# MEMORANDUM

**To** Michael MacDonagh | Greater Shepparton City Council

**From** Lachlan Inglis | Water Technology

**Date** 15 June 2022

**Subject** Waterbird Creek Structure Plan, Shepparton – Model of Flood Behaviour

**Our ref** 22020266_M02_V01b.docx

## 1 BACKGROUND

Water Technology was commissioned by Greater Shepparton City Council (GSCC) to investigate and better understand the flood impact that differing development density levels may have on the Waterbird Creek Structure Plan area and the broader floodplain of the Waterbird Creek and Seven Creeks. The Waterbird Creek Structure Plan area is dissected by the Waterbird Creek that runs between River Road and the Goulbourn Valley Highway; approximately 1 km upstream from the confluence of the Seven Creeks. The majority of flows into the Waterbird Creek Structure Plan area are from the Waterbird Creek (at River Road), secondary flows into the area also originate from an established residential area to the north. Both inflows are controlled by culverts and stormwater drainage infrastructure. There is also an interaction from Seven Creeks with overland flow coming across River Road and Seven Creeks also appears to back up from the Goulburn River under extreme flood events.

## 2 EXISTING FLOOD RISK

An existing hydraulic model developed as part of the Shepparton-Mooroopna Flood Intelligence and Mapping Study was cut down in size to reduce the model simulation time and was used for this assessment. Existing conditions were re-established for the 1% AEP event which incorporated Climate Change conditions. Figure 2-1 below shows the 1% AEP Climate Chage flood depth for existing conditions of the Waterbird Creek precinct.

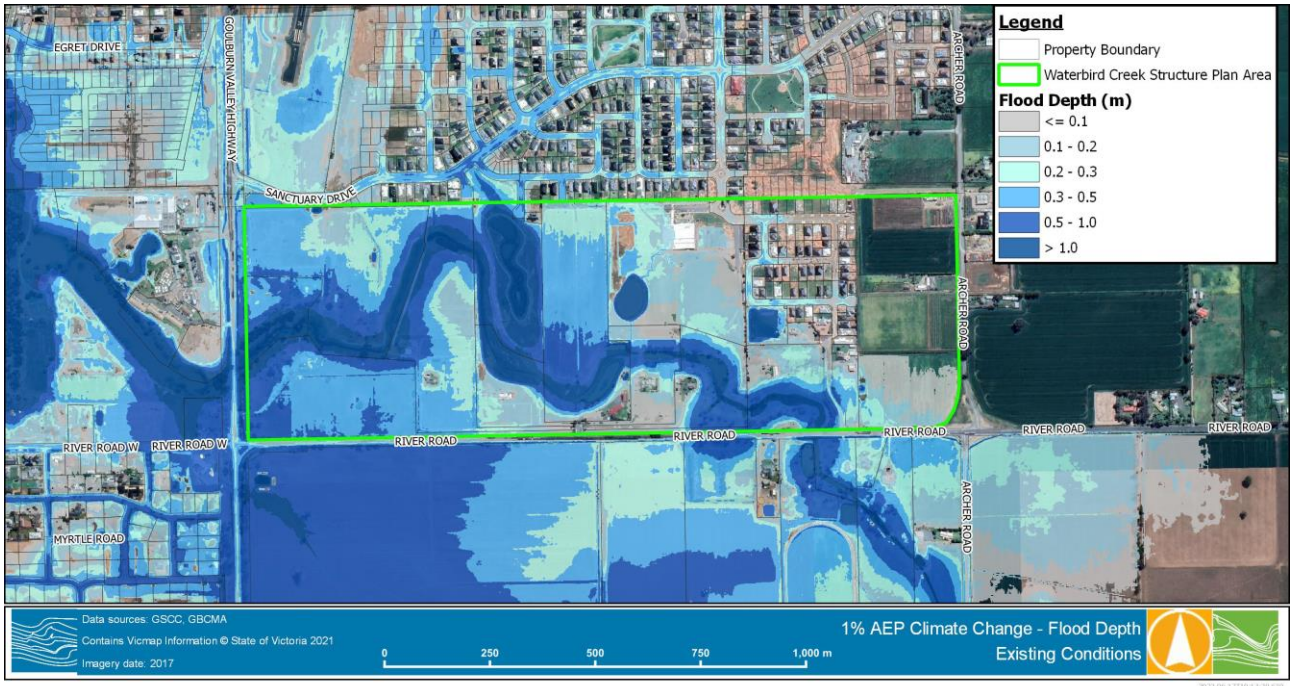


**Figure 2-1 1% AEP Climate Change Flood Depth – Existing Conditions**

# 3 DEVELOPMENT OPPORTUNITEIS

To represent the proposed development layout, several scenarios were assessed by increasing ground levels above the 1% AEP Climate Change flood level. Where depths were between 0 to 0.5 m under existing 1% AEP Climate Change conditions, fill was applied. A description of each scenario assessed is provided below:

- Development Scenario 1
  - Fill extents increased in height by 0.17 to 0.25 m above the existing 1% AEP Climate Change water level in areas where the existing flood depth was less than 0.5m.
- Development Scenario 2
  - Reduced fill extent compared to Development Scenario 1 along River Road to reduce increased flood levels across River Road and attempt to maintain floodplain storage within the precinct.
- Development Scenario 3
  - Reduced fill extent compared to Development Scenario 2 along River Road to reduce increased flood levels south of River Road and maintain flood storage within the precinct.
  - Inclusion of a 40 m floodway from River Road to Waterbird Creek, dissecting the southern fill extent.

Mapped overviews of each development scenario are shown in Figure 3-1, Figure 3-2 and Figure 3-3 below. To understand the impact this would have on water levels and extents, a direct comparison was drawn between the flood levels for existing and future development conditions.

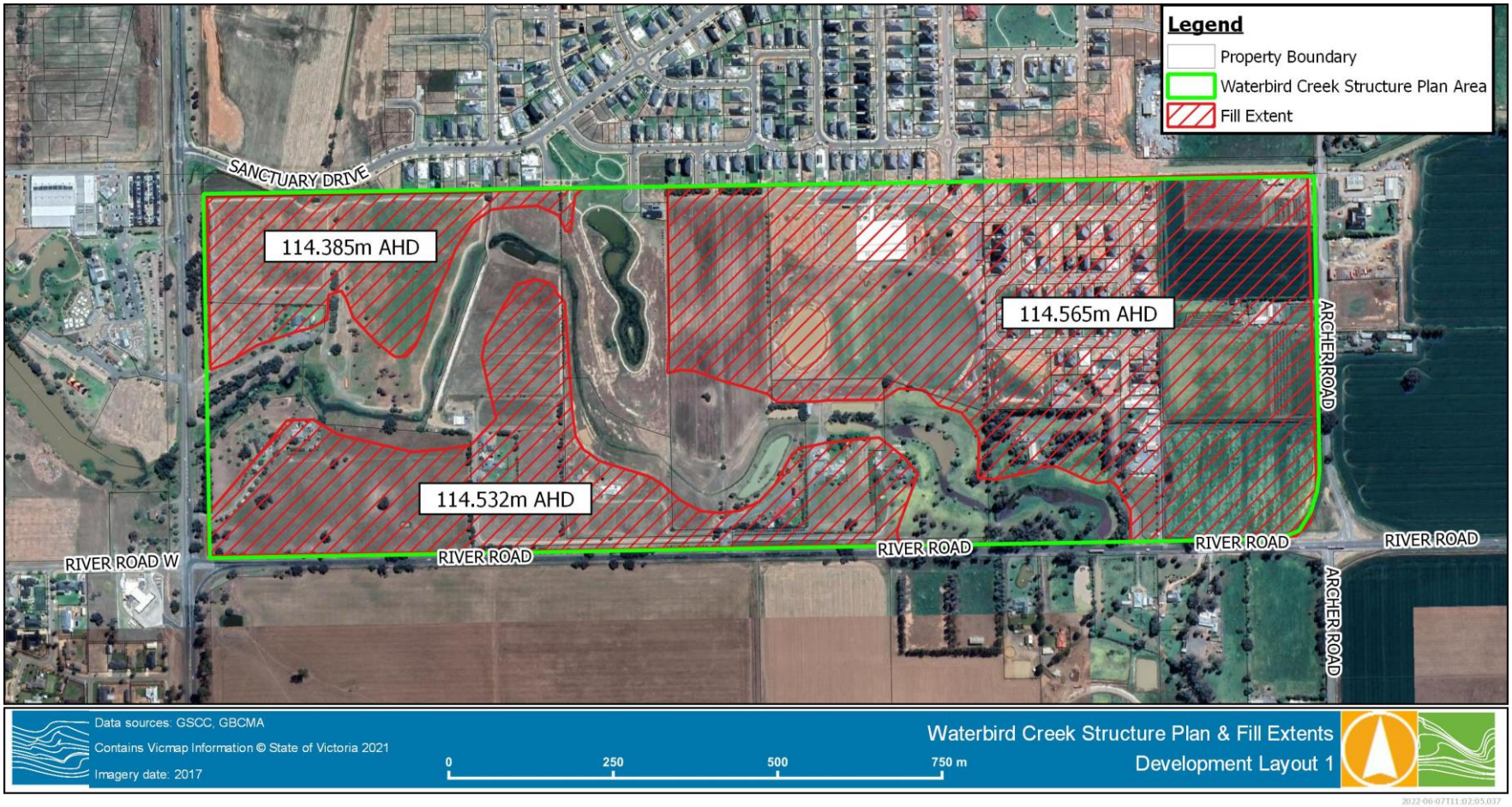


**Figure 3-1 Waterbird Creek Structure Plan & Fill Extents – Development Layout 1**

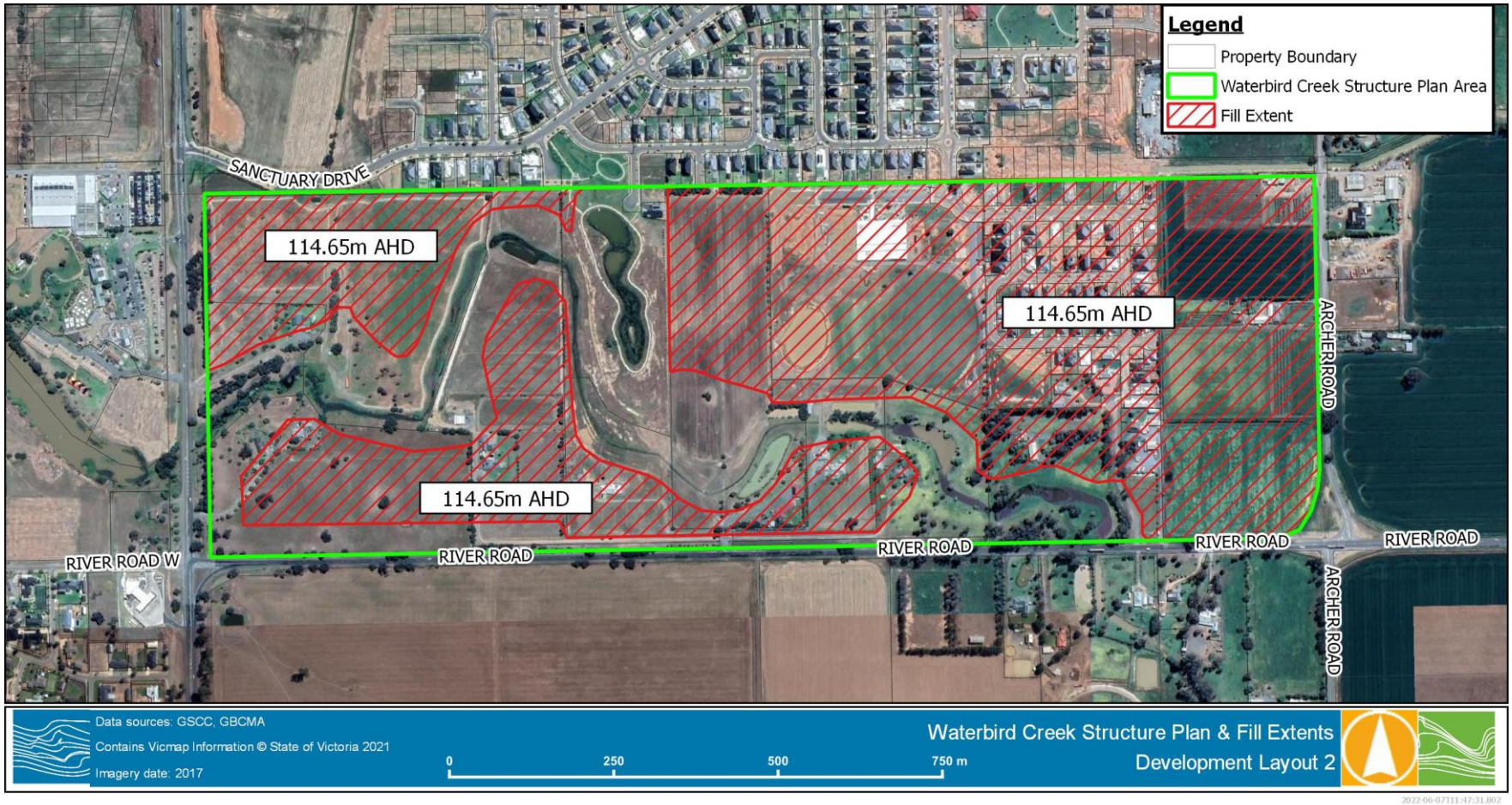


**Figure 3-2 Waterbird Creek Structure Plan & Fill Extents – Development Layout 2**

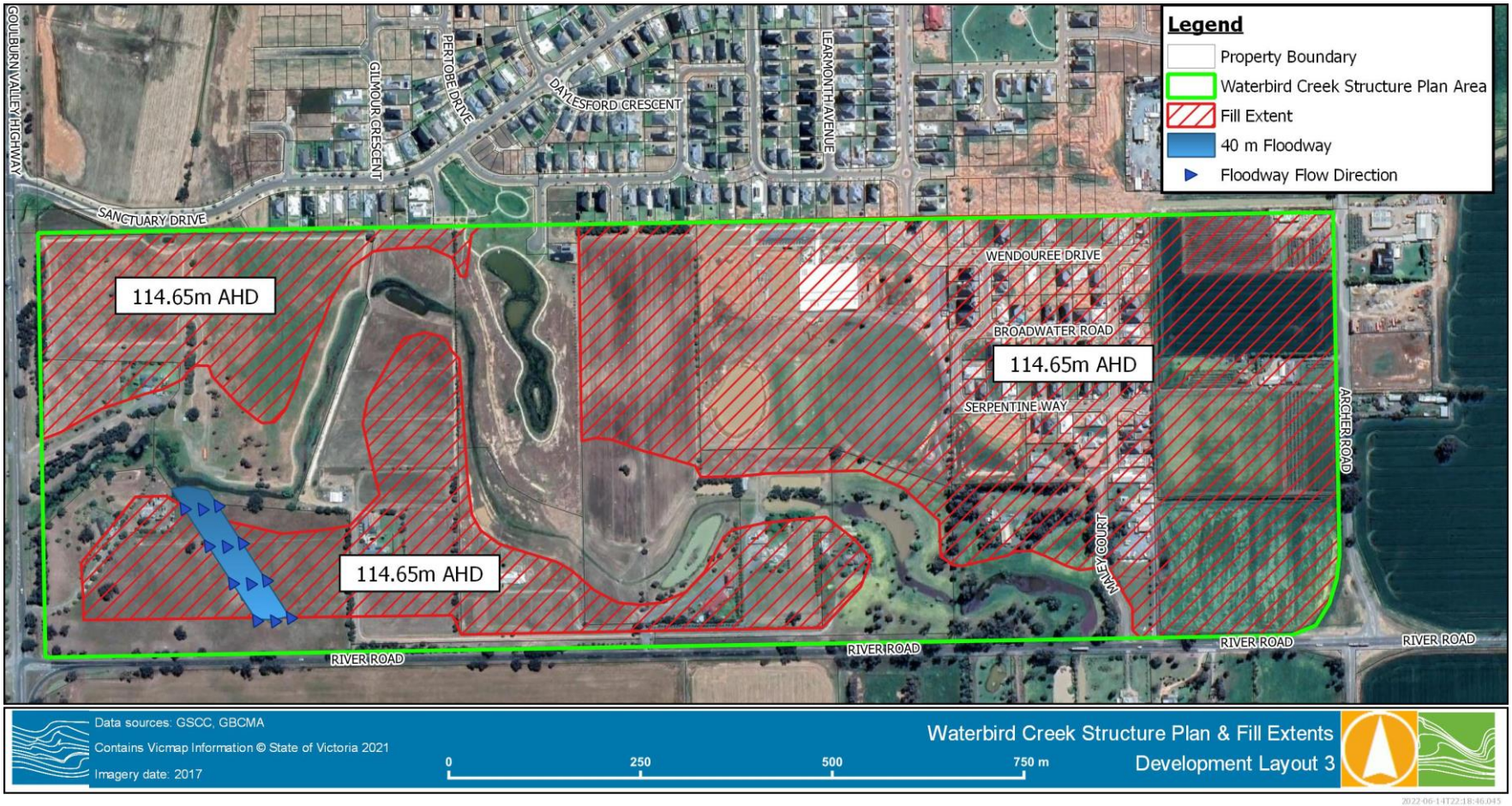


**Figure 3-3 Waterbird Creek Structure Plan & Fill Extents – Development Layout 3**

# 4 DEVELPOED CONDITIONS

Flood level difference maps comparing levels between existing and future development scenarios for the 1% AEP Climate Change event have been produced and are shown in Figure 4-1 -Figure 4-3.

## 4.1 Development Scenario 1

Development Scenario 1 shows the development area in the northwest to be above the 1% AEP floodplain under Climate Change conditions. However, the areas to the south and northeast of the Waterbird Creek will still be inundated. Furthermore, an increase in the 1% AEP flood extent will be experienced northeast of the Waterbird Creek under proposed developed conditions. Adverse afflux south of the precinct is also evident. It appears that the filled area south of the Waterbird Creek has restricted flows from travelling south to north, resulting in the increase in water level south of River Road.

## 4.2 Development Scenario 2

Development Scenario 2 has a reduced fill extent in the southwest corner of the precinct to maintain some of the existing overland flow path and reinstate some floodplain storage (when compared to Development Scenario 1). Finished levels for the future development area were also increased to a consistent height of 114.65 m AHD. The reduction in fill extent and increased elevations will bring all three areas above the 1% AEP floodplain under Climate Change conditions. Although, adverse afflux (increased flood levels) to the south and southwest will occur. Changes in flood levels south of River Road and west of the Goulburn Valley Hwy will increase by 2 to 5 cm.

## 4.3 Development Scenario 3

Development Scenario 3 features the same fill extent as Development Scenario 2 except with the inclusion of a 40 m floodway. The floodway aims to relieve floodwaters accumulating between the fill extent south of Waterbird Creek and River Road. The floodway directs waters back into the Waterbird Creek approximately 265 m upstream of the Goulburn Valley Hwy. The inclusion of a floodway of this magnitude has reduced adverse afflux (increased flood levels) south of River Road and west of the Goulburn Vally Hwy. Generally any increases are less than 2cm across the broader floodplain area. There are isolated increases in flood levels west of the Goulburn Valley Hwy in the car park of The Museum of Vehicle Evolution and Barclays Antiques and Collectibles. Increased flood levels in this area are in the range of 2 to 4 cm.

Given the increase in flood levels shown in Development Scenario 3, no private properties nor buildings are directly impacted by increased water levels greater than 2 cm. The floodway proposed in Development Scenario 3 will require further assessment to ensure it does not compromise access to the southwest extent during an emergency. The floodway could be refined at a later design stage to ensure access, erosion control and flood hazard are acceptable.

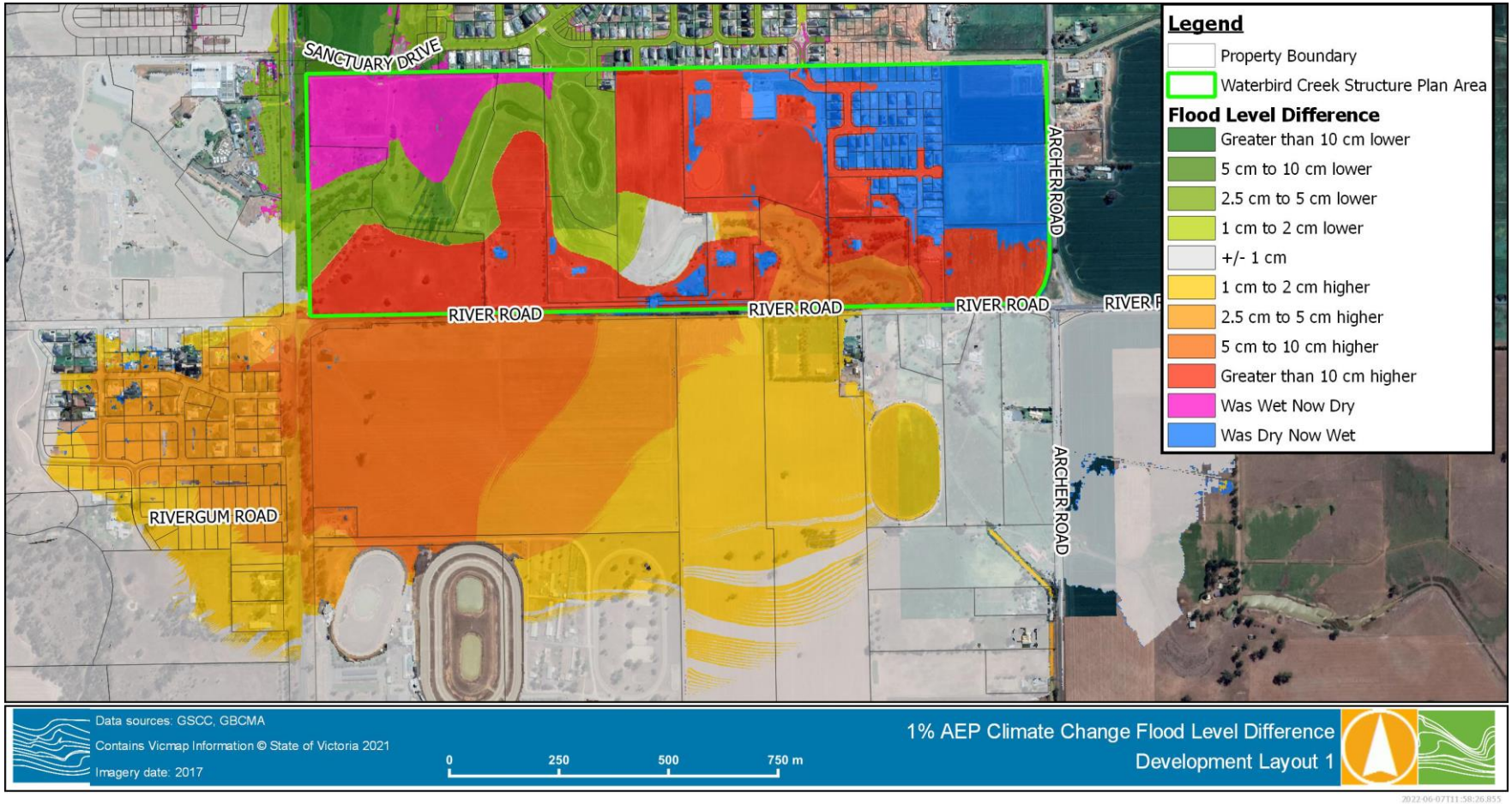


**Figure 4-1 1% AEP Climate Change Flood Level Difference – Development Layout 1**

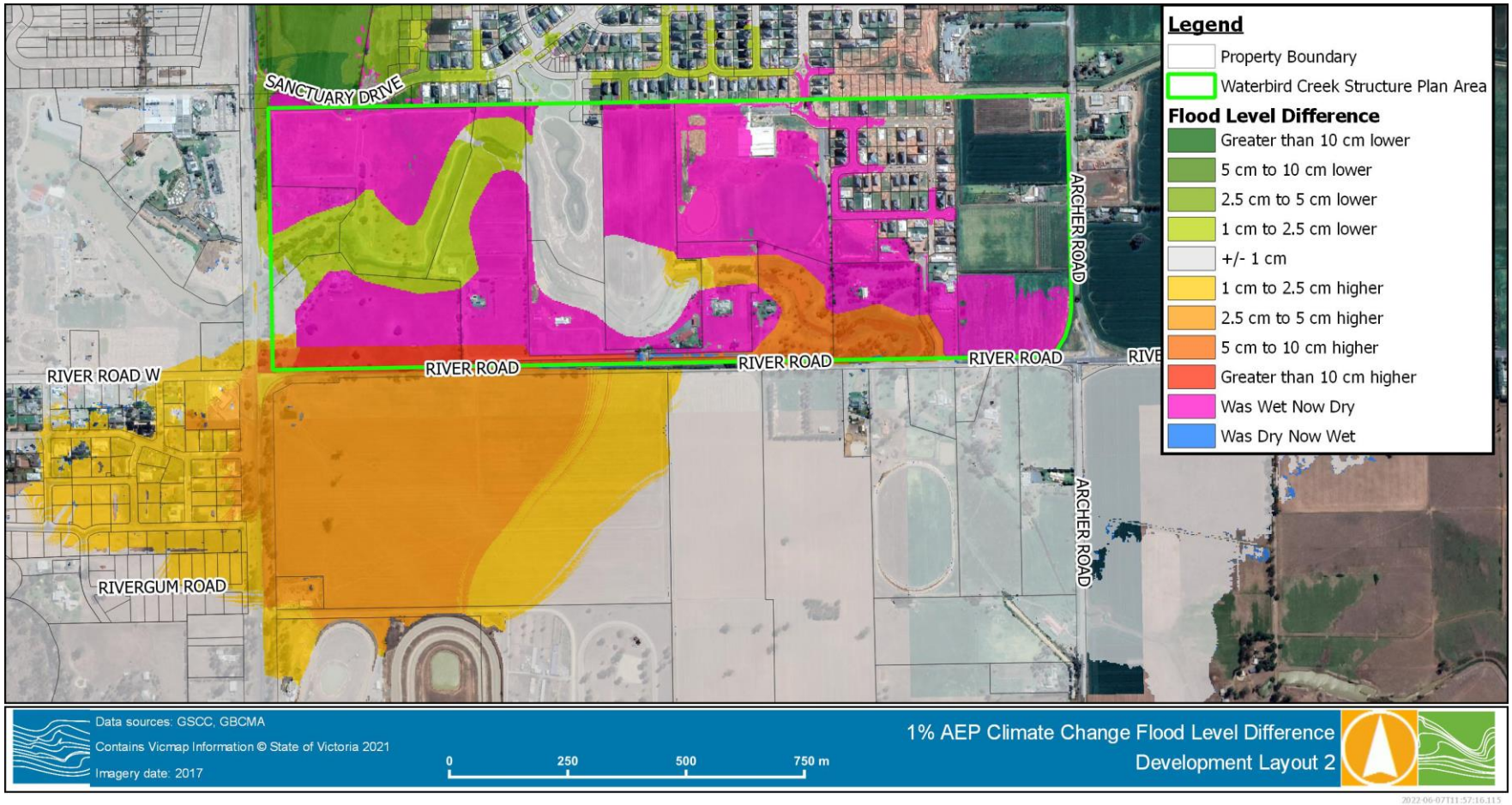


**Figure 4-2 1% AEP Climate Change Flood Level Difference – Development Layout 2**

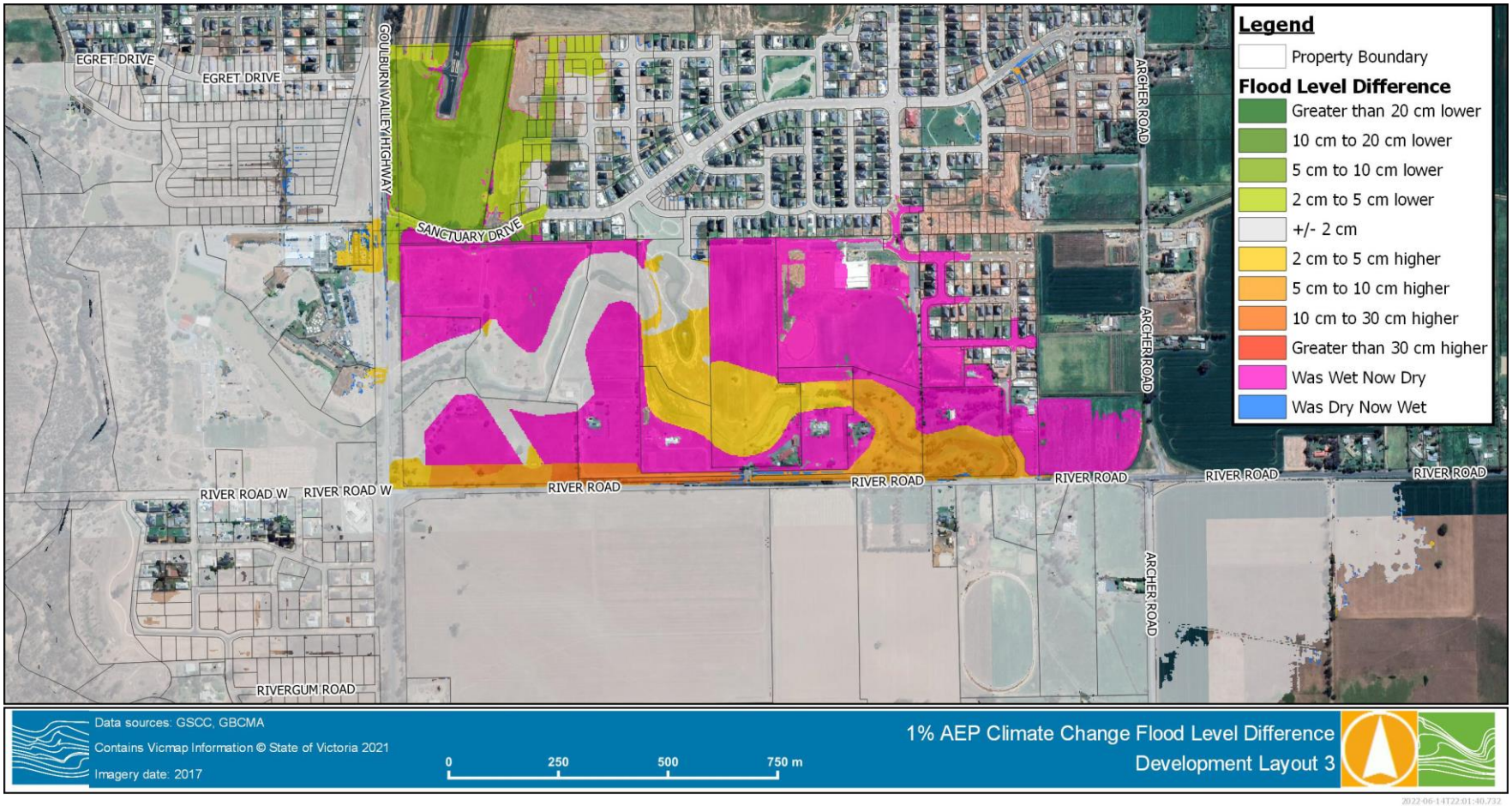


**Figure 4-3 1% AEP Climate Change Flood Level Difference – Development Layout 3**

# 5 EARTH WORKS AND FLOODPLAIN STORAGE

Development Scenario 3 appears to meet afflux requirements by not increasing flood levels by greater than 2cm (with the exception of an isolated area west of the site). The following sections of the report discuss potential earthworks required to fill the site and the impact on overall floodplain storage.

## 5.1 Earthworks

The proposed development scenario relies on filling of the site to above the 1% AEP (with climate change) flood level. This requires significant fill volumes to be imported into the development precinct. This can be somewhat offset by 'cut' taken from within the site.

The finished levels used for the flood modelling are not final design levels and are based on a grid resolution of 1.25m x 1.25m. These are indicative only and are used to provide an estimate of total earth works required. Cut and fill values quoted are likely to change slightly at a further detailed design stage and would also change once final road levels are included in the design.

The total cut and fill calculated from the final development layout (Development Scenario 3) is shown in Table 5-1. This shows there is a need to import around 251,235 $m^3$ of fill based on assumptions that the modelled scenario has adopted.

These calculations do not incorporate the floodplain storage requirements, which is discussed further below.

**Table 5-1 Cut Fill Earthworks Summary**

| Development Option | Fill Required ($m^3$) | Cut Required ($m^3$) | Net Balance ($m^3$) |
|---|---|---|---|
| 3 | 283,318 | 32,083 | 251,235 |

## 5.2 Floodplain Storage

Typically, the GBCMA would require that any loss of floodplain storage be compensated in a 1:1.3 ratio for a single private development. Given the size of the development being undertaken, it is understood the GBCMA will assess floodplain storage requirements on a 1:1 ratio. It is also assumed that provided flood the mapping shows no significant afflux outside of the site, negotiations into an acceptable reduction in floodplain storage may result in this requirement being waived.

A summary of the loss of floodplain storage (based on a 1:1 ratio) is shown in Table 5-2. This shows that Development Scenario 3 produced the smallest loss in storage at 109,410 $m^3$, whereas Development Scenario 1 produces the greatest loss in storage at 134,040 $m^3$. This equates to around 25.5% of the total volume stored within the precinct under existing conditions. Although close to a quarter of the floodplain storage volume is lost under Development Scenario 3, adverse afflux external to the precinct is considered minimal.

**Table 5-2 Floodplain Storage Calculations**

| Floodplain Storage | Existing Conditions ($m^3$) | Development Scenario 1 ($m^3$) | Development Scenario 2 ($m^3$) | Development Scenario 3 ($m^3$) |
|---|---|---|---|---|
| 1% AEP Climate Change | 428,677 | 294,637 | 299,282 | 319,266 |
| Net Balance | | - 134,040 | - 129,395 | - 109,410 |

# 6 DISCUSSION

Flood storage in the southwest corner of the precinct and inclusion of a floodway through the southern fill extent has been shown to be important hydraulic controls in maintaining conveyance and flood levels through the site and south of River Road. The flood conveyance through the site as been restricted as a result of the fill arrangements, however, accommodation of appropriate flood storge and flow paths have been provided to minimise increases in flood levels external to the site.

## 6.1 Potential Flood Risk with Development

Modelling of flood behaviour developed by Water Technology has shown that areas within the Waterbird Creek site may be suitable for residential development from a floodplain management perspective. The updated design has not considered drainage requirements from stormwater generated within the site.

### 6.1.1 Flood Warning Time

The site has considerable flood warning time from a Seven Creeks flood. There are currently streamflow gauges on Seven Creeks at Kialla West, Euroa, and further upstream at Polly McQuinn Weir. These gauges provide a good indication of expected peak flooding as well as estimated flood levels at Kialla West. The Seven Creeks at Kialla West gauge is part of the of Bureau of Meteorology Flood Warning Network and predicted flood levels are provided for this gauge.

Flood peak travel times from the gauge upstream of Euroa to Kialla West is estimated at 24-48 hours based on historical floods including 1993, 1995 and 2010.

### 6.1.2 Site Egress

Under the 1% AEP Climate Change existing conditions, access the precinct can be achieved. Although, conditions under Development Scenario 3 has the potential to prevent access to the isolated southern extent due to the location of the floodway, as shown in Figure 6-1 below. Depths in the 1% AEP Climate Change event exceed 0.5 m around the isolated fill extent and cut off access to River Road, Goulburn Valley Hwy and the remainder of the southern fill extent. Maintaining the same capacity of the floodway while increasing its width could reduce the flood depth in the floodway and permit safe egress towards the east. Other modifications of the finished topography or a short bridge could provide safe access.

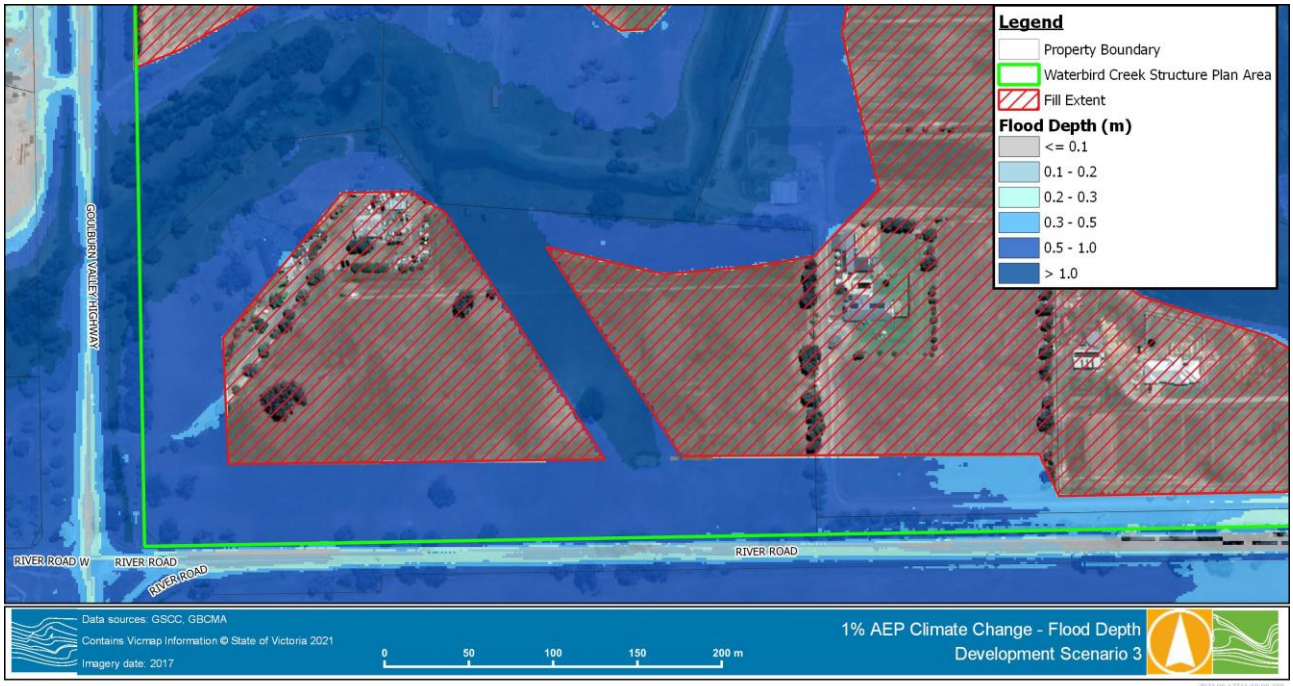


**Figure 6-1 Site Egress to southwest fill extent – 1% AEP Climate Change Flood Depth**

# 7 CONCLUSION

Based on the results from the existing flood development plan and through several iterations of the development footprint discussed with Council, Development Scenario 3 has shown that despite the 25.5% loss in floodplain storage within the site, it provided minimal afflux outside of the site in a 1% AEP (with climate change) event. Should Development Scenario 3 be considered for adoption, it is recommended that the further design work involving a reduction in loss of floodplain storage and potential floodway and lot layout/road network design be further investigated.