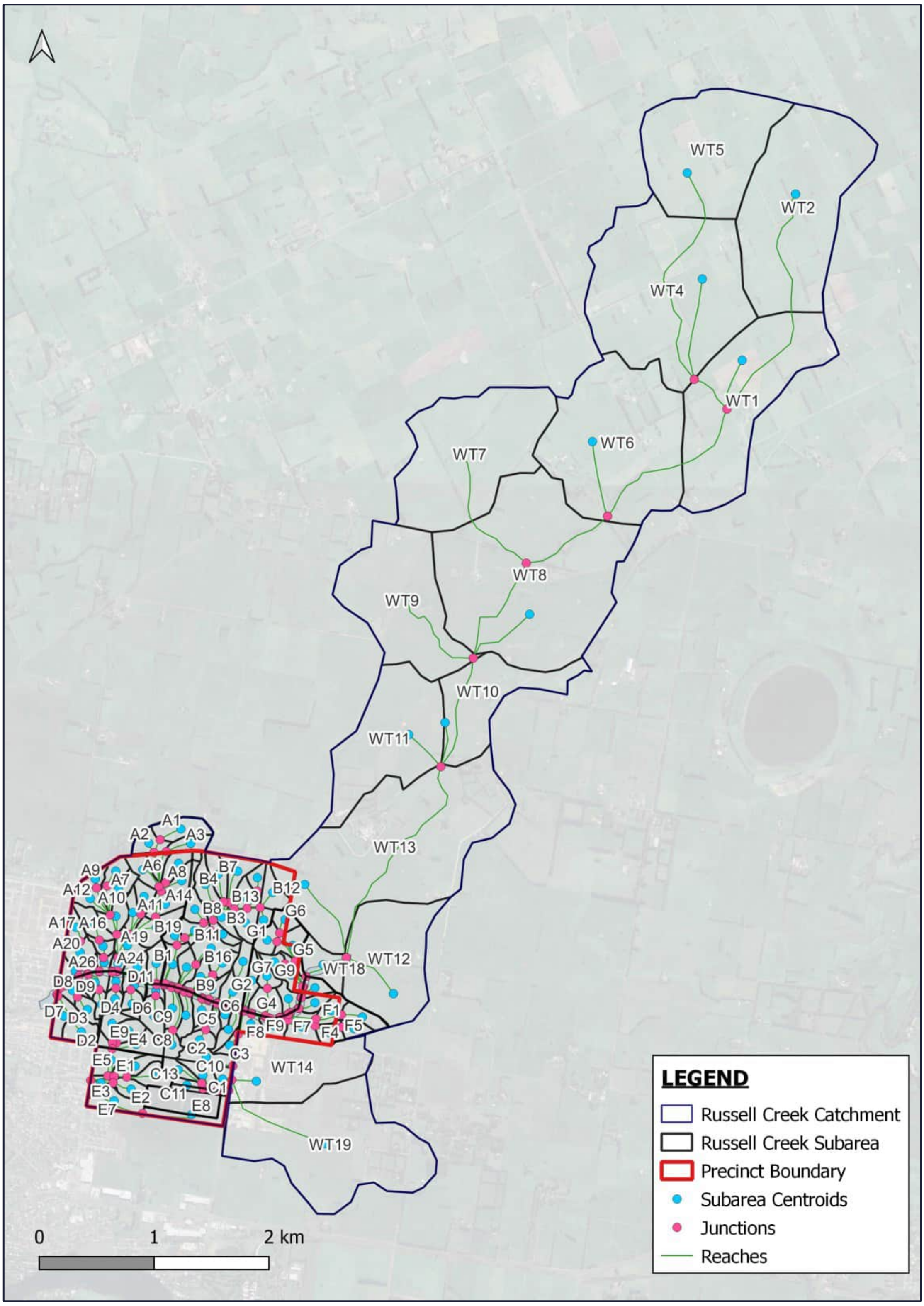


Figure A-1-3 Existing Condition RORB Model Setup

The magnified view of the East of Aberline PSP is shown in **Figure A-1-4**.

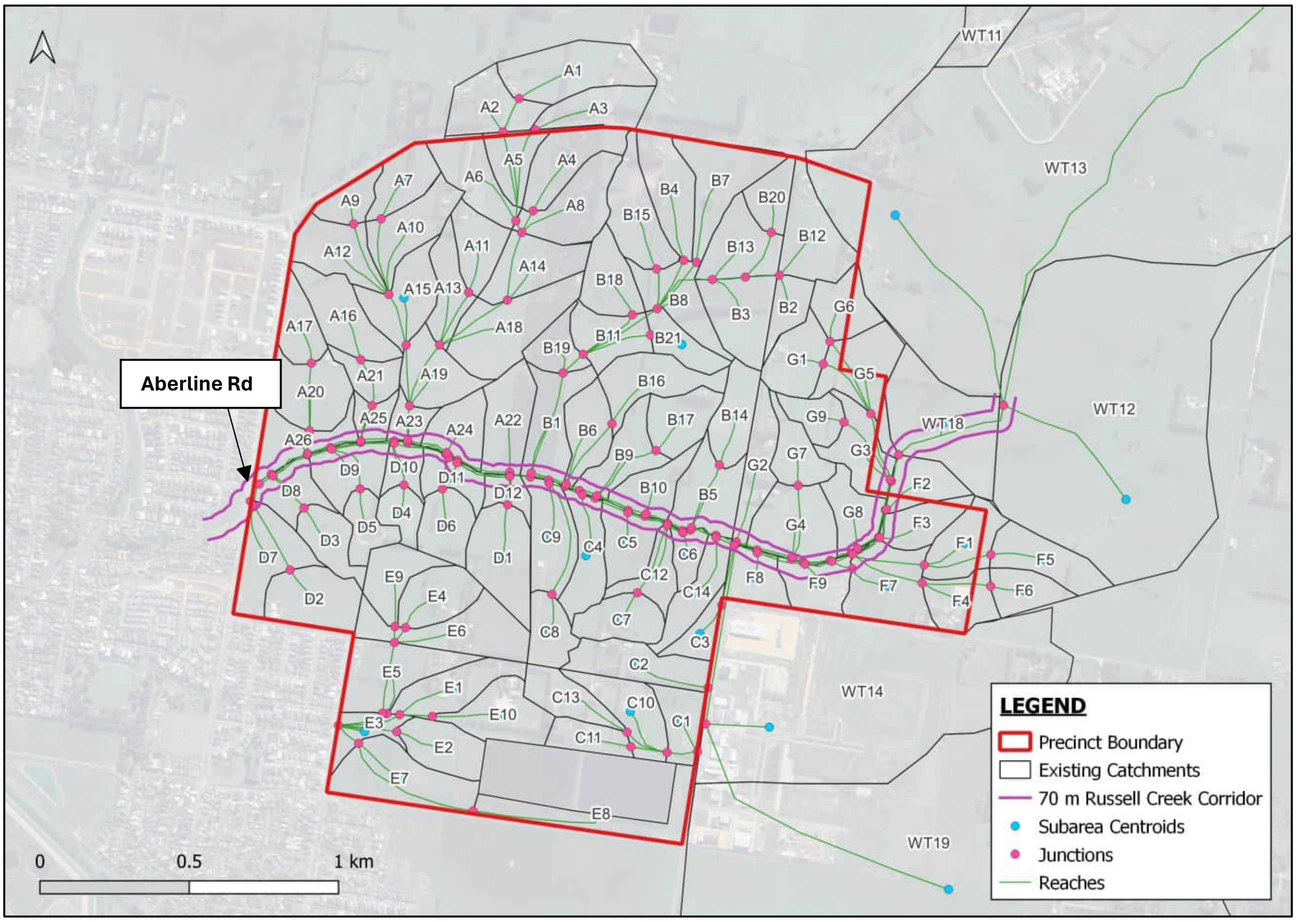


Figure A-1-4 East of Aberline PSP Existing Condition RORB Model Setup in QGIS

The sub catchment characteristics within the East of Aberline PSP area for the existing condition are presented in **Table A-1-1** below.

Table A-1-1 Existing Condition East of Aberline PSP Sub catchment Characteristics

Sub catchment	Sub catchment Area (km^2)	Fraction Imperviousness
A	1.15	0.05
B	0.93	0.05
C	0.51	0.05
D	0.43	0.05
E	0.51	0.05
F	0.37	0.05
G	0.39	0.05

A-1-3 Model Parameter Calibration

Design Rainfall Depth

Rainfall depths were obtained from the Australian Bureau of Meteorology (BoM) 2016 Rainfall IFD Data System. Areal reduction factors, and temporal patterns were adopted from the ARR Datahub.

Pre-burst rainfalls have been applied using the in-built functionality of RORB. Median pre-burst data downloaded from the ARR 2016 Datahub was read into RORB and applied in a single increment prior to the design storm.

Delay Parameter (k_c)

Due to the modification of the model setup which results in smaller subareas for the sub catchments, it is required to adjust the delay parameter (k_c) to ensure the delay response is consistent with the larger catchment model. Seven interstation were included to allow the adjustment of the k_c parameter to match the existing conditions outcome of the Water Technology (2017) flood study.

To determine an appropriate k_c value for the PSP area, k_c/d_{ave} for the larger Russell Creek RORB model was calculated and k_c values for each of the subareas within the East of Aberline PSP were estimated based on the known d_{ave} values. The following k_c values were adopted as presented in **Table A-1-2**.

Table A-1-2 Adopted k_c Values

Sub Catchment	Average Flow Distance (d_{ave}) (km)	Delay Parameter (k_c)
A	0.70	0.63
B	0.74	0.67
C	0.51	0.46
D	0.21	0.19
E	0.50	0.45
F	0.31	0.28
G	0.31	0.28
Aberline Rd	8.01	5.71

Loss Parameter

The initial and continuing loss factors were adopted from Water Technology (2017) and verified at the downstream node of the East of Aberline PSP to provide a similar flow as to Russell Creek existing conditions peak flow. Spiire has adopted a constant initial loss factor for various storm durations. ‘m’ value is also assumed to be 0.8.

A-1-4 Outcomes

Critical durations were determined using ensemble analysis for the different storm events. The temporal patterns that generate the closest peak flow to the median of all temporal patterns were adopted as the critical temporal pattern.

The RORB modelling results for the 10% AEP and 1% AEP storm events for the existing condition are outlined in **Table A-1-3** and **Table A-1-4**.

Table A-1-3 Existing Condition RORB Model Results – 10% AEP

Flow Estimate Location	Peak Flow (m^3/s)	Critical Duration
Catchment A Interstation	1.7	6 hrs
Catchment B Interstation	1.3	6 hrs
Catchment C Interstation	0.9	3 hrs
Catchment D Interstation	1.1	3 hrs
Catchment E Interstation	1.2	3 hrs
Catchment F Interstation	0.8	3 hrs
Catchment G Interstation	0.9	3 hrs
Aberline Rd Outlet	11.3	9 hrs

Table A-1-4 Existing Condition RORB Model Results – 1% AEP

Flow Estimate Location	Peak Flow (m^3/s)	Critical Duration
Catchment A Interstation	5.0	1.5 hrs
Catchment B Interstation	3.8	3 hrs
Catchment C Interstation	2.6	2 hrs
Catchment D Interstation	3.7	1 hr
Catchment E Interstation	3.8	1.5 hrs
Catchment F Interstation	2.6	1.5 hrs
Catchment G Interstation	2.7	1.5 hrs
Aberline Rd Outlet	38.4	9 hrs

The validation point was selected to be at Aberline Rd just downstream of the PSP boundary as shown in **Figure A-1-4**. Utilising the Water Technology (2017) loss parameters with the adjusted k_c values for each of the sub catchments within the PSP area provides a comparable peak flow at Aberline Road. The peak flow reported in Water Technology (2017) is 32 m^3/s compared to 38.4 m^3/s in the SMEC modelling. The difference in the peak flow is likely to be due to the refinements of reaches and subareas within the PSP boundary. Overall, the magnitude of peak flow and the adopted loss parameters are judged to be within a reasonable and acceptable range.

A-1-5 Developed Condition

The existing condition RORB model setup was modified to include the catchment changes as a result of the developed conditions including changes to subarea flow path and fraction of imperviousness. The developed conditions model was then run for a range of storm event, with adjusted IL and CL for urban surfaces as per Ball et al. (2019) and with the same k_c values as per the existing conditions.

The land use plan was provided by VPA on 10th June 2025 and the overall fraction impervious for each of the sub catchments was calculated. **Figure A-1-4** below shows the fraction impervious map for the PSP area.

The latest land use plan considers the following features:

- Growling Grass Frog (GGF) pond area is included.
- Local community facilities area and sports reserve near the GGF has been revised.

Drainage/retarding basins have also been added to the new land use plan.

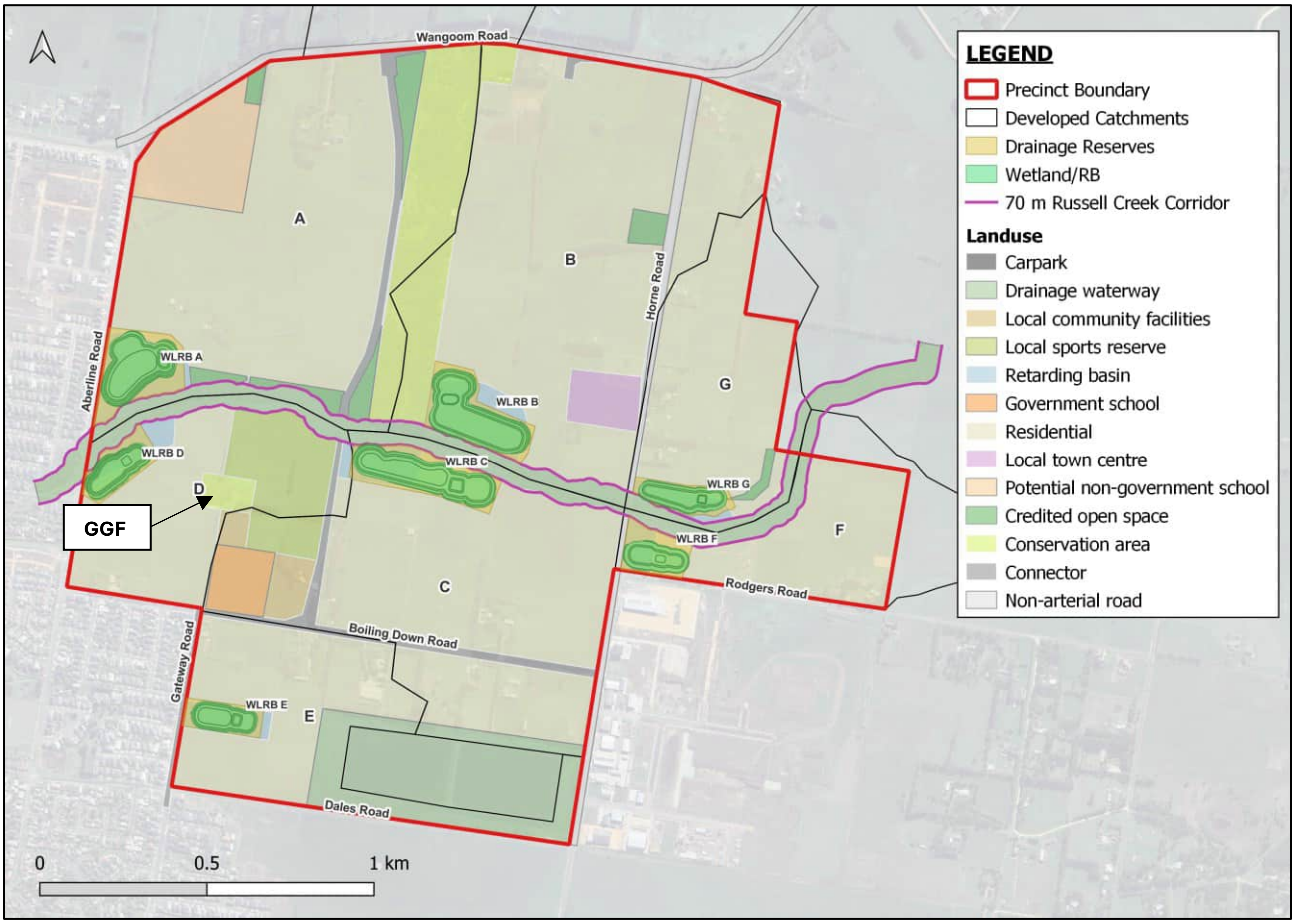


Figure A-1-4 East of Aberline PSP Area Fraction Impervious Map

Details of sub catchment area and fraction of impervious within the East of Aberline PSP area for the developed condition are presented in **Table A-1-5**.

Table A-1-5 Developed Condition East of Aberline PSP Sub catchment Characteristics

Sub catchment	Sub catchment Area (km^2)	Fraction Imperviousness
A	1.13	0.47
B	0.98	0.64
C	0.74	0.63
D	0.36	0.48
E	0.36	0.52
F	0.37	0.41
G	0.39	0.56

Figure A-1-5 and **Figure A-1-6** show the snippets of the developed condition RORB model.

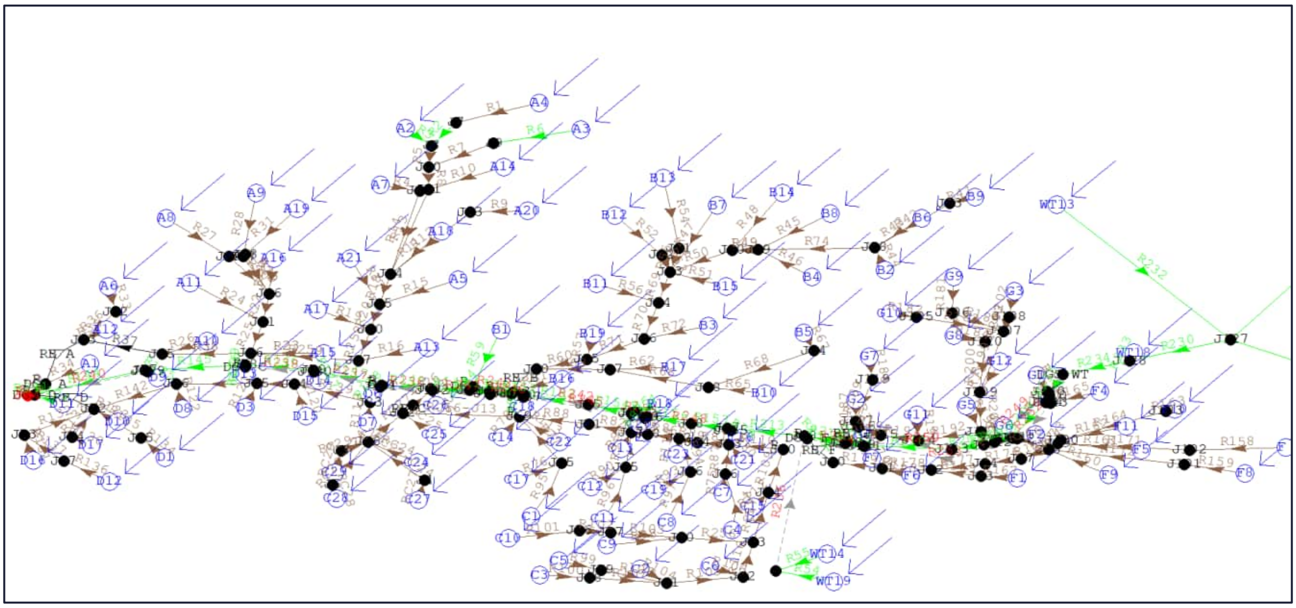


Figure A-1-5 Developed Condition RORB Model Setup – Aberline Rd as a discharge point

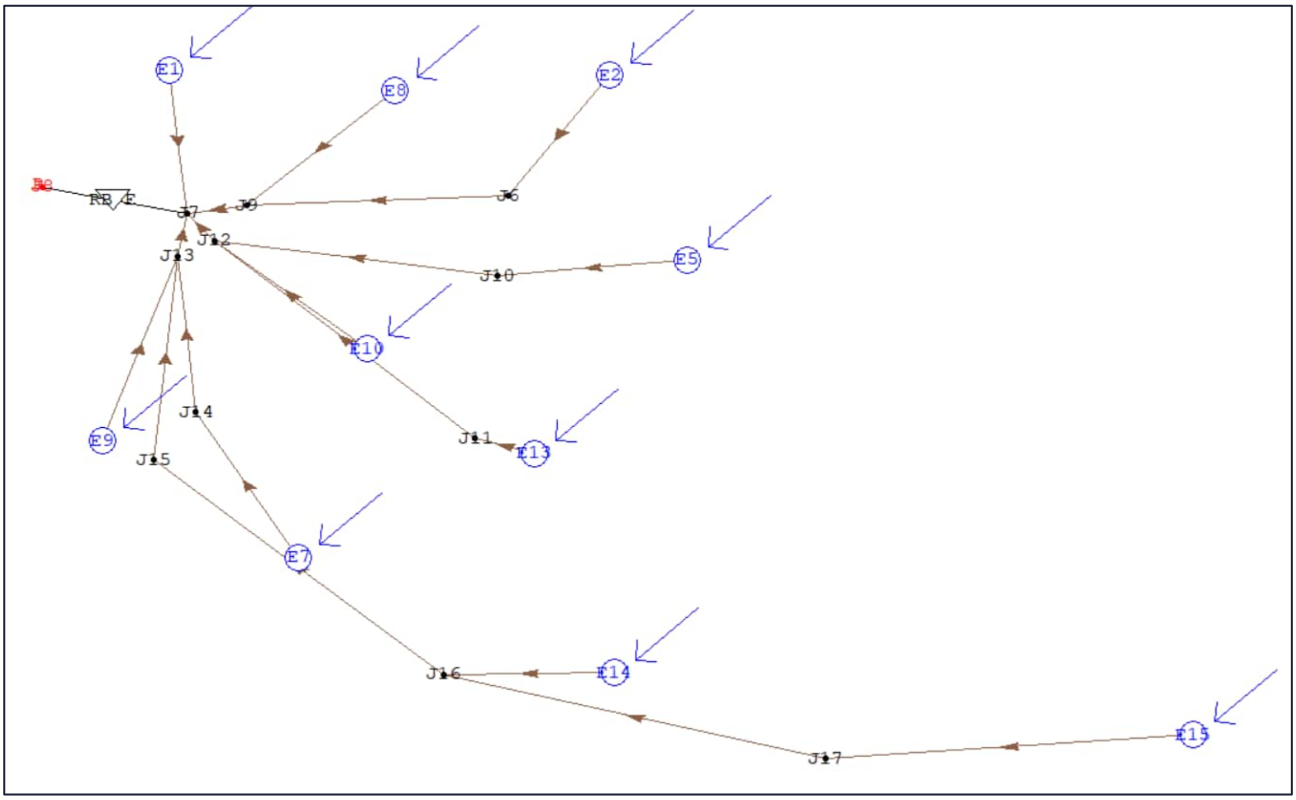


Figure A-1-6 Developed Condition RORB Model Setup – Gateway Rd as the discharge point

The developed condition RORB modelling results for the East of Aberline PSP for the 10% AEP and 1% AEP events are outlined in **Table A-1-6**.

Table A-1-6 Developed Condition RORB Model Results

Model	Peak Flow (m^3/s)	Critical Duration
10% AEP		
Combined Model -Aberline Rd discharge point	12.8	9 hrs
Catch E – Gateway Rd discharge point	0.6	3 hrs
1% AEP		
Combined Model -Aberline Rd discharge point	38.9	9 hrs
Catch E – Gateway Rd discharge point	1.4	2 hrs

A-1-6 Retarding Basin Sizing

Multiple retarding basins have been designed to retard developed condition flows back to the existing condition flows under the 1% AEP storm event (see **Figure A-1-7**).

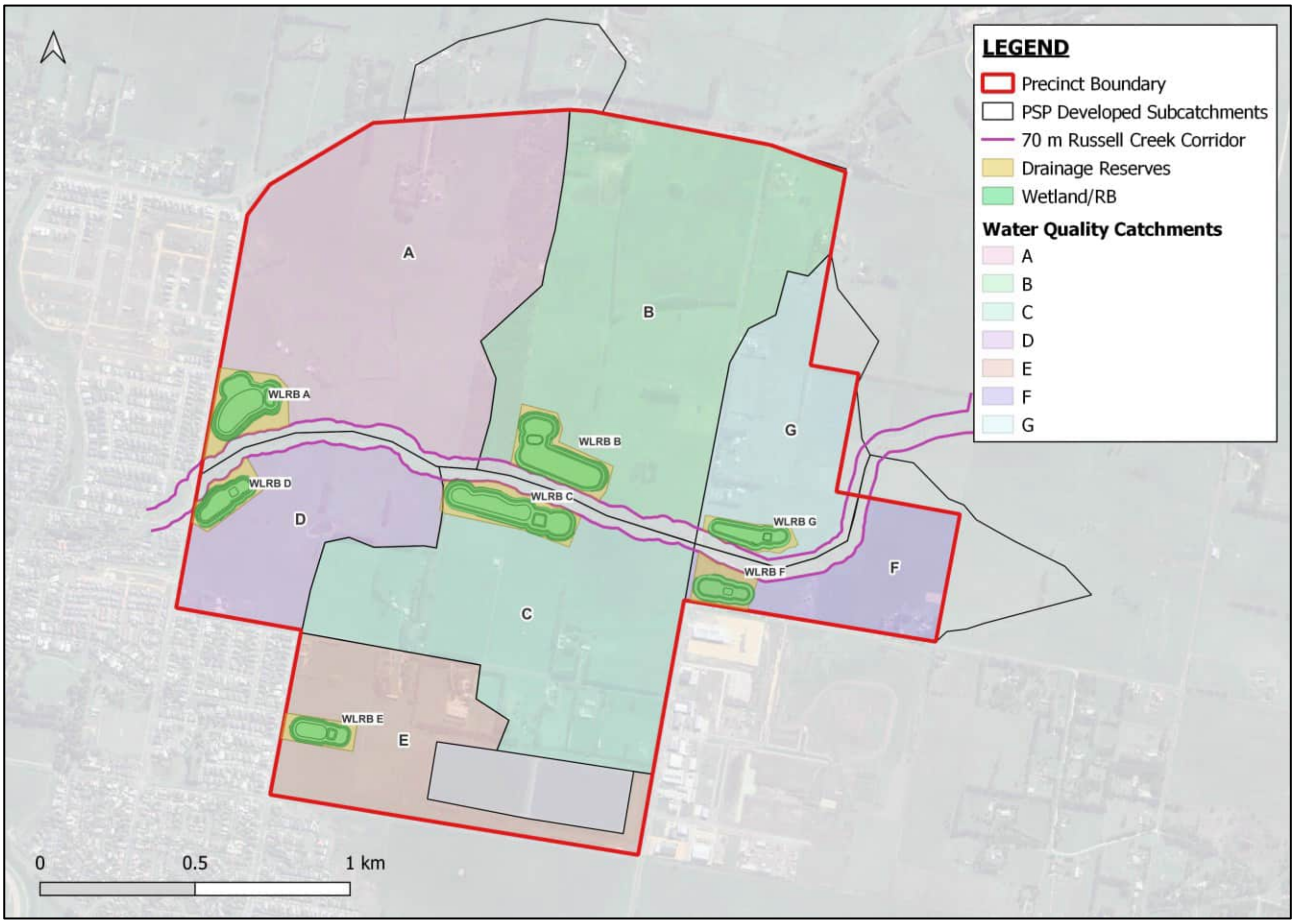


Figure A-1-7 Approximate Layout of the Retarding Basins

Details of the retarding basins are presented in **Table A-1-7.**

Table A-1-7 Details of the Retarding Basins within the East of Aberline PSP

RB Name	1% AEP Flood Level (m AHD)	Spillway Level (m AHD)	Storage (m^3)
WLRB A	24.6	25.5	24,500
WLRB B	29.0	30.0	27,000
WLRB C	27.5	28.3	20,600
WLRB D	22.8	23.2	4,930
WLRB E	29.3	30.2	7,470
WLRB F	31.8	31.2	4,230
WLRB G	31.8	32.5	6,940

A-1-1 RORB Results

10% AEP Design Flows

The RORB model 10% AEP flow estimates downstream of the retarding basins are presented in **Table A-1-8** and compared with those of existing condition.

Table A-1-8 10% AEP Flow Estimates Comparison

Flow Estimate Location	Existing 10% AEP Flow (m^3/s) & Critical Duration	Developed 10% AEP Flow (m^3/s) & Critical Duration
WLRB A	1.7 (6 hrs)	1.1 (9 hrs)
WLRB B	1.3 (6 hrs)	0.9 (9 hrs)
WLRB C	0.9 (3 hrs)	0.6 (9 hrs)
WLRB D	1.1 (3 hrs)	0.6 (3 hrs)
WLRB E	1.2 (3 hrs)	0.6 (3 hrs)
WLRB F	0.8 (3 hrs)	1.0 (1.5 hrs)
WLRB G	0.9 (3 hrs)	0.6 (3 hrs)
Aberline Rd	11.3 (9 hrs)	12.8 (9 hrs)

1% AEP Design Flows

The RORB model 1% AEP flow estimates downstream of the retarding basins are presented in **Table A-1-9** and compared with those of existing condition.

Table A-1-9 1% AEP Flow Estimates Comparison

Flow Estimate Location	Existing 1% AEP Flow (m^3/s) & Critical Duration	Developed 1% AEP Flow (m^3/s) & Critical Duration
WLRB A	5.0 (1.5 hrs)	2.9 (3 hrs)
WLRB B	3.8 (3 hrs)	1.8 (4.5 hrs)
WLRB C	2.6 (2 hrs)	1.4 (4.5 hrs)
WLRB D	3.7 (1 hr)	1.3 (1.5 hrs)
WLRB E	3.8 (1.5 hrs)	1.4 (2 hrs)

Table A-1-9 Continued

Flow Estimate Location	Existing 1% AEP Flow (m^3/s) & Critical Duration	Developed 1% AEP Flow (m^3/s) & Critical Duration
WLRB F	2.6 (1.5 hr)	2.3 (45 mins)
WLRB G	2.7 (1.5 hr)	1.2 (1.5 hrs)
Aberline Rd	38.4 (9 hrs)	38.9 (9 hrs)

A-1-2 Climate Change Sensitivity Analysis

The sensitivity of flood behaviour to projected Climate Change was tested for the SSP 5-8.5 for the year 2100. The increased rainfall intensity was simulated in the RORB model. The adjustment factors of 1.19 and 1.44 have been applied for the initial loss and continuous loss, respectively.

The RORB model 10% AEP and 1% AEP flow estimates downstream of the retarding basins with the impact from climate change on existing and developed conditions are presented in **Table A-1-10** and **Table A-1-11**.

Table A-1-10 10% AEP Flow Estimates Comparison with the Impact of Climate Change

Flow Estimate Location	Existing 10% AEP Flow (m^3/s) & Critical Duration	Developed 10% AEP Flow (m^3/s) & Critical Duration
WLRB A	4.8 (1.5 hrs)	2.6 (3 hrs)
WLRB B	3.7 (1.5 hrs)	1.6 (3 hrs)
WLRB C	2.7 (1.5 hrs)	1.2 (3 hrs)
WLRB D	3.9 (1.5 hrs)	1.3 (1.5 hrs)
WLRB E	3.5 (1.5 hr)	1.3 (1.5 hr)
WLRB F	2.7 (1.5 hrs)	2.5 (1.5 hrs)
WLRB G	2.8 (1.5 hrs)	1.3 (1.5 hrs)
Aberline Rd	27.3 (1.5 hrs)	27.6 (3 hrs)

Table A-1-11 1% AEP Flow Estimates Comparison with the Impact of Climate Change

Flow Estimate Location	Existing 1% AEP Flow (m^3/s) & Critical Duration	Developed 1% AEP Flow (m^3/s) & Critical Duration
WLRB A	12.8 (1.5 hrs)	6.0 (1.5 hrs)
WLRB B	9.7 (1.5 hrs)	3.2 (4.5 hrs)
WLRB C	6.8 (1 hr)	2.4 (3 hrs)
WLRB D	9.3 (45 mins)	2.9 (1 hr)
WLRB E	9.5 (45 mins)	2.9 (1.5 hr)
WLRB F	6.7 (45 mins)	5.5 (30 mins)
WLRB G	7.0 (45 mins)	2.5 (1 hr)
Aberline Rd	79.9 (1.5 hrs)	75.4 (1.5 hrs)

Table A-1-12 below presents the peak elevation, and the storage required for each of the retarding basins under 1% AEP storm event as opposed to the base design event.

Table A-1-12 1% AEP Flood Level and Storage Changes as a result of Climate Change

RB Name	1% AEP Flood Level (m AHD)	Spillway Level (m AHD)	Storage (m^3)
WLRB A	25.4	25.5	42,000
WLRB B	29.6	30.0	42,200
WLRB C	27.9	28.3	32,600
WLRB D	23.3	23.2	9,080
WLRB E	29.9	30.2	13,700
WLRB F	32.0	31.2	3,220
WLRB G	32.4	32.5	12,500

A-2 Data Hub Climate Change Factors

Location

Label: East of Aberline

Latitude: -38.364 [Nearest grid cell: 38.3625 (S)]

Longitude: 142.53 [Nearest grid cell: 142.5375 (E)]

IFD Design Rainfall Intensity (mm/h)

Issued: 14 July 2025

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Loss Factors

Initial Loss (Adjustment Factors)

	Losses SSP1-2.6	Losses SSP2-4.5	Losses SSP3-7.0	Losses SSP5-8.5
2030	**1.05**	**1.05**	**1.05**	**1.05**
2040	1.05	1.06	1.06	1.07
2050	**1.06**	**1.07**	**1.07**	**1.08**
2060	1.06	1.07	1.09	1.1
2070	1.06	1.08	1.1	1.12
2080	1.06	1.09	1.12	1.14
2090	**1.06**	**1.09**	**1.13**	**1.17**
2100	1.06	1.1	1.15	1.19

Continuing Loss (Adjustment Factors)

	Losses SSP1-2.6	Losses SSP2-4.5	Losses SSP3-7.0	Losses SSP5-8.5
2030	**1.1**	**1.1**	**1.1**	**1.11**
2040	1.12	1.12	1.13	1.14
2050	**1.12**	**1.15**	**1.16**	**1.18**
2060	1.13	1.17	1.19	1.23
2070	1.13	1.18	1.23	1.28
2080	1.13	1.2	1.27	1.33
2090	**1.13**	**1.21**	**1.31**	**1.39**
2100	1.12	1.22	1.34	1.44

Temperature Changes (Degrees, Relative to 1961-1990 Baseline)

Year	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
2030	**1.2**	**1.2**	**1.2**	**1.3**
2040	1.3	1.4	1.5	1.6
2050	**1.4**	**1.7**	**1.8**	**2.1**
2060	1.5	1.9	2.2	2.5
2070	1.5	2.1	2.5	3
2080	1.5	2.2	2.9	3.5
2090	**1.5**	**2.4**	**3.3**	**4.1**
2100	1.4	2.5	3.6	4.5

Appendix B

Overland Flow Assessment

B-1 Overland Flow Capacity within Road Reserve

An assessment has been completed whether any additional channel or waterway is required to safely convey the major flow path shown in the preliminary drainage concept plan. In doing so, the road overland flow capacity has been estimated using the PC Convey software tool. **Figure B-1-1** below shows the locations of the roads for which the overland flow capacity has been estimated.

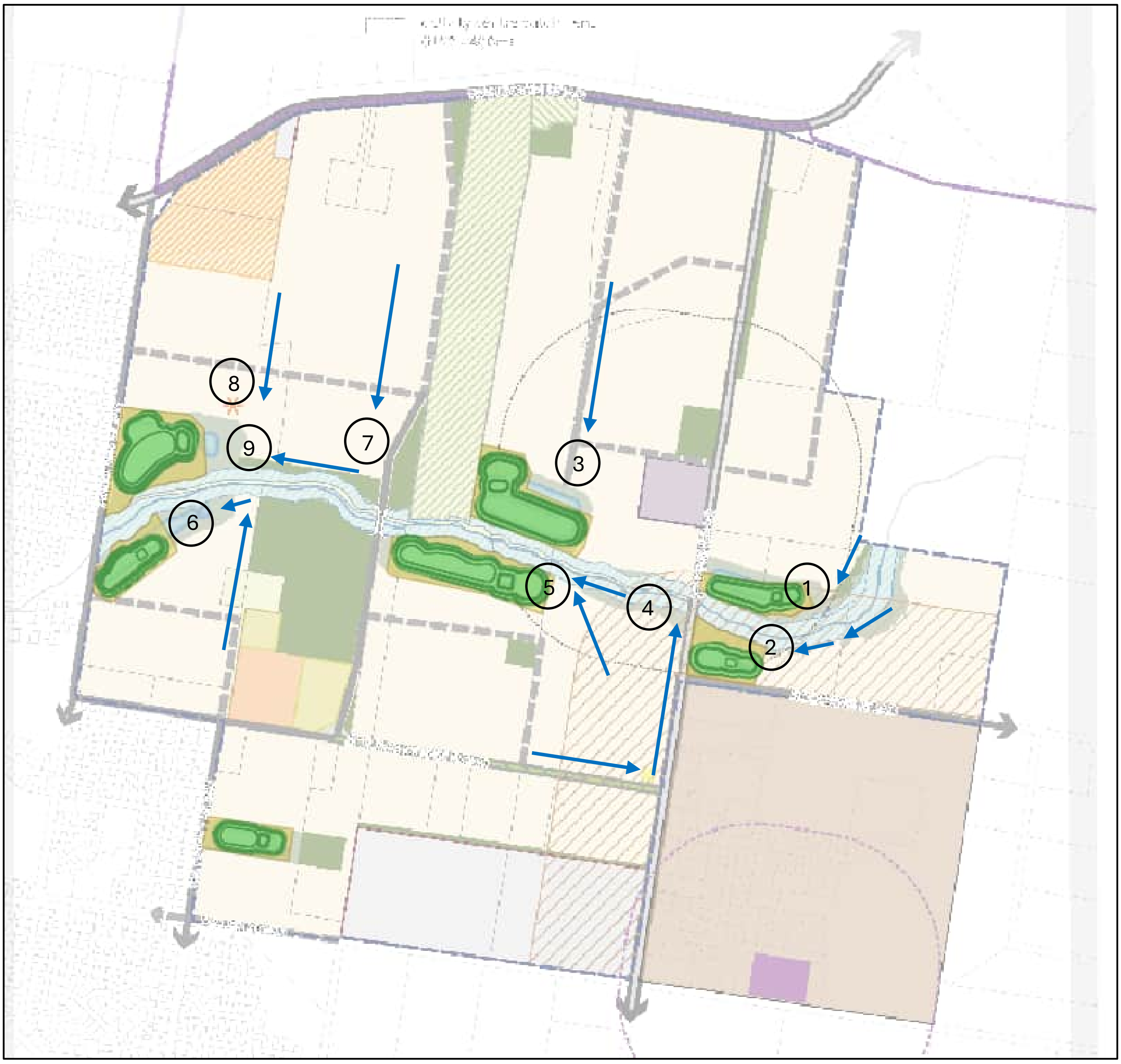


Figure B-1-1 Locations of the Roads

Roads within the PSP area are assumed to be 24 m wide collector street Level 1 and 16 m wide access street. The 16 m wide access street are assumed along the Russel Creek.

A typical road profile for a 24 m wide collector street Level 1 (without median reserve) and 16 m wide access street are illustrated in **Figure B-1-2** as proposed in IDM (LGIDA, 2020). These profiles are used to estimate the maximum road overland flow capacity.

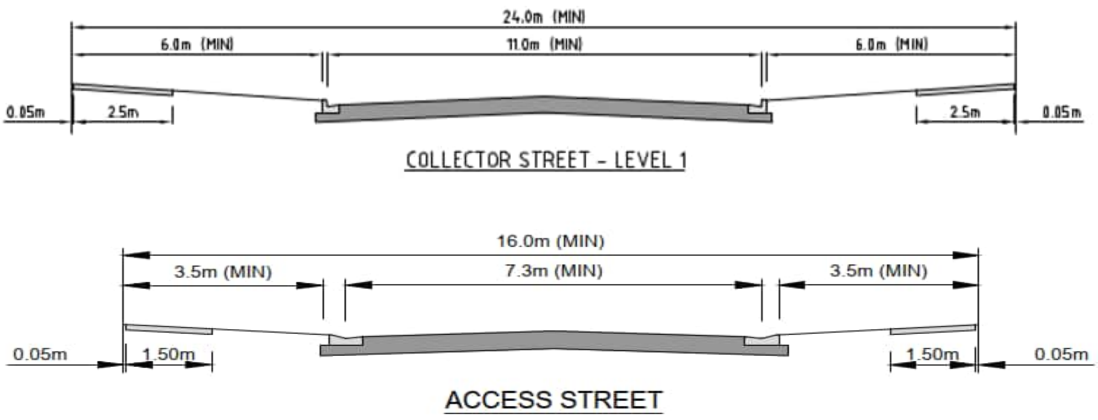


Figure B-1-2 Road Profiles for Collector Street Level 1 (top) and Access Street (bottom) (IDM,2020)

The PC Convey results for the road profile collector street Level and access street are presented below. Note that the verge width has been included in the estimation of the road overland flow capacity.

Table B-1-1 PC Convey Results for Collector Street Level 1 with Verge

Road Grade	Maximum Flow (m^3/s)	Average Depth (D_{ave}) (m)	Average Velocity (Vave) (m/s)	Dave x Vave (m^2/s)
0.5%	3.8	0.16	1.04	0.17
0.75%	4.7	0.16	1.27	0.20
1%	5.3	0.16	1.47	0.23
1.5%	6.6	0.16	1.81	0.29

Table B-1-2 PC Convey Results for Access Street

Road Grade	Maximum Flow (m^3/s)	Average Depth (D_{ave}) (m)	Average Velocity (Vave) (m/s)	Dave x Vave (m^2/s)
0.25%	1.8	0.13	0.81	0.11
0.5%	2.6	0.13	1.14	0.15
0.75%	3.1	0.13	1.41	0.19
1%	3.6	0.13	1.62	0.22

The gap flows between the 1% and 20% AEP storm events generated within each of the roads shown in **Figure B-1-1** have been calculated using RORB and compared with the PC Convey results to ensure the aforementioned roads have enough capacity to contain gap flows safely. The summary of the calculations is presented I **Table B-1-3**. Rows in red show that the road capacity is much smaller than the gap flows to contain them and rows in orange show that the capacity is just below the gap flows and thus it is assumed that the road can contain the gap flows (additional flows which cannot be contained within the roads are negligible).

Table B-1-3 Road Overland Flow Capacity

Print Points	Road Type	Road Grade (%)	1% AEP Flow (m^3/s)	20% AEP Flow (m^3/s)	Gap Flow (m^3/s)	Capacity (m^3/s)
1	Access Street	1%	2.7	1.1	1.6	3.6
2	Access Street	0.5%	3.0	1.1	1.9	2.6
3	Collector Street	0.75%	6.5	2.5	4.0	4.7
4	Collector Street	0.5%	1.7	0.7	1.0	3.8
5	Access Street	0.25%	3.6	1.5	2.1	1.8
6	Access Street	0.75%	1.4	0.4	1.0	3.1
7	Collector Street	1%	5.1	1.7	3.4	5.3
8	Collector Street	1.5%	3.9	1.6	2.3	6.6
9	Access Street	0.75%	8.9	3.2	5.7	3.1

The road overland flow capacity has also been estimated for the future climate (see **Table B-1-4**). Results of the two assessments (under current and future climate) show that some roads cannot contain the gap flows between the 1% AEP storm event and 20% AEP storm event (which is contained via underground pipes) Thus, it is recommended that these roads shall be either widened to contain the gap flows or swale drains need to also be proposed to contain additional gap flows which cannot be contained within the road reserves.

Table B-1-4 Road Overland Flow Capacity with the impact of the Climate Change

Print Points	Road Type	Road Grade (%)	1% AEP Flow (m^3/s)	20% AEP Flow (m^3/s)	Gap Flow (m^3/s)	Capacity (m^3/s)
1	Access Street	1%	6.2	1.1	5.1	3.6
2	Access Street	0.5%	6.9	1.1	5.8	2.6
3	Collector Street	0.75%	14.5	2.5	12.0	4.7
4	Collector Street	0.5%	4.0	0.7	3.3	3.8
5	Access Street	0.25%	7.8	1.5	6.3	1.8
6	Access Street	0.75%	3.3	0.4	2.9	3.1
7	Collector Street	1%	12.5	1.7	10.8	5.3
8	Collector Street	1.5%	8.6	1.6	7.0	6.6
9	Access Street	0.75%	20.8	3.2	17.6	3.1

In total, six swale drains have been sized to convey additional gap flows which cannot be contained with the roads (refer to **Figure B-1-3**). Swale drains have been designed for the future climate as the worst-case scenario. Manning's calculations were completed to size the swale drains based on roughness (n) value of 0.035.

The typical swale design parameters are presented in **Table B-1-5**. It is noted that the exact width and height of the swale will vary as the swale progress downstream be subject to detailed design.

It is also assumed that batter slopes of swales along the collector streets Level 1 (Swales 3 and 5) are assumed to be 1V:2H due to likely limited space available on the road verge. It is acknowledged that the minimum longitudinal grade of the swale drains should be between 2-3% however this is not viable at the proposed locations of the swales. Swales' longitudinal grades are assumed to be same as the road grades.

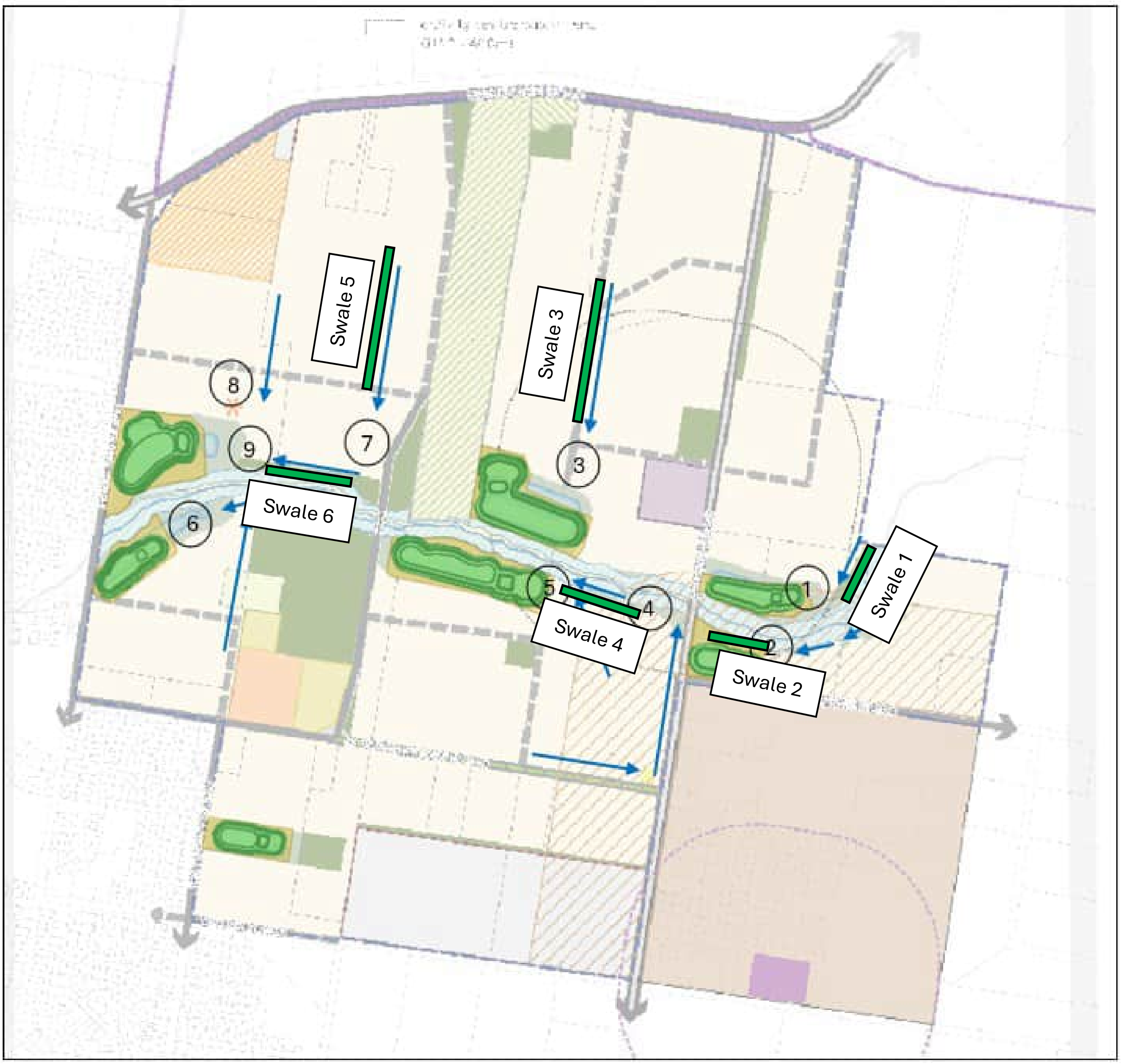


Figure B-1-3 Indicative Locations of the Swale Drains

Table B-1-5 Swale Drains Design Parameters

Parameters	Swale 1	Swale 2	Swale 3	Swale 4	Swale 5	Swale 6
Top Width (m)	6.0	8.2	7.0	11.0	5.4	14.7
Base Width (m)	1.0	2.2	3.8	4.0	2.2	6.7
Side Slope (1 in X)	1 in 5	1 in 5	1 in 2	1 in 5	1 in 2	1 in 5
Longitudinal Grade (%)	1%	0.5%	0.75%	0.25%	1%	0.75%
Depth (m)	0.5	0.6	0.8	0.7	0.8	0.8
Extra Gap Flow require to be captured (m^3/s)	1.5	3.2	7.3	4.5	5.5	14.5
Capacity (m^3/s)	2.2	3.3	7.5	4.6	5.7	14.7

Appendix C

Stormwater Quality

C-1 MUSIC Modelling

C-1-1 General

The objective of stormwater quality modelling is to achieve "best practice" set out in the Best Practice Environmental Management Guidelines for Urban Stormwater (BPEMG) document (CSIRO, 1999). The best practice water quality targets are detailed in **Table C-1-1**.

Table C-1-1 Best Practice Water Quality Targets

Pollutant	% Target Reduction
Total Suspended Solids	80
Total Phosphorus	45
Total Nitrogen	45
Gross Pollutant	70

C-1-2 Proposed Works

SMEC has identified the following works for provision of stormwater quality treatment:

- Sediment basins to treat up to and including 4EY (3-month ARI) flows for each of the sub catchments.
- Wetlands to treat up to and including 4EY (3-month ARI) flows for each of the sub catchments.

C-1-3 MUSIC Model Setup

The proposed stormwater treatment devices to meet these objectives have been modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 6 and the Melbourne Water MUSIC Guidelines (Melbourne Water, 2024).

The MUSIC model requires the specification of subarea parameters, and meteorological data (rainfall and evaporation). The parameters for the MUSIC model were adopted in accordance with the Melbourne Water MUSIC Modelling Guidelines (2024).

Subarea Parameters

Suitable source nodes and effective impervious areas (EIA) were assigned to the land uses. EIA calculation has been changed based on the new land use plan provided by VPA on 10/06/2025 and MUSIC model updated as a result of EIA change. **Table C-1-2** provides a breakdown of the subareas and their %EIA used to develop MUSIC model for the East of Aberline PSP area.

Table C-1-2 Subarea Parameters

Subarea ID	Area (ha)	EIA (%)
Catchment A	97	55
Catchment B	98	64
Catchment C	74	63
Catchment D	36	48
Catchment E	36	52
Catchment F	23	62
Catchment G	33	65

Climate Data

Rainfall data was adopted from station 90153 at "Camperdown Donalds Hill" for the designated project location. Details of climate data are summarised in **Table C-1-3**.

Table C-1-3 Meteorological Data

Station Name – CAMPERDOWN DONALDS HILL	
Station ID	90153
Data Period	01/10/1988 – 01/10/1989
Number of Years	1
Average Annual Rainfall (mm)	734
Average Annual Evapotranspiration (mm)	1615
Time Step (min)	6

C-1-4 Proposed Treatment Train

A combined treatment train of the sediment basins and wetlands has been proposed for the PSP area to meet best practice water quality objectives.

To ensure consistency between the hydrologic and water quality analysis, the MUSIC model was schematised with the same subarea configuration as the RORB model. A layout of the MUSIC model layout for the developed condition is shown in **Figure C-1-4**. Treatment feature parameters are detailed in Section 8.1.1. The layouts of the water quality catchments is shown in **Figure 8-1**.

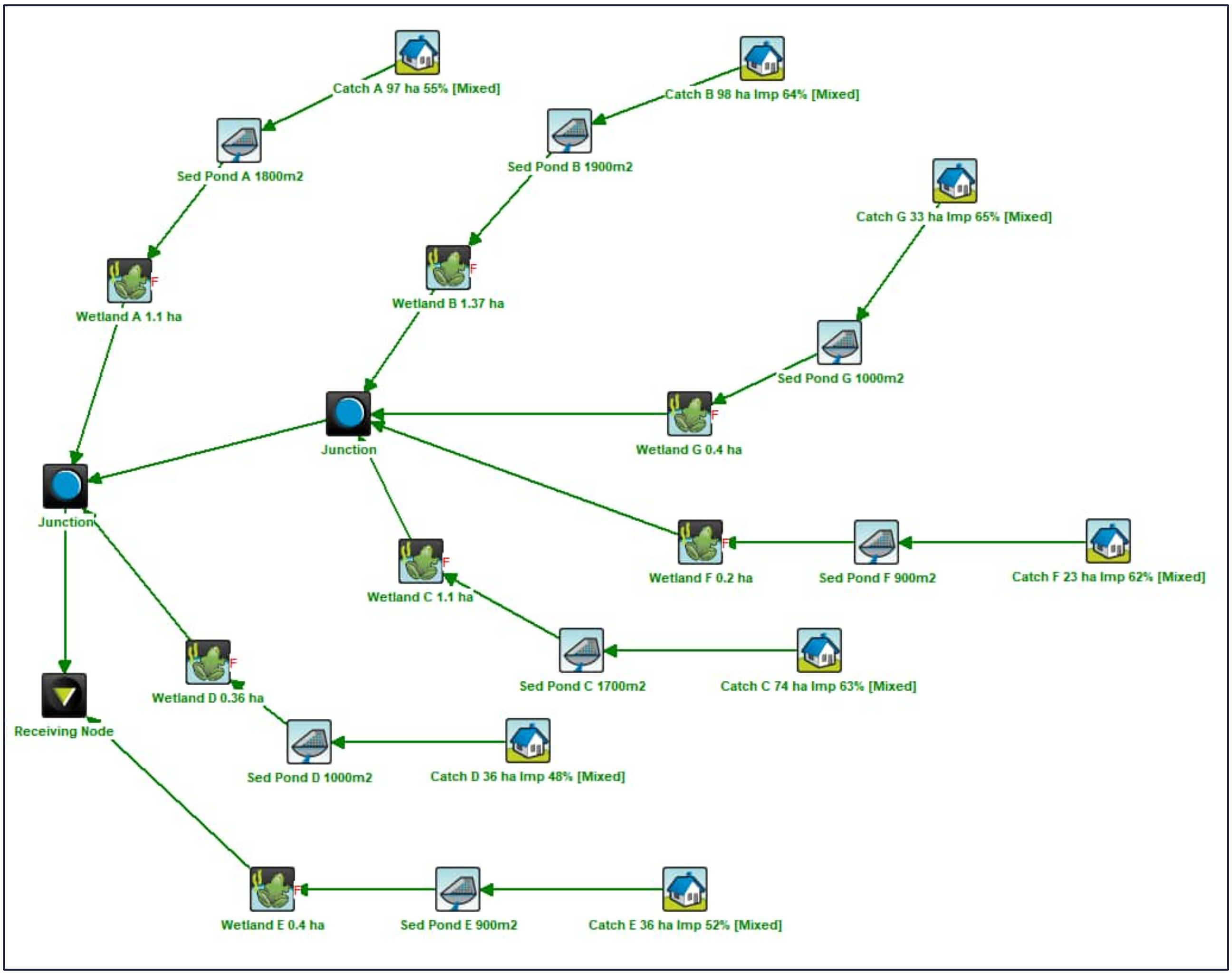


Figure C-1-4 MUSIC Model Schematic Layout

C-1-5 Stage Storage Inputs

The custom stage-storage relationships were determined in 12d and applied to the updated MUSIC model for the pipe and weir flows and storage volumes.

C-1-6 Treatment Areas

Table C-1-4 and **Table C-1-5** below shows the sediment basins and wetlands treatment areas for each asset proposed within the PSP.

Table C-1-4 Sediment Basins Treatment Areas

Parameters	SB A	SB B	SB C	SB D	SB E	SB F	SB G
Surface Area at NWL (m^2)	1,800	1,908	1,708	1029	911	903	1,019

Table C-1-5 Wetlands Treatment Areas

Parameters	WL A	WL B	WL C	WL D	WL E	WL F	WL G
Surface Area (m^2)	11,079	13,692	11,037	3,607	4,042	2,077	4,042

C-1-7 Wetlands Treatment Effectiveness

Tables below show the treatment effectiveness for each of the wetlands.

Table C-1-6 Wetland A Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	66,400	10,600	84.0
Total Phosphorus (TP)	142	41.9	70.5
Total Nitrogen (TN)	979	559	42.9
Gross Pollutants	16,600	0	100

Table C-1-7 Wetland B Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	74,500	11,500	84.6
Total Phosphorus (TP)	161	45.9	71.6
Total Nitrogen (TN)	1,120	615	45.1
Gross Pollutants	18,700	0	100

Table C-1-8 Wetland C Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	55,300	7,210	87.0
Total Phosphorus (TP)	121	31.6	73.8
Total Nitrogen (TN)	815	427	47.6
Gross Pollutants	13,900	0	100

Table C-1-9 Wetland D Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	20,900	2,600	87.6
Total Phosphorus (TP)	46	11.9	74.1
Total Nitrogen (TN)	311	160	48.6
Gross Pollutants	5,520	0	100

Table C-1-10 Wetland E Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	23,400	3,120	86.7
Total Phosphorus (TP)	50.2	13.3	73.6
Total Nitrogen (TN)	346	182	47.5
Gross Pollutants	5,880	0	100

Table C-1-11 Wetland F Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	18,000	2,510	86.0
Total Phosphorus (TP)	35.2	10.4	70.5
Total Nitrogen (TN)	251	142	43.4
Gross Pollutants	4,280	0	100

Table C-1-12 Wetland G Treatment Efficiency

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	27,000	3,700	86.3
Total Phosphorus (TP)	52.8	14.9	71.8
Total Nitrogen (TN)	367	204	45.7
Gross Pollutants	6,350	0	100

C-1-8 Treatment Train Effectiveness

As per the MUSIC modelling results, the removal efficiency of proposed treatment nodes in the PSP area is shown in **Table C-1-13**.

Table C-1-13 Reduction in Pollutant Loads

Pollutant	Source Loads (kg/yr)	Residual Loads (kg/yr)	% Reduction
Total Suspended Solids (TSS)	286,000	41,200	85.6
Total Phosphorus (TP)	609	170	72.1
Total Nitrogen (TN)	4,200	2,290	45.5
Gross Pollutants	71,200	0	100

C-2 Connection Sizing between Sediment Basins and Wetlands

Sediment Basin to Wetland A

Sizing connection between SP and MZ (IO4, first dot point)	
4EY flow (m3/s)	0.89
Pipe number and diamater	
Number of pipes	1
Pipe diameter (mm)	825
Flow rate controlled by pipe (flowing full)	
Cp - pipe discharge coefficient	0.60
H - head level difference between NWLs at SP and MZ (m)	0.10
h - head level driving flow through the pipe (m) given that SP is at TEDD and MZ at NWL	0.45
A - pipe cross section area (m2)	0.53
V - pipe flow velocity (m/s)	2.97
Q - pipe capacity (m3/s)	0.95
Pit dimensions	
Pit length (m)	1.6
Pit width (m)	1.5
Flow rate controlled by pit acting as a weir	
B - blockage factor **"assumed to be 0.50"**	0.50
C_w - weir coefficient **"1.40 Recommended by MW, 1.70 by QLD"**	1.40
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.90
Flow rate controlled by pit acting as an orifice	
B - blockage factor **"assumed to be 0.50"**	0.50
e- portion of pit area not taken up by bars **"0.90 for pipe grille by MW"**	0.90
Cd - orifice discharge coefficient **"0.45 by MW, and 0.60 by QLD"**	0.45
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	1.27
Check if connection between SP & MZ has minimum capacity to cnovey 4EY flow	
Qdes - design flow rate (m3/s)	0.90
Capacity check "Target ≥ 4EY flow"	OK

Sediment Basin to Wetland B

Sizing connection between SP and MZ (IO4, first dot point)	
4EY flow (m3/s)	0.81
Pipe number and diamater	
Number of pipes	1
Pipe diameter (mm)	825
Flow rate controlled by pipe (flowing full)	
Cp - pipe discharge coefficient	0.60
H - head level difference between NWLs at SP and MZ (m)	0.10
h - head level driving flow through the pipe (m) given that SP is at TEDD and MZ at NWL	0.45
A - pipe cross section area (m2)	0.53
V - pipe flow velocity (m/s)	2.97
Q - pipe capacity (m3/s)	0.95
Pit dimensions	
Pit length (m)	1.5
Pit width (m)	1.35
Flow rate controlled by pit acting as a weir	
B - blockage factor **"assumed to be 0.50"**	0.50
C_w - weir coefficient **"1.40 Recommended by MW, 1.70 by QLD"**	1.40
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.83
Flow rate controlled by pit acting as an orifice	
B - blockage factor **"assumed to be 0.50"**	0.50
e- portion of pit area not taken up by bars **"0.90 for pipe grille by MW"**	0.90
Cd - orifice discharge coefficient **"0.45 by MW, and 0.60 by QLD"**	0.45
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	1.07
Check if connection between SP & MZ has minimum capacity to cnovey 4EY flow	
Qdes - design flow rate (m3/s)	0.83
Capacity check "Target ≥ 4EY flow"	OK

Sediment Basin to Wetland C

Sizing connection between SP and MZ (IO4, first dot point)	
4EY flow (m3/s)	0.91
Pipe number and diamater	
Number of pipes	1
Pipe diameter (mm)	825
Flow rate controlled by pipe (flowing full)	
Cp - pipe discharge coefficient	0.60
H - head level difference between NWLs at SP and MZ (m)	0.10
h - head level driving flow through the pipe (m) given that SP is at TEDD and MZ at NWL	0.45
A - pipe cross section area (m2)	0.53
V - pipe flow velocity (m/s)	2.97
Q - pipe capacity (m3/s)	0.95
Pit dimensions	
Pit length (m)	1.6
Pit width (m)	1.6
Flow rate controlled by pit acting as a weir	
B - blockage factor **"assumed to be 0.50"**	0.50
C_w - weir coefficient **"1.40 Recommended by MW, 1.70 by QLD"**	1.40
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.93
Flow rate controlled by pit acting as an orifice	
B - blockage factor **"assumed to be 0.50"**	0.50
e- portion of pit area not taken up by bars **"0.90 for pipe grille by MW"**	0.90
Cd - orifice discharge coefficient **"0.45 by MW, and 0.60 by QLD"**	0.45
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	1.36
Check if connection between SP & MZ has minimum capacity to cnovey 4EY flow	
Qdes - design flow rate (m3/s)	0.93
Capacity check "Target ≥ 4EY flow"	OK

Sediment Basin to Wetland D

Sizing connection between SP and MZ (IO4, first dot point)	
4EY flow (m3/s)	0.39
Pipe number and diamater	
Number of pipes	1
Pipe diameter (mm)	600
Flow rate controlled by pipe (flowing full)	
Cp - pipe discharge coefficient	0.60
H - head level difference between NWLs at SP and MZ (m)	0.10
h - head level driving flow through the pipe (m) given that SP is at TEDD and MZ at NWL	0.45
A - pipe cross section area (m2)	0.28
V - pipe flow velocity (m/s)	2.97
Q - pipe capacity (m3/s)	0.50
Pit dimensions	
Pit length (m)	0.9
Pit width (m)	0.9
Flow rate controlled by pit acting as a weir	
B - blockage factor **"assumed to be 0.50"**	0.50
C_w - weir coefficient **"1.40 Recommended by MW, 1.70 by QLD"**	1.40
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.52
Flow rate controlled by pit acting as an orifice	
B - blockage factor **"assumed to be 0.50"**	0.50
e- portion of pit area not taken up by bars **"0.90 for pipe grille by MW"**	0.90
Cd - orifice discharge coefficient **"0.45 by MW, and 0.60 by QLD"**	0.45
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.43
Check if connection between SP & MZ has minimum capacity to cnovey 4EY flow	
Qdes - design flow rate (m3/s)	0.43
Capacity check "Target ≥ 4EY flow"	OK

Sediment Basin to Wetland E

Sizing connection between SP and MZ (IO4, first dot point)	
4EY flow (m3/s)	0.43
Pipe number and diamater	
Number of pipes	1
Pipe diameter (mm)	600
Flow rate controlled by pipe (flowing full)	
Cp - pipe discharge coefficient	0.60
H - head level difference between NWLs at SP and MZ (m)	0.10
h - head level driving flow through the pipe (m) given that SP is at TEDD and MZ at NWL	0.45
A - pipe cross section area (m2)	0.28
V - pipe flow velocity (m/s)	2.97
Q - pipe capacity (m3/s)	0.50
Pit dimensions	
Pit length (m)	1.1
Pit width (m)	0.9
Flow rate controlled by pit acting as a weir	
B - blockage factor **"assumed to be 0.50"**	0.50
C_w - weir coefficient **"1.40 Recommended by MW, 1.70 by QLD"**	1.40
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.58
Flow rate controlled by pit acting as an orifice	
B - blockage factor **"assumed to be 0.50"**	0.50
e- portion of pit area not taken up by bars **"0.90 for pipe grille by MW"**	0.90
Cd - orifice discharge coefficient **"0.45 by MW, and 0.60 by QLD"**	0.45
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.53
Check if connection between SP & MZ has minimum capacity to cnovey 4EY flow	
Qdes - design flow rate (m3/s)	0.50
Capacity check "Target ≥ 4EY flow"	OK

Sediment Basin to Wetland F

Sizing connection between SP and MZ (IO4, first dot point)	
4EY flow (m3/s)	0.32
Pipe number and diamater	
Number of pipes	1
Pipe diameter (mm)	525
Flow rate controlled by pipe (flowing full)	
Cp - pipe discharge coefficient	0.60
H - head level difference between NWLs at SP and MZ (m)	0.10
h - head level driving flow through the pipe (m) given that SP is at TEDD and MZ at NWL	0.45
A - pipe cross section area (m2)	0.22
V - pipe flow velocity (m/s)	2.97
Q - pipe capacity (m3/s)	0.39
Pit dimensions	
Pit length (m)	0.9
Pit width (m)	0.9
Flow rate controlled by pit acting as a weir	
B - blockage factor **"assumed to be 0.50"**	0.50
C_w - weir coefficient **"1.40 Recommended by MW, 1.70 by QLD"**	1.40
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.52
Flow rate controlled by pit acting as an orifice	
B - blockage factor **"assumed to be 0.50"**	0.50
e- portion of pit area not taken up by bars **"0.90 for pipe grille by MW"**	0.90
Cd - orifice discharge coefficient **"0.45 by MW, and 0.60 by QLD"**	0.45
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.43
Check if connection between SP & MZ has minimum capacity to cnovey 4EY flow	
Qdes - design flow rate (m3/s)	0.39
Capacity check "Target ≥ 4EY flow"	OK

Sediment Basin to Wetland G

Sizing connection between SP and MZ (IO4, first dot point)	
4EY flow (m3/s)	0.47
Pipe number and diamater	
Number of pipes	1
Pipe diameter (mm)	600
Flow rate controlled by pipe (flowing full)	
Cp - pipe discharge coefficient	0.60
H - head level difference between NWLs at SP and MZ (m)	0.10
h - head level driving flow through the pipe (m) given that SP is at TEDD and MZ at NWL	0.45
A - pipe cross section area (m2)	0.28
V - pipe flow velocity (m/s)	2.97
Q - pipe capacity (m3/s)	0.50
Pit dimensions	
Pit length (m)	1.1
Pit width (m)	0.9
Flow rate controlled by pit acting as a weir	
B - blockage factor **"assumed to be 0.50"**	0.50
C_w - weir coefficient **"1.40 Recommended by MW, 1.70 by QLD"**	1.40
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.58
Flow rate controlled by pit acting as an orifice	
B - blockage factor **"assumed to be 0.50"**	0.50
e- portion of pit area not taken up by bars **"0.90 for pipe grille by MW"**	0.90
Cd - orifice discharge coefficient **"0.45 by MW, and 0.60 by QLD"**	0.45
h - height of water above the crest of the outlet pit (m)	0.35
Q - pit capacity (m3/s)	0.53
Check if connection between SP & MZ has minimum capacity to cnovey 4EY flow	
Qdes - design flow rate (m3/s)	0.50
Capacity check "Target ≥ 4EY flow"	OK

C-3 Inundation Frequency Analysis

Wetland Analysis Tool

Welcome to the Wetland Analysis Tool for checking compliance with the Melbourne Water Constructed Wetland Manual. This tool assesses the wetland depths relative to plant heights and the wetland residence time and advises whether the Deemed to Comply requirements are satisfied.

Please enter the 'Shallow marsh zone planting depth' and 'Deep marsh zone plating depth'.

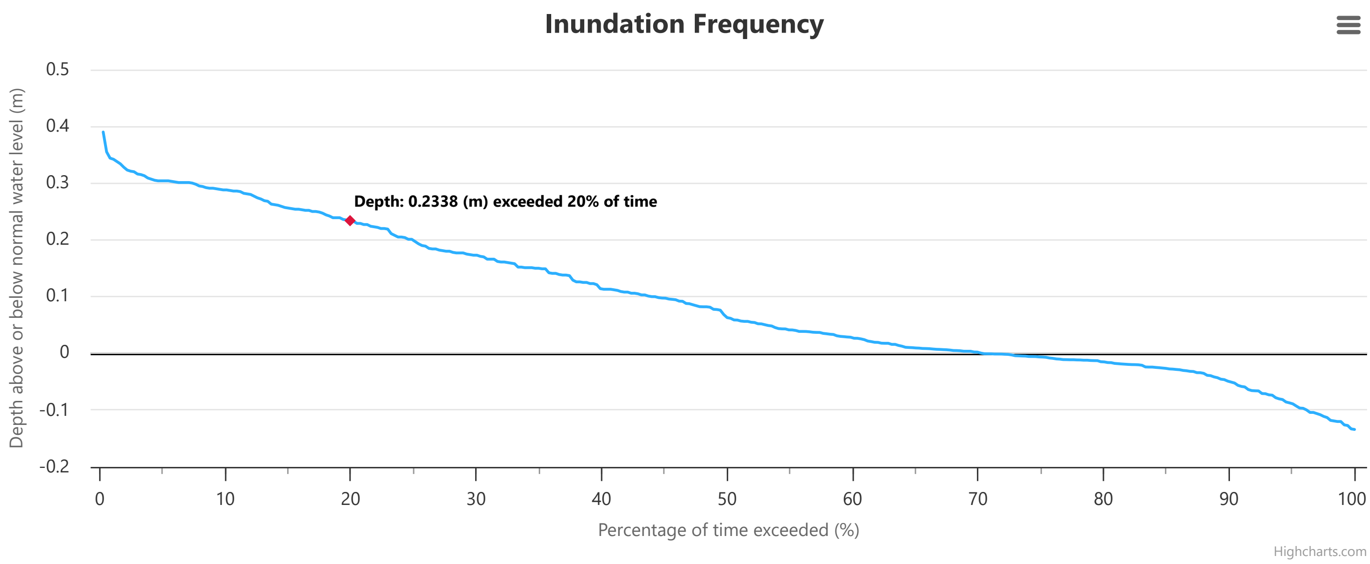
Shallow Planting Depth 0.15 m
Deep Planting Depth 0.35 m

Please enter the permanent pool volume.

Permanent Pool Volume 2973.0 m�

Please select the daily flux file generated in MUSIC for a wetland.
The file must be generated with MUSIC Version 6 and be a �DAILY� flux file.

Choose File RB A _Daily_Flux.csv
FILE IS UPLOADED



Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

Name	Average plant height (m)	Shallow marsh plants	Deep marsh plants	Suitability
Sea Club-rush *Bolboschoenus caldwellii*	1	☑		Shallow Only
Water Ribbons *Triglochin procerum*	1	☑	☐	

Jointed Club-rush *Baumea articulata*	1.8	☑	☑	
Tall Club-rush *Bolboschoenus fluviatilis*	1.8	☑	☑	
Marsh Club-rush *Bolboschoenus medianus*	1.5	☑	☑	Shallow and Deep
Leafy Twig-rush *Cladium procerum*	2	☑	☑	
River Club-rush *Schoenoplectus tabernaemontani*	1.8	☑	☑	
Tall Spike-rush *Eleocharis sphacelata*	1.5		☑	Deep Only
Common reed *Phragmites australis*	2.5		☑	
Common Spike-rush *Eleocharis acuta*	0.5	☐		Unsuitable

[+] Add user defined plant

Report

File: RB A _Daily_Flux.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.2338 m

Water level exceeded for 50% of time: 0.630E-01 m
·Warning: Effective normal water level is significantly above design normal water level. It is recommended that the effective water level of (xxx m) is adopted as the base for determining shallow and deep marsh zone depths and extents. It may be desirable to adjust the bypasses, outlet design or wetland size to reduce the difference in design and effective normal water level.

90th Percentile Residence Time: 2 days

☐ Spells Analysis?

Wetland Analysis Tool

Welcome to the Wetland Analysis Tool for checking compliance with the Melbourne Water Constructed Wetland Manual. This tool assesses the wetland depths relative to plant heights and the wetland residence time and advises whether the Deemed to Comply requirements are satisfied.

Please enter the 'Shallow marsh zone planting depth' and 'Deep marsh zone plating depth'.

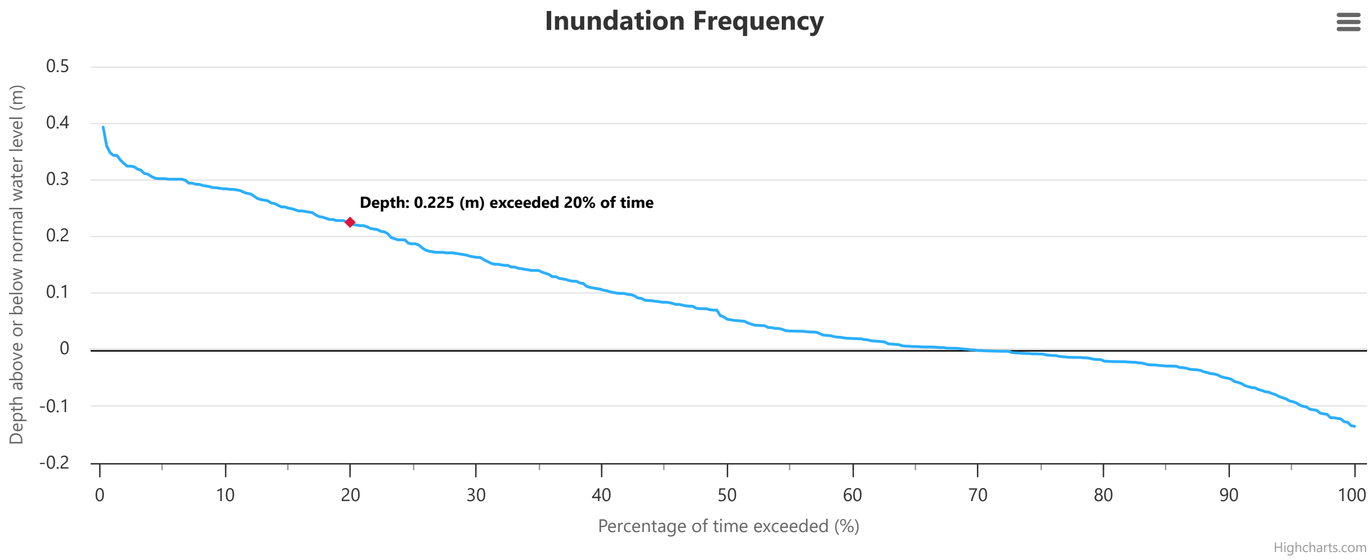
Shallow Planting Depth 0.15 m
Deep Planting Depth 0.35 m

Please enter the permanent pool volume.

Permanent Pool Volume 3369.0 m�

Please select the daily flux file generated in MUSIC for a wetland.
The file must be generated with MUSIC Version 6 and be a �DAILY� flux file.

Choose File RB B_Daily_Flux.csv
FILE IS UPLOADED



Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

Name	Average plant height (m)	Shallow marsh plants	Deep marsh plants	Suitability
Sea Club-rush *Bolboschoenus caldwellii*	1	☑		Shallow Only
Water Ribbons *Triglochin procerum*	1	☑	☐	

Jointed Club-rush *Baumea articulata*	1.8	☑	☑	
Tall Club-rush *Bolboschoenus fluviatilis*	1.8	☑	☑	
Marsh Club-rush *Bolboschoenus medianus*	1.5	☑	☑	Shallow and Deep
Leafy Twig-rush *Cladium procerum*	2	☑	☑	
River Club-rush *Schoenoplectus tabernaemontani*	1.8	☑	☑	
Tall Spike-rush *Eleocharis sphacelata*	1.5		☑	Deep Only
Common reed *Phragmites australis*	2.5		☑	
Common Spike-rush *Eleocharis acuta*	0.5	☐		Unsuitable

[+] Add user defined plant

Report

File: RB B_Daily_Flux.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.225 m

Water level exceeded for 50% of time: 0.539E-01 m
·Warning: Effective normal water level is significantly above design normal water level. It is recommended that the effective water level of (xxx m) is adopted as the base for determining shallow and deep marsh zone depths and extents. It may be desirable to adjust the bypasses, outlet design or wetland size to reduce the difference in design and effective normal water level.

90th Percentile Residence Time: 2 days

☐ Spells Analysis?

Wetland Analysis Tool

Welcome to the Wetland Analysis Tool for checking compliance with the Melbourne Water Constructed Wetland Manual. This tool assesses the wetland depths relative to plant heights and the wetland residence time and advises whether the Deemed to Comply requirements are satisfied.

Please enter the 'Shallow marsh zone planting depth' and 'Deep marsh zone plating depth'.

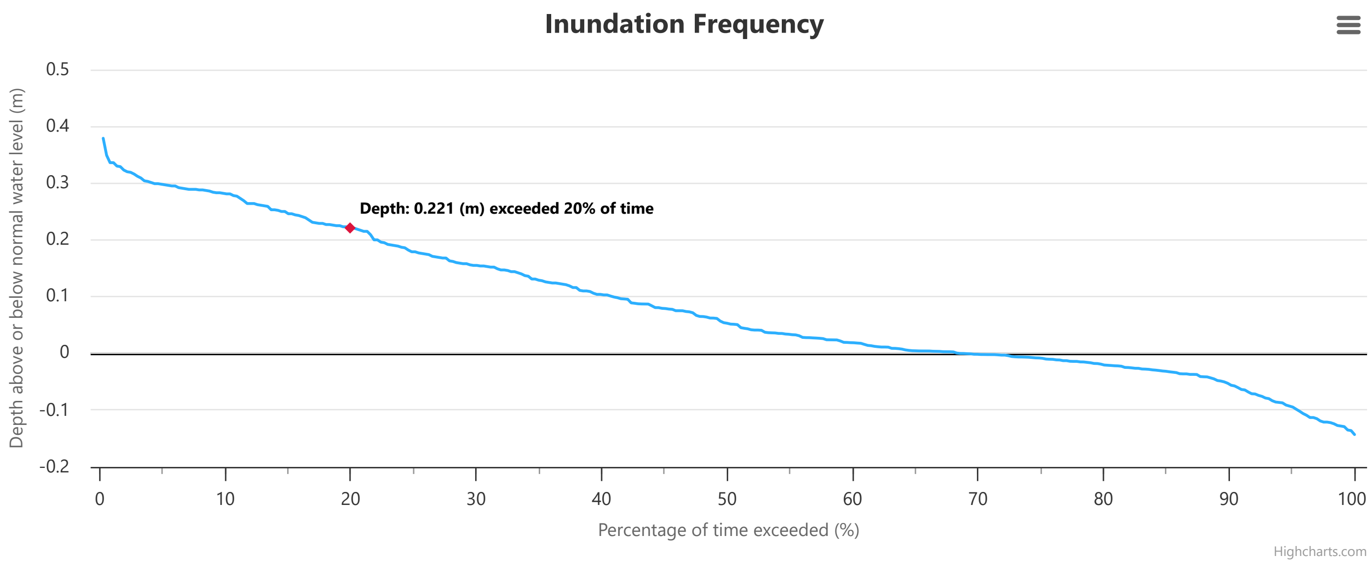
Shallow Planting Depth 0.15 m
Deep Planting Depth 0.35 m

Please enter the permanent pool volume.

Permanent Pool Volume 2837.0 m�

Please select the daily flux file generated in MUSIC for a wetland.
The file must be generated with MUSIC Version 6 and be a �DAILY� flux file.

Choose File RB C_Daily_Flux.csv
FILE IS UPLOADED



Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

Name	Average plant height (m)	Shallow marsh plants	Deep marsh plants	Suitability
Sea Club-rush *Bolboschoenus caldwellii*	1	☑		Shallow Only
Water Ribbons *Triglochin procerum*	1	☑	☐	

Jointed Club-rush *Baumea articulata*	1.8	☑	☑	
Tall Club-rush *Bolboschoenus fluviatilis*	1.8	☑	☑	
Marsh Club-rush *Bolboschoenus medianus*	1.5	☑	☑	Shallow and Deep
Leafy Twig-rush *Cladium procerum*	2	☑	☑	
River Club-rush *Schoenoplectus tabernaemontani*	1.8	☑	☑	
Tall Spike-rush *Eleocharis sphacelata*	1.5		☑	Deep Only
Common reed *Phragmites australis*	2.5		☑	
Common Spike-rush *Eleocharis acuta*	0.5	☐		Unsuitable

[+] Add user defined plant

Report

File: RB C_Daily_Flux.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.221 m

Water level exceeded for 50% of time: 0.531E-01 m
·Warning: Effective normal water level is significantly above design normal water level. It is recommended that the effective water level of (xxx m) is adopted as the base for determining shallow and deep marsh zone depths and extents. It may be desirable to adjust the bypasses, outlet design or wetland size to reduce the difference in design and effective normal water level.

90th Percentile Residence Time: 2 days

☐ Spells Analysis?

Wetland Analysis Tool

Welcome to the Wetland Analysis Tool for checking compliance with the Melbourne Water Constructed Wetland Manual. This tool assesses the wetland depths relative to plant heights and the wetland residence time and advises whether the Deemed to Comply requirements are satisfied.

Please enter the '[Shallow marsh zone planting depth]' and '[Deep marsh zone plating depth]'.

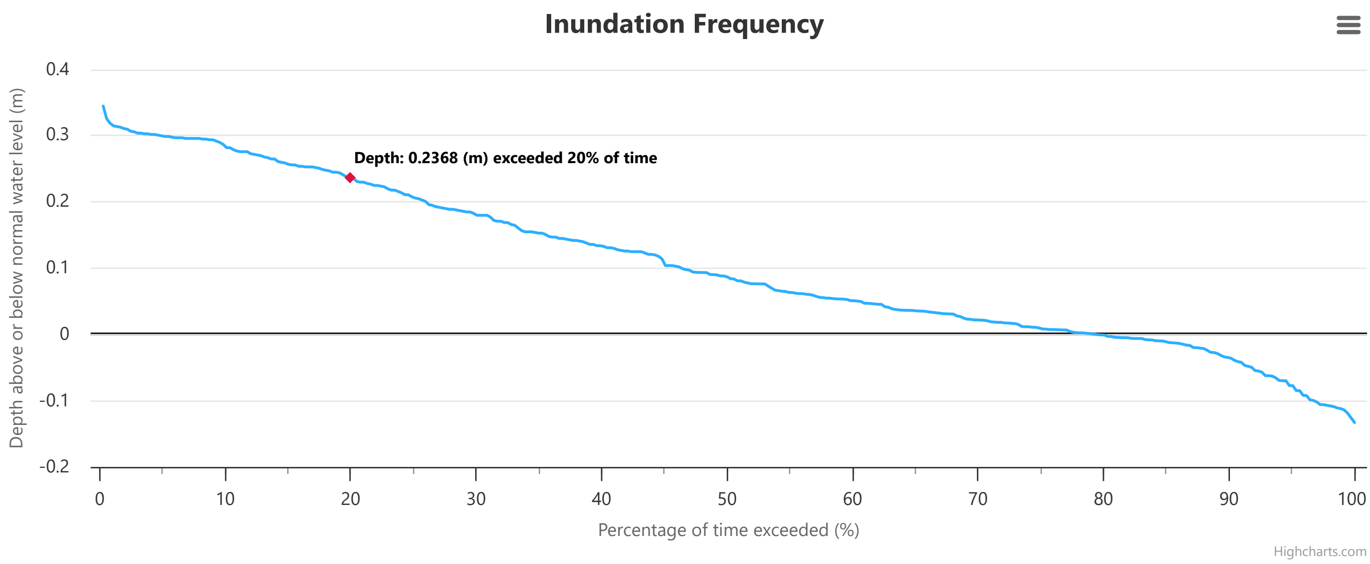
Shallow Planting Depth 0.15 m
Deep Planting Depth 0.35 m

Please enter the permanent pool volume.

Permanent Pool Volume 1302.0 m�

Please select the [daily flux file] generated in MUSIC for a wetland.
The file must be generated with MUSIC Version 6 and be a �DAILY� flux file.

Choose File RB D_Daily_Flux.csv
FILE IS UPLOADED



Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

Name	Average plant height (m)	Shallow marsh plants	Deep marsh plants	Suitability
Sea Club-rush *Bolboschoenus caldwellii*	1	☑		Shallow Only
Water Ribbons *Triglochin procerum*	1	☑	☐	

Jointed Club-rush *Baumea articulata*	1.8	☑	☑	
Tall Club-rush *Bolboschoenus fluviatilis*	1.8	☑	☑	
Marsh Club-rush *Bolboschoenus medianus*	1.5	☑	☑	Shallow and Deep
Leafy Twig-rush *Cladium procerum*	2	☑	☑	
River Club-rush *Schoenoplectus tabernaemontani*	1.8	☑	☑	
Tall Spike-rush *Eleocharis sphacelata*	1.5		☑	Deep Only
Common reed *Phragmites australis*	2.5		☑	
Common Spike-rush *Eleocharis acuta*	0.5	☐		Unsuitable

[+] Add user defined plant

Report

File: RB D_Daily_Flux.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.2368 m

Water level exceeded for 50% of time: 0.870E-01 m
·Warning: Effective normal water level is significantly above design normal water level. It is recommended that the effective water level of (xxx m) is adopted as the base for determining shallow and deep marsh zone depths and extents. It may be desirable to adjust the bypasses, outlet design or wetland size to reduce the difference in design and effective normal water level.

90th Percentile Residence Time: 3 days

☐ Spells Analysis?

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›

Wetland Analysis Tool

Welcome to the Wetland Analysis Tool for checking compliance with the Melbourne Water Constructed Wetland Manual. This tool assesses the wetland depths relative to plant heights and the wetland residence time and advises whether the Deemed to Comply requirements are satisfied.

Please enter the '[Shallow marsh zone planting depth]' and '[Deep marsh zone plating depth]'.

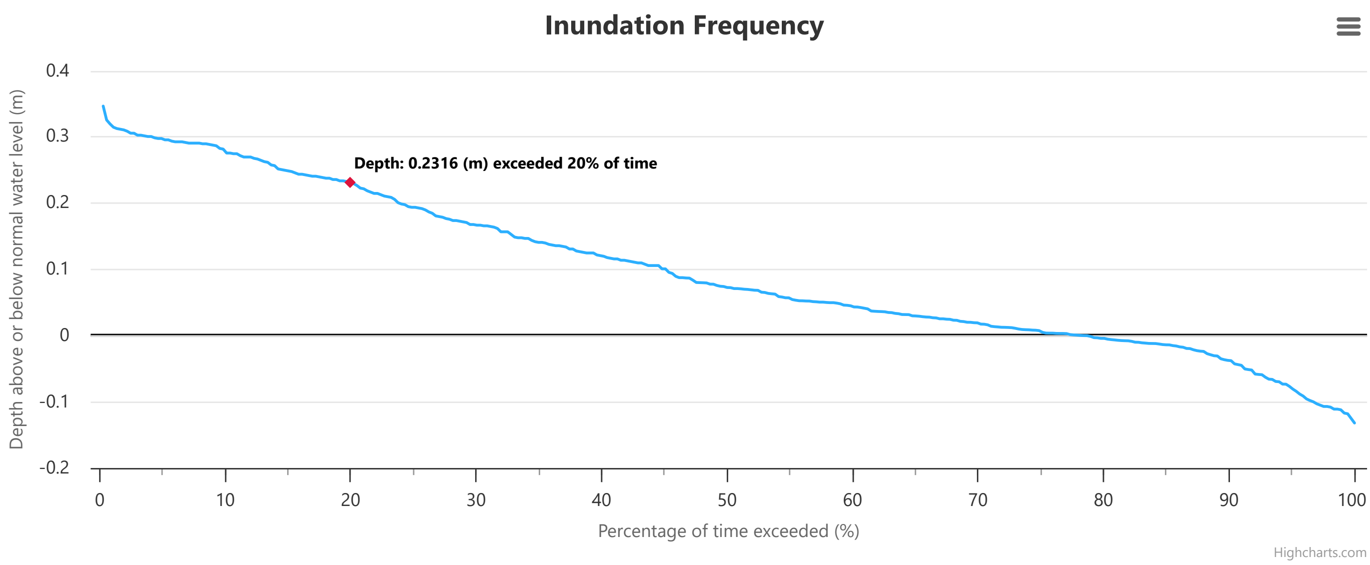
Shallow Planting Depth 0.15 m
Deep Planting Depth 0.35 m

Please enter the permanent pool volume.

Permanent Pool Volume 1207.0 m�

Please select the [daily flux file] generated in MUSIC for a wetland.
The file must be generated with MUSIC Version 6 and be a �DAILY� flux file.

Choose File RB E_Daily_Flux.csv
FILE IS UPLOADED



Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

Name	Average plant height (m)	Shallow marsh plants	Deep marsh plants	Suitability
Sea Club-rush *Bolboschoenus caldwellii*	1	☑		Shallow Only
Water Ribbons *Triglochin procerum*	1	☑	☐	

Jointed Club-rush *Baumea articulata*	1.8	☑	☑	
Tall Club-rush *Bolboschoenus fluviatilis*	1.8	☑	☑	
Marsh Club-rush *Bolboschoenus medianus*	1.5	☑	☑	Shallow and Deep
Leafy Twig-rush *Cladium procerum*	2	☑	☑	
River Club-rush *Schoenoplectus tabernaemontani*	1.8	☑	☑	
Tall Spike-rush *Eleocharis sphacelata*	1.5		☑	Deep Only
Common reed *Phragmites australis*	2.5		☑	
Common Spike-rush *Eleocharis acuta*	0.5	☐		Unsuitable

[+] Add user defined plant

Report

File: RB E_Daily_Flux.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.2316 m

Water level exceeded for 50% of time: 0.728E-01 m
·Warning: Effective normal water level is significantly above design normal water level. It is recommended that the effective water level of (xxx m) is adopted as the base for determining shallow and deep marsh zone depths and extents. It may be desirable to adjust the bypasses, outlet design or wetland size to reduce the difference in design and effective normal water level.

90th Percentile Residence Time: 2 days

☐ Spells Analysis?

Wetland Analysis Tool

Welcome to the Wetland Analysis Tool for checking compliance with the Melbourne Water Constructed Wetland Manual. This tool assesses the wetland depths relative to plant heights and the wetland residence time and advises whether the Deemed to Comply requirements are satisfied.

Please enter the '[Shallow marsh zone planting depth]' and '[Deep marsh zone plating depth]'.

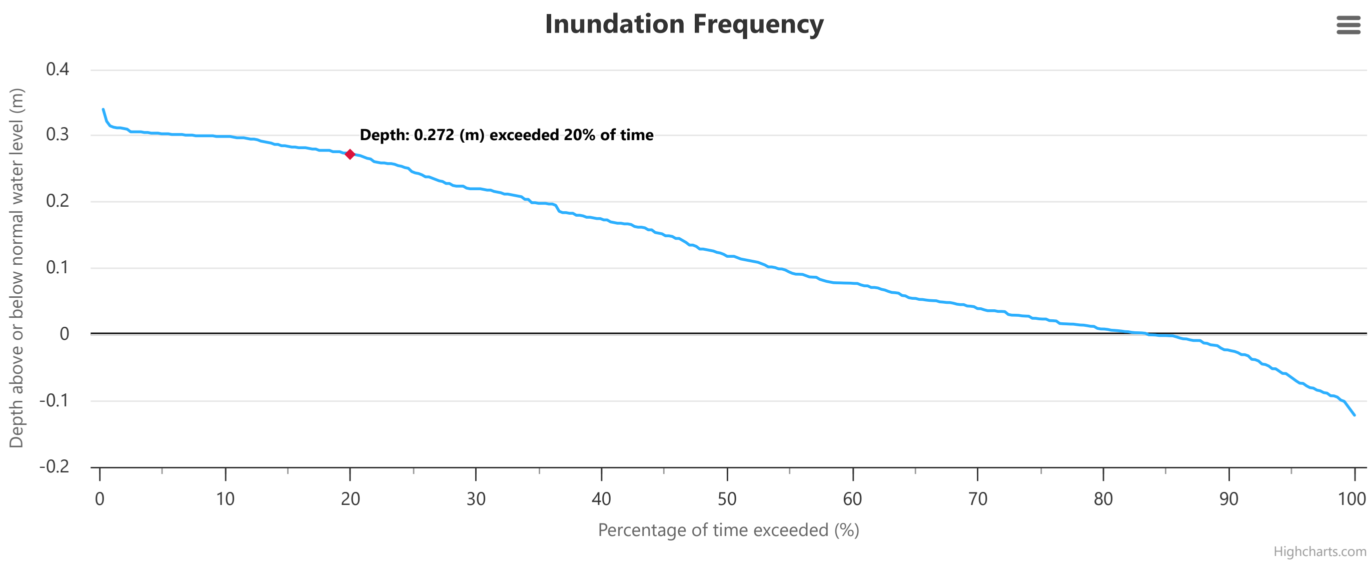
Shallow Planting Depth 0.15 m
Deep Planting Depth 0.35 m

Please enter the permanent pool volume.

Permanent Pool Volume 1005.0 m�

Please select the [daily flux file] generated in MUSIC for a wetland.
The file must be generated with MUSIC Version 6 and be a �DAILY� flux file.

Choose File RB F_Daily_Flux.csv
FILE IS UPLOADED



Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

Name	Average plant height (m)	Shallow marsh plants	Deep marsh plants	Suitability
Sea Club-rush *Bolboschoenus caldwellii*	1	☑		Shallow Only
Water Ribbons *Triglochin procerum*	1	☑	☐	

Jointed Club-rush *Baumea articulata*	1.8	☑	☑	
Tall Club-rush *Bolboschoenus fluviatilis*	1.8	☑	☑	
Marsh Club-rush *Bolboschoenus medianus*	1.5	☑	☑	Shallow and Deep
Leafy Twig-rush *Cladium procerum*	2	☑	☑	
River Club-rush *Schoenoplectus tabernaemontani*	1.8	☑	☑	
Tall Spike-rush *Eleocharis sphacelata*	1.5		☑	Deep Only
Common reed *Phragmites australis*	2.5		☑	
Common Spike-rush *Eleocharis acuta*	0.5	☐		Unsuitable

[+] Add user defined plant

Report

File: RB F_Daily_Flux.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.272 m

Water level exceeded for 50% of time: 0.118 m
·Warning: Effective normal water level is significantly above design normal water level. It is recommended that the effective water level of (xxx m) is adopted as the base for determining shallow and deep marsh zone depths and extents. It may be desirable to adjust the bypasses, outlet design or wetland size to reduce the difference in design and effective normal water level.

90th Percentile Residence Time: 4 days

☐ Spells Analysis?

Wetland Analysis Tool

Welcome to the Wetland Analysis Tool for checking compliance with the Melbourne Water Constructed Wetland Manual. This tool assesses the wetland depths relative to plant heights and the wetland residence time and advises whether the Deemed to Comply requirements are satisfied.

Please enter the '[Shallow marsh zone planting depth](#)' and '[Deep marsh zone plating depth](#)'.

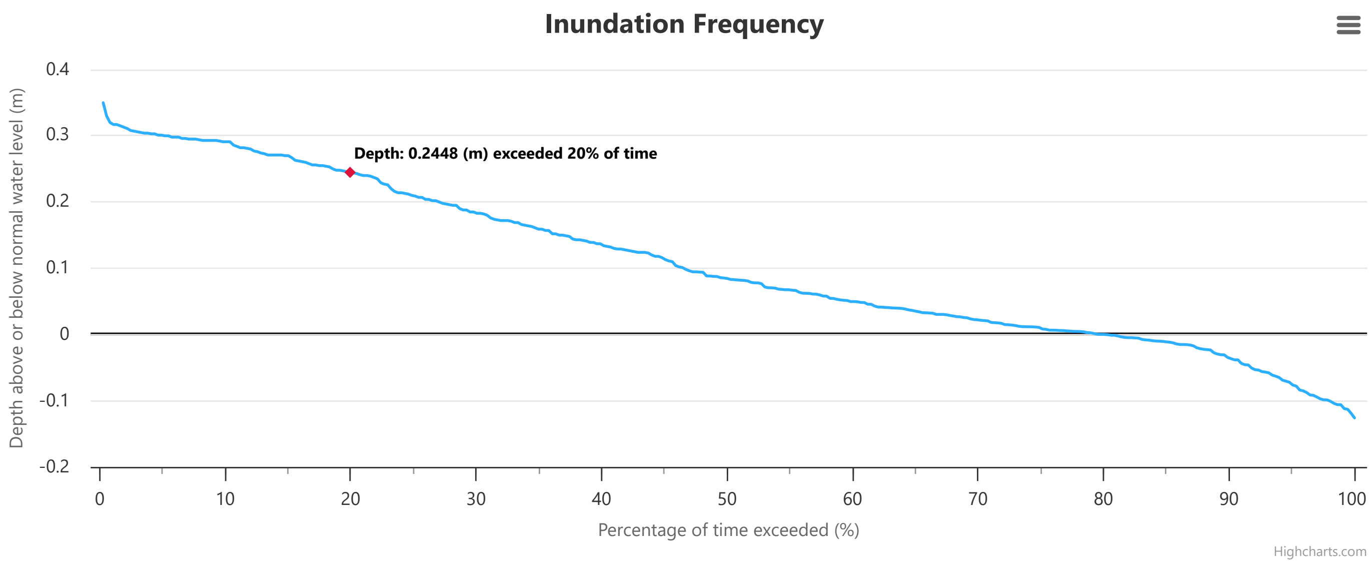
Shallow Planting Depth 0.15 m
Deep Planting Depth 0.35 m

Please enter the permanent pool volume.

Permanent Pool Volume 1326.0 m�

Please select the [daily flux file](#) generated in MUSIC for a wetland.
The file must be generated with MUSIC Version 6 and be a �DAILY� flux file.

Choose File RB G_Daily_Flux.csv
FILE IS UPLOADED



Please select at least 3 plants for each of the shallow and deep marsh zones.

Clear Selection

Name	Average plant height (m)	Shallow marsh plants	Deep marsh plants	Suitability
Sea Club-rush *Bolboschoenus caldwellii*	1	☑		Shallow Only
Water Ribbons *Triglochin procerum*	1	☑	☐	

Jointed Club-rush *Baumea articulata*	1.8	☑	☑	
Tall Club-rush *Bolboschoenus fluviatilis*	1.8	☑	☑	
Marsh Club-rush *Bolboschoenus medianus*	1.5	☑	☑	Shallow and Deep
Leafy Twig-rush *Cladium procerum*	2	☑	☑	
River Club-rush *Schoenoplectus tabernaemontani*	1.8	☑	☑	
Tall Spike-rush *Eleocharis sphacelata*	1.5		☑	Deep Only
Common reed *Phragmites australis*	2.5		☑	
Common Spike-rush *Eleocharis acuta*	0.5	☐		Unsuitable

[+] Add user defined plant

Report

File: RB G_Daily_Flux.csv
Shallow marsh zone meets deemed to comply criteria

Deep marsh zone meets deemed to comply criteria

Water level exceeded for 20% of time: 0.2448 m

Water level exceeded for 50% of time: 0.846E-01 m
·Warning: Effective normal water level is significantly above design normal water level. It is recommended that the effective water level of (xxx m) is adopted as the base for determining shallow and deep marsh zone depths and extents. It may be desirable to adjust the bypasses, outlet design or wetland size to reduce the difference in design and effective normal water level.

90th Percentile Residence Time: 3 days

☐ Spells Analysis?

Appendix D

Integrated Water Management Strategy

D-1 IWMS Summary Tables

Site Information

Table D-1-1 Lot Balance

Lot Size (m^2)	Number of lots	Occupancy
0-300	0	
300-500	6,908	2.8
>500	0	
Total	6,908	

Table D-1-2 Land Budget

Land Use	Unit	Value	Percentage
Residential	ha	276.3	67.7
Active Open Space	ha	17.75	4.4
Passive Open Space	ha	31.15	7.6
Commercial	ha	7.45	1.8
Education	ha	15.11	3.7
Transport	ha	20.07	4.9
Drainage Reserve	ha	38.05	9.3
Other Developable Area	ha	2.12	0.5
Total	ha	408.00	100.0

MUSIC Model Inputs

Table D-1-3 MUSIC Model Parameters

Parameter	Unit	Value
Rainfall station	Station # and location	90082 – Warrnambool Post Office
Date period	Year starting to year ending	1962 - 1971
Time step	Daily	-

Analysis Assumptions

Table D-1-4 Water Demand Assumptions

Parameter	Unit	Value
Residential		
Potable water demand (per lot)	L/day	329
Non-potable water demand incl irrigation (per lot)	L/day	110
Active Open Space		
Irrigation rate for active open space	ML/ha/year	5
Passive Open Space		
Irrigation rate for passive open space	ML/ha/year	2

Table D-1-5 Reuse Demand Assumptions

Parameter	Unit	Value
Residential		
Toilet reuse demand (per lot)	L/day	56
Irrigation reuse demand (per lot)	L/day	106
Rainwater tank volume (per lot)	kL	2
Uptake rate of rainwater tank installed for residential lots	%	100
Total reuse supplied	KL/day	841.5
Total reuse supplied	ML/year	307.1

Table D-1-6 Site Total Water Demand Assumptions

Parameter	Unit	Value
Residential potable water demand	ML/year	829.5
Residential non-potable water demand	ML/year	339.7
Residential potable and non-potable water demand	ML/year	1,169.2
Residential rainwater tanks installed	no.	6,908
Residential areas rainwater supplied	ML/year	307.1
Residential areas stormwater supplied	ML/year	0
Residential alternative water supplied (non-potable water demand minus rainwater supplied)	ML/year	32.5
Residential potable water reduction from alternative water supplied	%	29

D-2 MUSIC Modelling Layout

The snippets of the MUSIC model incorporating rainwater harvesting tanks are shown in the figures below.

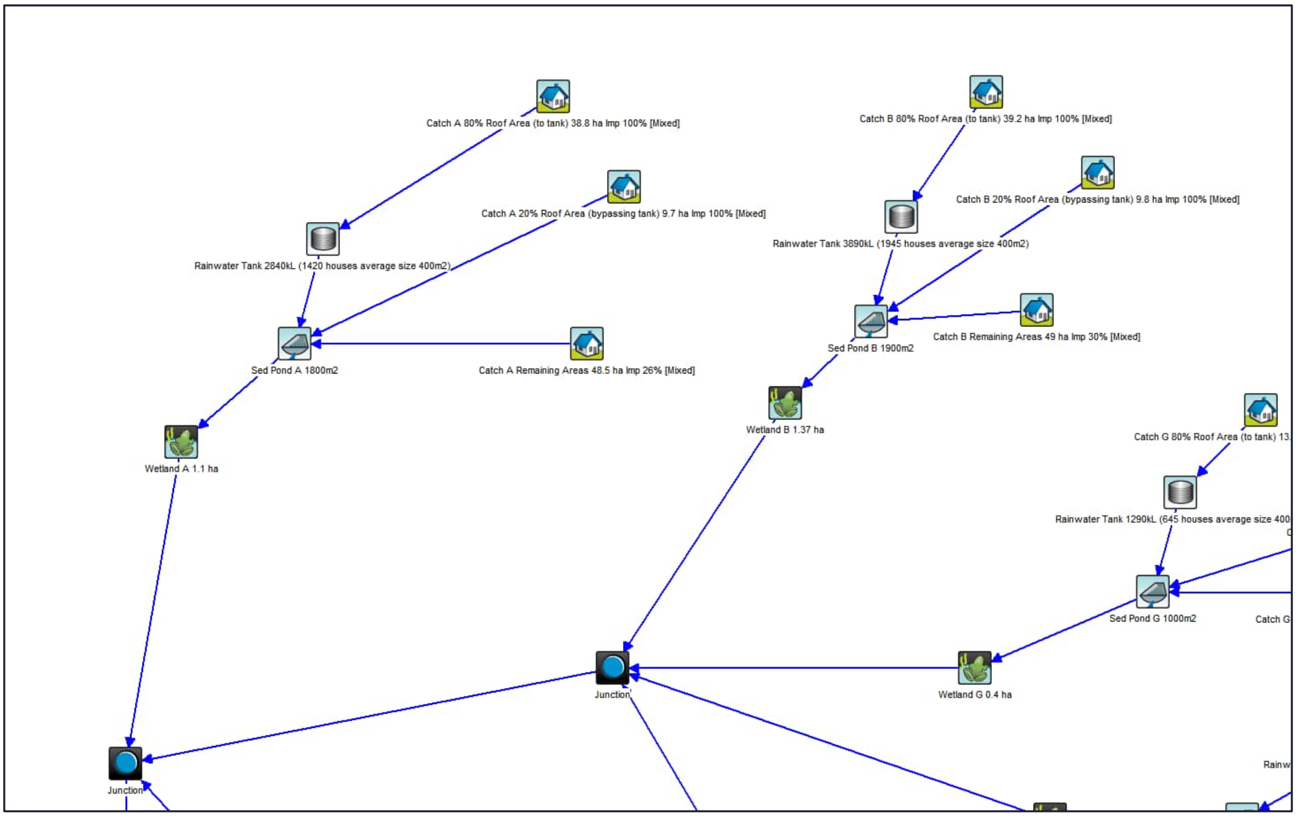


Figure D-2-1 MUSIC Model Layout – Catchments A and B

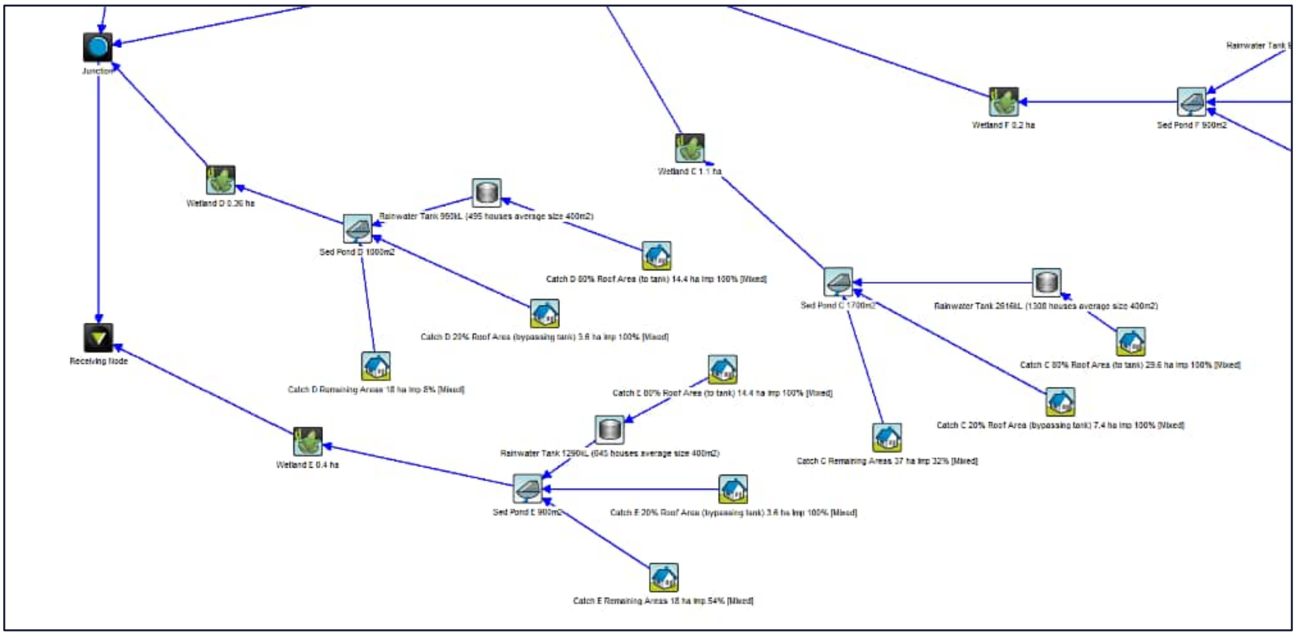


Figure D-2-2 MUSIC Model Layout – Catchments C, D, and E

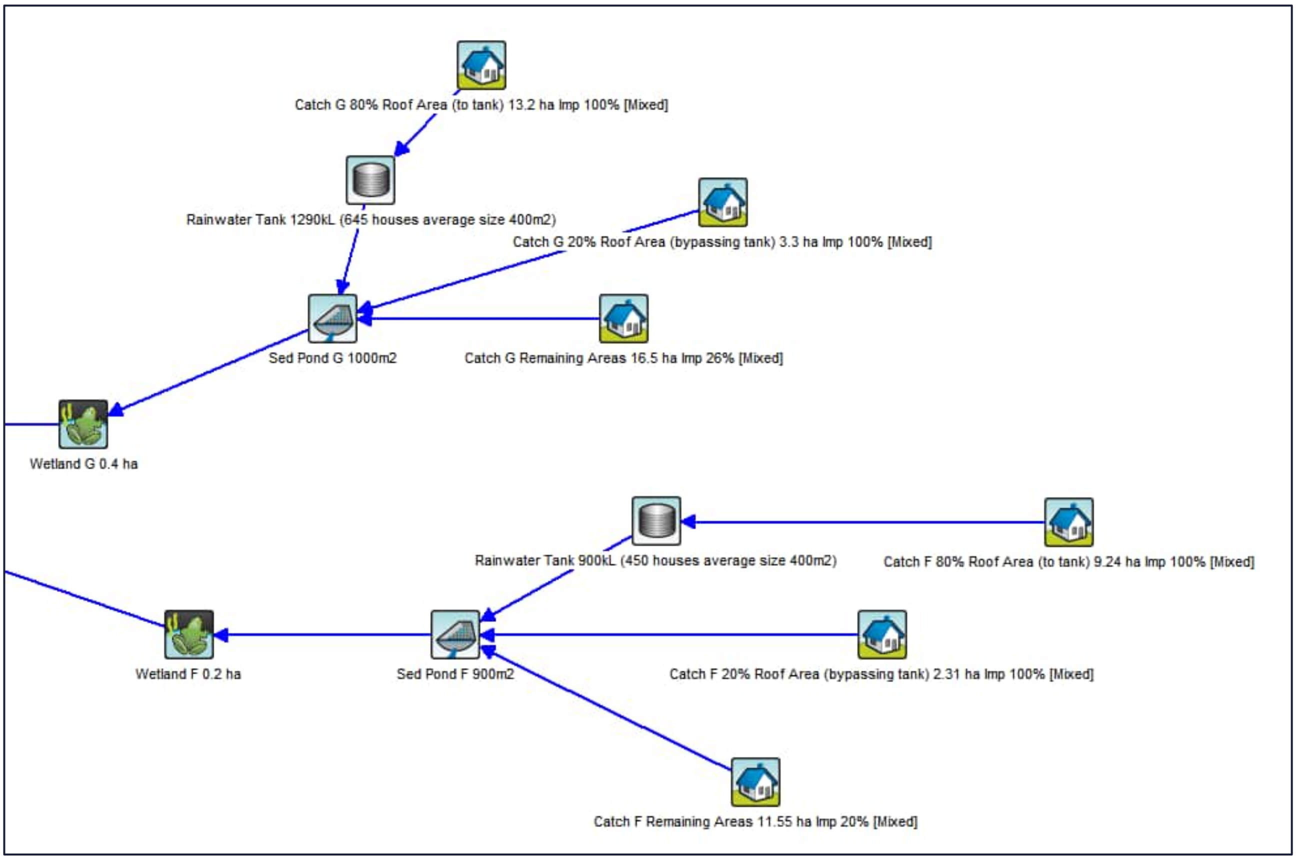


Figure D-2-3 MUSIC Model Layout – Catchments F and G

Appendix E

Technical Memo - GHCMA

Technical Memorandum

Memo No.	181-TM-001	Date of Issue	1 April 2025
Subject	Russell Creek Interim Flood Extent	Discipline	Flood Modelling
Project Title	East of Aberline PSP Stormwater Functional Design	Project No.	30043612
Document No.	30046312-181-TM-001	Revision	0
Author	Karl Velasco – Associate Engineer Water Resources / Project Manager		
Reviewed by	Tim Rhodes – Technical Principal Water Resources	Approved by	Sander van Hall – Project Director
Prepared for	Gareth Hately - Victorian Planning Authority	Attention to	Glenelg Hopkins Catchment Management Authority
Attachments	• Appendix B – Flood Maps		

1. Introduction

SMEC has been engaged by the Victorian Planning Authority (VPA) to prepare a stormwater drainage strategy for the East of Aberline Precinct Structure Plan (PSP). The subject site is located approximately 4.5 km northeast of Warrnambool as shown in **Figure 1-1**.

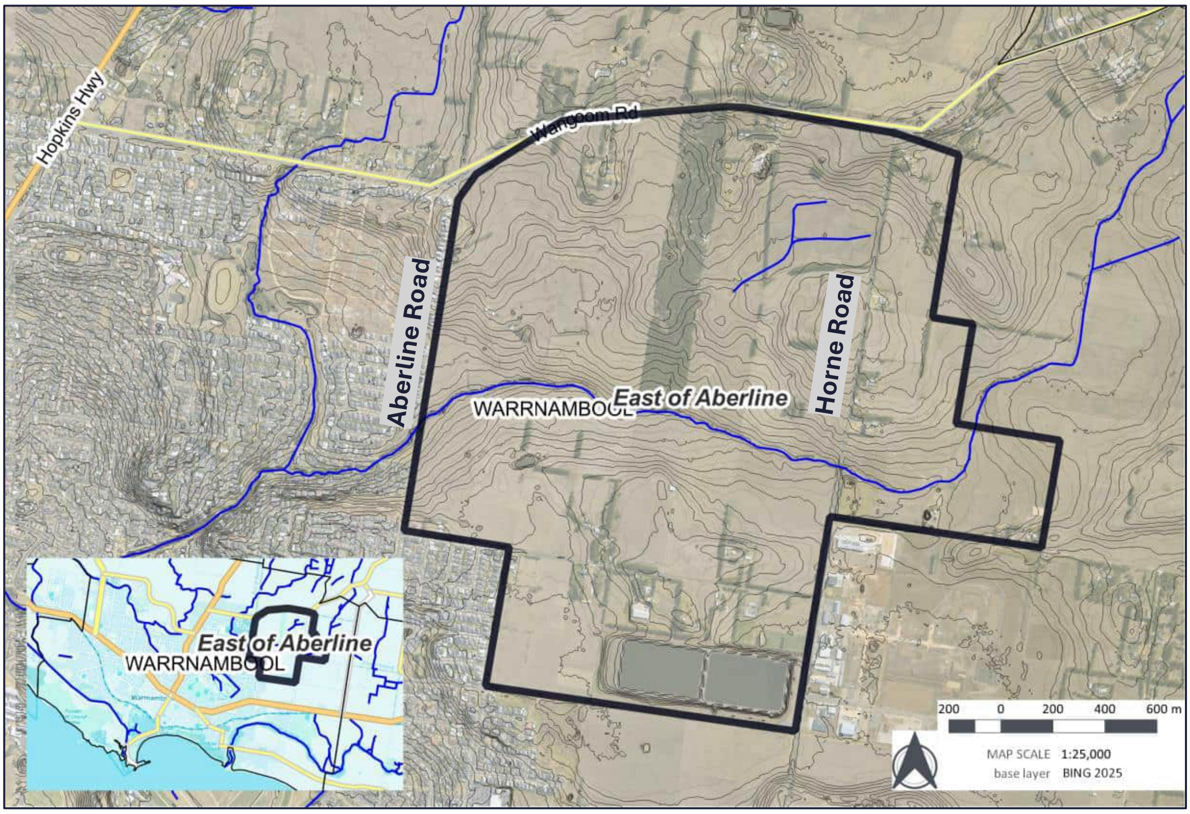


Figure 1-1 East of Aberline PSP and Russell Creek

A number of previous flood studies and drainage strategies for the Russell Creek area were reviewed to inform the PSP. These are as follows:

- Existing Situational Analysis Report | East of Aberline PSP | Stormwater Drainage Concept and Functional Design (Spiire, 2020)
- Aberline to Horne Growth Corridor | Stormwater Management Report (Engeny, 2018)
- Russell Creek Flood Mitigation – As constructed Flood Modelling (Water Technology, 2017)
- Design of North Warrnambool Floodplain Management Plan | Implementation Works (Cardno, 2010)

The industry standard guideline document for flood analysis, Australian Rainfall and Runoff was updated in 2019 (Ball et al., 2019) and more recently in September 2024 (Version 4.2). The updates incorporate changes to design rainfall and then, in 2024, changes to climate change impact estimation procedures. As a result, the Russell Creek flood extent for the 1% AEP is now out of date.

The flood extent defines the development exclusion zone and an estimate of the updated flood extent is required to inform the Russell Creek waterway corridor and provide certainty for development planning purposes.

1.1 Consultation with GHCMA

SMEC's scope does not include a comprehensive flood study for the entire Russell Creek catchment, instead SMEC proposes an interim design basis to inform the PSP drainage investigation that is acceptable to Glenelg Hopkins Catchment Management Authority (GHCMA). The methodology proposed below outlines a conservative approach for GHCMA consideration and approval.

2. Methodology

2.1 Inputs

The preliminary flood model described in Spiire (2020) was supplied by the VPA inclusive of the associated data as follows:

- Russell Creek– rainfall runoff model – RORB
- Russell Creek - 2d hydraulic model - TUFLOW
- RORB sub catchment and reaches in GIS format (shapefiles) (from Water Technology, 2017)

2.2 Hydrology

The interim modelling methodology assesses the sensitivity of the flood extent to the hydrological inputs. Three scenarios were evaluated as follows.

1. Existing conditions (without climate change) – based on outcomes presented in Water Technology (2017) and Spiire (2020).
2. Existing conditions (with climate change uplift using 2017 procedures)– based on outcomes presented in Spiire (2020).
3. Existing conditions (with climate change uplift using 2024 procedures) – based on Ball et al. (2019) and GHCMA (2024).

The design rainfall depths and uplifts adopted for each scenario are summarised in **Table 2-1**.

Table 2-1 Hydrological Sensitivity Scenarios

Scenario Number	Description	Design Rainfall Depth Source	Adopted Time Horizon	Global Climate Condition	Design Rainfall Depth Uplift Factor
1	Existing conditions (without climate change)	BoM IFD 2016	n/a	n/a	n/a
2	Existing conditions (with climate change uplift using 2017 procedures)	BoM IFD 2016 w/ uplift as per Ball et al. (2019) Version 4.1	2100	RCP8.5 3.57 degrees °C increase	1.19
3	Existing conditions (with climate change uplift using 2024 procedures)	BoM IFD 2016 w/ uplift as per Ball et al. (2019) Version 4.2	2100	SSP8.5 4.5 degrees °C increase	1.41 to 1.86[1]

1. Uplift factor varies with storm duration

Scenario 1 represents the existing conditions without climate change uplift and adopting the latest (2016) design rainfall depths (IFD).

Scenario 2 represents the existing conditions with climate change scenario uplift of 19% adopting a global temperature (3.57°C) increase in the year 2100 consistent with former practice in 2017.

Scenario 3 is the existing condition with climate change scenario based on Ball et al. (2019) flood modelling guidance which specifies an increase in global temperature of 4.5 °C in the year 2100. The climate change uplift factors vary depending on the storm duration and AEP. A summary table of the uplift factors applicable to the site location is illustrated in **Table 2-2**. Detailed climate change factors are included in **Appendix A**.

Table 2-2 Data hub Climate Change Consideration Uplift Factors (Babister et al. 2016)

SSP5-8.5

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	**1.2**	**1.18**	**1.17**	**1.16**	**1.14**	**1.13**	**1.13**	**1.12**	**1.11**	**1.11**
2040	1.26	1.24	1.22	1.2	1.18	1.17	1.16	1.15	1.14	1.14
2050	**1.34**	**1.31**	**1.29**	**1.26**	**1.24**	**1.23**	**1.21**	**1.2**	**1.18**	**1.18**
2060	1.42	1.38	1.35	1.32	1.29	1.28	1.26	1.24	1.22	1.21
2070	1.52	1.47	1.43	1.4	1.36	1.34	1.31	1.29	1.27	1.26
2080	1.63	1.57	1.52	1.48	1.43	1.4	1.37	1.35	1.33	1.31
2090	**1.77**	**1.69**	**1.64**	**1.58**	**1.52**	**1.49**	**1.45**	**1.42**	**1.39**	**1.37**
2100	1.86	1.77	1.71	1.64	1.58	1.54	1.5	1.47	1.43	1.41

2.3 RORB model setup

For scenario 1 & 2, the previous RORB (Laurenson et al., 2010) model was rerun from the Spiire (2020) study. Refer to **Figure 2-1**.

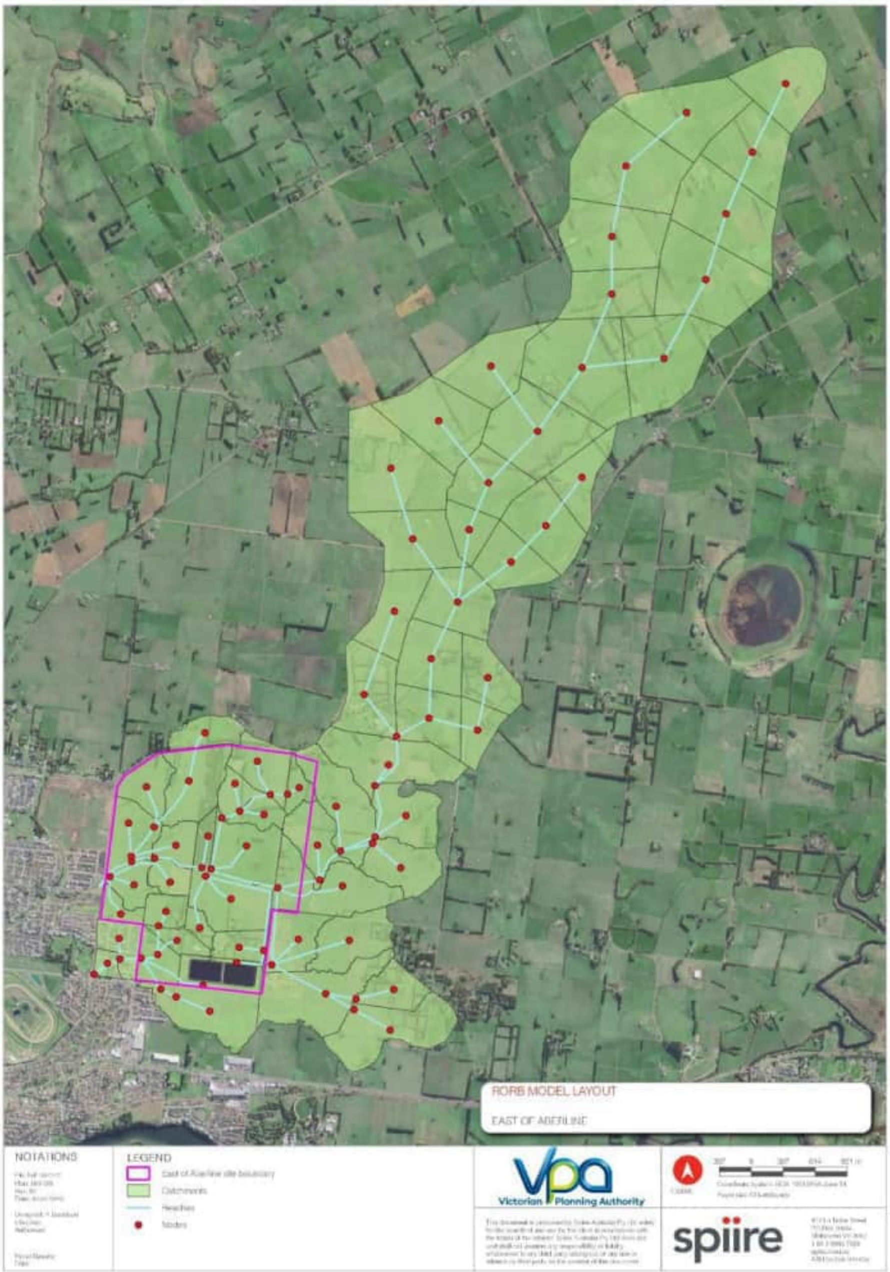


Figure 2-1 Spiire (2020) RORB Model Setup

For scenario 3, a new RORB model was created with smaller subareas representing the PSP area. Refer to **Figure 2-2** for the SMEC RORB model. For the external catchment upstream of the PSP, the subarea delineation and reach setup were based on the Water Technology (2017) Russell Creek model setup as shown in **Figure 2-3**.

A k_c value of 5.71 was adopted in the overall SMEC model to achieve a match to the peak flow of 32 m^3/s at Aberline Road (Water Technology, 2017). In order to account for the difference of subarea scale, the RORB interstation function was applied for the smaller subareas representing the 6 sub catchments adjacent to Russell Creek. There are in total 6 interstation areas created as shown in **Figure 2-2**. This allows the routing parameters to maintain the k_c/d_{ave} ratio for each sub catchment interstation. The k_c values for each interstation are presented in **Table 2-3**.

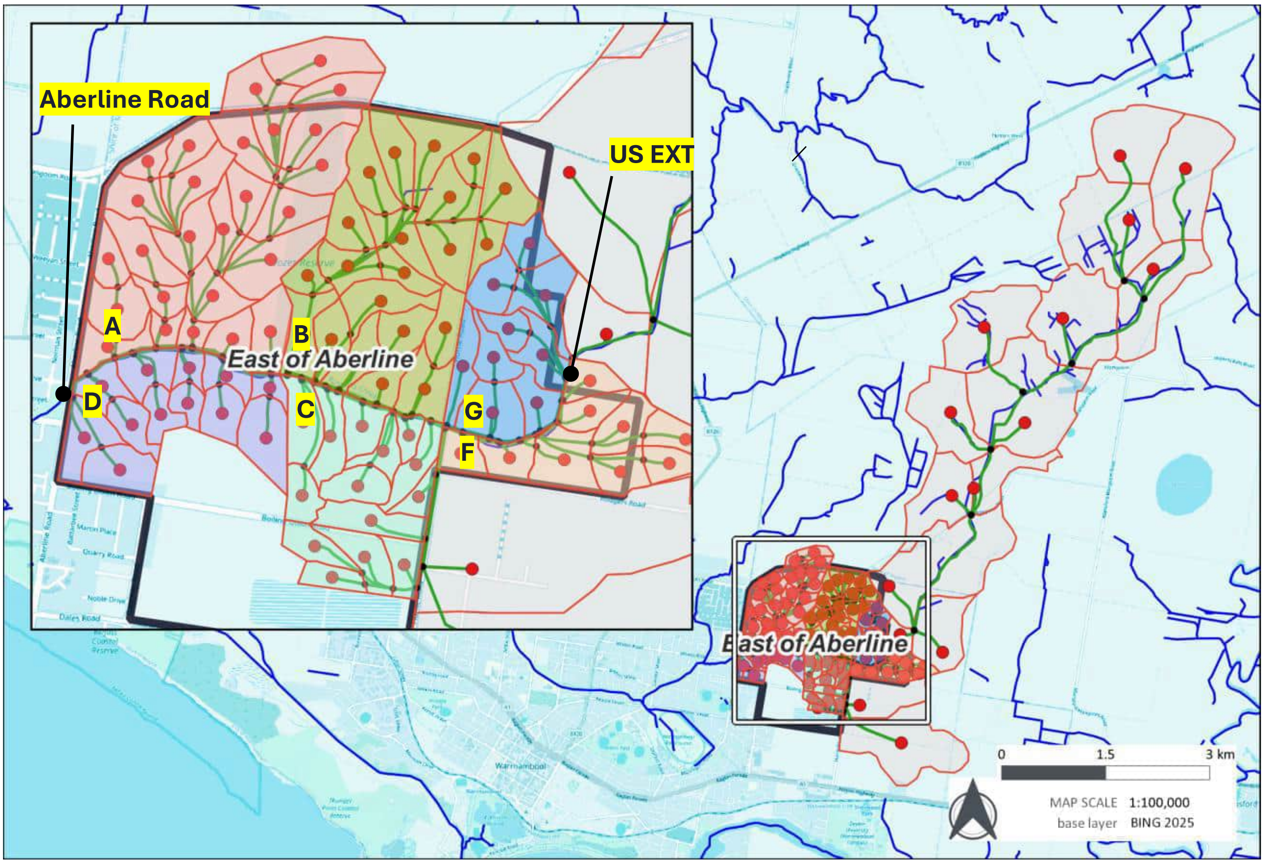


Figure 2-2 SMEC RORB catchment model

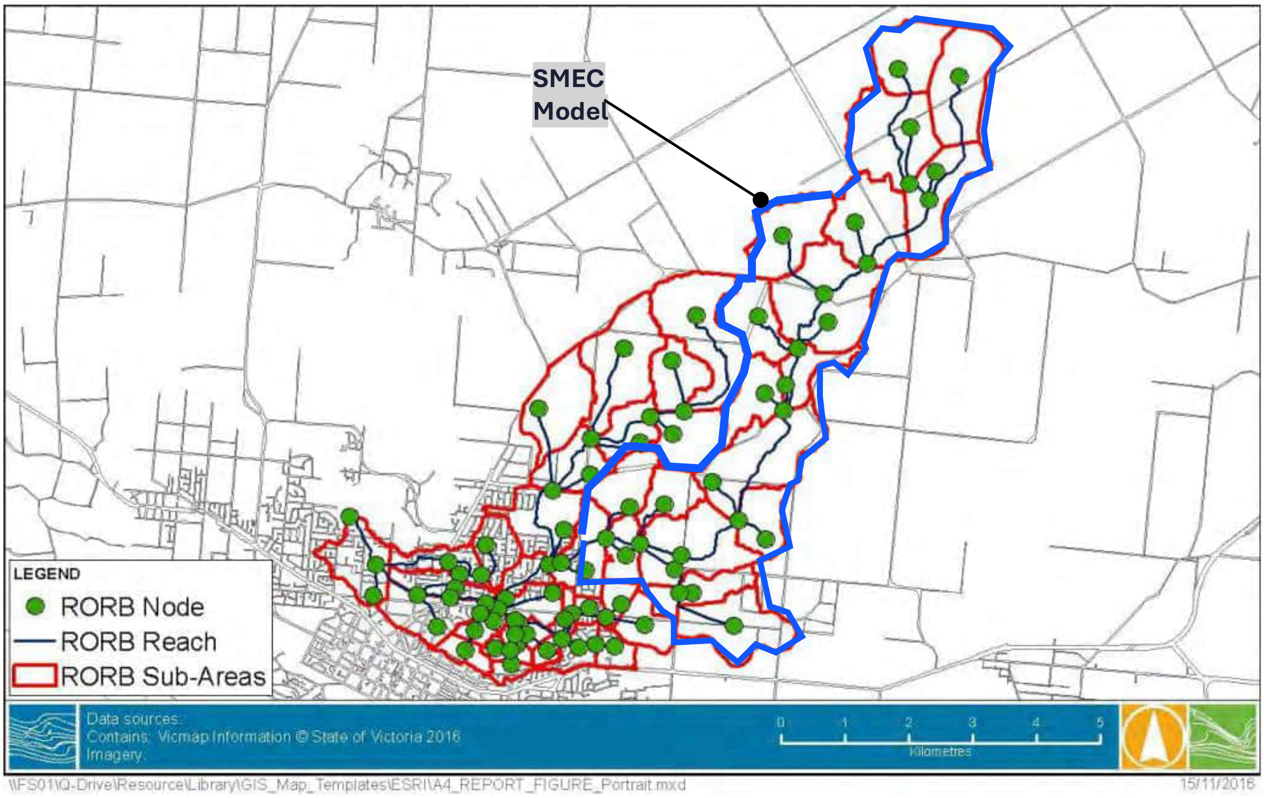


Figure 2-3 Water Technology (2017) RORB model Setup (blue as the extent of model incorporated in SMEC RORB model)

Table 2-3 k_c / d_{ave}

Parameter	Water Technology (2017)	Spiire (2020)	SMEC						
			Overall Model	A	B	C	D	G	F
k_c	8.38	6.0	5.71	1.15	0.78	0.46	0.58	0.71	0.62
d_{ave}	9.29	5.79	6.33	1.28	0.86	0.51	0.64	0.79	0.69

RORB Loss Parameters

The Initial Loss/ Continuing Loss (IL/CL) values adopted in Water Technology (2017) have been assessed. SMEC did not find any reason to change the previous outcomes and they have been adopted for Scenario 1 & 2. Refer to **Table 2-4**. The previous model run applied a median pre-burst depth according to Datahub (Babister et al, 2016) values which were unchanged.

Table 2-4 RORB model parameters

Parameter	Water Technology (2017)	SMEC (Scenario 1 & 2)
m	0.8	0.8
Initial Loss	20 mm	20 mm
Continuing Loss	4.6 mm/hr	4.6 mm/hr

For Scenario 3, the IL/CL were increased according to the latest Climate Change guidance adopting 4.5°C increase and year 2100. Refer to **Table 2-5** for adjusted values. **Appendix A** shows the loss adjustment factors from Data hub (Babister et al, 2016).

Table 2-5 Climate Change Loss Adjustment

Parameter	Climate Change Uplift Factor (2100)	SMEC (Scenario 3)
Initial Loss	1.19	23.8 mm
Continuing Loss	1.44	6.62 mm/hr

Results

The 1% AEP peak flow estimated at Aberline Road and the external catchment upstream of Horne Road, with the corresponding critical storm duration and temporal pattern, are summarised in **Table 2-6.** Refer to **Figure 2-2** for reference locations**.**

Table 2-6 1% AEP Peak Flow

Scenario	Description	1% AEP Peak Flow (m^3/s) (critical duration)	
		Aberline Road	~800 m upstream of Horne Road
1	Existing conditions (without climate change)	32 (6hr TP22)	8 (3hr TP25)
2	Existing conditions (with climate change uplift in 2017)	42.5 (6hr TP26)	11.5 (2hr TP28)
3	Existing conditions (with climate change uplift in 2024)	78 (3hr TP28)	61.4 (2hr TP27)

2.4 Hydraulic Modelling

A 2d hydraulic model (TUFLOW) was setup to determine the sensitivity of the flood extents to various hydrological scenarios. The TUFLOW model created by the previous consultant was reviewed and rerun as follows:

- Inflow hydrograph at the upstream end of the model domain and a number of adjacent catchment inflows.
- Outflow boundary condition based on longitudinal slope.
- 2 m grid size based on 2017 LiDAR of 1m resolution.
- HPC computation scheme with sub-grid-sampling (SGS) enabled.
- Roughness definition (materials file) were maintained as per the original model.
- Model extent is limited to the Russell Creek reach within the PSP area and a few hundred meters upstream and downstream.

The TUFLOW model domain is shown in **Figure 2-4**.

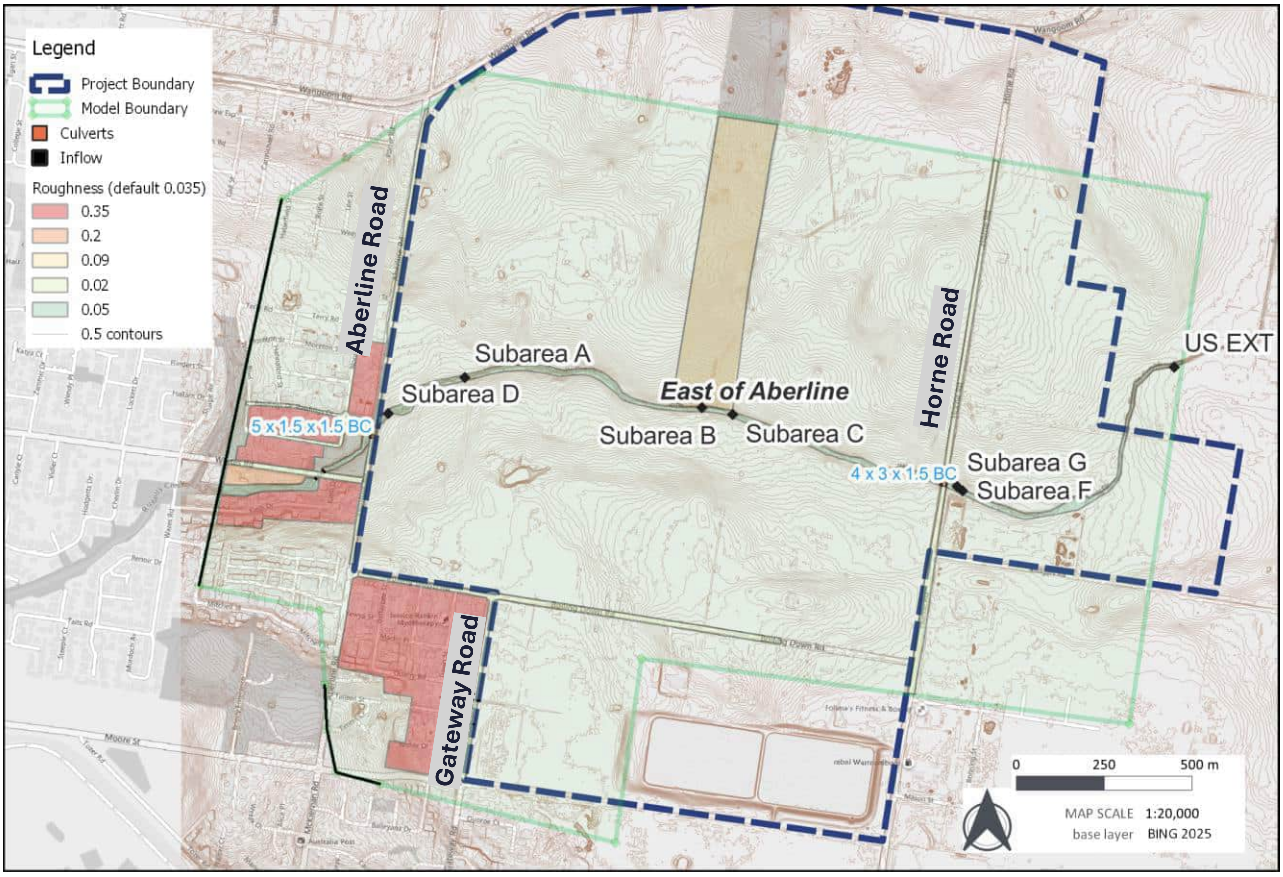


Figure 2-4 TUFLOW Model Setup

Limitations

The following limitations are noted:

- The inflow hydrographs for each adjacent sub catchment were extracted from the RORB model and distributed at a few locations along Russell Creek and one external catchment inflow to represent the remaining upstream catchment of Russell Creek.
- The model is limited to Russell Creek only. Further flood modelling for the Gateway Road catchment will be presented in Stage 2 – proof of concept stage (exhibition document) of the project.
- The storm durations simulated were those identified as critical by the RORB model at Aberline Road.

3. Results

3.1 1% AEP Flood Extent with Climate Change

The 1% AEP flood extents for the three scenarios are shown in **Figure 3-1** and **Appendix B – Map 1 to 3**. Note that flood depths less than 50mm have been filtered out from the final extents.

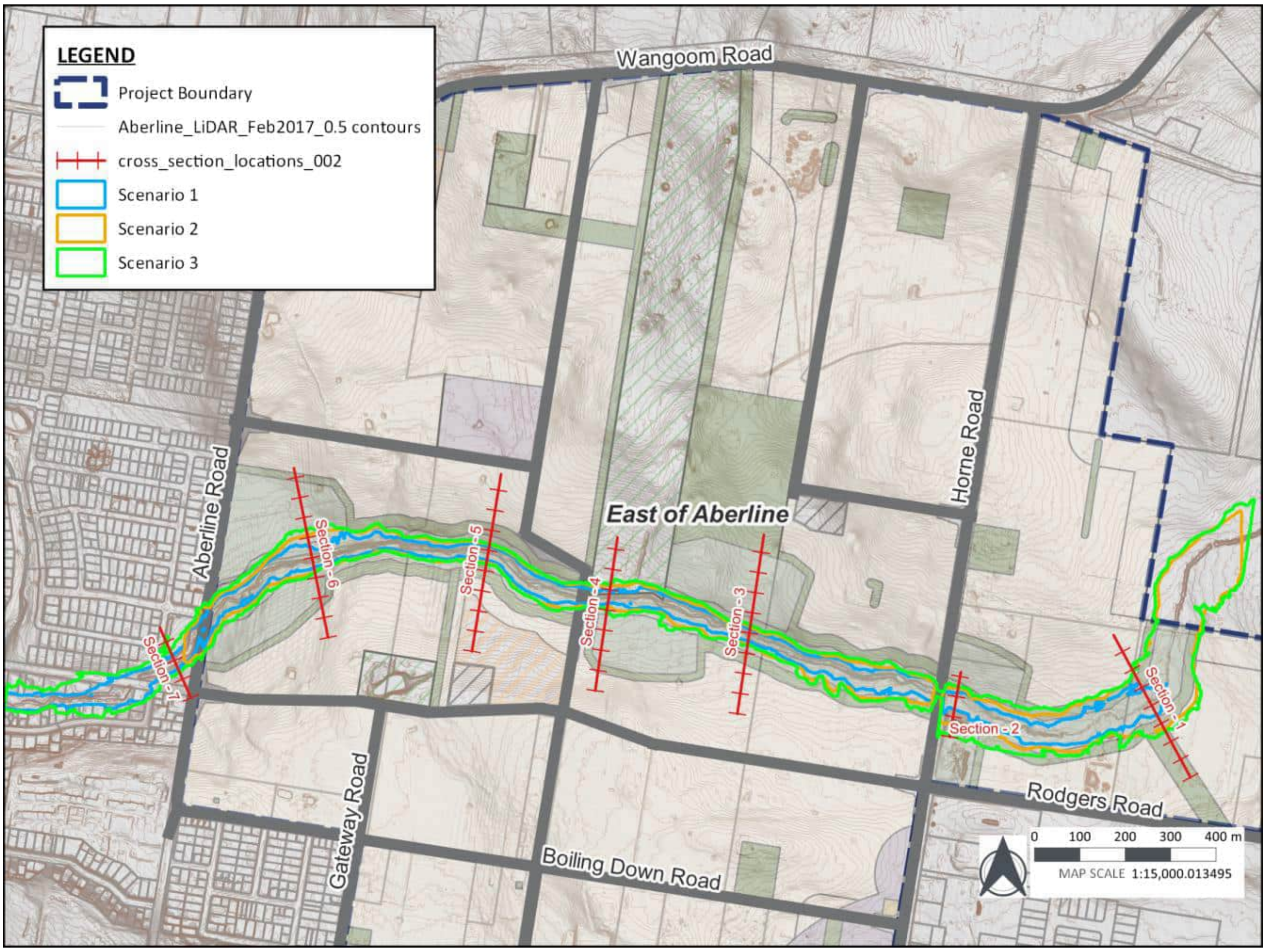


Figure 3-11%AEP Flood Extent

Comparison

- For the most upstream section of the model, the climate change Scenario 3 extent is wider by about 30-50 m on each side of the waterway compared to Scenario 1 (existing conditions). Refer to **Figure 3-2.**
- For the section of Russell Creek between Horne Road and Aberline Road (cross sections 2 – 6), the outcomes indicate that the flood extent area varies by up to 20 m between Scenario 1 and Scenario 3.
- Between the two climate change scenarios (2 and 3), the flood extent difference is less than approximately 10 m on either side of the waterway. Refer to cross sections **Figure 3-3** to **Figure 3-5**. The largest deviation can be seen in the areas where flows break out into the floodplain. This comparison is of interest as it indicates the sensitivity of the different climate change uplifts factors.
- The sensitivity run of Scenario 3 gives the largest flood extent of all the scenarios. The 1% AEP (with Climate Change) flood extents are contained within the bounds of the Russell Creek waterway corridor, with the exception of a small portion to the east where the flood extends about 25 m out of the waterway. <u>It is recommended that the Scenario 3 flood extent is adopted as the basis of design for the East of Aberline PSP drainage strategy</u> as it is consistent with current GHCMA guidance.

Cross sections

A number of cross sections are provided in **Figure 3-2** to **Figure 3-5** illustrating the maximum flood depth relative to the topography of Russell Creek and the floodplain. The figure shows the sections looking downstream. The approximate distance between Scenario 1 (blue) to Scenario 3 (green) flood extent is 50 m at widest flooding in section location 1. Refer to **Figure 3-2.**

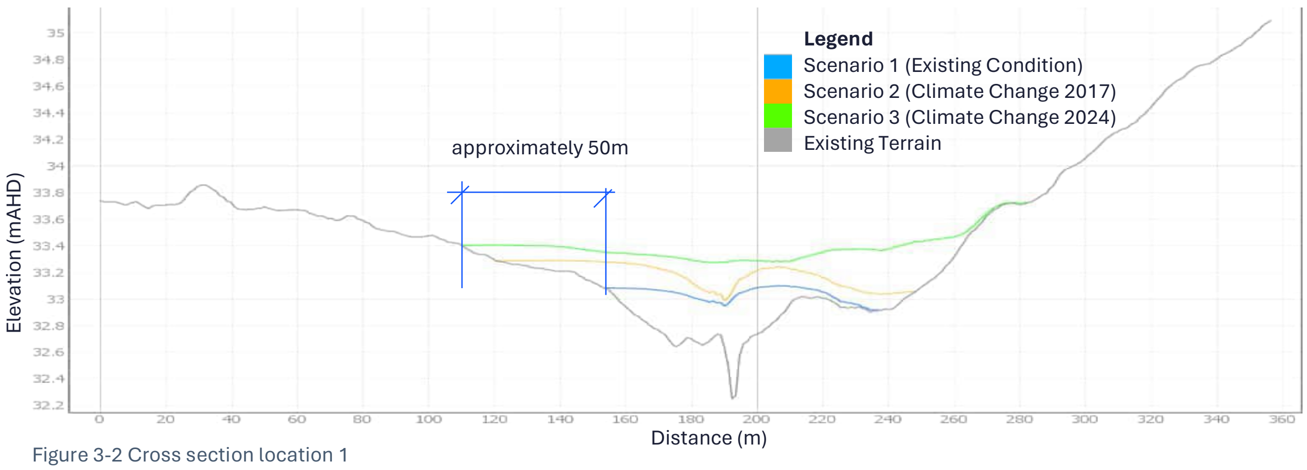


Figure 3-2 Cross section location 1

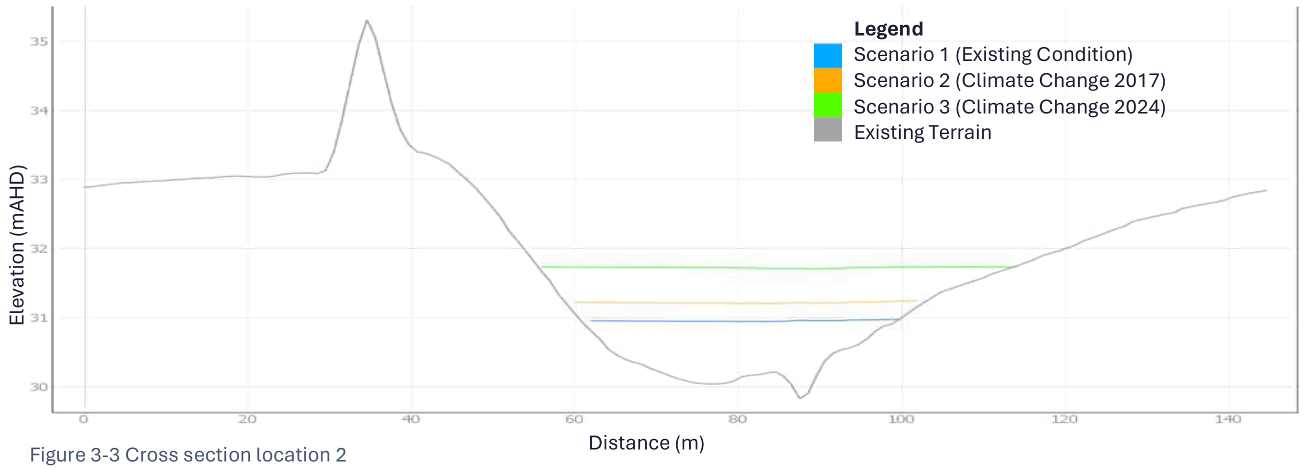


Figure 3-3 Cross section location 2

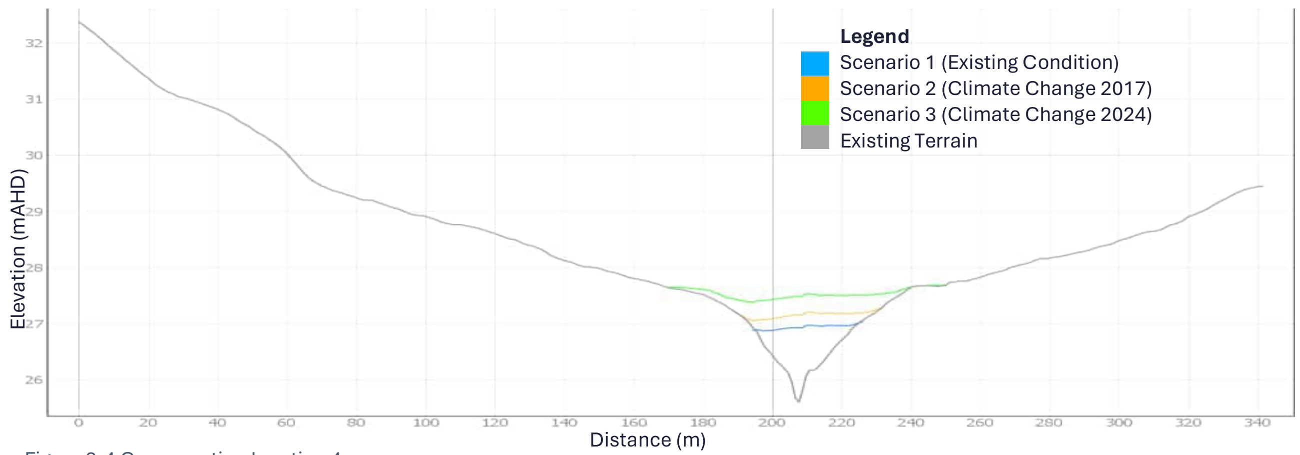


Figure 3-4 Cross section location 4

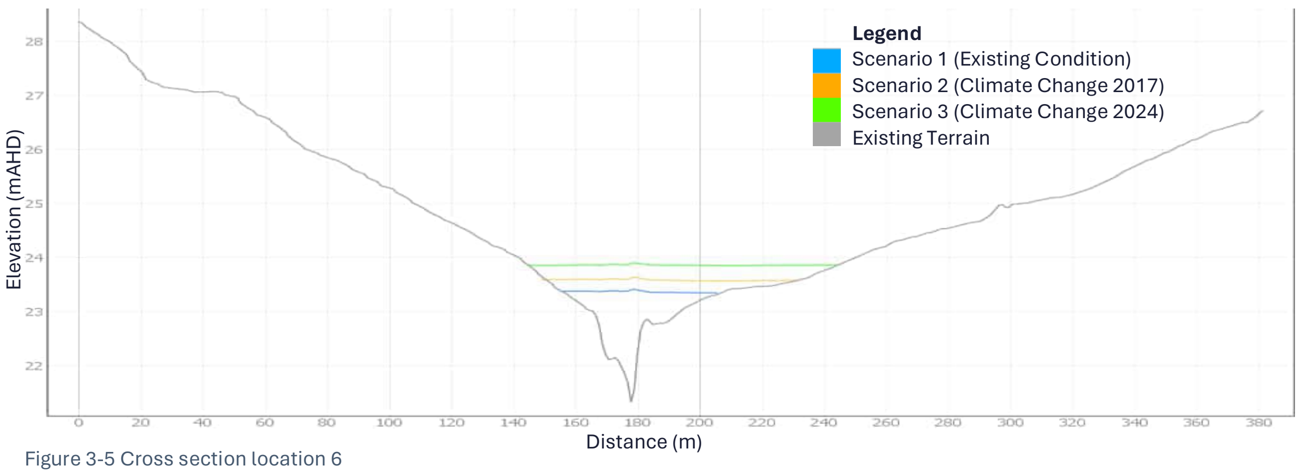


Figure 3-5 Cross section location 6

4. Conclusion

Hydrology and hydraulic analyses have been completed to understand the sensitivity of flood extents to climate change impacts. The results show that the flood extent is confined within the Russell Creek waterway corridor for the majority of the PSP, with the exception of the most upstream section which shows a wider extent (up to 50 m). The 1% AEP (with climate change) flood extent (Scenario 3) is wider by up to 20 m on each side in comparison to the existing conditions (Scenario 1).

SMEC proposes to adopt the Scenario 3 flood extent as the basis of design, as it incorporates the current climate change modelling guidance presented in Ball et al. (2019) and is consistent with the GHCMA guidance.

GHCMA's in-principle support to the above methodology and outcomes is required to provide confidence in the proposed East of Aberline PSP development footprint.

It is noted that the extent of the flood model is limited to the immediate area surrounding the PSP. GHCMA has previously indicated that further assessment may be required to demonstrate that no worsening impact would occur further downstream of East of Aberline PSP. It is advised that this concern be discussed with GHCMA to understand the necessary scope of works.

5. References

Babister, M., Trim, A., Testoni, I. & Retallick, M. 2016. The Australian Rainfall & Runoff Datahub, 37th Hydrology and Water Resources Symposium Queenstown NZ

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) (2019), (AR&R) Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia (Geoscience Australia), Version 4.2, 2019.

Glenelg Hopkins Catchment Management Authority (2024), Flood Modelling Guidelines and Specifications, August 2024.

Laurenson,E.M, Mein,R.G. and Nathan,R.J (2010), RORB – Version 6.15, Runoff Routing Program, User Manual, Department of Civil Engineering, Monash University, Clayton, Australia.

Spiire (2020), Existing Situational Analysis Report, East of Aberline PSP, Stormwater Drainage Concept and Functional Design. September 2020.

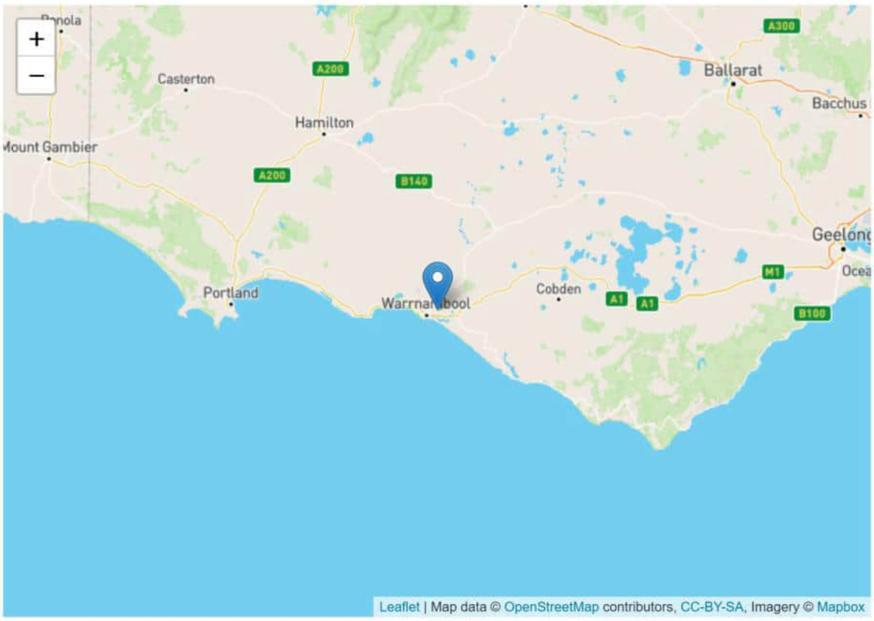
Water Technology (2017), Russell Creek Flood Mitigation – As constructed Flood Modelling.

Appendix A – Data Hub Climate Change Factors

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	142.529
Latitude	-38.368
Selected Regions (clear)	
Climate Change Factors	show



Loss Factors

Initial Loss (Adjustment Factors)

	Losses SSP1-2.6	Losses SSP2-4.5	Losses SSP3-7.0	Losses SSP5-8.5
2030	**1.05**	**1.05**	**1.05**	**1.05**
2040	1.05	1.06	1.06	1.07
2050	**1.06**	**1.07**	**1.07**	**1.08**
2060	1.06	1.07	1.09	1.1
2070	1.06	1.08	1.1	1.12
2080	1.06	1.09	1.12	1.14
2090	**1.06**	**1.09**	**1.13**	**1.17**
2100	1.06	1.1	1.15	1.19

Continuing Loss (Adjustment Factors)

	Losses SSP1-2.6	Losses SSP2-4.5	Losses SSP3-7.0	Losses SSP5-8.5
2030	**1.1**	**1.1**	**1.1**	**1.11**
2040	1.12	1.12	1.13	1.14
2050	**1.12**	**1.15**	**1.16**	**1.18**
2060	1.13	1.17	1.19	1.23
2070	1.13	1.18	1.23	1.28
2080	1.13	1.2	1.27	1.33
2090	**1.13**	**1.21**	**1.31**	**1.39**
2100	1.12	1.22	1.34	1.44

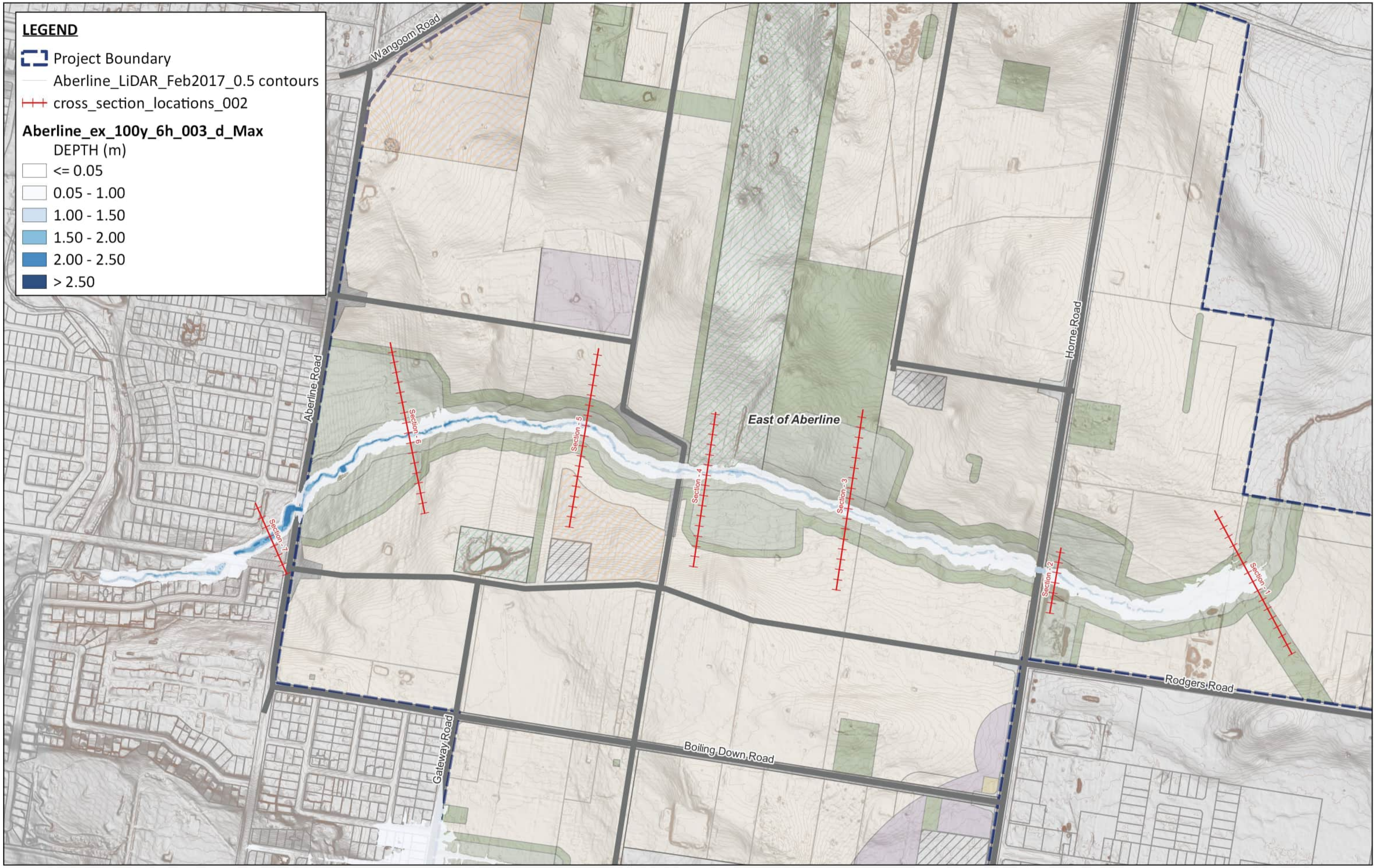
Temperature Changes (Degrees, Relative to 1961-1990 Baseline)

Year	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
2030	**1.2**	**1.2**	**1.2**	**1.3**
2040	1.3	1.4	1.5	1.6
2050	**1.4**	**1.7**	**1.8**	**2.1**
2060	1.5	1.9	2.2	2.5
2070	1.5	2.1	2.5	3
2080	1.5	2.2	2.9	3.5
2090	**1.5**	**2.4**	**3.3**	**4.1**
2100	1.4	2.5	3.6	4.5

Layer Info

Time Accessed	27 October 2024 11:03PM
Version	2024_v1
Note	Updated climate change factors for IFD Initial loss and continuing loss based on IPCC AR6 temperature increases from the updated Climate Change Considerations (Book 1: Chapter 6) in ARR (Version 4.2). ARR recomends the use of Current and near-term (2030 midpoint). Medium-term (2050 midpoint) and Long-term (2090 midpoint)

Appendix B – Flood Extent Map



PROJECT TITLE:	EAST OF ABERLINE PSP STORMWATER DESIGN	REVISION: A	DATE: 02/04/2025
PROJECT NO:	30043612	STATUS: DRAFT	SIZE: A3
MAP NO:	01 - SCENARIO 1	AUTHOR: KV	SOURCES: VPA
MAP TITLE:	1%AEP FLOOD EXTENT EXISTING CONDITIONS	CHECKED: TH	CRS: GDA94 / MGA zone 54

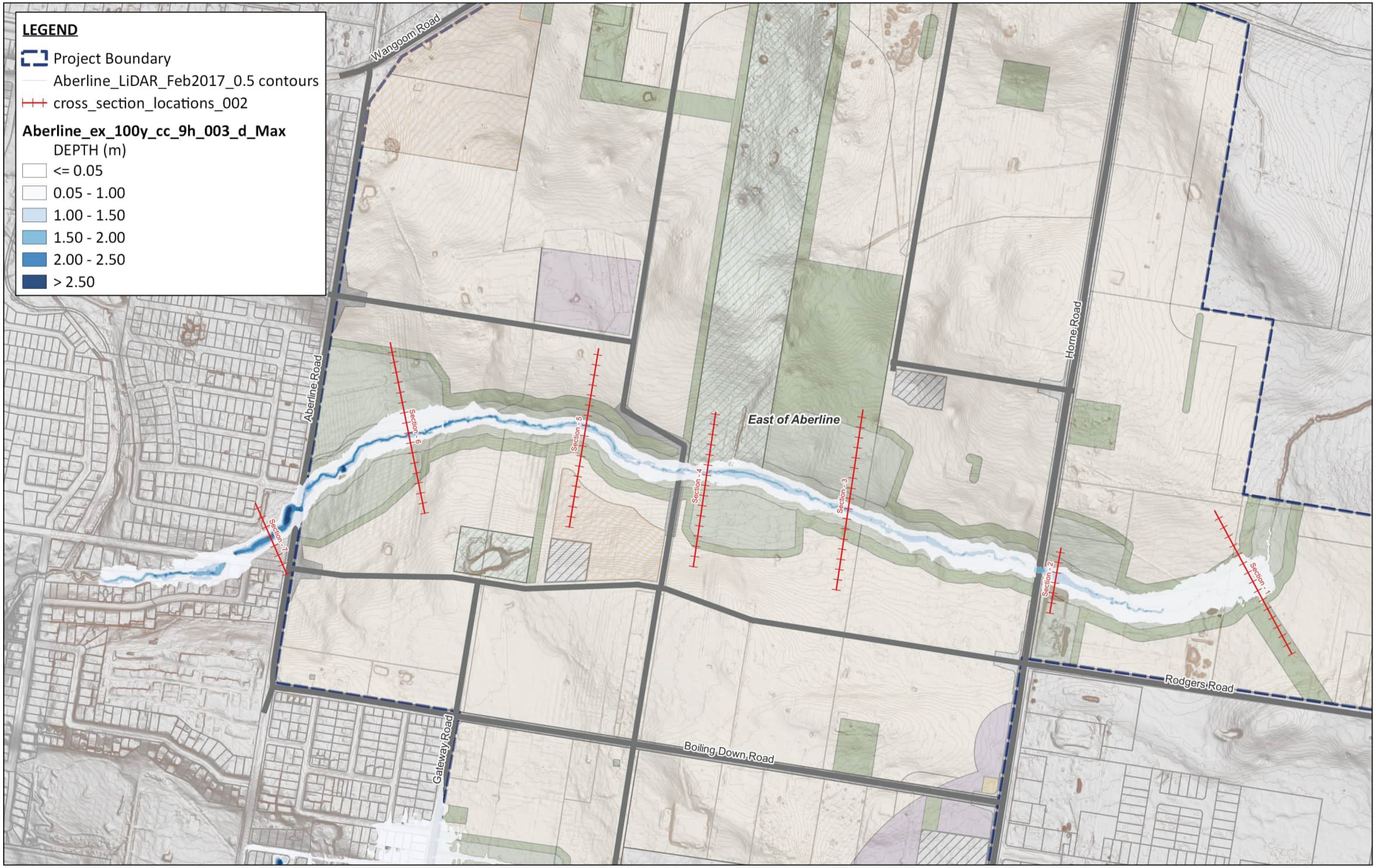
0 50 100 150 200 m

SCALE: 1:7,500

CLIENT:

CONSULTANT:

www.smec.com



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PROJECT NO:	30043612	STATUS:	DRAFT	SIZE: A3
MAP NO:	01 - SCENARIO 2	AUTHOR:	KV	SOURCES: VPA
MAP TITLE:	1%AEP EXISTING CONDITIONS w CC 2017	CHECKED:	TH	CRS: GDA94 / MGA zone 54

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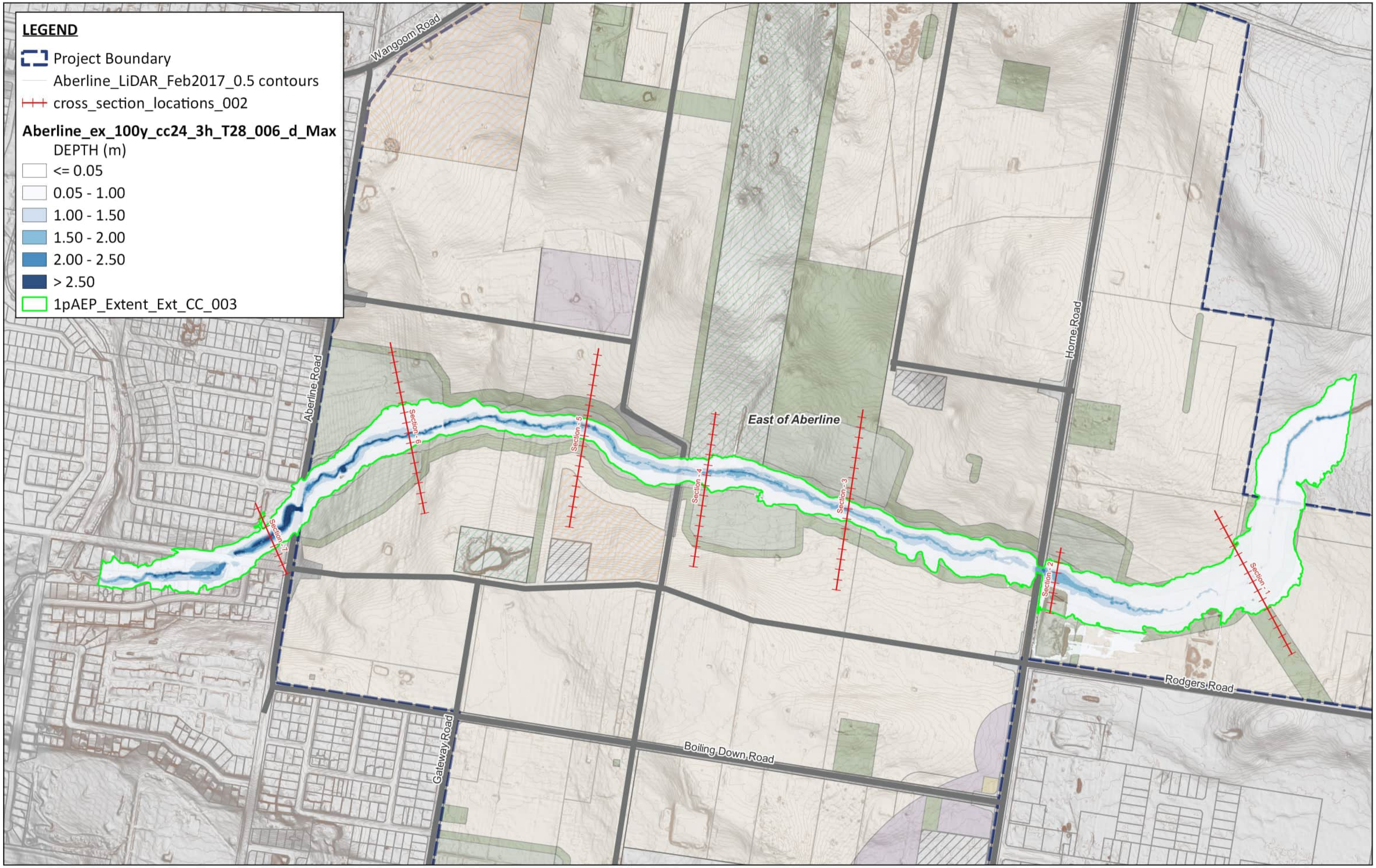
SCALE: 1:7,500

CLIENT:

CONSULTANT:

www.smec.com



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PROJECT NO:	30043612	STATUS:	DRAFT	SIZE:	A3
MAP NO:	01 - SCENARIO 3	AUTHOR:	KV	SOURCES:	VPA
MAP TITLE:	1%AEP EXISTING CONDITIONS w CC 2024	CHECKED:	TH	CRS:	GDA94 / MGA zone 54

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SCALE: 1:7,500

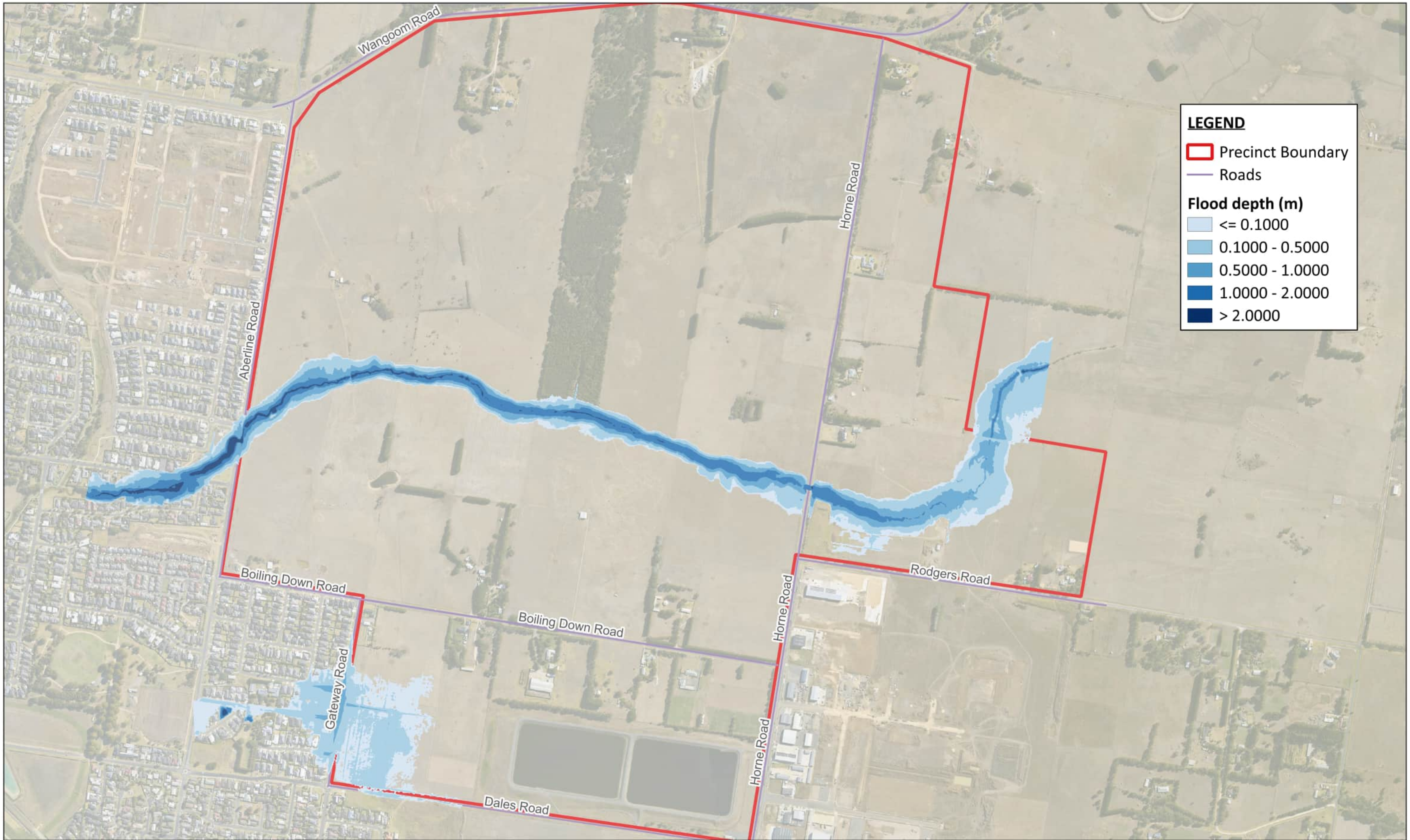
CLIENT:

CONSULTANT:

www.smec.com

Appendix F

Flood Impact Assessment Maps



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PROJECT NO:	30043612	STATUS:	FINAL	SIZE:	A3
MAP NO:	03	AUTHOR:	W.W	SOURCES:	METROMAPS
MAP TITLE:	EXISTING CONDITION FLOOD IMPACT ASSESSMENT 1% AEP	CHECKED:	K.V.	CRS:	GDA94 / MGA zone 54

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SCALE: 1:10,000

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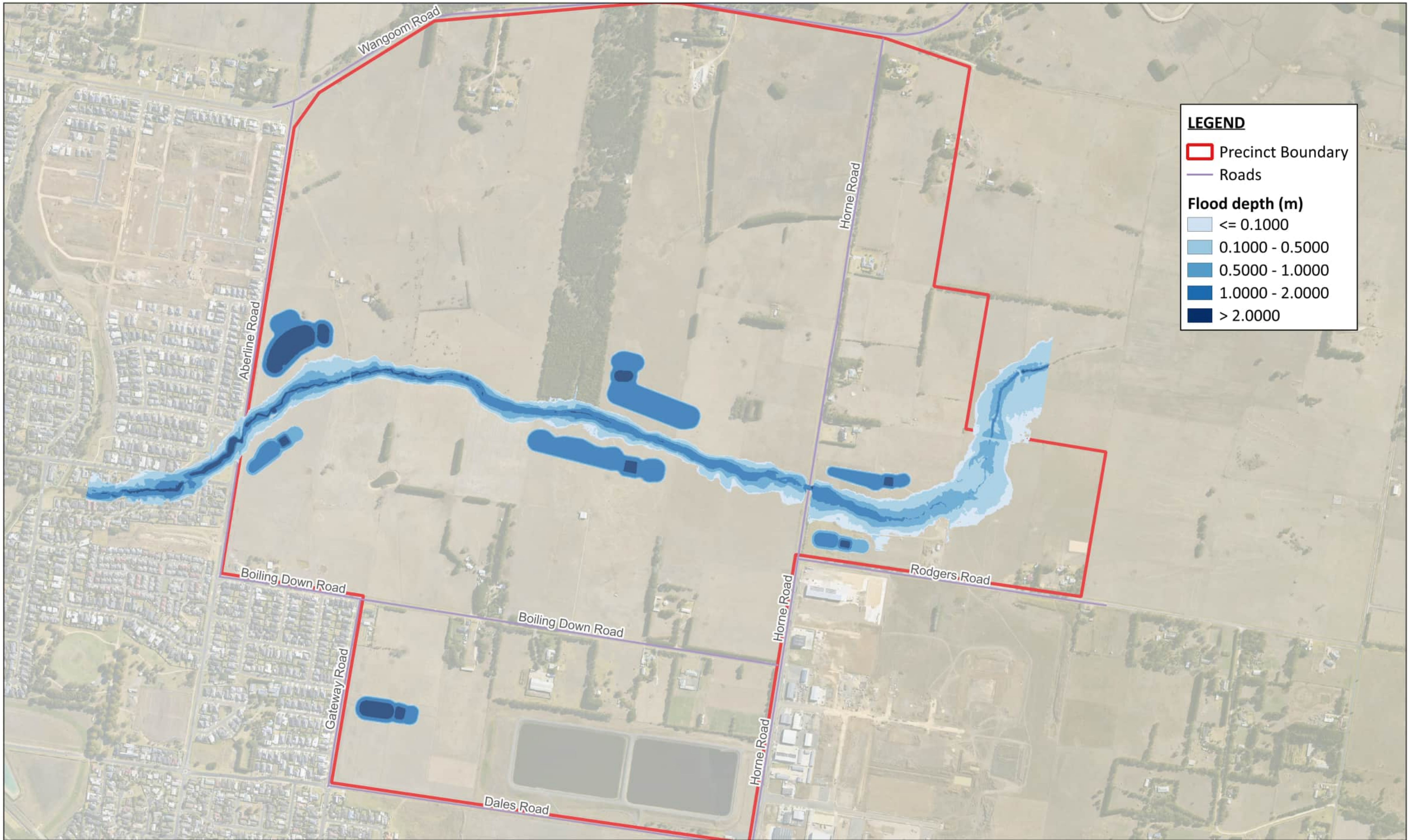
CLIENT:

CONSULTANT:



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PROJECT NO:	30043612	STATUS:	FINAL	SIZE:	A3
MAP NO:	04	AUTHOR:	W.W	SOURCES:	METROMAPS
MAP TITLE:	DEVELOPED CONDITION FLOOD IMPACT ASSESSMENT 1% AEP	CHECKED:	K.V.	CRS:	GDA94 / MGA zone 54

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SCALE: 1:10,000

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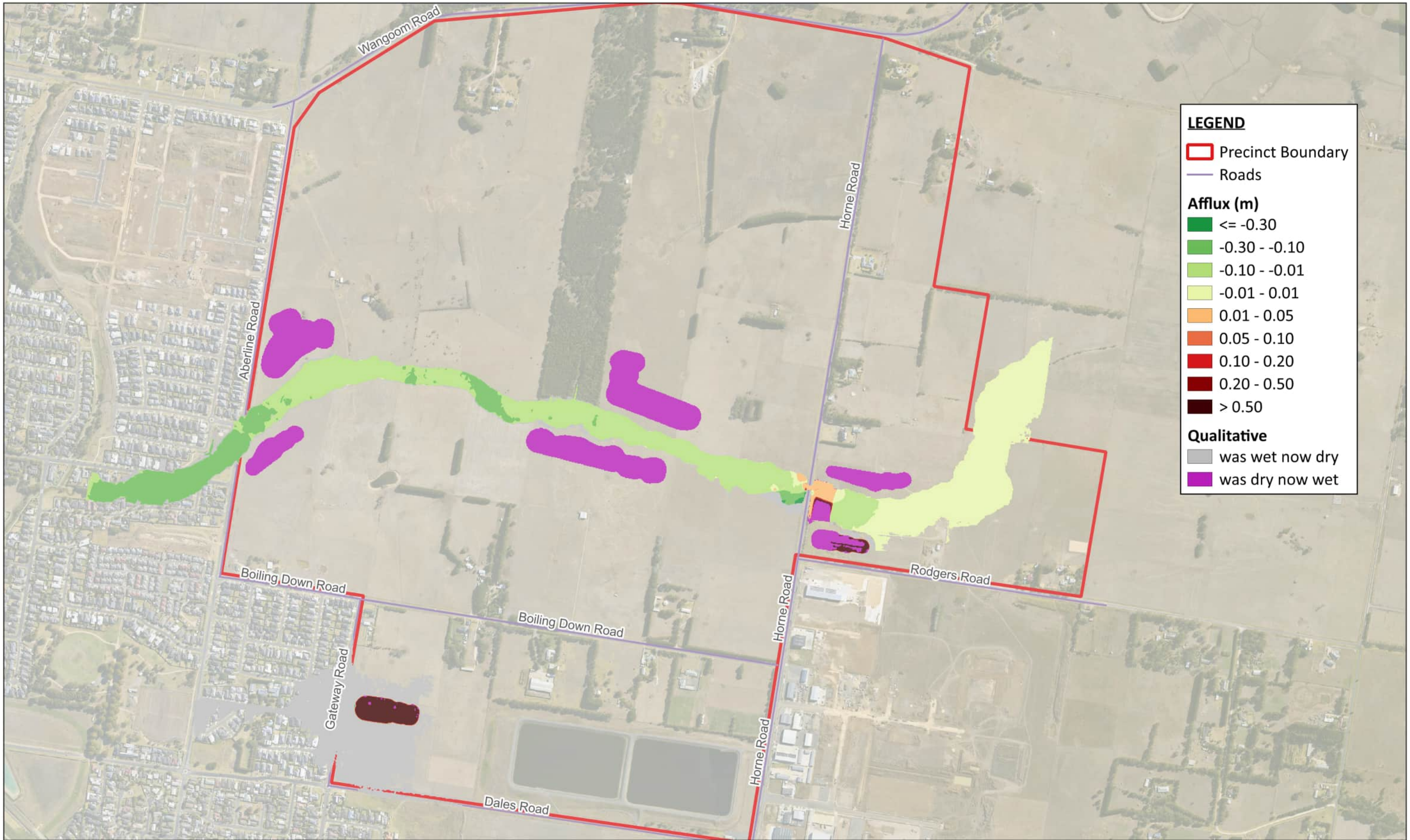
CLIENT:

CONSULTANT:



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PROJECT NO:	30043612	STATUS:	FINAL	SIZE:	A3
MAP NO:	05	AUTHOR:	W.W	SOURCES:	METROMAPS
MAP TITLE:	FLOOD IMPACT ASSESSMENT AFFLUX 1% AEP (DEVELOPED VS EXISTING CONDITION)	CHECKED:	K.V.	CRS:	GDA94 / MGA zone 54

0 100 200 300 400 m

SCALE: 1:10,000

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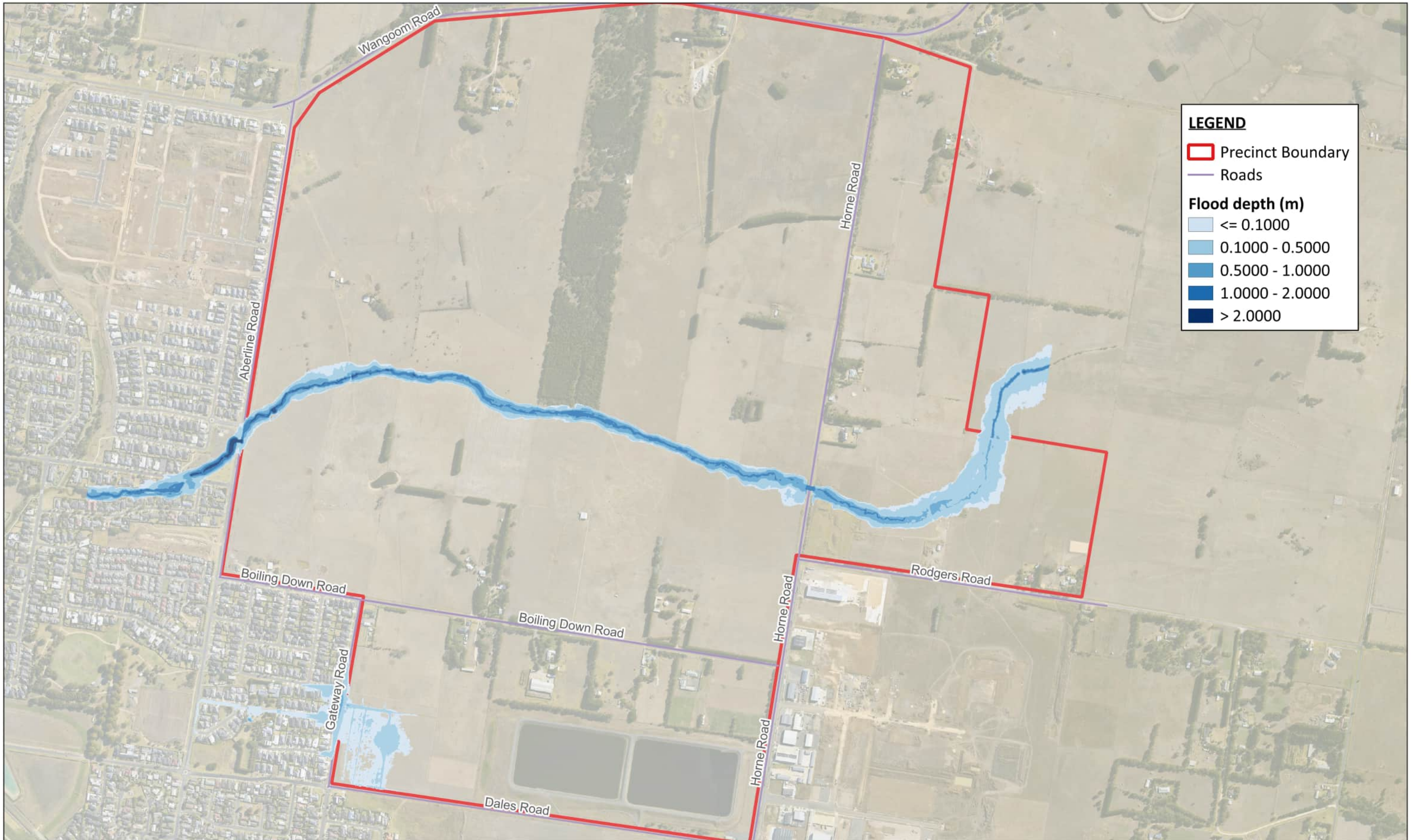
CLIENT:

CONSULTANT:



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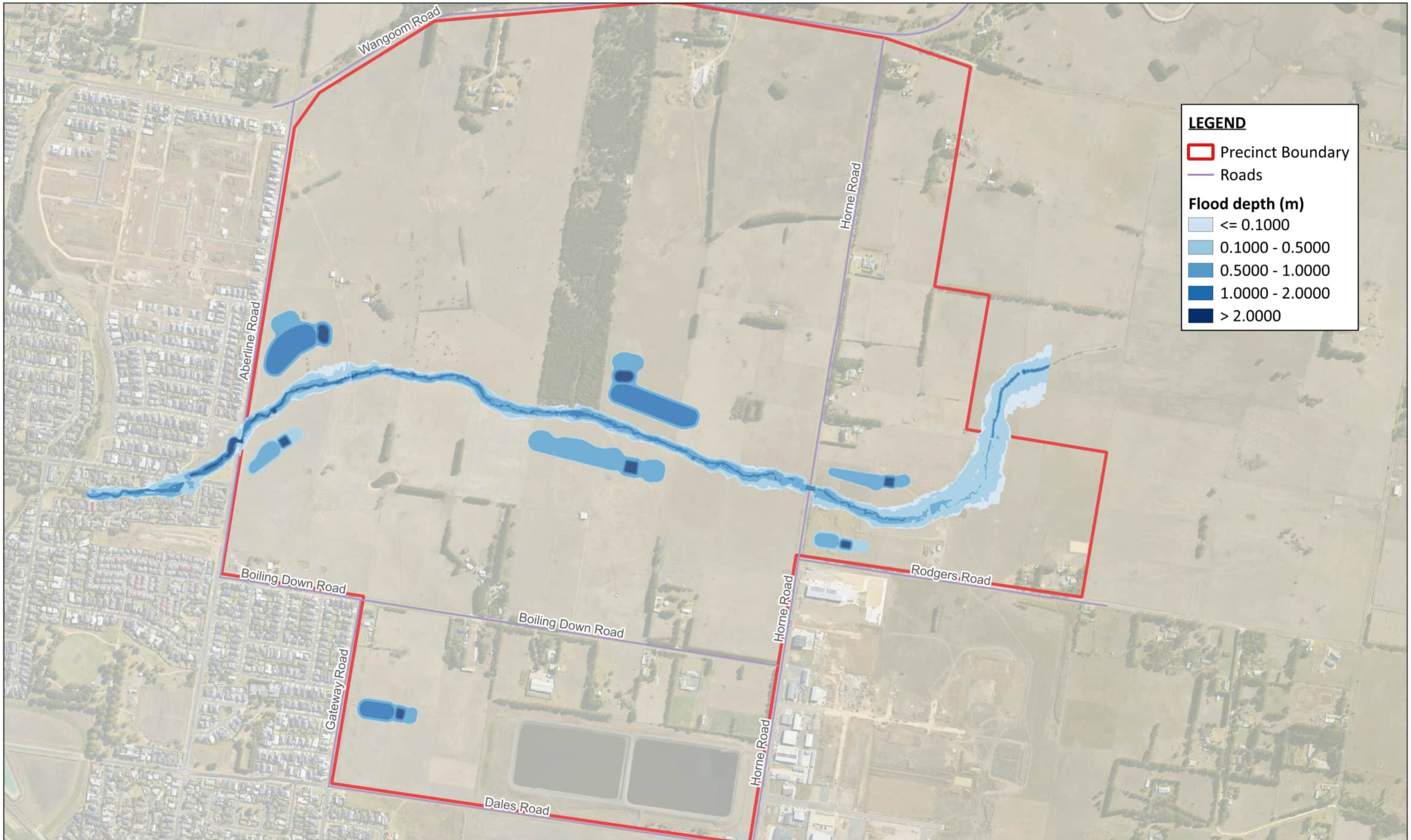
PROJECT NO:	30043612	STATUS:	FINAL	SIZE:	A3
MAP NO:	06	AUTHOR:	W.W	SOURCES:	METROMAPS
MAP TITLE:	EXISTING CONDITION FLOOD IMPACT ASSESSMENT 10% AEP	CHECKED:	K.V.	CRS:	GDA94 / MGA zone 54

CLIENT:

CONSULTANT:



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PROJECT NO:	30043612	STATUS:	FINAL	SIZE:	A3
MAP NO:	07	AUTHOR:	W.W	SOURCES:	METROMAPS
MAP TITLE:	DEVELOPED CONDITION FLOOD IMPACT ASSESSMENT 10% AEP	CHECKED:	K.V.	CRS:	GDA94 / MGA zone 54

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SCALE: 1:10,000

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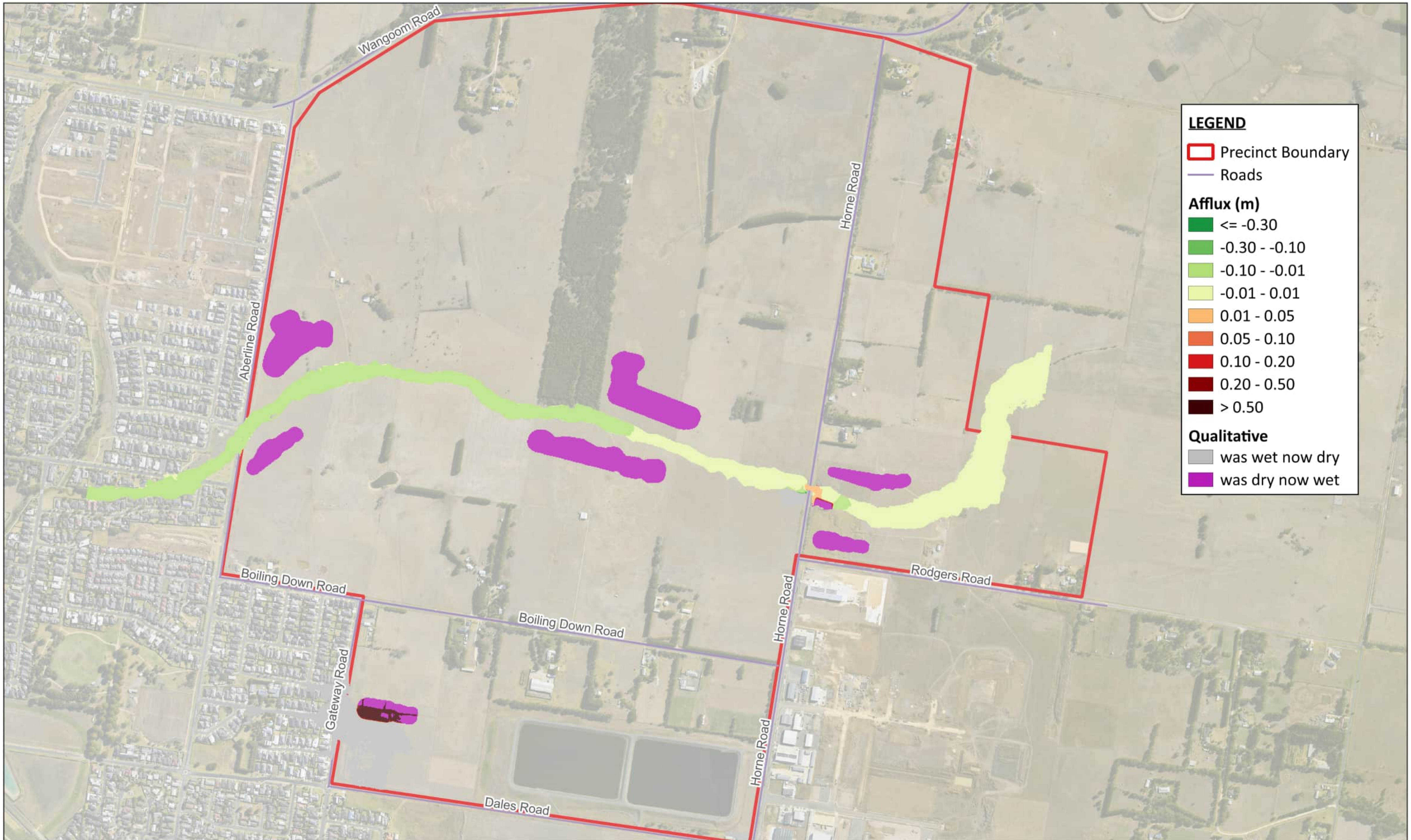
CLIENT:

CONSULTANT:

smec



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MAP NO:	08	AUTHOR:	W.W	SOURCES:	METROMAPS
MAP TITLE:	FLOOD IMPACT ASSESSMENT AFFLUX 10% AEP (DEVELOPED VS EXISTING CONDITION)	CHECKED:	K.V.	CRS:	GDA94 / MGA zone 54

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SCALE: 1:10,000

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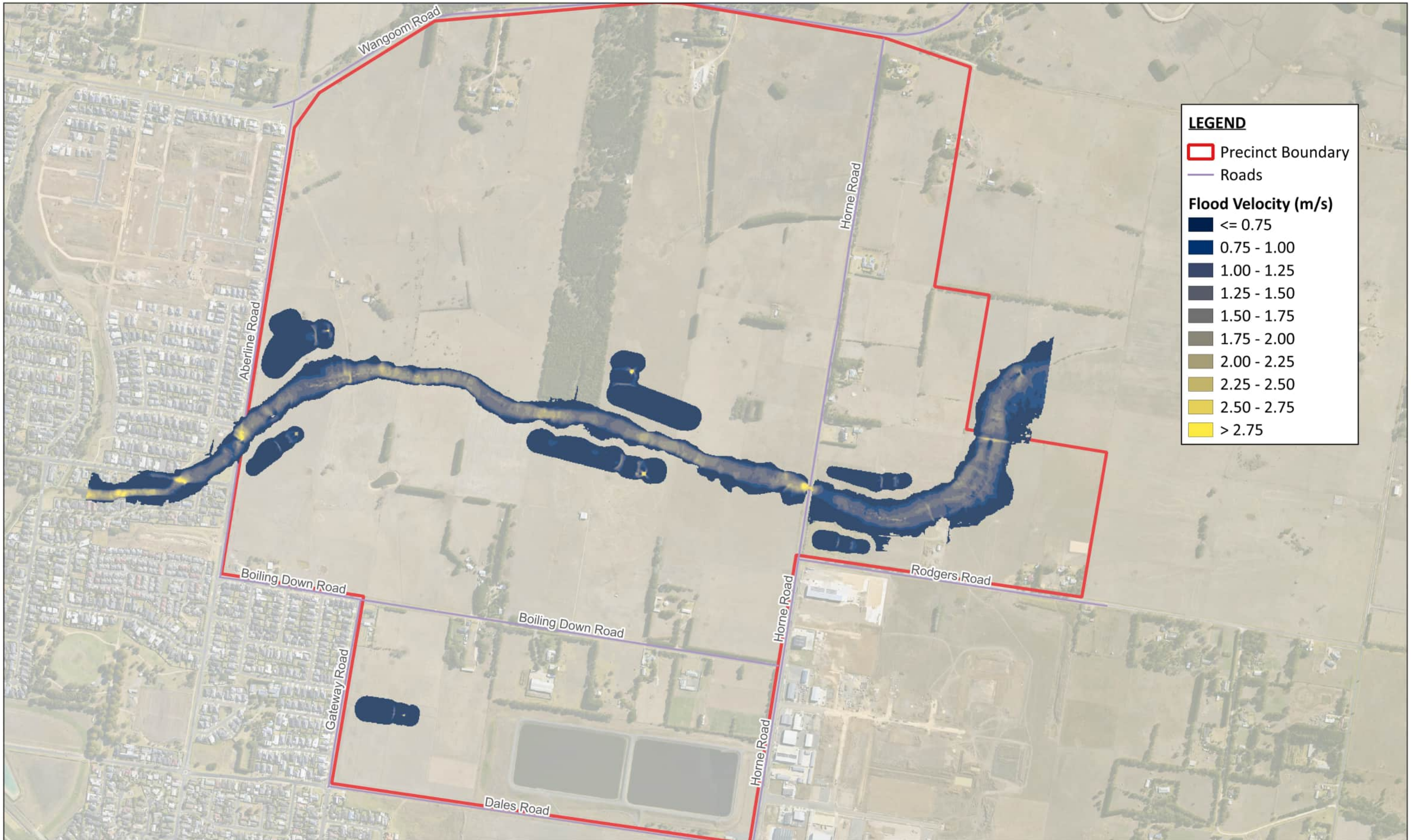
CLIENT:

CONSULTANT:



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PROJECT NO:	30043612	STATUS:	FINAL	SIZE:	A3
MAP NO:	09	AUTHOR:	W.W	SOURCES:	METROMAPS
MAP TITLE:	DEVELOPED CONDITION FLOOD IMPACT ASSESSMENT Flood Velocity at 1% AEP	CHECKED:	K.V.	CRS:	GDA94 / MGA zone 54

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SCALE: 1:10,000

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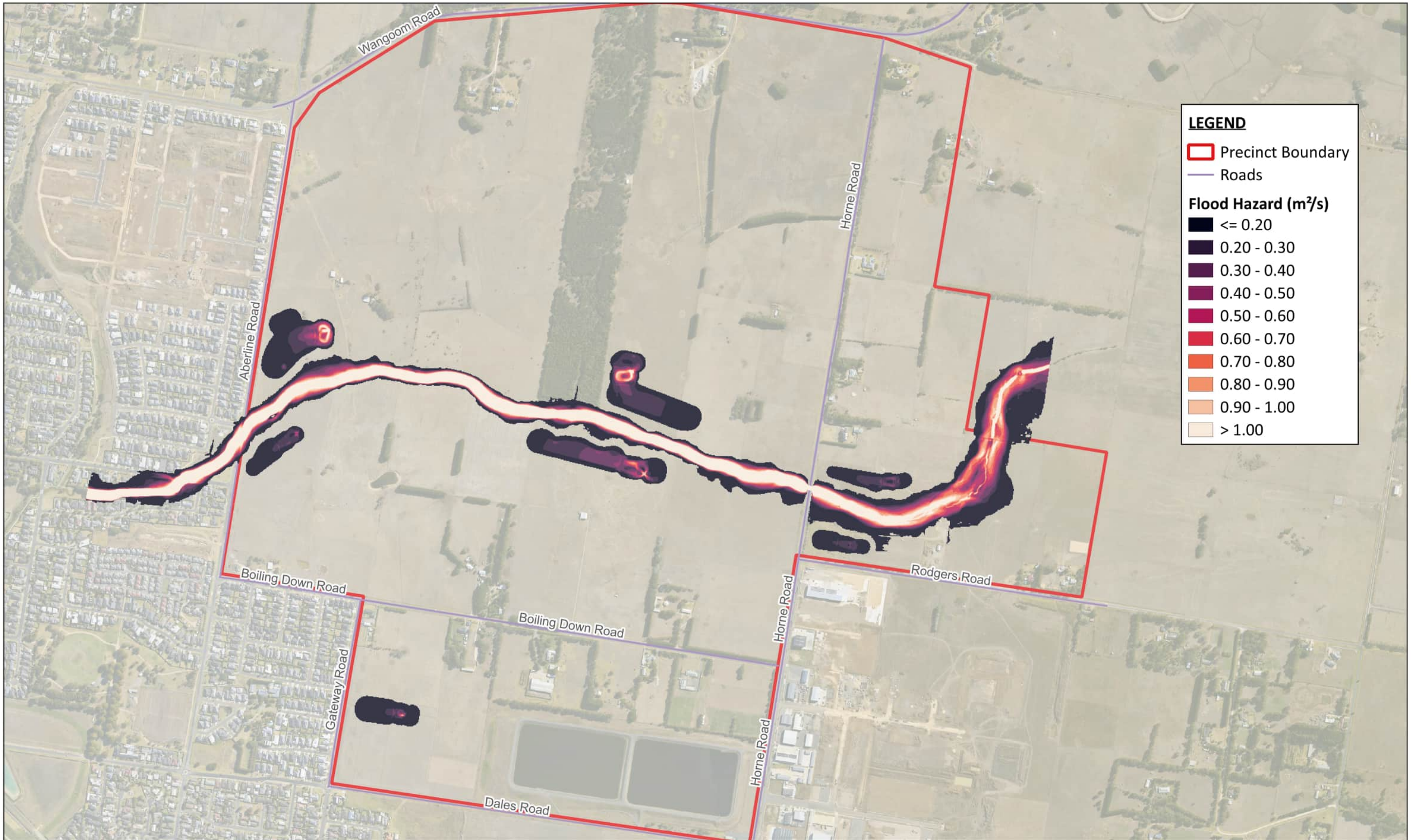
CLIENT:

CONSULTANT:



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MAP NO:	10	AUTHOR:	W.W
MAP TITLE:	DEVELOPED CONDITION FLOOD IMPACT ASSESSMENT Flood Hazard at 1% AEP	CHECKED:	K.V.

DATE:	29/08/2025
SIZE:	A3
SOURCES:	METROMAPS
CRS:	GDA94 / MGA zone 54

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SCALE: 1:10,000

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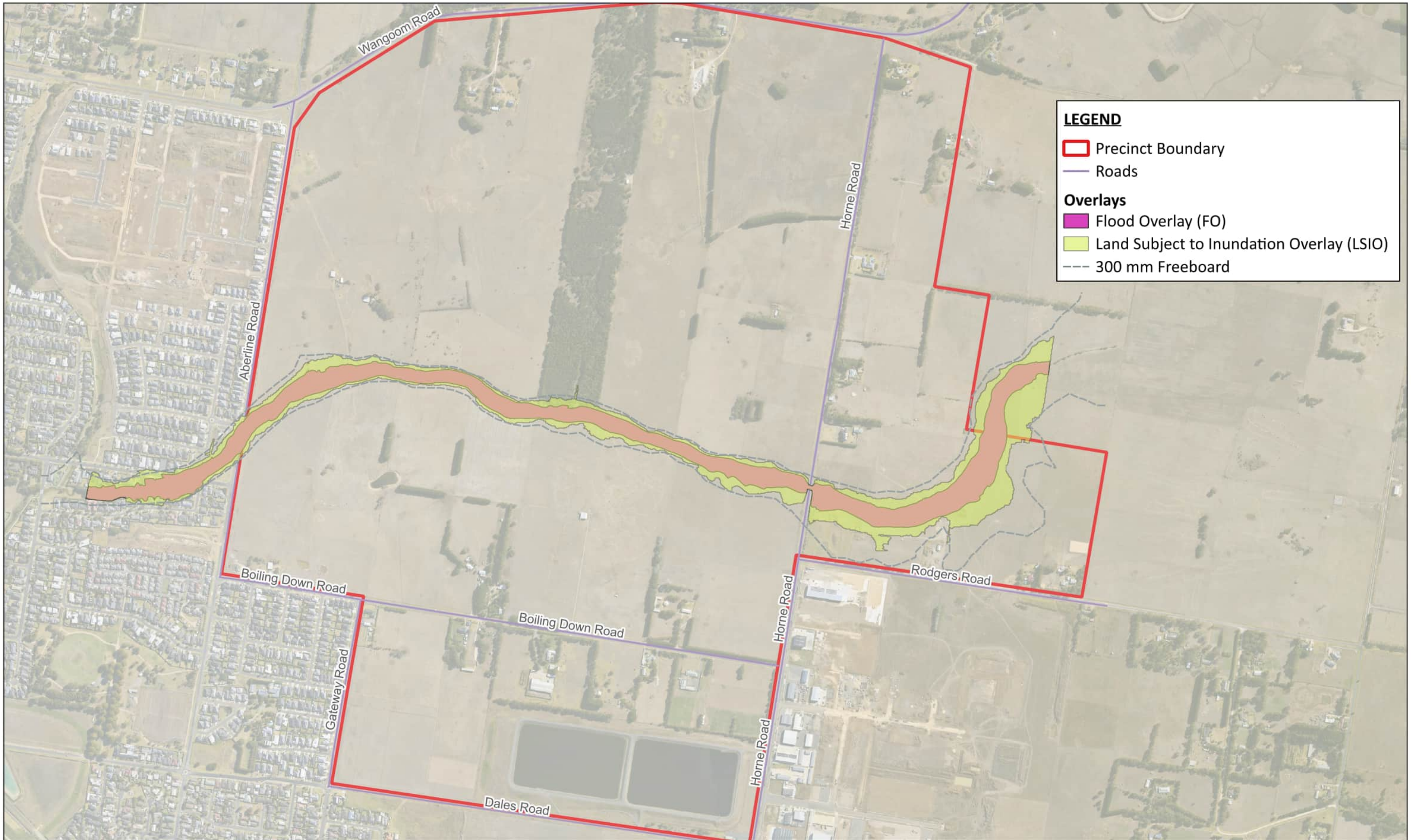
CLIENT:

CONSULTANT:



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PROJECT NO:	30043612	STATUS:	FINAL	SIZE:	A3
MAP NO:	11	AUTHOR:	W.W	SOURCES:	METROMAPS
MAP TITLE:	PROPOSED FLOOD OVERLAY AND LAND SUBJECT TO INUNDATION OVERLAY	CHECKED:	K.V.	CRS:	GDA94 / MGA zone 54

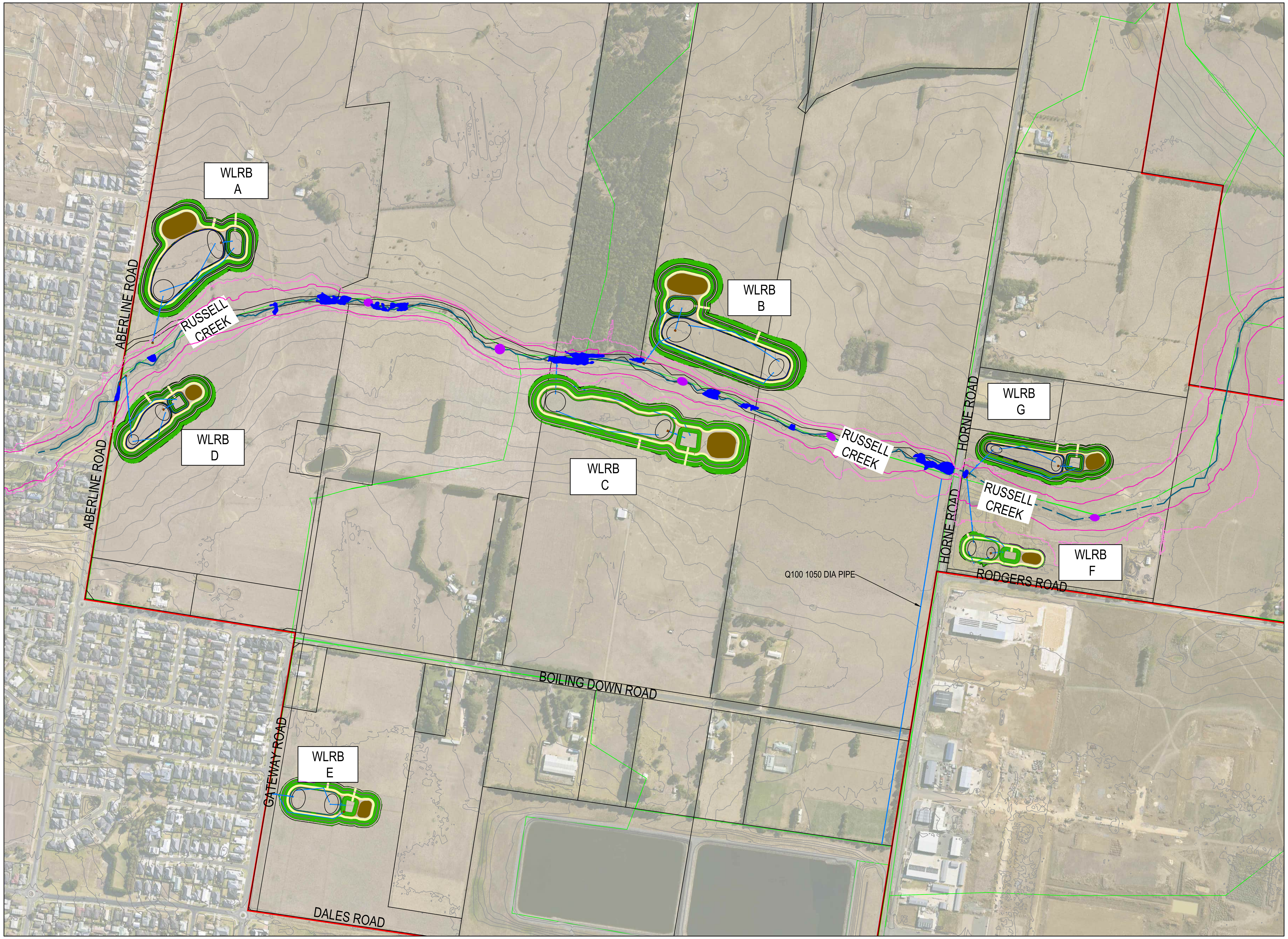
CLIENT:

CONSULTANT:

Appendix G

Design Drawings

East of Aberline PSP Stormwater Functional Design



REGISTERED PROFESSIONAL ENGINEER APPROVAL:

Drawing Index

REV	DRAWING NO.	DRAWING TITLE
A	3612E-001-101	Cover Plan & General Notes
A	3612E-001-111	Wetland A Layout Plan
A	3612E-001-112	Wetland B Layout Plan
A	3612E-001-113	Wetland C Layout Plan
A	3612E-001-114	Wetland D Layout Plan
A	3612E-001-115	Wetland E Layout Plan
A	3612E-001-116	Wetland F & G Layout Plan
A	3612E-001-201	Wetland A, B, F & G Long Sections
A	3612E-001-202	Wetland C & D & E Long Sections
A	3612E-001-251	Cross Sections: Wetland A, B & C
A	3612E-001-252	Cross Sections: Wetland D, E, F & G

LEGEND
ALL PROPOSED, FUTURE & EXISTING SERVICE LOCATIONS ARE SHOWN INDICATIVELY

- STORMWATER DRAIN & PIT
- NTWL
- TED
- Q100
- MAINTENANCE TRACK
- DRYING BENCH
- ROCK BEACHING
- CREEK CENTRELINE
- LAND SUBJECT TO INUNDATION OVERLAY
- FLOOD OVERLAY
- CREEK STABILISATION EXTENT
- POOLS & RIFFLE EXTENT
- MAJOR CATCHMENT BOUNDARY
- PSP BOUNDARY

NOTES:

1. THE FUNCTIONAL DESIGN HAS BEEN PREPARED FOR THE PURPOSES OF THE PSP LAND USE PLANNING AND DCP COSTING PURPOSES. THE DESIGN HAS BEEN DEVELOPED WITH A NUMBER OF ASSUMPTIONS. REFER TO THE EAST OF ABERLINE STORMWATER FUNCTIONAL DESIGN REPORT (SMEC, 2025)
2. THE ADOPTED NORMAL WATER LEVEL (NWL) ARE SUBJECT TO CHANGE AS THE DEVELOPMENT PROGRESS IN THE FUTURE. FOR THE PURPOSES OF THIS DRAWING, THE SEDIMENT POND ARE SHOWN TO BE THE SAME IN THE FUNCTIONAL DESIGN DRAWINGS. THE ACTUAL DESIGN LEVELS MAY VARY BETWEEN SEDIMENT POND AND WETLAND MACROPHYTE ZONE AS SHOWN IN THE FUNCTIONAL DESIGN REPORT.

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DRAFTER	DESIGNER	CHECKER	RP ENG
A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO.	PLAN OF SUB. NO.	RP ENG	K. Velasco
		RP ENG NO.	PE0006835
		DATE	

INFORMATION ONLY

SCALE AS SHOWN AT A1

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Road and Drainage
Cover Plan & General Notes

MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-101	01 of 11	A

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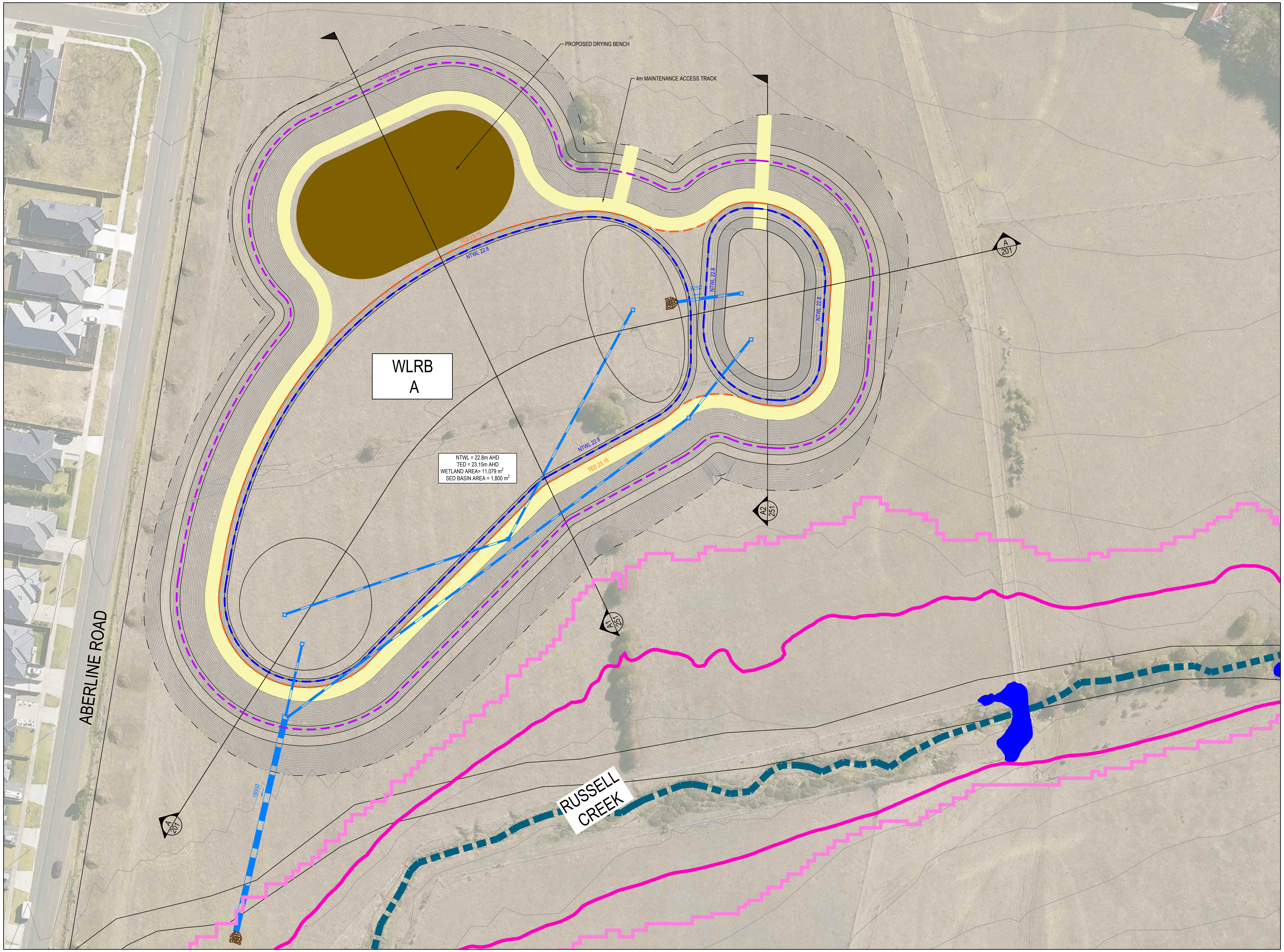

LEGEND

ALL PROPOSED, FUTURE & EXISTING SERVICE LOCATIONS ARE SHOWN INDICATIVELY

- STORMWATER DRAIN & PIT
- NTWL
- TED
- Q100
- MAINTENANCE TRACK
- DRYING BENCH
- ROCK BEACHING
- CREEK CENTRELINE
- LAND SUBJECT TO INUNDATION OVERLAY
- FLOOD OVERLAY
- CREEK STABILISATION EXTENT
- POOLS & RIFFLE EXTENT
- MAJOR CATCHMENT BOUNDARY
- PSP BOUNDARY

WARNING

BEWARE OF UNDERGROUND SERVICES

The location of underground services is approximate only and the exact position should be proven on site. No guarantee is given that all existing services are shown. Contractor to locate all underground services prior to commencement of works.

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REV	DATE	AMENDMENT / REVISION DESCRIPTION	DRAFTER	DESIGNER	CHECKER	RP ENG
A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO.	PLAN OF SUB. NO.	RP ENG	K. Velasco
		RP ENG NO.	PE0006835
		DATE	

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0 5 10 20

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Road and Drainage
Wetland A Layout Plan

MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-111	02 of 11	A

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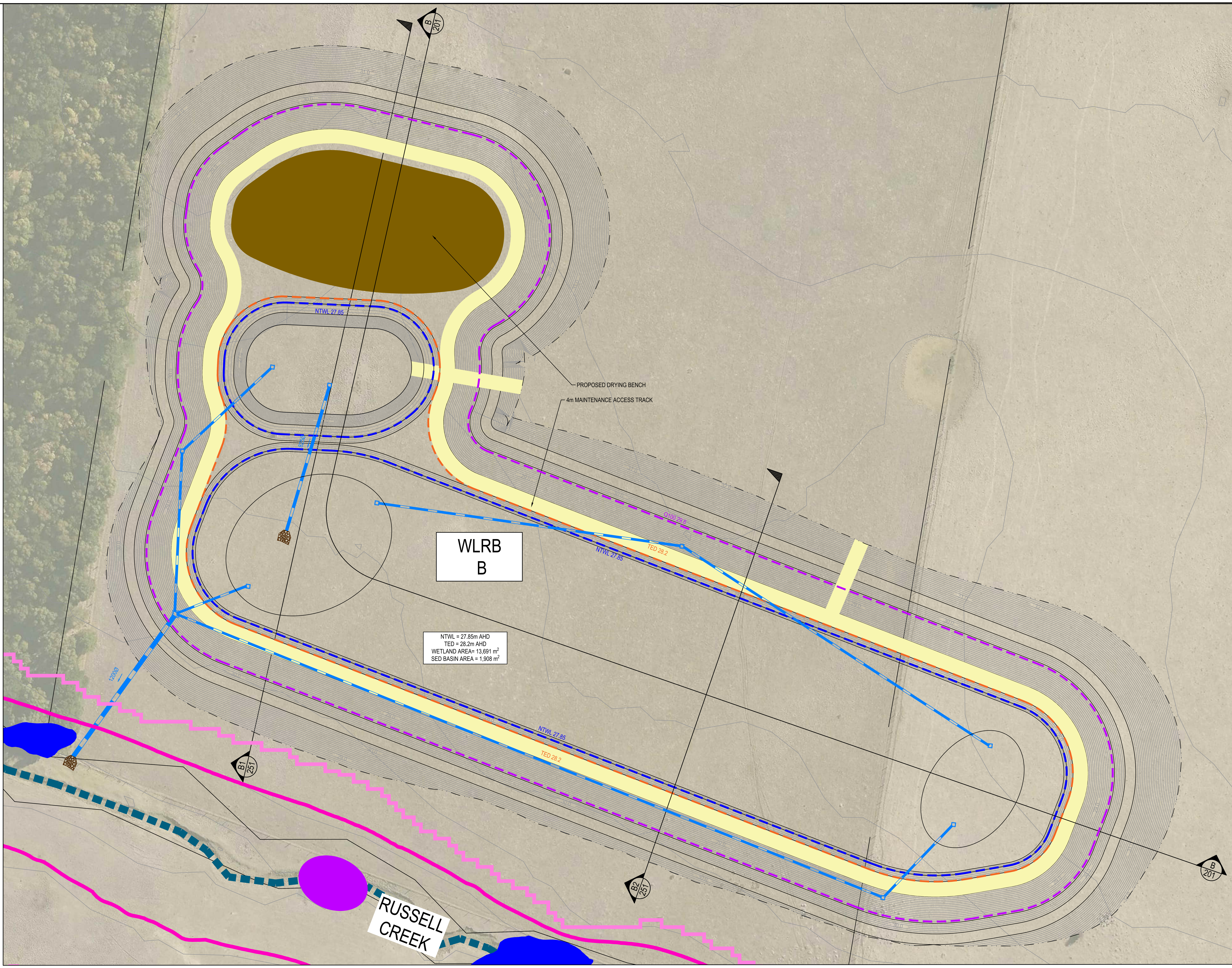

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LEGEND

ALL PROPOSED, FUTURE & EXISTING SERVICE LOCATIONS ARE SHOWN INDICATIVELY

	STORMWATER DRAIN & PIT
	NTWL
	TED
	Q100
	MAINTENANCE TRACK
	DRYING BENCH
	ROCK BEACHING
	CREEK CENTRELINE
	LAND SUBJECT TO INUNDATION OVERLAY
	FLOOD OVERLAY
	CREEK STABILISATION EXTENT
	POOLS & RIFFLE EXTENT
	MAJOR CATCHMENT BOUNDARY
	PSP BOUNDARY

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DRAFTER	DESIGNER	CHECKER	RP ENG
A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO.	PLAN OF SUB. NO.	RP ENG	K. Velasco
		RP ENG NO.	PE0006835
		DATE	

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Wetland B Layout Plan

MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-112	03 of 11	A

LEGEND

ALL PROPOSED, FUTURE & EXISTING SERVICE LOCATIONS ARE SHOWN INDICATIVELY

- STORMWATER DRAIN & PIT
- NTWL
- TED
- Q100
- MAINTENANCE TRACK
- DRYING BENCH
- ROCK BEACHING
- CREEK CENTRELINE
- LAND SUBJECT TO INUNDATION OVERLAY
- FLOOD OVERLAY
- CREEK STABILISATION EXTENT
- POOLS & RIFFLE EXTENT
- MAJOR CATCHMENT BOUNDARY
- PSP BOUNDARY

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A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO. | PLAN OF SUB. NO.

RP ENG	K. Velasco
RP ENG NO.	PE0006835
DATE	

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MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-113	04 of 11	A

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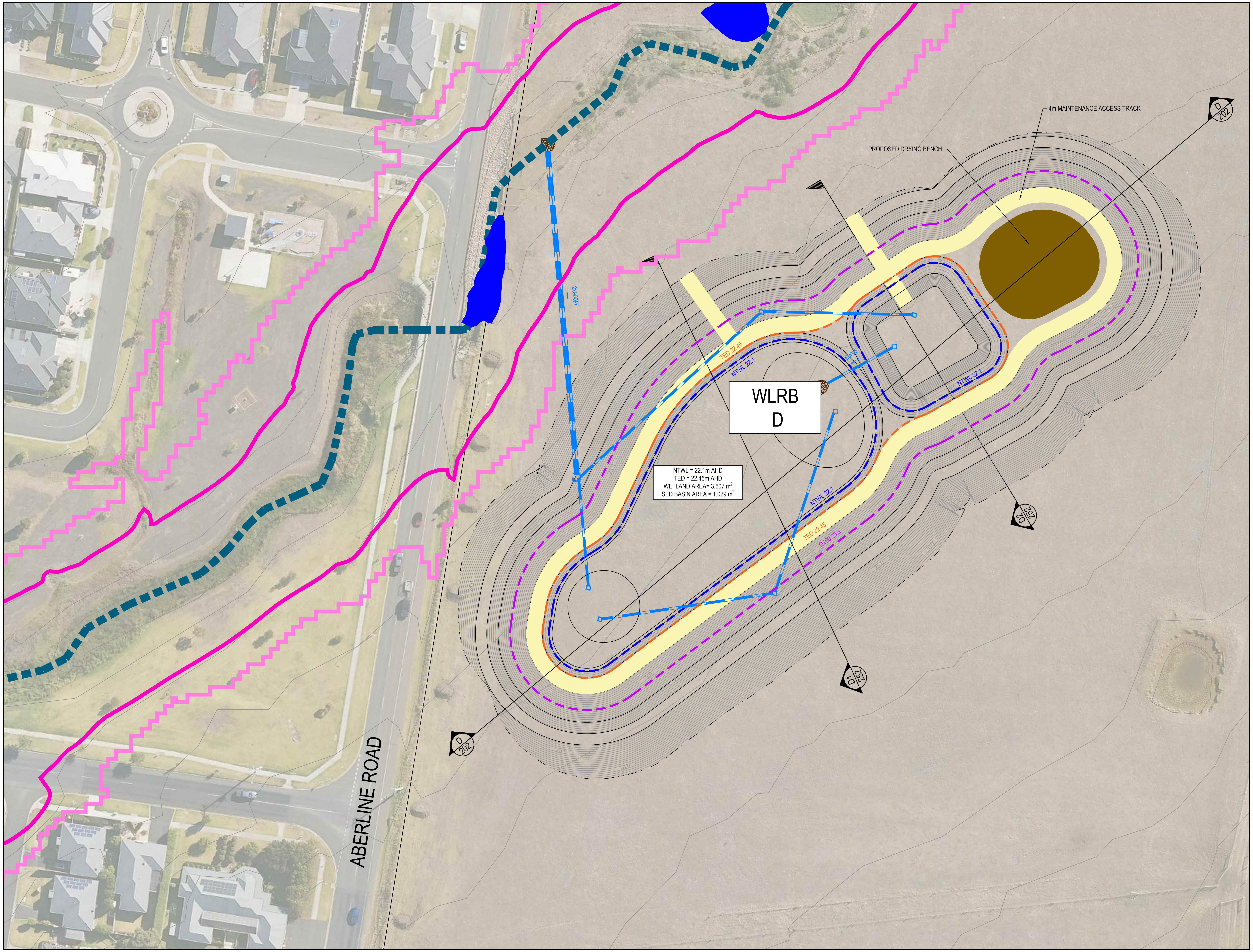

LEGEND

ALL PROPOSED, FUTURE & EXISTING SERVICE LOCATIONS ARE SHOWN INDICATIVELY

- STORMWATER DRAIN & PIT
- NTWL
- TED
- Q100
- MAINTENANCE TRACK
- DRYING BENCH
- ROCK BEACHING
- CREEK CENTRELINE
- LAND SUBJECT TO INUNDATION OVERLAY
- FLOOD OVERLAY
- CREEK STABILISATION EXTENT
- POOLS & RIFFLE EXTENT
- MAJOR CATCHMENT BOUNDARY
- PSP BOUNDARY

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REV	DATE	AMENDMENT / REVISION DESCRIPTION	DRAFTER	DESIGNER	CHECKER	RP ENG
A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO.	PLAN OF SUB. NO.	RP ENG	K. Velasco
		RP ENG NO.	PE0006835
		DATE	

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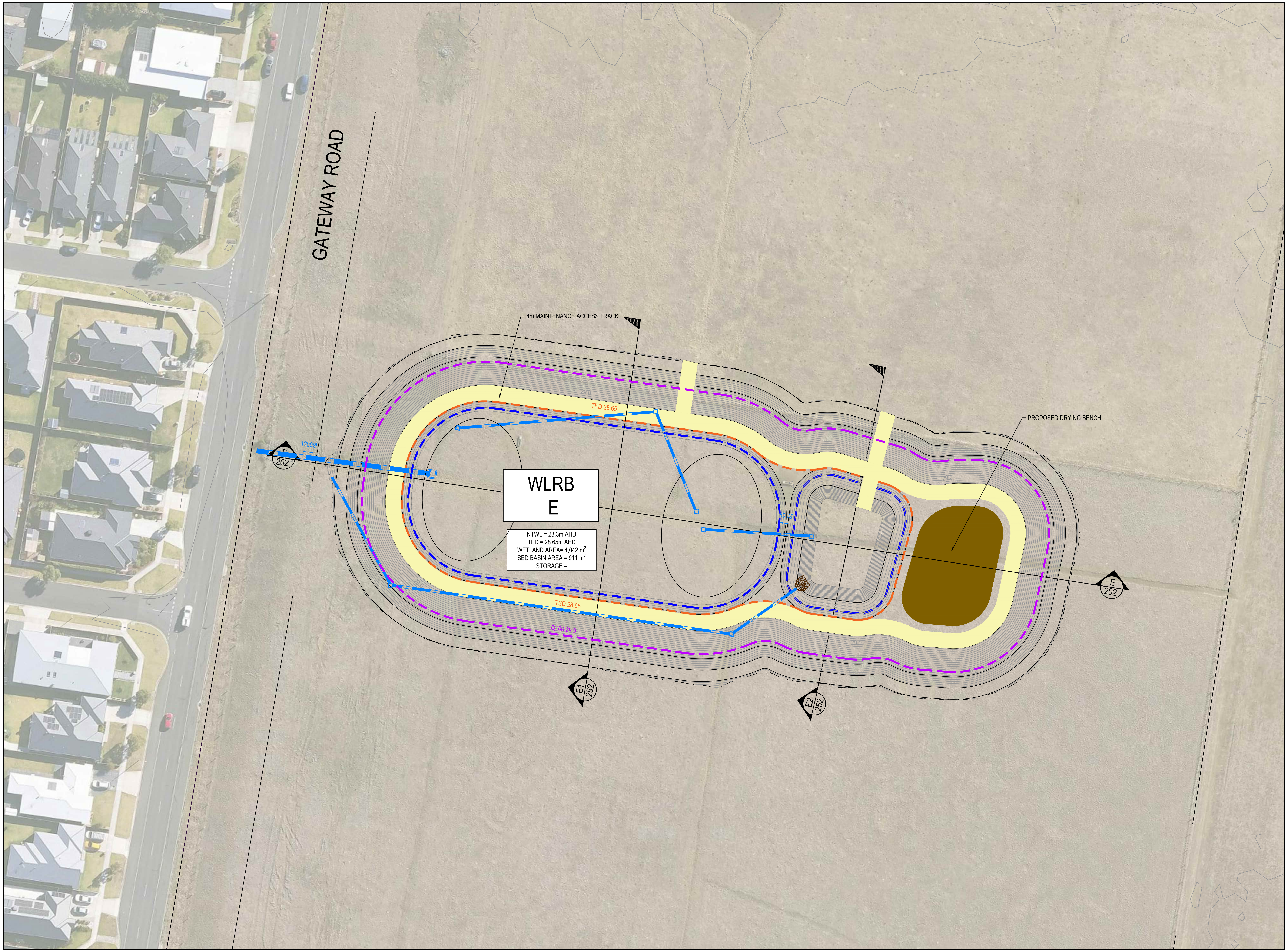
Road and Drainage
Wetland D Layout Plan

MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-114	05 of 11	A



LEGEND

ALL PROPOSED, FUTURE & EXISTING SERVICE LOCATIONS ARE SHOWN INDICATIVELY

(blue line with pits)	STORMWATER DRAIN & PIT
(blue dashed)	NTWL
(orange dashed)	TED
(purple dashed)	Q100
(pale yellow fill)	MAINTENANCE TRACK
(brown fill)	DRYING BENCH
(speckled brown fill)	ROCK BEACHING
(teal dashed)	CREEK CENTRELINE
(pink line)	LAND SUBJECT TO INUNDATION OVERLAY
(magenta line)	FLOOD OVERLAY
(blue fill)	CREEK STABILISATION EXTENT
(violet fill)	POOLS & RIFFLE EXTENT
(green line)	MAJOR CATCHMENT BOUNDARY
(red fill)	PSP BOUNDARY

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A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO.	PLAN OF SUB. NO.	RP ENG	K. Velasco
		RP ENG NO.	PE0006835
		DATE	

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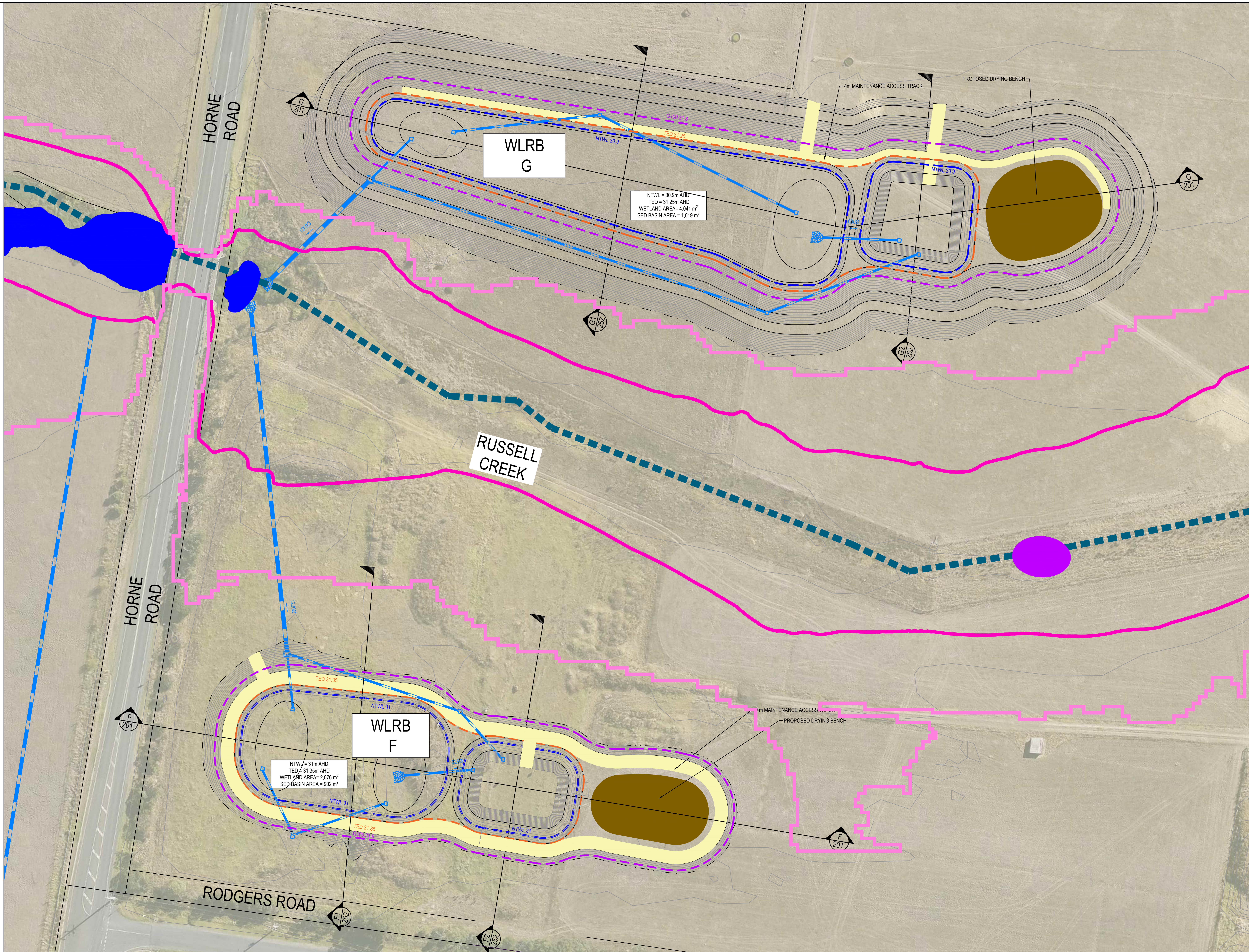
MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-115	06 of 11	A

DWG PATH: C:\12dS\data\SMECSYN\30043612 - East of Aberline PSP Stormwater Functional Design_2417\DWG\3612E-001-115.dwg PRINTED BY: DS13776 on 29/08/2025 at 05:03:13 PM



LEGEND

ALL PROPOSED, FUTURE & EXISTING SERVICE LOCATIONS ARE SHOWN INDICATIVELY

- STORMWATER DRAIN & PIT
- NTWL
- TED
- Q100
- MAINTENANCE TRACK
- DRYING BENCH
- ROCK BEACHING
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REV	DATE	AMENDMENT / REVISION DESCRIPTION	DRAFTER	DESIGNER	CHECKER	RP ENG
A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO.

PLAN OF SUB. NO.

RP ENG	K. Velasco
RP ENG NO.	PE0006835
DATE	

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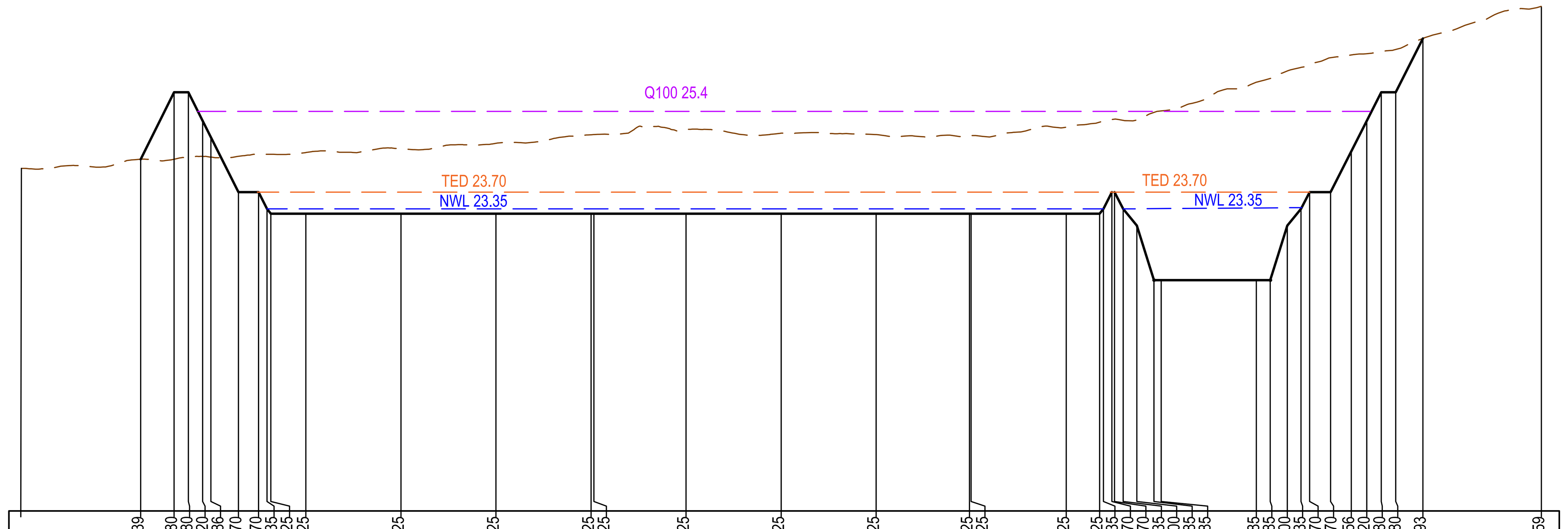
MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-116	07 of 11	A

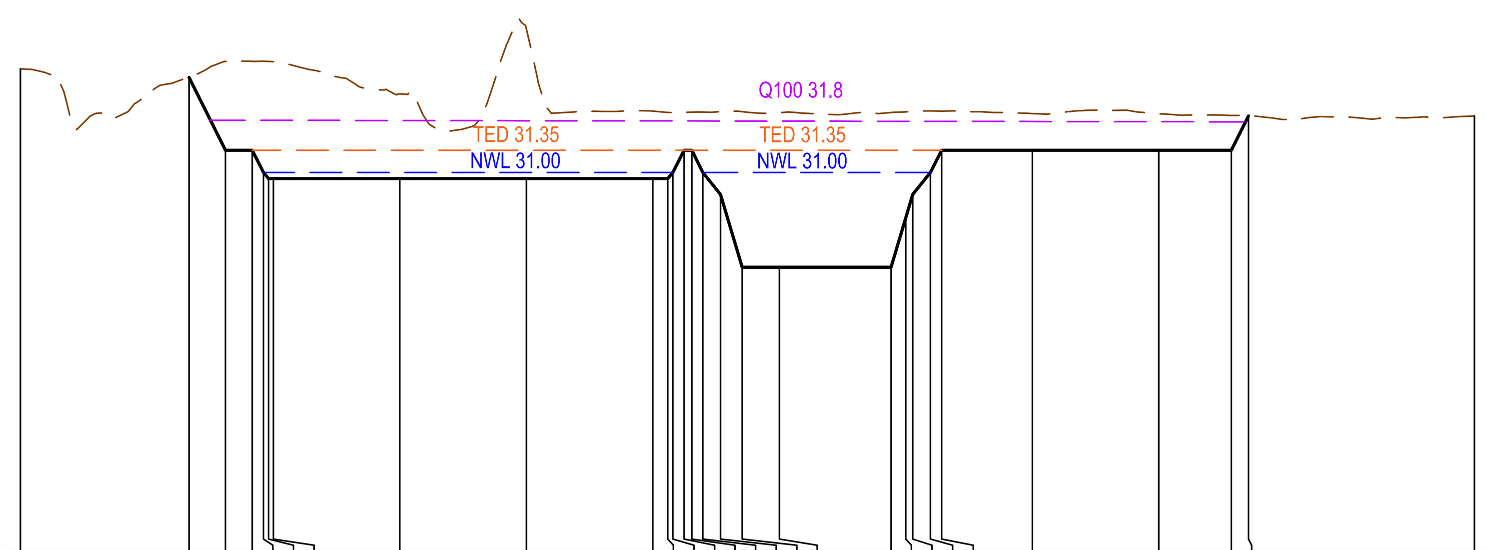
DWG PATH: C:\12dS\data\SMECSYN\30043612 - East of Aberline PSP Stormwater Functional Design_2417\DWG\3612E-001-116.dwg PRINTED BY: DS13776 on 29/08/2025 at 05:03:54 PM



DATUM RL17

CHAINAGE	DESIGN SURFACE	EXISTING SURFACE
0.00		24.20
25.23	24.39	24.39
32.26	25.80	24.39
35.27	25.80	24.44
38.27	25.20	24.45
40.00	24.86	24.44
45.79	23.70	24.45
50.05	23.70	24.50
51.80	23.35	24.50
52.61	23.25	24.50
60.00	23.25	24.53
80.00	23.25	24.61
100.00	23.25	24.73
120.00	23.25	24.91
120.60	23.25	24.91
140.00	23.25	25.01
160.00	23.25	24.94
180.00	23.25	24.91
199.66	23.25	24.89
200.00	23.25	24.89
220.00	23.25	25.07
227.01	23.25	25.17
227.83	23.35	25.20
229.61	23.70	25.23
230.14	23.70	25.24
231.97	23.35	25.21
234.88	23.00	25.22
238.47	21.85	25.38
240.00	21.85	25.41
260.00	21.85	26.01
262.92	21.85	26.09
266.51	23.00	26.25
269.42	23.35	26.32
271.24	23.70	26.36
275.61	23.70	26.53
280.00	24.56	26.59
283.27	25.20	26.61
286.31	25.80	26.66
289.35	25.80	26.70
295.06	26.93	26.93
320.00	27.59	27.61

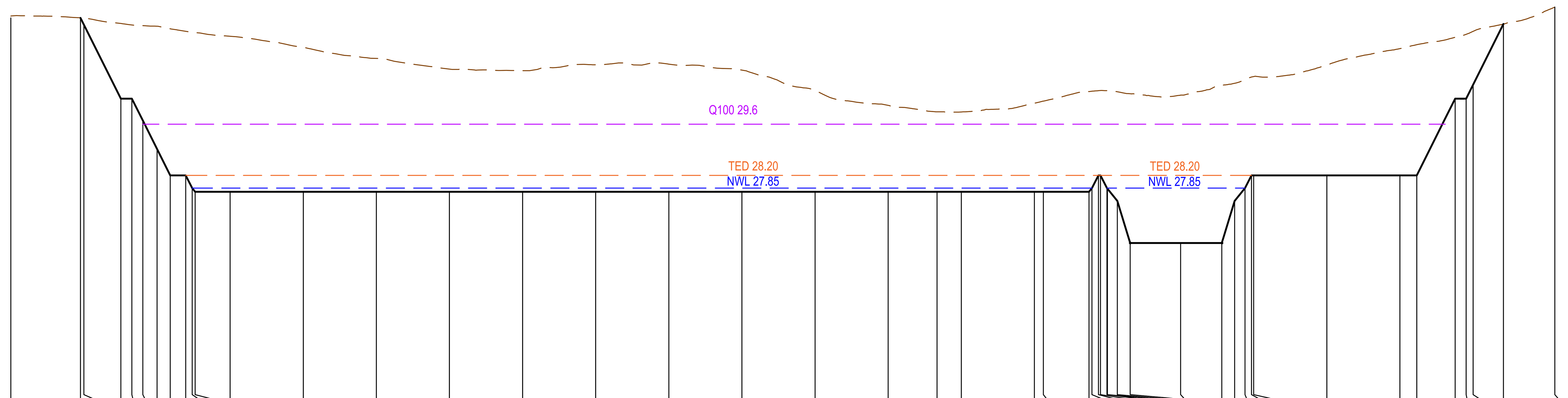
A LONGITUDINAL SECTION



DATUM RL25

CHAINAGE	DESIGN SURFACE	EXISTING SURFACE
0.00	32.64	32.64
26.64	32.50	32.50
32.41	31.35	32.76
36.67	31.35	32.76
38.43	31.00	32.76
39.23	30.90	32.75
40.00	30.90	32.75
60.00	30.90	32.24
80.00	30.90	33.27
100.00	30.90	31.97
102.37	30.90	31.95
103.17	31.00	31.95
104.92	31.35	31.95
106.15	31.35	31.95
107.90	31.00	31.95
110.70	30.65	31.96
114.15	29.50	31.96
120.00	29.50	31.95
137.65	29.50	31.95
140.00	30.28	31.96
141.10	30.65	31.97
143.90	31.00	31.97
145.65	31.35	31.97
160.00	31.35	31.93
180.00	31.35	31.93
191.45	31.35	31.90
194.17	31.89	31.90
229.92	31.89	31.89

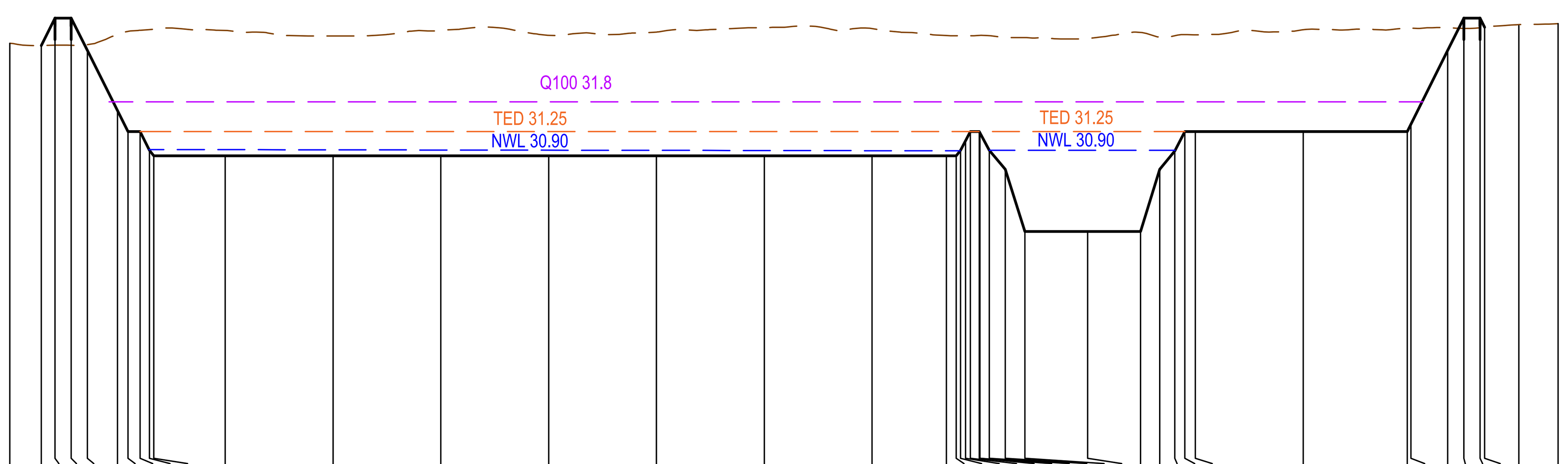
F LONGITUDINAL SECTION



DATUM RL22

CHAINAGE	DESIGN SURFACE	EXISTING SURFACE
0.00		32.56
19.05	32.51	32.51
20.00	32.32	32.50
30.10	30.30	32.36
33.10	30.30	32.31
36.11	29.70	32.30
40.00	28.92	32.28
43.61	28.20	32.21
47.86	28.20	32.14
49.61	27.85	32.12
50.41	27.75	32.11
60.00	27.75	32.01
80.00	27.75	31.70
100.00	27.75	31.40
120.00	27.75	31.11
140.00	27.75	31.06
160.00	27.75	31.23
180.00	27.75	31.24
200.00	27.75	31.08
220.00	27.75	30.52
240.00	27.75	30.11
253.36	27.75	29.94
260.00	27.75	29.93
280.00	27.75	30.18
282.47	27.75	30.23
294.95	27.75	30.49
295.76	27.85	30.50
297.53	28.20	30.52
298.07	28.20	30.52
299.85	27.85	30.52
300.00	27.83	30.52
302.69	27.50	30.49
306.19	26.35	30.43
320.00	26.35	30.39
331.27	26.35	30.67
334.77	27.50	30.72
337.62	27.85	30.81
339.39	28.20	30.89
340.00	28.20	30.90
360.00	28.20	31.22
380.00	28.20	31.67
384.59	28.20	31.78
395.09	30.30	31.98
398.09	30.30	32.06
400.00	30.68	32.14
408.31	32.34	32.34
422.38	32.81	32.81

B LONGITUDINAL SECTION



DATUM RL25

CHAINAGE	DESIGN SURFACE	EXISTING SURFACE
0.00	32.88	32.88
5.86	32.84	32.84
8.40	33.35	32.85
11.41	33.35	32.85
14.41	32.75	32.86
20.00	31.63	33.05
21.93	31.25	33.10
24.18	31.25	33.12
25.94	30.90	33.13
26.74	30.80	33.14
40.00	30.80	33.12
60.00	30.80	33.02
80.00	30.80	33.12
100.00	30.80	33.03
120.00	30.80	33.09
140.00	30.80	33.17
160.00	30.80	33.16
173.81	30.80	33.03
175.60	30.80	33.02
176.41	30.90	33.02
177.35	31.08	33.02
178.23	31.25	33.02
179.88	31.25	33.03
180.00	31.23	33.03
181.74	30.90	33.02
184.70	30.55	32.99
188.35	29.40	32.99
200.00	29.40	32.97
209.82	29.40	33.08
213.36	30.55	33.00
216.15	30.89	33.02
218.03	31.25	33.04
220.00	31.25	33.04
240.00	31.25	33.13
259.30	31.25	33.17
260.00	31.39	33.16
266.80	32.75	33.17
269.80	33.35	33.16
272.82	33.35	33.17
273.66	33.18	33.18
280.00	33.21	33.23
287.29	33.24	33.24

G LONGITUDINAL SECTION

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DRAFTER	DESIGNER	CHECKER	RP ENG
A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO.	PLAN OF SUB. NO.	RP ENG	K. Velasco
		RP ENG NO.	PE0006835
		DATE	

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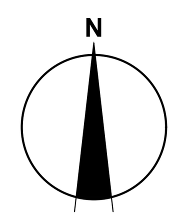
Scale H1:1000, V1:100
SCALE AS SHOWN AT A1



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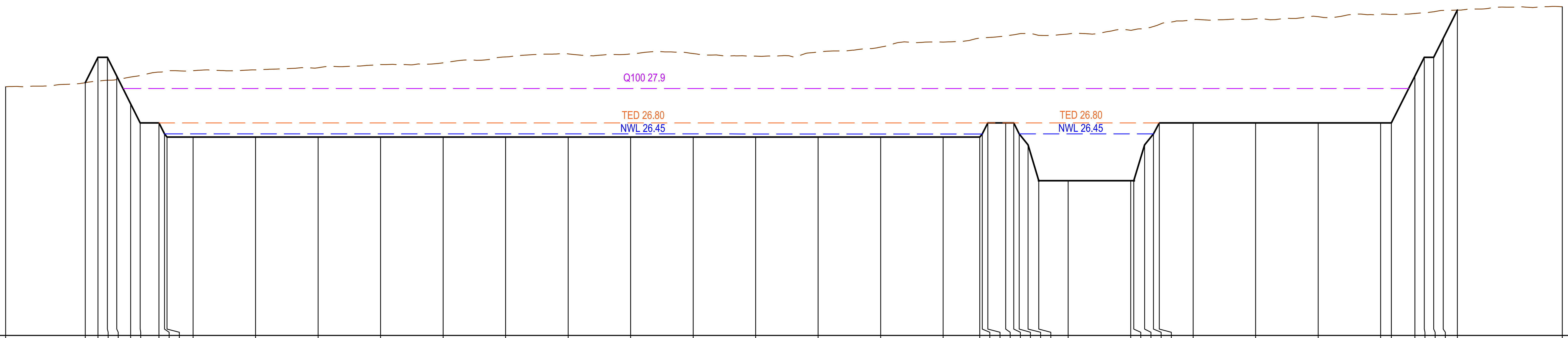
Road and Drainage
Wetland A, B, F & G Long Sections

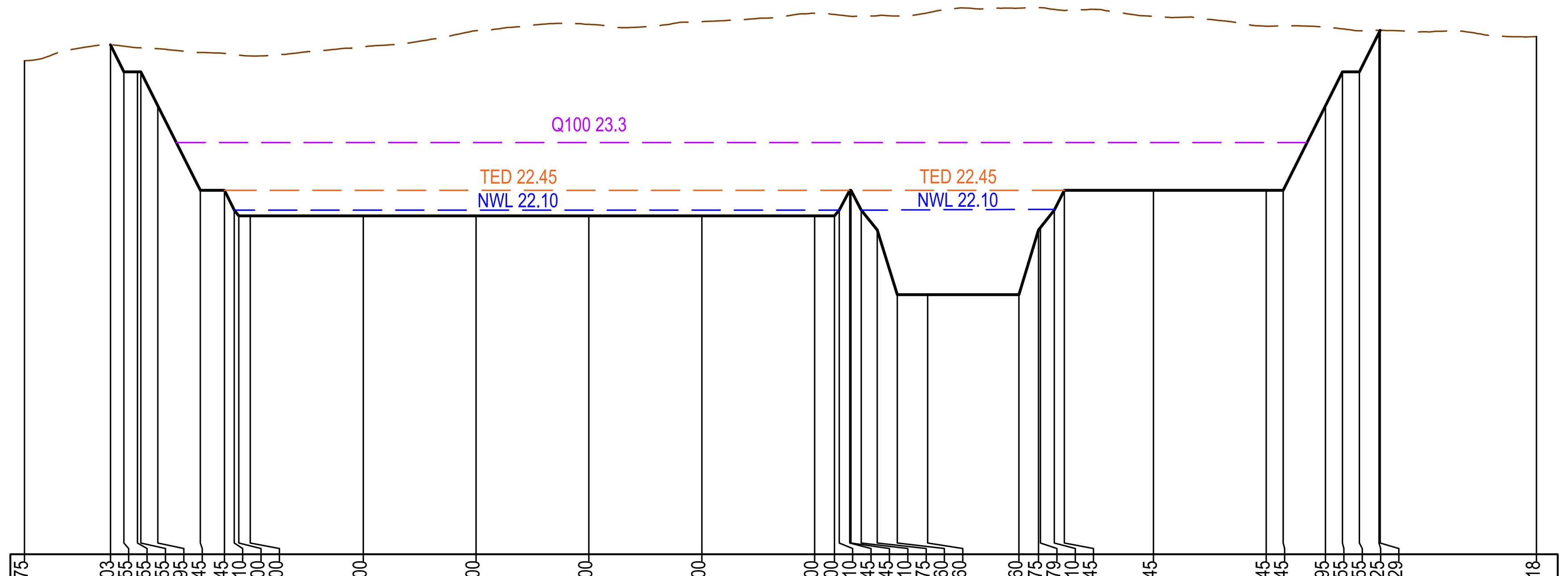
MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-201	08 of 11	A



DATUM RL20

CHAINAGE	DESIGN SURFACE	EXISTING SURFACE
0.00	27.96	27.96
25.50	28.09	28.09
29.55	28.90	28.14
32.55	28.90	28.17
35.56	28.30	28.19
40.00	27.41	28.27
43.07	26.80	28.32
49.08	26.80	28.43
50.84	26.45	28.44
51.64	26.35	28.46
60.00	26.35	28.47
80.00	26.35	28.50
100.00	26.35	28.57
120.00	26.35	28.67
140.00	26.35	28.72
160.00	26.35	28.91
180.00	26.35	29.01
200.00	26.35	29.01
220.00	26.35	29.02
240.00	26.35	28.94
260.00	26.35	29.07
280.00	26.35	29.23
300.00	26.35	29.39
311.70	26.35	29.52
312.51	26.45	29.53
314.29	26.80	29.54
320.00	26.80	29.59
322.60	26.80	29.62
324.35	26.45	29.65
327.15	26.10	29.66
330.60	24.95	29.60
340.00	24.95	29.65
360.00	24.95	29.77
360.97	24.95	29.78
364.47	26.10	29.82
367.31	26.45	29.89
369.17	26.80	29.95
380.00	26.80	30.10
400.00	26.80	30.14
420.00	26.80	30.20
440.00	26.80	30.28
443.41	26.80	30.27
450.94	28.30	30.30
453.95	28.90	30.33
456.96	28.90	30.36
460.00	29.51	30.40
464.53	30.41	30.41
498.09	30.52	30.52

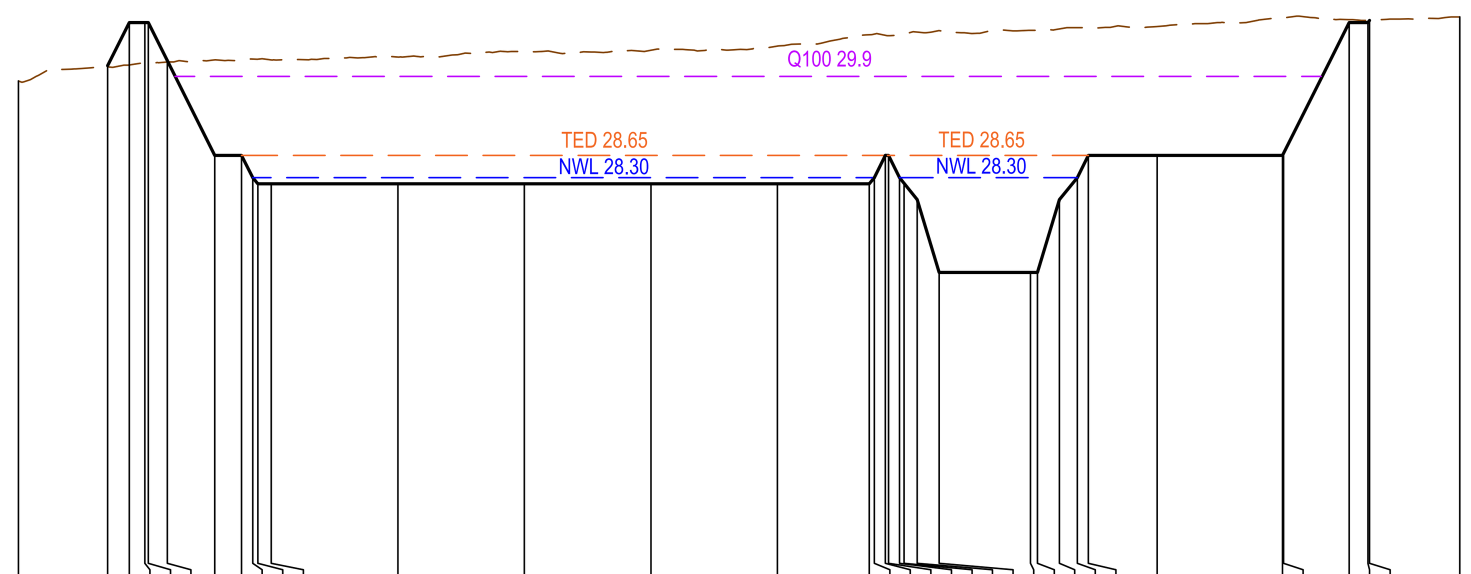
C LONGITUDINAL SECTION



DATUM RL16

CHAINAGE	DESIGN SURFACE	EXISTING SURFACE
0.00	24.75	24.75
15.22	25.03	25.03
17.60	24.55	25.00
20.00	24.55	24.98
20.61	24.55	24.98
23.61	23.95	24.96
31.13	22.45	24.89
35.41	22.45	24.88
37.17	22.10	24.86
37.98	22.00	24.85
40.00	22.00	24.83
60.00	22.00	25.00
80.00	22.00	25.28
100.00	22.00	25.39
120.00	22.00	25.44
140.00	22.00	25.59
143.49	22.00	25.57
144.34	22.10	25.56
146.20	22.45	25.54
146.44	22.45	25.53
148.24	22.10	25.54
151.09	21.75	25.55
154.62	20.60	25.54
160.00	20.60	25.60
176.19	20.60	25.68
179.65	21.75	25.69
180.00	21.79	25.69
182.47	22.10	25.66
184.23	22.45	25.64
200.00	22.45	25.54
220.00	22.45	25.36
223.00	22.45	25.37
230.51	23.95	25.34
233.51	24.55	25.31
236.52	24.55	25.28
240.00	25.25	25.29
240.21	25.29	25.29
267.90	25.18	25.18

D LONGITUDINAL SECTION



DATUM RL22

CHAINAGE	DESIGN SURFACE	EXISTING SURFACE
0.00	29.83	29.83
14.13	30.07	30.05
17.54	30.75	30.08
20.00	30.75	30.12
20.54	30.75	30.12
23.54	30.15	30.13
31.04	28.65	30.16
35.29	28.65	30.16
37.04	28.30	30.17
37.84	28.20	30.17
40.00	28.20	30.16
60.00	28.20	30.20
80.00	28.20	30.29
100.00	28.20	30.31
120.00	28.20	30.38
134.50	28.20	30.56
135.30	28.30	30.57
137.05	28.65	30.55
137.55	28.65	30.54
139.30	28.30	30.56
140.00	28.21	30.56
142.10	27.95	30.60
145.55	26.80	30.62
160.00	26.80	30.63
161.10	26.80	30.63
164.57	27.95	30.65
167.39	28.30	30.67
169.15	28.65	30.67
180.00	28.65	30.69
199.84	28.65	30.82
200.00	28.68	30.82
210.35	30.75	30.79
213.36	30.75	30.78
213.59	30.78	30.78
227.84	30.84	30.84

E LONGITUDINAL SECTION

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DRAFTER	DESIGNER	CHECKER	RP ENG
A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO.

PLAN OF SUB. NO.

RP ENG	K. Velasco
RP ENG NO.	PE0006835
DATE	

INFORMATION ONLY

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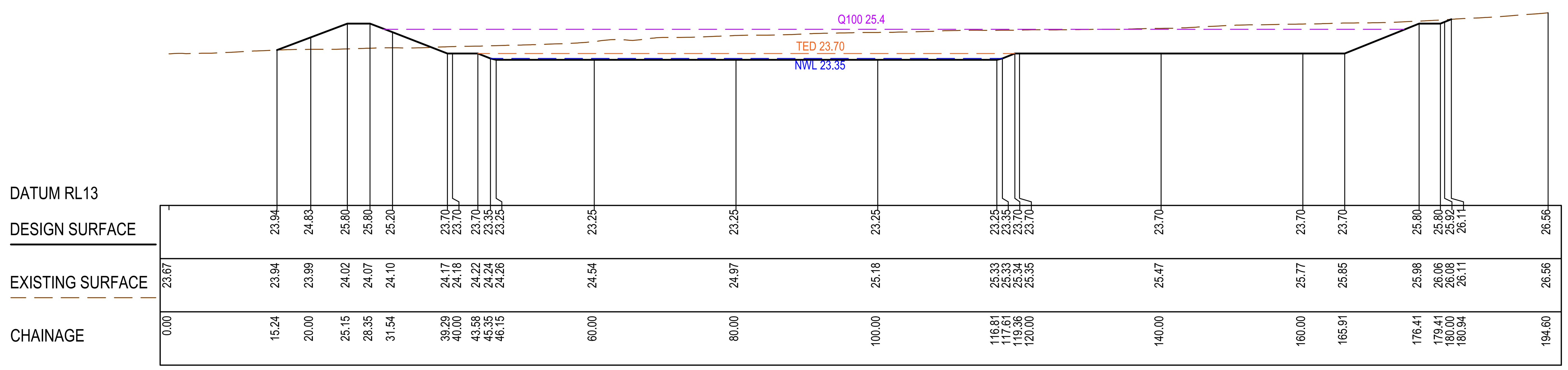
Road and Drainage
Wetland C & D & E Long Sections

MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-202	09 of 11	A



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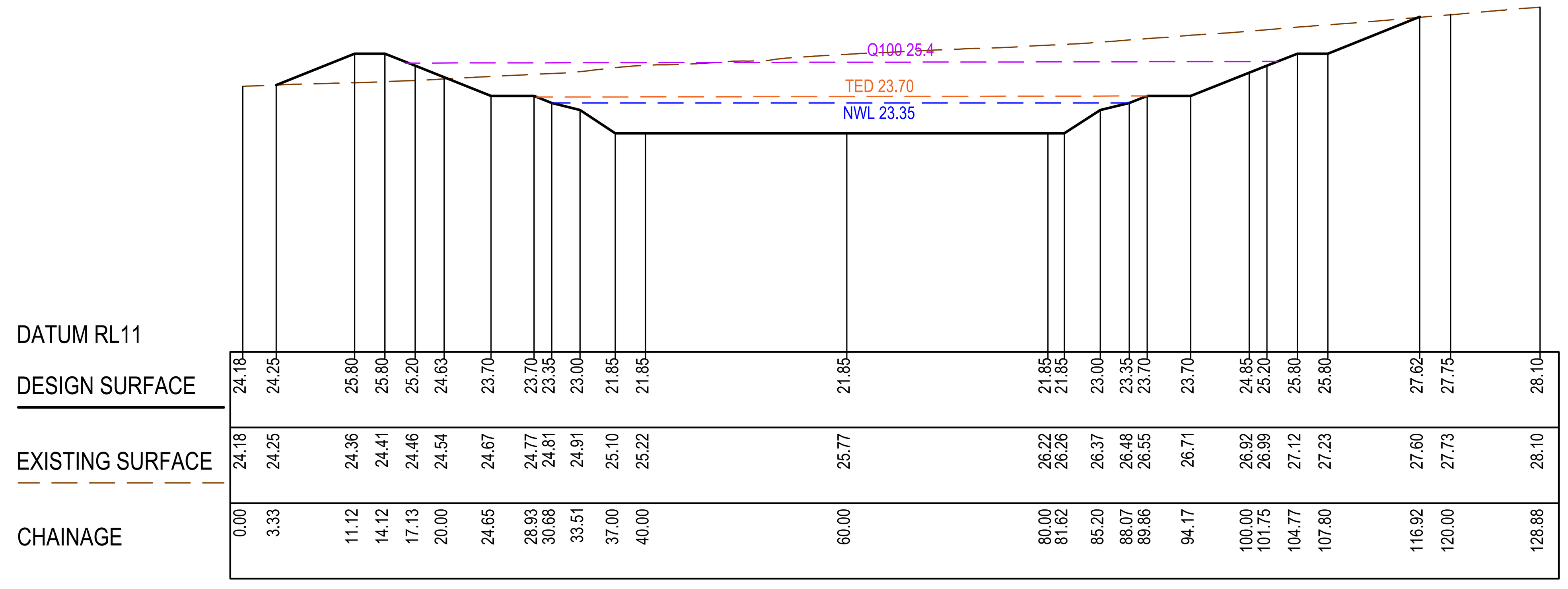

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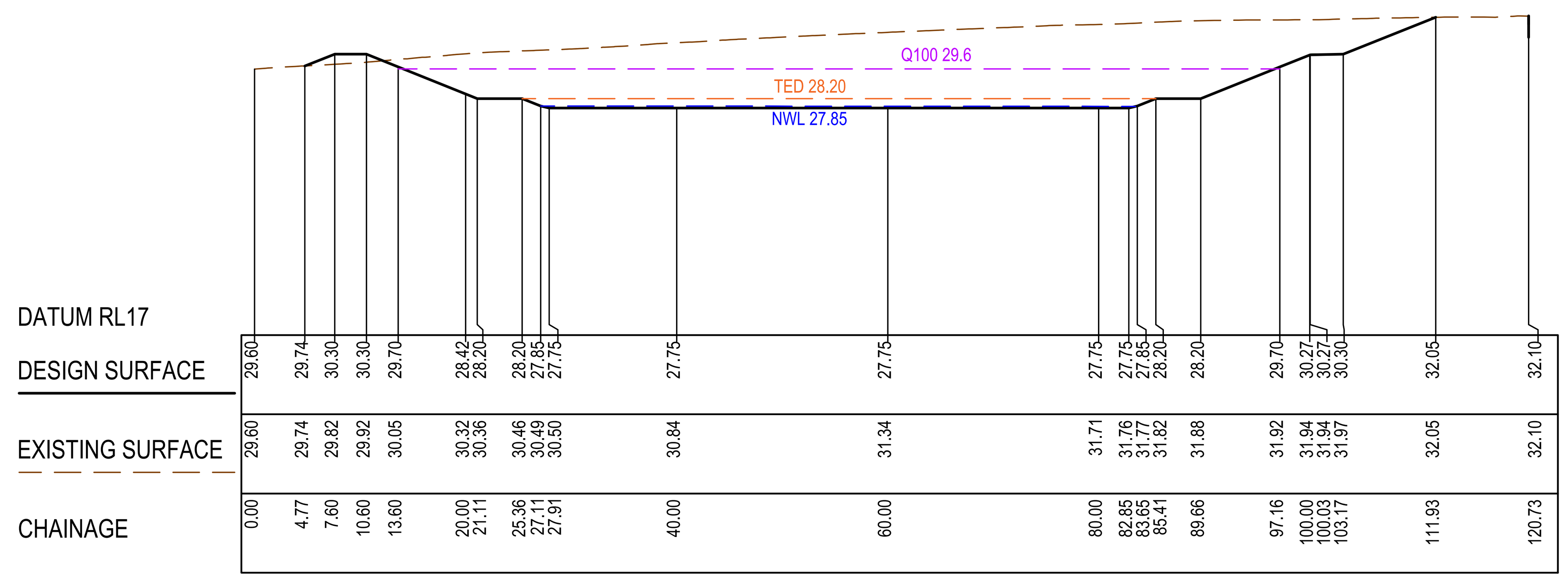

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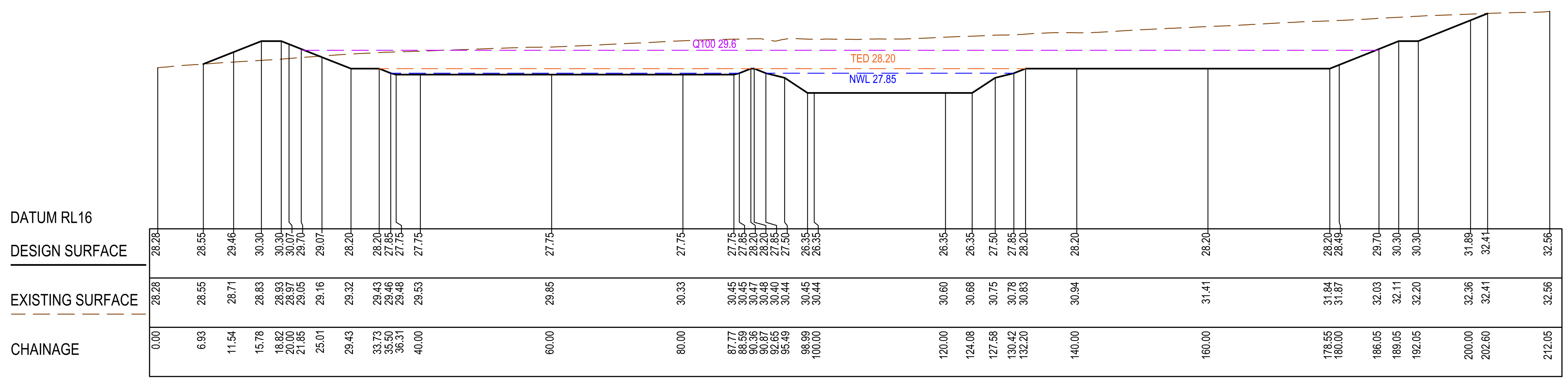

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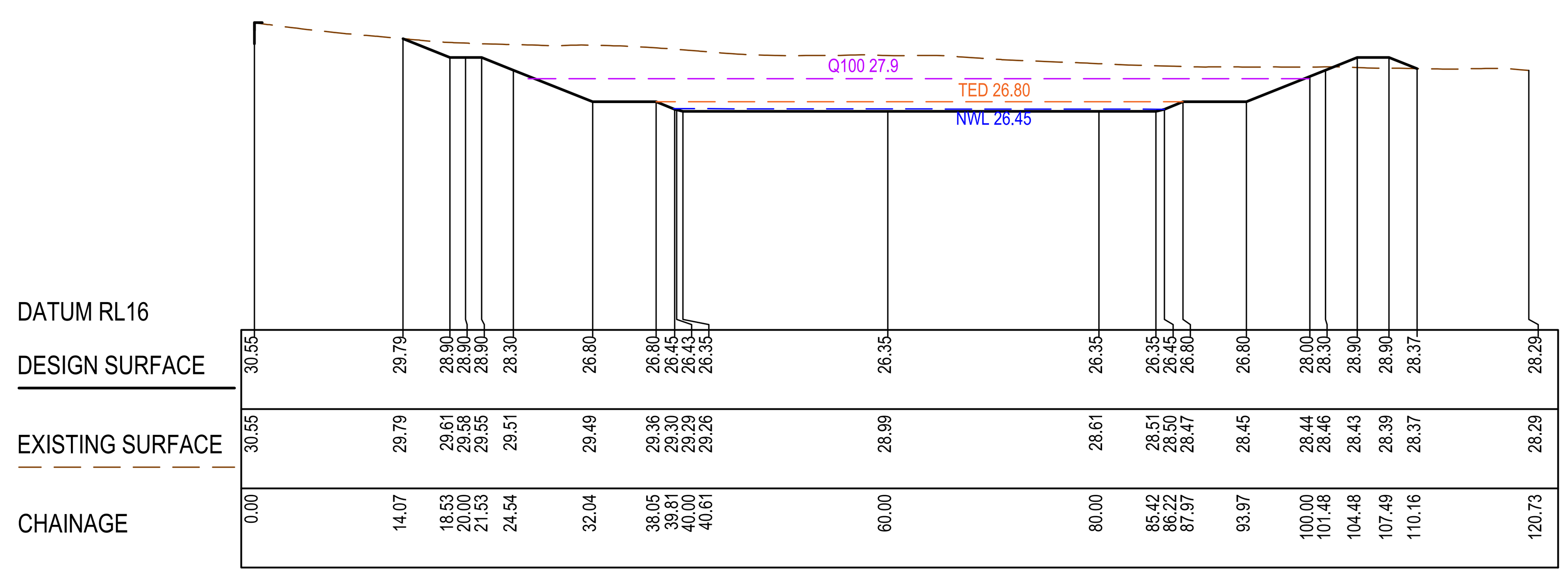
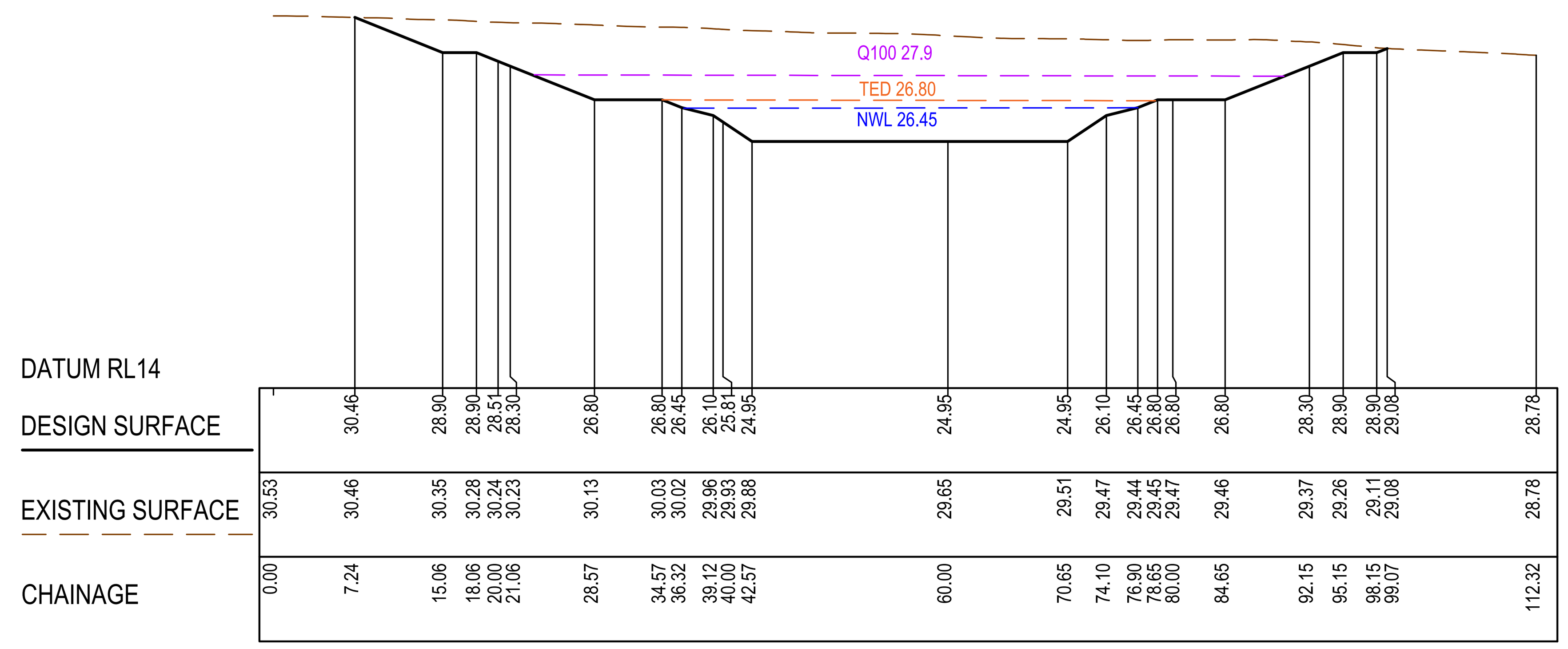


C1 SECTION



C2 SECTION

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DRAFTER	DESIGNER	CHECKER	RP ENG
A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO.	PLAN OF SUB. NO.		
		RP ENG	K. Velasco
		RP ENG NO.	PE0006835
		DATE	

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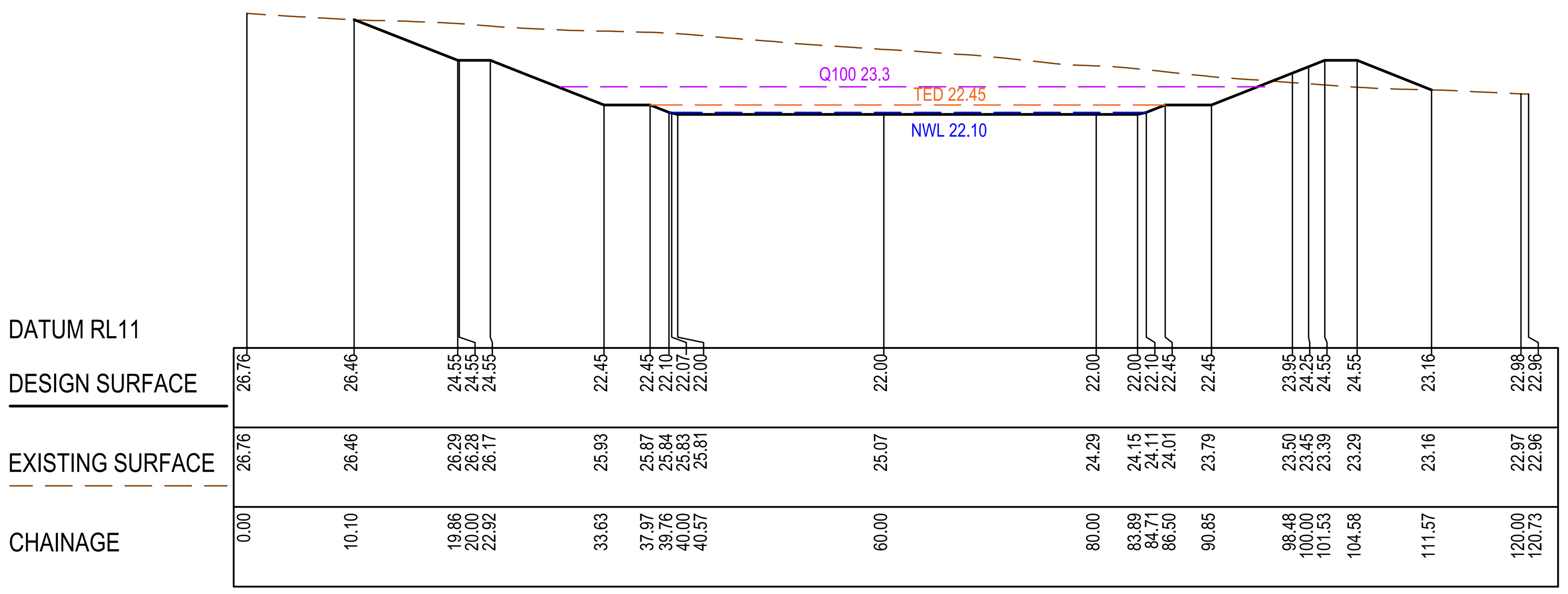
Road and Drainage
Cross Sections: Wetland A, B & C

MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-251	10 of 11	A



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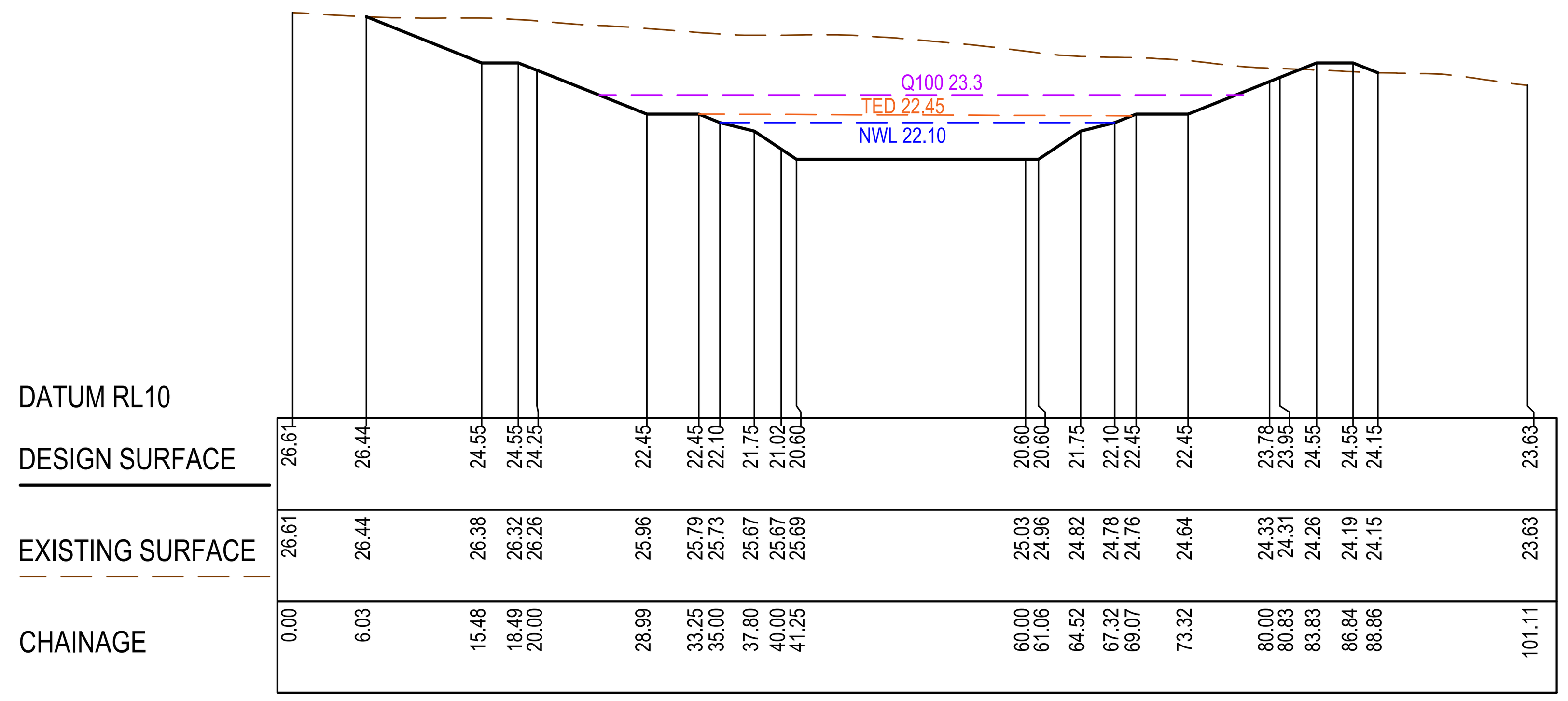

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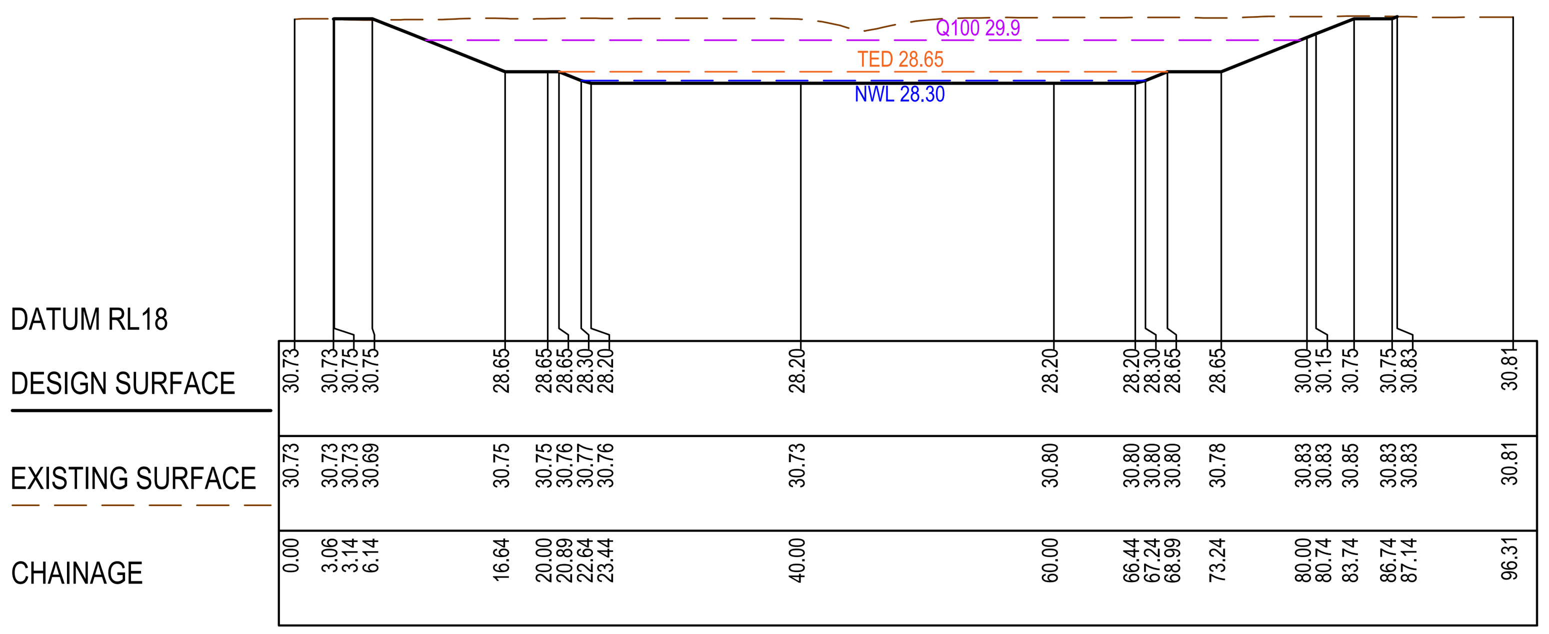

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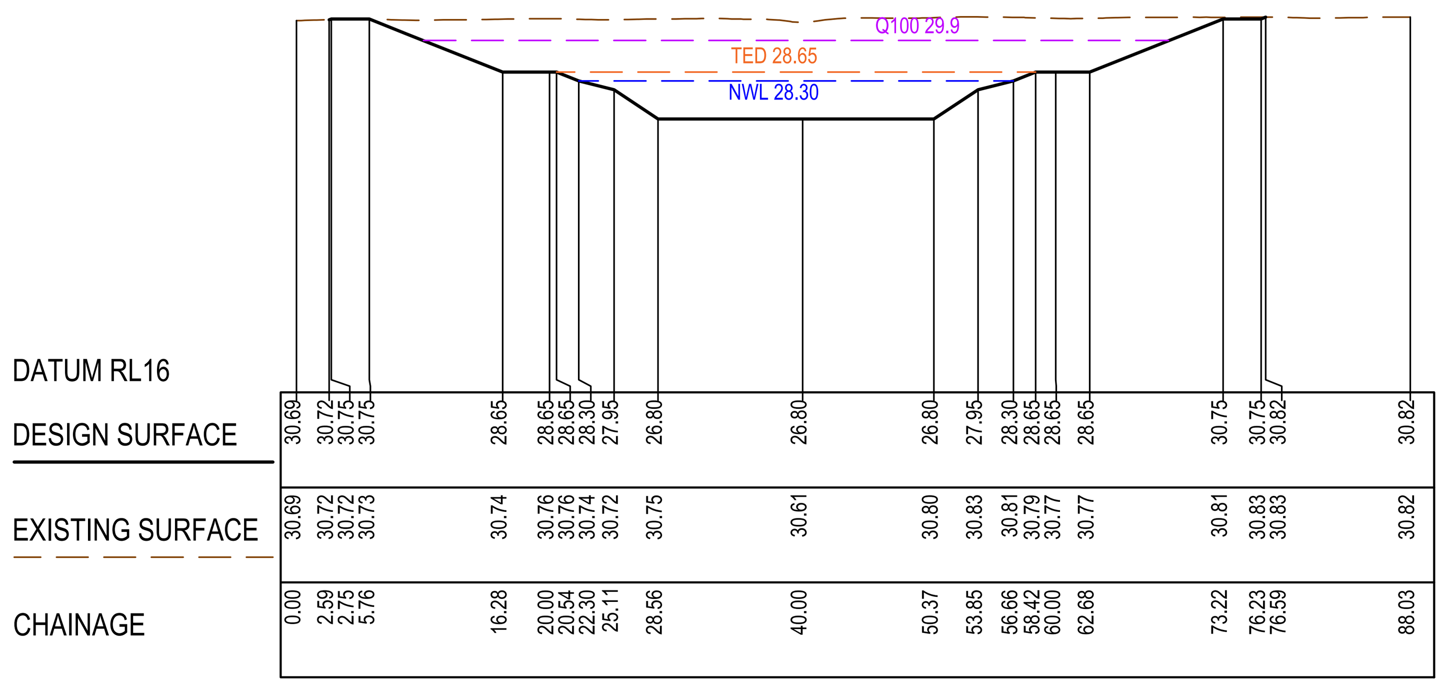

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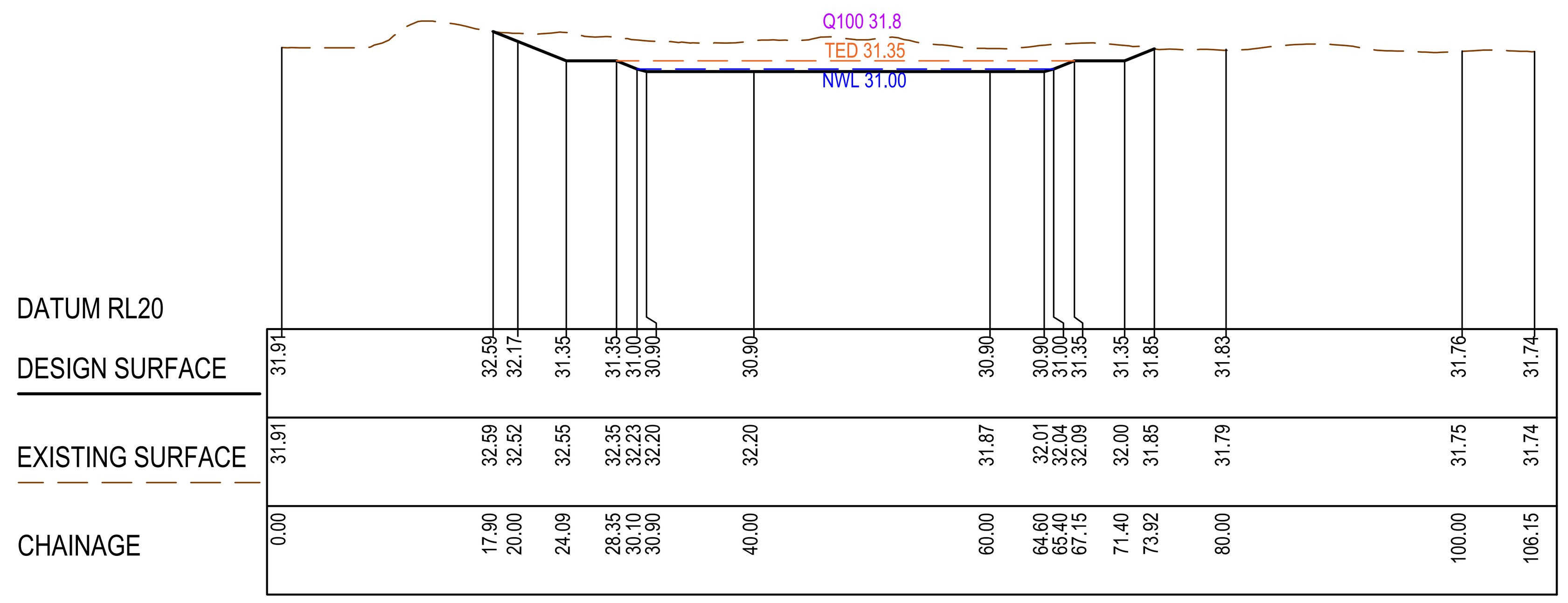

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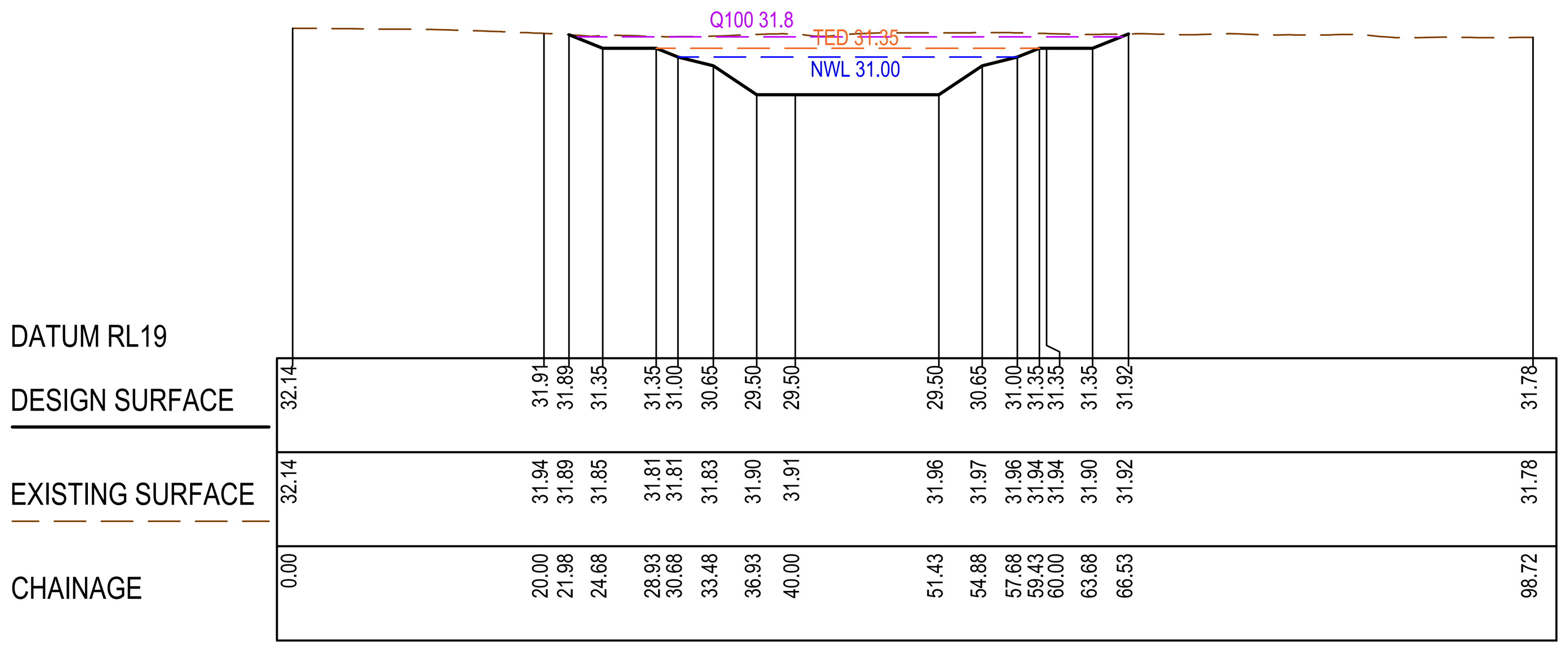
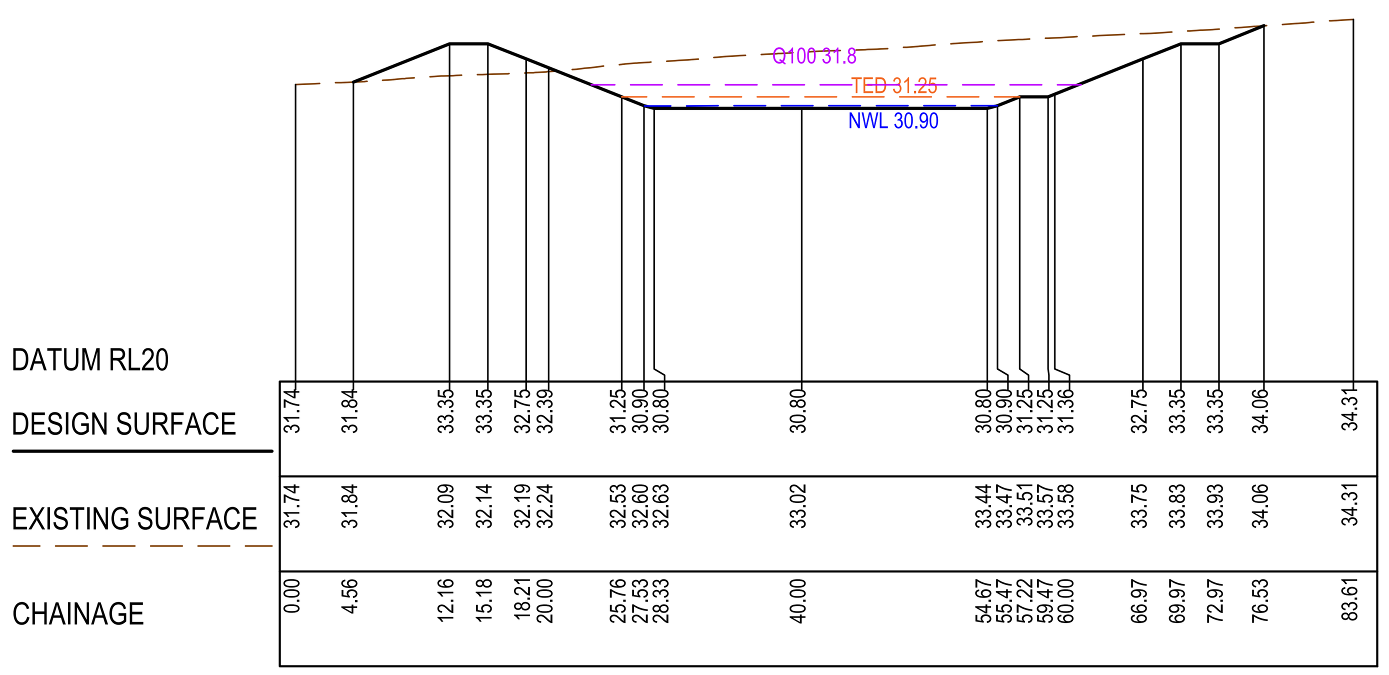


F2 SECTION



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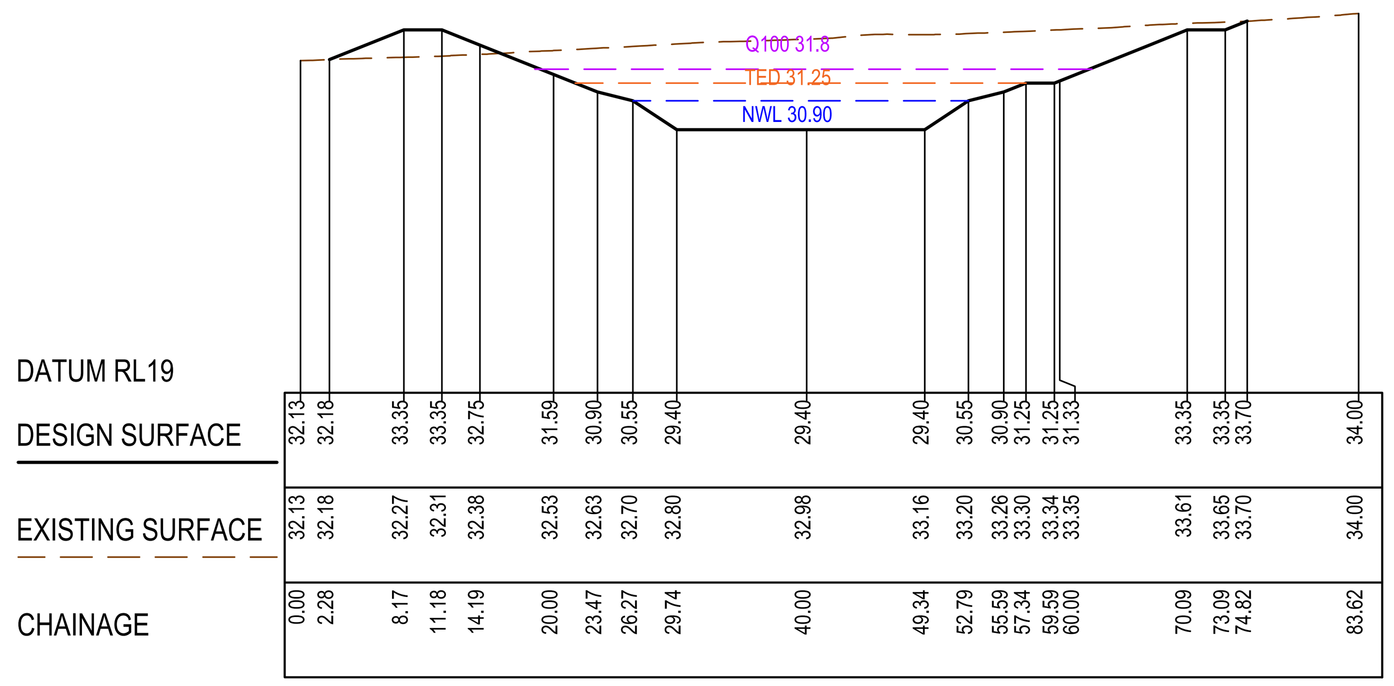

G2 SECTION

REV	DATE	AMENDMENT / REVISION DESCRIPTION	DRAFTER	DESIGNER	CHECKER	RP ENG
A	29.08.25	ISSUED FOR INFORMATION ONLY	D.SCHMID	D.SCHMID	K.VELASCO	K.VELASCO

PERMIT REF. NO. | PLAN OF SUB. NO.

RP ENG	K. Velasco
RP ENG NO.	PE0006835
DATE	

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Cross Sections: Wetland D, E, F & G

MELWAYS REF	PROJECT / DRAWING No.	SHEET No.	REVISION
	3612E-001-252	11 of 11	A

Appendix H

Cost Estimates

SUMMARY

31/08/2025

Item	Description	Amount $
1.1	ANCILLARY WORKS COST ESTIMATE	$ 5,258,475.62
1.2	WLRB A COST ESTIMATE	$ 5,408,800.84
1.3	WLRB B COST ESTIMATE	$ 8,785,972.86
1.4	WLRB C COST ESTIMATE	$ 7,609,554.64
1.4	WLRB D COST ESTIMATE	$ 3,863,290.33
1.5	WLRB E COST ESTIMATE	$ 2,945,101.64
1.5	WLRB F COST ESTIMATE	$ 1,835,418.05
1.6	WLRB G COST ESTIMATE	$ 2,925,766.21
	TOTAL ESTIMATED COST	$ 38,632,380.18

This preliminary costing is only an indicative costs associated to the construction of the drainage strategy which will take several years to be constructed. Therefore,

Does not include land acquisition or land filling

Exclude investigations fee

Nominal allowance included for Russell Ck stabilisation works

Does not include costs associated with uncertainties such as contaminated soil disposal or clay liner imporation

RB/WL costs are highly variable cost items and dependent on soil conditions of the site. Without further information appropriate contingency should be applied.

Preliminary estimate above are based on Victorian Metro projects. Final estimates will consider local rates if available.

ANCILLARY WORKS COST ESTIMATE

31/08/2025

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	WORKS					
1	SITEWORKS AND EARTHWORKS					
1.1	Site preparation	1	Item	$ 10,000.00	$ 10,000.00	
1.2	Temp Diversion Works	1	Item	$ 10,001.00	$ 10,001.00	
1.3	Waterway connection		Item			
1.4	Stripping of topsoil		m2			
1.5	Excavation		m3			
1.6	Formation of batters		m3			
2	DRAINAGE WORKS					
2.1	WATERWAYS					
2.1.1	Revegetation	12519	m2	$ 30.00	$ 375,570.00	Nominal Allowance for High Shear Stress Areas
2.1.2	Stabilisation Works	12519	m2	$ 130.00	$ 1,627,470.00	Nominal Allowance for High Shear Stress Areas
2.1.3	Pools and Riffle	5	Item	$ 20,000.00	$ 100,000.00	
2.2	DRAINAGE PIPES/PITS					
2.2.1	Q100 Pipe	690	LM	$ 1,500.00	$ 1,035,000.00	Pipe Along Horne Road (Assumed this is a 1050mm pipe)
2.2.2	SWALE					
2.2.3	Grassed Swale 1	288	LM	$ 150.00	$ 43,200.00	Overland Swale (Linear metre rate of $150 including excavation, topsoil and grassing)
2.2.4	Grassed Swale 2	467	LM	$ 150.00	$ 70,050.00	Overland Swale (Linear metre rate of $150 including excavation, topsoil and grassing)
2.2.5	Grassed Swale 3	200	LM	$ 150.00	$ 30,000.00	Overland Swale (Linear metre rate of $150 including excavation, topsoil and grassing)
2.2.6	Grassed Swale 4	397	LM	$ 150.00	$ 59,550.00	Overland Swale (Linear metre rate of $150 including excavation, topsoil and grassing)
	Grassed Swale 5	200	LM	$ 150.00	$ 30,000.00	Overland Swale (Linear metre rate of $150 including excavation, topsoil and grassing)
2.2.7	Grassed Swale 6	534	LM	$ 150.00	$ 80,100.00	Overland Swale (Linear metre rate of $150 including excavation, topsoil and grassing)
3	OTHER					
3.1						
3.2			Item		$ -	
4	MISCELLANEOUS					
4.1						
	SUB-TOTAL WORKS				$ 3,470,941.00	
5	DELIVERY					
5.1	Council Fees	3.25	%		$ 112,805.58	
5.2	Authority Fees	1	%		$ 34,709.41	
5.3	Traffic Management	5	%		$ 173,547.05	
5.4	Environmental Management	0.5	%		$ 17,354.71	
5.5	Survey & Design	5	%		$ 173,547.05	
5.6	Supervision & Project Management	9	%		$ 312,384.69	
5.7	Site Establishment	2.5	%		$ 86,773.53	
5.8	Contingency	20	%		$ 876,412.60	
	SUB-TOTAL DELIVERY				$ 1,787,534.62	
6	TOTAL ESTIMATED COST				$ 5,258,475.62	

This preliminary costing is only an indicative costs associated to the construction of the drainage strategy which will take several years to be constructed. Therefore, the costs required to fund these drainage assets will be spread over severa

Does not include land acquisition or land filling

Exclude investigations fee

Nominal allowance included for Russell Ck stabilisation works

Does not include costs associated with uncertainties such as contaminated soil disposal or clay liner imporation

RB/WL costs are highly variable cost items and dependent on soil conditions of the site. Without further information appropriate contingency should be applied.

Cost estimate above are based on Victorian Metro projects. Final estimates will consider local rates if available.

WLRB A COST ESTIMATE

31/08/2025

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	WORKS					
1	SITEWORKS AND EARTHWORKS					
1.1	Site preparation		Item			Included in Site Establishment
1.2	Temp Diversion Works	1	Item	$ 20,000.00	$ 20,000.00	
1.3	Waterway connection	1	Item	$ 5,000.00	$ 5,000.00	Erosion Protection Connection into Waterway
1.4	Stripping of topsoil		m2			Included below
1.5	Excavation		m3			Included below
1.6	Formation of batters		m3			Included below
2	DRAINAGE WORKS					
2.1	WATERWAYS					
2.1.1						
2.2	SEDIMENTATION PONDS					
2.2.1	SP A	1800	m2	$ 250.00	$ 450,000.00	Recently received a $250/sq.m rate for bioretention system
2.3	DRAINAGE PIPES/PITS					
2.3.1	Outlet Pipes	149	LM	$ 1,300.00	$ 193,700.00	1200 Dia Pipe
2.3.2	Balance Pipes	169	LM	$ 350.00	$ 59,150.00	assumed 300mm pipe
2.3.3	High Flow Bypass	138	LM	$ 977.00	$ 134,826.00	assumed 900mm pipe
2.3.4	Control Structures	1	Item	$ 20,000.00	$ 20,000.00	estimated rate for a large pit 2000mm x 2000mm
2.3.5	Junction Pits	8	Item	$ 2,500.00	$ 20,000.00	assumed small sized junction pit (600mm x 900mm)
2.3.6	Outfall Pit Structure	1	Item	$ 4,000.00	$ 4,000.00	Rockwork
2.3.7	Littre Traps / GPT	1	Item	$ 32,200.00	$ 32,200.00	CDS Unit
2.4	EARTHWORKS					
2.4.1	Wetland / RB A					
	Stripping of topsoil & stockpiling	6597	m3	$ 7.50	$ 49,477.50	Assumed 200mm topsoil
	Spread topsoil	6597	m3	$ 12.50	$ 82,462.50	Assumed 200mm topsoil
	Cut	42607.64	m3	$ 40.00	$ 1,704,305.60	Assumed cut to onsite stockpile
	Fill	670.497	m3	$ 10.00	$ 6,704.97	Spread and compact, no import
2.5	ROCKWORKS					
2.5.1	Supply and installation of rockwork at sediment basin and wetland pipes	21	m2	$ 140.00	$ 2,940.00	
2.6	CLAY LINER					
2.6.1	Sediment basin: placement of 300mm compacted clay liners for sediment basin	2086	m2	$ 19.50	$ 40,677.00	Assumed in-situ material is used
2.6.2	Wetland / RB : placement of 300mm compacted clay liners for wetland	11840	m2	$ 19.50	$ 230,880.00	
2.7	AQUATIC PLANTING					
2.7.1	Supply & install aquatic plants	10303.2	m2	$ 10.00	$ 103,032.00	
2.7.2	Supply & install terrestrial planting	2128	m2	$ 10.00	$ 21,280.00	
2.7.3	WL/SB: Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 in wetland and sediment basin, including overlap of matting (300mm longitudinally/direction of flow), 150mm vertically	6897	m2	$ 10.00	$ 68,970.00	
2.7.4	Supply, install and maintain plant protection netting for a select species in the aquatic zones	1	No.	$ 20,000.00	$ 20,000.00	
2.8	LANDSCAPING					
2.8.1	Supply & install RB perimeter concrete access path	2463	m2	$ 100.00	$ 246,300.00	
2.8.2	Supply & install gravel access path within RB (thickness 150mm)	191	m2	$ 60.00	$ 11,460.00	
2.8.3	Supply & install trees (tubestock)	100	No.	$ 6.00	$ 600.00	
4	MISCELLANEOUS					
4.1	Works maintenance – 1 year	1800	m2	$ 0.50	$ 900.00	
4.2	Civil Works Defect Maintenance inclu pits, pipes and rockwork	1	month	$ 2,500.00	$ 2,500.00	
4.3	3 month Plant Establisment Maintenance period of all soft landscape work including waterof plants and trees during establisment, weed control of all plants area	3	month	$ 2,000.00	$ 6,000.00	
4.4	24 month plant maintenance period of all soft landscape works including watering plants and trees during establishment, weed control of all planted areas as per specification	24	month	$ 750.00	$ 18,000.00	
4.5	Allowance for timber bollards	12	No.	$ 300.00	$ 3,600.00	
4.6	Allowance for seats	2	No.	$ 2,500.00		
4.7	WL/SB: install habitat logs approx. 4.0m long (no securing require) to wetland area	2	No.	$ 5,000.00	$ 10,000.00	
4.8	Fencing: supply and install timber post and rail fencing around sediment basin pipe inlet headwall	1	No.	$ 1,200.00	$ 1,200.00	assumed 10m. $120/m rate
	SUB-TOTAL WORKS				$ 3,570,165.57	
5	DELIVERY					
5.1	Council Fees	3.25	%		$ 116,030.38	
5.2	Authority Fees	1	%		$ 35,701.66	
5.3	Traffic Management	5	%		$ 178,508.28	
5.4	Environmental Management	0.5	%		$ 17,850.83	
5.5	Survey & Design	5	%		$ 178,508.28	
5.6	Supervision & Project Management	9	%		$ 321,314.90	
5.7	Site Establishment	2.5	%		$ 89,254.14	
5.8	Contingency	20	%		$ 901,466.81	
	SUB-TOTAL DELIVERY				$ 1,838,635.27	
6	TOTAL ESTIMATED COST				$ 5,408,800.84	

This preliminary costing is only an indicative costs associated to the construction of the drainage strategy which will take several years to be constructed. Therefore, the costs required to fund these drainage assets will be spread over several years.

Does not include land acquisition or land filling

Exclude investigations fee

Does not include costs associated with uncertainties such as contaminated soil disposal or clay liner imporation

RB/WL costs are highly variable cost items and dependent on soil conditions of the site. Without further information appropriate contingency should be applied.

Cost estimate above are based on Victorian Metro projects. Final estimates will consider local rates if available.

WLRB B COST ESTIMATE

31/08/2025

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	WORKS					
1	SITEWORKS AND EARTHWORKS					
1.1	Site preparation		Item			Included in Site Establishment
1.2	Temp Diversion Works	1	Item	$ 20,000.00	$ 20,000.00	
1.3	Waterway connection	1	Item	$ 5,000.00	$ 5,000.00	Erosion Protection Connection into Waterway
1.4	Stripping of topsoil		m2			Included below
1.5	Excavation		m3			Included below
1.6	Formation of batters		m3			Included below
2	DRAINAGE WORKS					
2.1	WATERWAYS					
2.1.1						
2.2	SEDIMENTATION PONDS					
2.2.1	SP B	1900	m2	$ 250.00	$ 475,000.00	Recently received a $250/sq.m rate for bioretention system
2.3	DRAINAGE PIPES/PITS					
2.3.1	Outlet Pipes	71	LM	$ 1,300.00	$ 92,300.00	1200 Dia Pipe
2.3.2	Balance Pipes	478	LM	$ 350.00	$ 167,300.00	assumed 300mm pipe
2.3.3	High Flow Bypass	81	LM	$ 750.00	$ 60,750.00	assumed 900mm pipe
2.3.4	Control Structures	1	Item	$ 20,000.00	$ 20,000.00	estimated rate for a large pit 2000mm x 2000mm
2.3.5	Junction Pits	10	Item	$ 2,500.00	$ 25,000.00	assumed small sized junction pit (600mm x 900mm)
2.3.6	Outfall Pit Structure	1	Item	$ 4,000.00	$ 4,000.00	
2.3.7	Littre Traps / GPT	1	Item	$ 32,200.00	$ 32,200.00	
2.4	EARTHWORKS					
2.4.1	Wetland / RB B					
	Stripping of topsoil & stockpiling	8306	m3	$ 7.50	$ 62,295.00	Assumed 200mm topsoil
	Spread topsoil	8306	m3	$ 12.50	$ 103,825.00	Assumed 200mm topsoil
	Cut	93962.113	m3	$ 40.00	$ 3,758,484.52	Assumed cut to onsite stockpile
	Fill	0	m3	$ 10.00	$ -	Spread and compact, no import
2.5	ROCKWORKS					
2.5.1	Supply and installation of rockwork at sediment basin and wetland pipes	21	m2	$ 140.00	$ 2,940.00	
2.6	CLAY LINER					
2.6.1	Sediment basin: placement of 300mm compacted clay liners for sediment basin	2199	m2	$ 19.50	$ 42,880.50	
2.6.2	Wetland : placement of 300mm compacted clay liners for wetland	14710	m2	$ 19.50	$ 286,845.00	
2.7	AQUATIC PLANTING					
2.7.1	Supply & install aquatic plants	12479.2	m2	$ 10.00	$ 124,792.00	
2.7.2	Supply & install terrestrial planting	2271	m2	$ 10.00	$ 22,710.00	
2.7.3	WL/SB: Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 in wetland and sediment basin, including overlap of matting (300mm longitudinally/direction of flow), 150mm vertically	8005	m2	$ 10.00	$ 80,050.00	
2.7.4	Supply, install and maintain plant protection netting for a select species in the aquatic zones	1	No.	$ 20,000.00	$ 20,000.00	
2.8	LANDSCAPING					
2.8.1	Supply & install RB perimeter concrete access path	3334	m2	$ 100.00	$ 333,400.00	
2.8.2	Supply & install gravel access path within RB (thickness 150mm)	195	m2	$ 60.00	$ 11,700.00	
2.8.3	Supply & install trees (tubestock)	100	No.	$ 6.00	$ 600.00	
4	MISCELLANEOUS					
4.1	Works maintenance – 1 year	1900	m2	$ 0.50	$ 950.00	
4.2	Civil Works Defect Maintenance inclu pits, pipes and rockwork	1	month	$ 2,500.00	$ 2,500.00	
4.3	3 month Plant Establisment Maintenance period of all soft landscape work including waterof plants and trees during establisment, weed control of all plants area	3	month	$ 2,000.00	$ 6,000.00	
4.4	24 month plant maintenance period of all soft landscape works including watering plants and trees during establishment, weed control of all planted areas as per specification	24	month	$ 750.00	$ 18,000.00	
4.5	Allowance for timber bollards	12	No.	$ 300.00	$ 3,600.00	
4.6	Allowance for seats	2	No.	$ 2,500.00	$ 5,000.00	
4.7	WL/SB: install habitat logs approx. 4.0m long (no securing require) to wetland area	2	No.	$ 5,000.00	$ 10,000.00	
4.8	Fencing: supply and install timber post and rail fencing around sediment basin pipe inlet headwall	1	No.	$ 1,200.00	$ 1,200.00	assumed 10m. $120/m rate
	SUB-TOTAL WORKS				$ 5,799,322.02	
5	DELIVERY					
5.1	Council Fees	3.25	%		$ 188,477.97	
5.2	Authority Fees	1	%		$ 57,993.22	
5.3	Traffic Management	5	%		$ 289,966.10	
5.4	Environmental Management	0.5	%		$ 28,996.61	
5.5	Survey & Design	5	%		$ 289,966.10	
5.6	Supervision & Project Management	9	%		$ 521,938.98	
5.7	Site Establishment	2.5	%		$ 144,983.05	
5.8	Contingency	20	%		$ 1,464,328.81	
	SUB-TOTAL DELIVERY				$ 2,986,650.84	
6	TOTAL ESTIMATED COST				$ 8,785,972.86	

This preliminary costing is only an indicative costs associated to the construction of the drainage strategy which will take several years to be constructed. Therefore, the costs required to fund these drainage assets will be spread over several years.

Does not include land acquisition or land filling

Exclude investigations fee

Does not include costs associated with uncertainties such as contaminated soil disposal or clay liner imporation

RB/WL costs are highly variable cost items and dependent on soil conditions of the site. Without further information appropriate contingency should be applied.

Preliminary estimate above are based on Victorian Metro projects. Final estimates will consider local rates if available.

WLRB C COST ESTIMATE

31/08/2025

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	WORKS					
1	SITEWORKS AND EARTHWORKS					
1.1	Site preparation		Item			Included in Site Establishment
1.2	Temp Diversion Works	1	Item	$ 20,000.00	$ 20,000.00	
1.3	Waterway connection	1	Item	$ 5,000.00	$ 5,000.00	Erosion Protection Connection into Waterway
1.4	Stripping of topsoil		m2			Included below
1.5	Excavation		m3			Included below
1.6	Formation of batters		m3			Included below
2	DRAINAGE WORKS					
2.1	WATERWAYS					
2.1.1						
2.2	SEDIMENTATION PONDS					
2.2.1	SP C	1700	m2	$ 250.00	$ 425,000.00	Recently received a $250/sq.m rate for bioretention system
2.3	DRAINAGE PIPES/PITS					
2.3.1	Outlet Pipes	65	LM	$ 1,500.00	$ 97,500.00	1200 Dia Pipe
2.3.2	Balance Pipes	235	LM	$ 110.00	$ 25,850.00	assumed 300mm pipe
2.3.3	High Flow Bypass	285	LM	$ 750.00	$ 213,750.00	assumed 900mm pipe
2.3.4	Control Structures	1	Item	$ 20,000.00	$ 20,000.00	estimated rate for a large pit 2000mm x 2000mm
2.3.5	Junction Pits	8	Item	$ 2,500.00	$ 20,000.00	assumed small sized junction pit (600mm x 900mm)
2.3.6	Outfall Pit Structure	1	Item	$ 4,000.00	$ 4,000.00	
2.3.7	Littre Traps / GPT	1	Item	$ 32,200.00	$ 32,200.00	
2.4	EARTHWORKS					
2.4.1	Wetland / RB C					
	Stripping of topsoil & stockpiling	7988	m3	$ 7.50	$ 59,910.00	Assumed 200mm topsoil
	Spread topsoil	7988	m3	$ 12.50	$ 99,850.00	Assumed 200mm topsoil
	Cut	76095.496	m3	$ 40.00	$ 3,043,819.84	Assumed cut to onsite stockpile
	Fill	0	m3	$ 10.00	$ -	Spread and compact, no import
2.5	ROCKWORKS					
2.5.1	Supply and installation of rockwork at sediment basin and wetland pipes	21	m2	$ 140.00	$ 2,940.00	
2.6	CLAY LINER					
2.6.1	Sediment basin: placement of 300mm compacted clay liners for sediment basin	1989	m2	$ 19.50	$ 38,785.50	
2.6.2	Wetland : placement of 300mm compacted clay liners for wetland	12078	m2	$ 19.50	$ 235,521.00	
2.7	AQUATIC PLANTING					
2.7.1	Supply & install aquatic plants	10195.2	m2	$ 10.00	$ 101,952.00	
2.7.2	Supply & install terrestrial planting	4199	m2	$ 10.00	$ 41,990.00	
2.7.3	WL/SB: Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 in wetland and sediment basin, including overlap of matting (300mm longitudinally/direction of flow), 150mm vertically	10037	m2	$ 10.00	$ 100,370.00	
2.7.4	Supply, install and maintain plant protection netting for a select species in the aquatic zones	1	No.	$ 20,000.00	$ 20,000.00	
2.8	LANDSCAPING					
2.8.1	Supply & install RB perimeter concrete access path	3548	m2	$ 100.00	$ 354,800.00	
2.8.2	Supply & install gravel access path within RB (thickness 150mm)	197	m2	$ 60.00	$ 11,820.00	
2.8.3	Supply & install trees (tubestock)	100	No.	$ 6.00	$ 600.00	
4	MISCELLANEOUS					
4.1	Works maintenance – 1 year	1700	m2	$ 0.50	$ 850.00	
4.2	Civil Works Defect Maintenance inclu pits, pipes and rockwork	1	month	$ 2,500.00	$ 2,500.00	
4.3	3 month Plant Establisment Maintenance period of all soft landscape work including waterof plants and trees during establisment, weed control of all plants area	3	month	$ 2,000.00	$ 6,000.00	
4.4	24 month plant maintenance period of all soft landscape works including watering plants and trees during establishment, weed control of all planted areas as per specification	24	month	$ 750.00	$ 18,000.00	
4.5	Allowance for timber bollards	12	No.	$ 300.00	$ 3,600.00	
4.6	Allowance for seats	2	No.	$ 2,500.00	$ 5,000.00	
4.7	WL/SB: install habitat logs approx. 4.0m long (no securing require) to wetland area	2	No.	$ 5,000.00	$ 10,000.00	
4.8	Fencing: supply and install timber post and rail fencing around sediment basin pipe inlet headwall	1	No.	$ 1,200.00	$ 1,200.00	assumed 10m. $120/m rate
	SUB-TOTAL WORKS				$ 5,022,808.34	
5	DELIVERY					
5.1	Council Fees	3.25	%		$ 163,241.27	
5.2	Authority Fees	1	%		$ 50,228.08	
5.3	Traffic Management	5	%		$ 251,140.42	
5.4	Environmental Management	0.5	%		$ 25,114.04	
5.5	Survey & Design	5	%		$ 251,140.42	
5.6	Supervision & Project Management	9	%		$ 452,052.75	
5.7	Site Establishment	2.5	%		$ 125,570.21	
5.8	Contingency	20	%		$ 1,268,259.11	
	SUB-TOTAL DELIVERY				$ 2,586,746.30	
6	TOTAL ESTIMATED COST				$ 7,609,554.64	

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Does not include land acquisition or land filling

Exclude investigations fee

Does not include costs associated with uncertainties such as contaminated soil disposal or clay liner imporation

RB/WL costs are highly variable cost items and dependent on soil conditions of the site. Without further information appropriate contingency should be applied.

Cost estimate above are based on Victorian Metro projects. Final estimates will consider local rates if available.

WLRB D COST ESTIMATE

31/08/2025

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	WORKS					
1	SITEWORKS AND EARTHWORKS					
1.1	Site preparation		Item			Included in Site Establishment
1.2	Temp Diversion Works	1	Item	$ 20,000.00	$ 20,000.00	
1.3	Waterway connection	1	Item	$ 5,000.00	$ 5,000.00	Erosion Protection Connection into Waterway
1.4	Stripping of topsoil		m2			Included below
1.5	Excavation		m3			Included below
1.6	Formation of batters		m3			Included below
2	DRAINAGE WORKS					
2.1	WATERWAYS					
2.1.1						
2.2	SEDIMENTATION PONDS					
2.2.1	SP D	1000	m2	$ 250.00	$ 250,000.00	Recently received a $250/sq.m rate for bioretention system
2.3	DRAINAGE PIPES/PITS					
2.3.1	Outlet Pipes	232	LM	$ 750.00	$ 174,000.00	2 x 900 Dia Pipe
2.3.2	Balance Pipes	117	LM	$ 110.00	$ 12,870.00	assumed 300mm pipe
2.3.3	High Flow Bypass	104	LM	$ 750.00	$ 78,000.00	assumed 900mm pipe
2.3.4	Control Structures	1	Item	$ 20,000.00	$ 20,000.00	estimated rate for a large pit 2000mm x 2000mm
2.3.5	Junction Pits	8	Item	$ 2,500.00	$ 20,000.00	assumed small sized junction pit (600mm x 900mm)
2.3.6	Outfall Pit Structure	1	Item	$ 4,000.00	$ 4,000.00	
2.3.7	Littre Traps / GPT	1	Item	$ 32,200.00	$ 32,200.00	
2.4	EARTHWORKS					
2.4.1	Wetland / RB D					
	Stripping of topsoil & stockpiling	3629	m3	$ 7.50	$ 27,217.50	Assumed 200mm topsoil
	Spread topsoil	3629	m3	$ 12.50	$ 45,362.50	Assumed 200mm topsoil
	Cut	35584.378	m3	$ 40.00	$ 1,423,375.12	Assumed cut to onsite stockpile
	Fill	0	m3	$ 10.00	$ -	Spread and compact, no import
2.5	ROCKWORKS					
2.5.1	Supply and installation of rockwork at sediment basin and wetland pipes	21	m2	$ 140.00	$ 2,940.00	
2.6	CLAY LINER					
2.6.1	Sediment basin: placement of 300mm compacted clay liners for sediment basin	1245	m2	$ 19.50	$ 24,277.50	
2.6.2	Wetland : placement of 300mm compacted clay liners for wetland	4072	m2	$ 19.50	$ 79,404.00	
2.7	AQUATIC PLANTING					
2.7.1	Supply & install aquatic plants	3708	m2	$ 10.00	$ 37,080.00	
2.7.2	Supply & install terrestrial planting	1145	m2	$ 10.00	$ 11,450.00	
2.7.3	WL/SB: Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 in wetland and sediment basin, including overlap of matting (300mm longitudinally/direction of flow), 150mm vertically	3529	m2	$ 10.00	$ 35,290.00	
2.7.4	Supply, install and maintain plant protection netting for a select species in the aquatic zones	1	No.	$ 20,000.00	$ 20,000.00	
2.8	LANDSCAPING					
2.8.1	Supply & install RB perimeter concrete access path	1696	m2	$ 100.00	$ 169,600.00	
2.8.2	Supply & install gravel access path within RB (thickness 150mm)	176	m2	$ 60.00	$ 10,560.00	
2.8.3	Supply & install trees (tubestock)	100	No.	$ 6.00	$ 600.00	
4	MISCELLANEOUS					
4.1	Works maintenance – 1 year	1000	m2	$ 0.50	$ 500.00	
4.2	Civil Works Defect Maintenance inclu pits, pipes and rockwork	1	month	$ 2,500.00	$ 2,500.00	
4.3	3 month Plant Establisment Maintenance period of all soft landscape work including waterof plants and trees during establisment, weed control of all plants area	3	month	$ 2,000.00	$ 6,000.00	
4.4	24 month plant maintenance period of all soft landscape works including watering plants and trees during establishment, weed control of all	24	month	$ 750.00	$ 18,000.00	
4.5	Allowance for timber bollards	12	No.	$ 300.00	$ 3,600.00	
4.6	Allowance for seats	2	No.	$ 2,500.00	$ 5,000.00	
4.7	WL/SB: install habitat logs approx. 4.0m long (no securing require) to wetland area	2	No.	$ 5,000.00	$ 10,000.00	
4.8	Fencing: supply and install timber post and rail fencing around sediment basin pipe inlet headwall	1	No.	$ 1,200.00	$ 1,200.00	assumed 10m. $120/m rate
	SUB-TOTAL WORKS				$ 2,550,026.62	
5	DELIVERY					
5.1	Council Fees	3.25	%		$ 82,875.87	
5.2	Authority Fees	1	%		$ 25,500.27	
5.3	Traffic Management	5	%		$ 127,501.33	
5.4	Environmental Management	0.5	%		$ 12,750.13	
5.5	Survey & Design	5	%		$ 127,501.33	
5.6	Supervision & Project Management	9	%		$ 229,502.40	
5.7	Site Establishment	2.5	%		$ 63,750.67	

WLRB E COST ESTIMATE

31/08/2025

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	WORKS					
1	SITEWORKS AND EARTHWORKS					
1.1	Site preparation		Item			Included in Site Establishment
1.2	Temp Diversion Works	1	Item	$ 20,000.00	$ 20,000.00	
1.3	Waterway connection	1	Item	$ 5,000.00	$ 5,000.00	Erosion Protection Connection into Waterway
1.4	Stripping of topsoil		m2			Included below
1.5	Excavation		m3			Included below
1.6	Formation of batters		m3			Included below
2	DRAINAGE WORKS					
2.1	WATERWAYS					
2.1.1						
2.2	SEDIMENTATION PONDS					
2.2.1	SP E	900	m2	$ 250.00	$ 225,000.00	Recently received a $250/sq.m rate for bioretention system
2.3	DRAINAGE PIPES/PITS					
2.3.1	Outlet Pipes	46	LM	$ 1,500.00	$ 69,000.00	1200 Dia Pipe
2.3.2	Balance Pipes	108	LM	$ 110.00	$ 11,880.00	assumed 300mm pipe
2.3.3	High Flow Bypass	145	LM	$ 750.00	$ 108,750.00	assumed 900mm pipe
2.3.4	Control Structures	1	Item	$ 20,000.00	$ 20,000.00	estimated rate for a large pit 2000mm x 2000mm
2.3.5	Junction Pits	8	Item	$ 2,500.00	$ 20,000.00	assumed small sized junction pit (600mm x 900mm)
2.3.6	Outfall Pit Structure	1	Item	$ 4,000.00	$ 4,000.00	
2.3.7	Littre Traps / GPT	1	Item	$ 32,200.00	$ 32,200.00	
2.4	EARTHWORKS					
2.4.1	Wetland / RB E					
	Stripping of topsoil & stockpiling	2912	m3	$ 7.50	$ 21,840.00	Assumed 200mm topsoil
	Spread topsoil	2912	m3	$ 12.50	$ 36,400.00	Assumed 200mm topsoil
	Cut	23525.012	m3	$ 40.00	$ 941,000.48	Assumed cut to onsite stockpile
	Fill	0	m3	$ 10.00	$ -	Spread and compact, no import
2.5	ROCKWORKS					
2.5.1	Supply and installation of rockwork at sediment basin and wetland pipes	10.5	m2	$ 140.00	$ 1,470.00	
2.6	CLAY LINER					
2.6.1	Sediment basin: placement of 300mm compacted clay liners for sediment basin	1115	m2	$ 19.50	$ 21,742.50	
2.6.2	Wetland : placement of 300mm compacted clay liners for wetland	4491	m2	$ 19.50	$ 87,574.50	
2.7	AQUATIC PLANTING					
2.7.1	Supply & install aquatic plants	3962.4	m2	$ 10.00	$ 39,624.00	
2.7.2	Supply & install terrestrial planting	1102	m2	$ 10.00	$ 11,020.00	
2.7.3	WL/SB: Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 in wetland and sediment basin, including overlap of matting (300mm longitudinally/direction of flow), 150mm vertically	3343	m2	$ 10.00	$ 33,430.00	
2.7.4	Supply, install and maintain plant protection netting for a select species in the aquatic zones	1	No.	$ 20,000.00	$ 20,000.00	
2.8	LANDSCAPING					
2.8.1	Supply & install RB perimeter concrete access path	1581	m2	$ 100.00	$ 158,100.00	
2.8.2	Supply & install gravel access path within RB (thickness 150mm)	143	m2	$ 60.00	$ 8,580.00	
2.8.3	Supply & install trees (tubestock)	100	No.	$ 6.00	$ 600.00	
4	MISCELLANEOUS					
4.1	Works maintenance – 1 year	900	m2	$ 0.50	$ 450.00	
4.2	Civil Works Defect Maintenance inclu pits, pipes and rockwork	1	month	$ 2,500.00	$ 2,500.00	
4.3	3 month Plant Establisment Maintenance period of all soft landscape work including waterof plants and trees during establisment, weed control of all plants area	3	month	$ 2,000.00	$ 6,000.00	
4.4	24 month plant maintenance period of all soft landscape works including watering plants and trees during establishment, weed control of all planted areas as per specification	24	month	$ 750.00	$ 18,000.00	
4.5	Allowance for timber bollards	12	No.	$ 300.00	$ 3,600.00	
4.6	Allowance for seats	2	No.	$ 2,500.00	$ 5,000.00	
4.7	WL/SB: install habitat logs approx. 4.0m long (no securing require) to wetland area	2	No.	$ 5,000.00	$ 10,000.00	
4.8	Fencing: supply and install timber post and rail fencing around sediment basin pipe inlet headwall	1	No.	$ 1,200.00	$ 1,200.00	assumed 10m. $120/m rate
	SUB-TOTAL WORKS				$ 1,943,961.48	
5	DELIVERY					
5.1	Council Fees	3.25	%		$ 63,178.75	
5.2	Authority Fees	1	%		$ 19,439.61	
5.3	Traffic Management	5	%		$ 97,198.07	
5.4	Environmental Management	0.5	%		$ 9,719.81	
5.5	Survey & Design	5	%		$ 97,198.07	
5.6	Supervision & Project Management	9	%		$ 174,956.53	
5.7	Site Establishment	2.5	%		$ 48,599.04	
5.8	Contingency	20	%		$ 490,850.27	
	SUB-TOTAL DELIVERY				$ 1,001,140.16	
6	TOTAL ESTIMATED COST				$ 2,945,101.64	

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Does not include land acquisition or land filling

Exclude investigations fee

Does not include costs associated with uncertainties such as contaminated soil disposal or clay liner imporation

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WLRB F COST ESTIMATE

31/08/2025

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	WORKS					
1	SITEWORKS AND EARTHWORKS					
1.1	Site preparation		Item			Included in Site Establishment
1.2	Temp Diversion Works	1	Item	$ 20,000.00	$ 20,000.00	
1.3	Waterway connection	1	Item	$ 5,000.00	$ 5,000.00	Erosion Protection Connection into Waterway
1.4	Stripping of topsoil		m2			Included below
1.5	Excavation		m3			Included below
1.6	Formation of batters		m3			Included below
2	DRAINAGE WORKS					
2.1	WATERWAYS					
2.1.1						
2.2	SEDIMENTATION PONDS					
2.2.1	SP F	900	m2	$ 250.00	$ 225,000.00	Recently received a $250/sq.m rate for bioretention system
2.3	DRAINAGE PIPES/PITS					
2.3.1	Outlet Pipes	61	LM	$ 1,500.00	$ 91,500.00	1200 Dia Pipe
2.3.2	Balance Pipes	136	LM	$ 110.00	$ 14,960.00	assumed 300mm pipe
2.3.3	High Flow Bypass	178	LM	$ 750.00	$ 133,500.00	assumed 900mm pipe
2.3.4	Control Structures	1	Item	$ 20,000.00	$ 20,000.00	estimated rate for a large pit 2000mm x 2000mm
2.3.5	Junction Pits	8	Item	$ 2,500.00	$ 20,000.00	assumed small sized junction pit (600mm x 900mm)
2.3.6	Outfall Pit Structure	1	Item	$ 4,000.00	$ 4,000.00	
2.3.7	Littre Traps / GPT	1	Item	$ 32,200.00	$ 32,200.00	
2.4	EARTHWORKS					
2.4.1	Wetland / RB F					
	Stripping of topsoil & stockpiling	1504	m3	$ 7.50	$ 11,280.00	Assumed 200mm topsoil
	Spread topsoil	1504	m3	$ 12.50	$ 18,800.00	Assumed 200mm topsoil
	Cut	6645.064	m3	$ 40.00	$ 265,802.56	Assumed cut to onsite stockpile
	Fill	0	m3	$ 10.00	$ -	Spread and compact, no import
2.5	ROCKWORKS					
2.5.1	Supply and installation of rockwork at sediment basin and wetland pipes	21	m2	$ 140.00	$ 2,940.00	
2.6	CLAY LINER					
2.6.1	Sediment basin: placement of 300mm compacted clay liners for sediment basin	1105	m2	$ 19.50	$ 21,547.50	
2.6.2	Wetland : placement of 300mm compacted clay liners for wetland	2390	m2	$ 19.50	$ 46,605.00	
2.7	AQUATIC PLANTING					
2.7.1	Supply & install aquatic plants	2383.2	m2	$ 10.00	$ 23,832.00	
2.7.2	Supply & install terrestrial planting	994	m2	$ 10.00	$ 9,940.00	
2.7.3	WL/SB: Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 in wetland and sediment basin, including overlap of matting (300mm longitudinally/direction of flow), 150mm vertically	3066	m2	$ 10.00	$ 30,660.00	
2.7.4	Supply, install and maintain plant protection netting for a select species in the aquatic zones	1	No.	$ 20,000.00	$ 20,000.00	
2.8	LANDSCAPING					
2.8.1	Supply & install RB perimeter concrete access path	1428	m2	$ 100.00	$ 142,800.00	
2.8.2	Supply & install gravel access path within RB (thickness 150mm)	63	m2	$ 60.00	$ 3,780.00	
2.8.3	Supply & install trees (tubestock)	100	No.	$ 6.00	$ 600.00	
4	MISCELLANEOUS					
4.1	Works maintenance – 1 year	900	m2	$ 0.50	$ 450.00	
4.2	Civil Works Defect Maintenance inclu pits, pipes and rockwork	1	month	$ 2,500.00	$ 2,500.00	
4.3	3 month Plant Establisment Maintenance period of all soft landscape work including waterof plants and trees during establisment, weed control of all plants area	3	month	$ 2,000.00	$ 6,000.00	
4.4	24 month plant maintenance period of all soft landscape works including watering plants and trees during establishment, weed control of all planted areas as per specification	24	month	$ 750.00	$ 18,000.00	
4.5	Allowance for timber bollards	12	No.	$ 300.00	$ 3,600.00	
4.6	Allowance for seats	2	No.	$ 2,500.00	$ 5,000.00	
4.7	WL/SB: install habitat logs approx. 4.0m long (no securing require) to wetland area	2	No.	$ 5,000.00	$ 10,000.00	
4.8	Fencing: supply and install timber post and rail fencing around sediment basin pipe inlet headwall	1	No.	$ 1,200.00	$ 1,200.00	assumed 10m. $120/m rate
	SUB-TOTAL WORKS				$ 1,211,497.06	
5	DELIVERY					
5.1	Council Fees	3.25	%		$ 39,373.65	
5.2	Authority Fees	1	%		$ 12,114.97	
5.3	Traffic Management	5	%		$ 60,574.85	
5.4	Environmental Management	0.5	%		$ 6,057.49	
5.5	Survey & Design	5	%		$ 60,574.85	
5.6	Supervision & Project Management	9	%		$ 109,034.74	
5.7	Site Establishment	2.5	%		$ 30,287.43	
5.8	Contingency	20	%		$ 305,903.01	
	SUB-TOTAL DELIVERY				$ 623,920.99	
6	TOTAL ESTIMATED COST				$ 1,835,418.05	

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Does not include land acquisition or land filling

Exclude investigations fee

Does not include costs associated with uncertainties such as contaminated soil disposal or clay liner imporation

RB/WL costs are highly variable cost items and dependent on soil conditions of the site. Without further information appropriate contingency should be applied.

Cost estimate above are based on Victorian Metro projects. Final estimates will consider local rates if available.

WLRB G COST ESTIMATE 31/08/2025

Item	Description	Quantity	Unit	Rate $	Amount $	Comments
	WORKS					
1	SITEWORKS AND EARTHWORKS					
1.1	Site preparation		Item			Included in Site Establishment
1.2	Temp Diversion Works	1	Item	$ 20,000.00	$ 20,000.00	
1.3	Waterway connection	1	Item	$ 5,000.00	$ 5,000.00	Erosion Protection Connection into Waterway
1.4	Stripping of topsoil		m2			Included below
1.5	Excavation		m3			Included below
1.6	Formation of batters		m3			Included below
2	DRAINAGE WORKS					
2.1	WATERWAYS					
2.1.1						
2.2	SEDIMENTATION PONDS					
2.2.1	SP G	1000	m2	$ 250.00	$ 250,000.00	Recently received a $250/sq.m rate for bioretention system
2.3	DRAINAGE PIPES/PITS					
2.3.1	Outlet Pipes	124	LM	$ 1,500.00	$ 186,000.00	1200 Dia Pipe
2.3.2	Balance Pipes	84	LM	$ 110.00	$ 9,240.00	assumed 300mm pipe
2.3.3	High Flow Bypass	77	LM	$ 750.00	$ 57,750.00	assumed 900mm pipe
2.3.4	Control Structures	1	Item	$ 20,000.00	$ 20,000.00	estimated rate for a large pit 2000mm x 2000mm
2.3.5	Junction Pits	8	Item	$ 2,500.00	$ 20,000.00	assumed small sized junction pit (600mm x 900mm)
2.3.6	Outfall Pit Structure	1	Item	$ 4,000.00	$ 4,000.00	
2.3.7	Littre Traps / GPT	1	Item	$ 32,200.00	$ 32,200.00	
2.4	EARTHWORKS					
2.4.1	Wetland / RB G					
	Stripping of topsoil & stockpiling	3562	m3	$ 7.50	$ 26,715.00	Assumed 200mm topsoil
	Spread topsoil	3562	m3	$ 12.50	$ 44,525.00	Assumed 200mm topsoil
	Cut	22709.616	m3	$ 40.00	$ 908,384.64	Assumed cut to onsite stockpile
	Fill	726.668	m3	$ 10.00	$ 7,266.68	Spread and compact, no import
2.5	ROCKWORKS					
2.5.1	Supply and installation of rockwork at sediment basin and wetland pipes	21	m2	$ 140.00	$ 2,940.00	
2.6	CLAY LINER					
2.6.1	Sediment basin: placement of 300mm compacted clay liners for sediment basin	1236	m2	$ 19.50	$ 24,102.00	
2.6.2	Wetland : placement of 300mm compacted clay liners for wetland	4649	m2	$ 19.50	$ 90,655.50	
2.7	AQUATIC PLANTING					
2.7.1	Supply & install aquatic plants	4048	m2	$ 10.00	$ 40,480.00	
2.7.2	Supply & install terrestrial planting	1132	m2	$ 10.00	$ 11,320.00	
2.7.3	WL/SB: Supply and install heavy jute mat (800gsm) pre-slit at density 6/m2 in wetland and sediment basin, including overlap of matting (300mm longitudinally/direction of flow), 150mm vertically	2700	m2	$ 10.00	$ 27,000.00	
2.7.4	Supply, install and maintain plant protection netting for a select species in the aquatic zones	1	No.	$ 20,000.00	$ 20,000.00	
2.8	LANDSCAPING					
2.8.1	Supply & install RB perimeter concrete access path	668	m2	$ 100.00	$ 66,800.00	
2.8.2	Supply & install gravel access path within RB (thickness 150mm)	157	m2	$ 60.00	$ 9,420.00	
2.8.3	Supply & install trees (tubestock)	100	No.	$ 6.00	$ 600.00	
4	MISCELLANEOUS					
4.1	Works maintenance – 1 year	1000	m2	$ 0.50	$ 500.00	
4.2	Civil Works Defect Maintenance inclu pits, pipes and rockwork	1	month	$ 2,500.00	$ 2,500.00	
4.3	3 month Plant Establisment Maintenance period of all soft landscape work including waterof plants and trees during establisment, weed control of all plants area	3	month	$ 2,000.00	$ 6,000.00	
4.4	24 month plant maintenance period of all soft landscape works including watering plants and trees during establishment, weed control of all planted areas as per specification	24	month	$ 750.00	$ 18,000.00	
4.5	Allowance for timber bollards	12	No.	$ 300.00	$ 3,600.00	
4.6	Allowance for seats	2	No.	$ 2,500.00	$ 5,000.00	
4.7	WL/SB: install habitat logs approx. 4.0m long (no securing require) to wetland area	2	No.	$ 5,000.00	$ 10,000.00	
4.8	Fencing: supply and install timber post and rail fencing around sediment basin pipe inlet headwall	1	No.	$ 1,200.00	$ 1,200.00	assumed 10m. $120/m rate
	SUB-TOTAL WORKS				$ 1,931,198.82	
5	DELIVERY					
5.1	Council Fees	3.25	%		$ 62,763.96	
5.2	Authority Fees	1	%		$ 19,311.99	
5.3	Traffic Management	5	%		$ 96,559.94	
5.4	Environmental Management	0.5	%		$ 9,655.99	
5.5	Survey & Design	5	%		$ 96,559.94	
5.6	Supervision & Project Management	9	%		$ 173,807.89	
5.7	Site Establishment	2.5	%		$ 48,279.97	
5.8	Contingency	20	%		$ 487,627.70	
	SUB-TOTAL DELIVERY				$ 994,567.39	
6	TOTAL ESTIMATED COST				$ 2,925,766.21	

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