Report

Mooroopna West Growth Corridor – Model of Flood Behaviour

Greater Shepparton City Council

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Cover Photo: Mooroopna Drain Outlet from site

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1 INTRODUCTION

Water Technology was engaged by Greater Shepparton City Council (GSCC) to undertake an assessment of the Mooroopna West Growth Corridor (MWGC) with the latest available flood modelling information. The following report introduces the study, the existing flood modelling results, the impact of the originally proposed development and the revised recommended proposed development of the Mooroopna West Growth Area to meet floodplain development guidelines.

1.1 Background

The development of a detailed flood model of the MWGC was required to provide information on developable land and the broader context of flooding and drainage along the growth corridor. The growth corridor is located on the western side of Mooroopna, located between the Midland Highway to the south, Cornish Road to the north, existing development and Echuca Road to the east and the proposed Shepparton Bypass alignment to the west (Figure 1-1).

Water Technology has completed revised 1% AEP flood modelling for the Shepparton Mooroopna area[1] (2020). The 2020 project provided an update to the mapping provided in the Shepparton Mooroopna Flood Intelligence Study[2] (2019) and includes climate change modelling based on the 0.5% AEP design hydrology developed in the 2019 study. The updated modelling has provided a dataset for Goulburn Broken Catchment Management Authority (GBCMA) and GSCC to prepare planning controls for a proposed planning scheme amendment in line with the latest industry guidelines.

[1] Water Technology (2020), Supplementary Mapping for Shepparton and Mooroopna, for the Greater Shepparton City Council

[2] Water Technology (2019), Shepparton Mooroopna Flood Intelligence Study, for the Greater Shepparton City Council and Goulburn Broken Catchment Management Authority (2019)

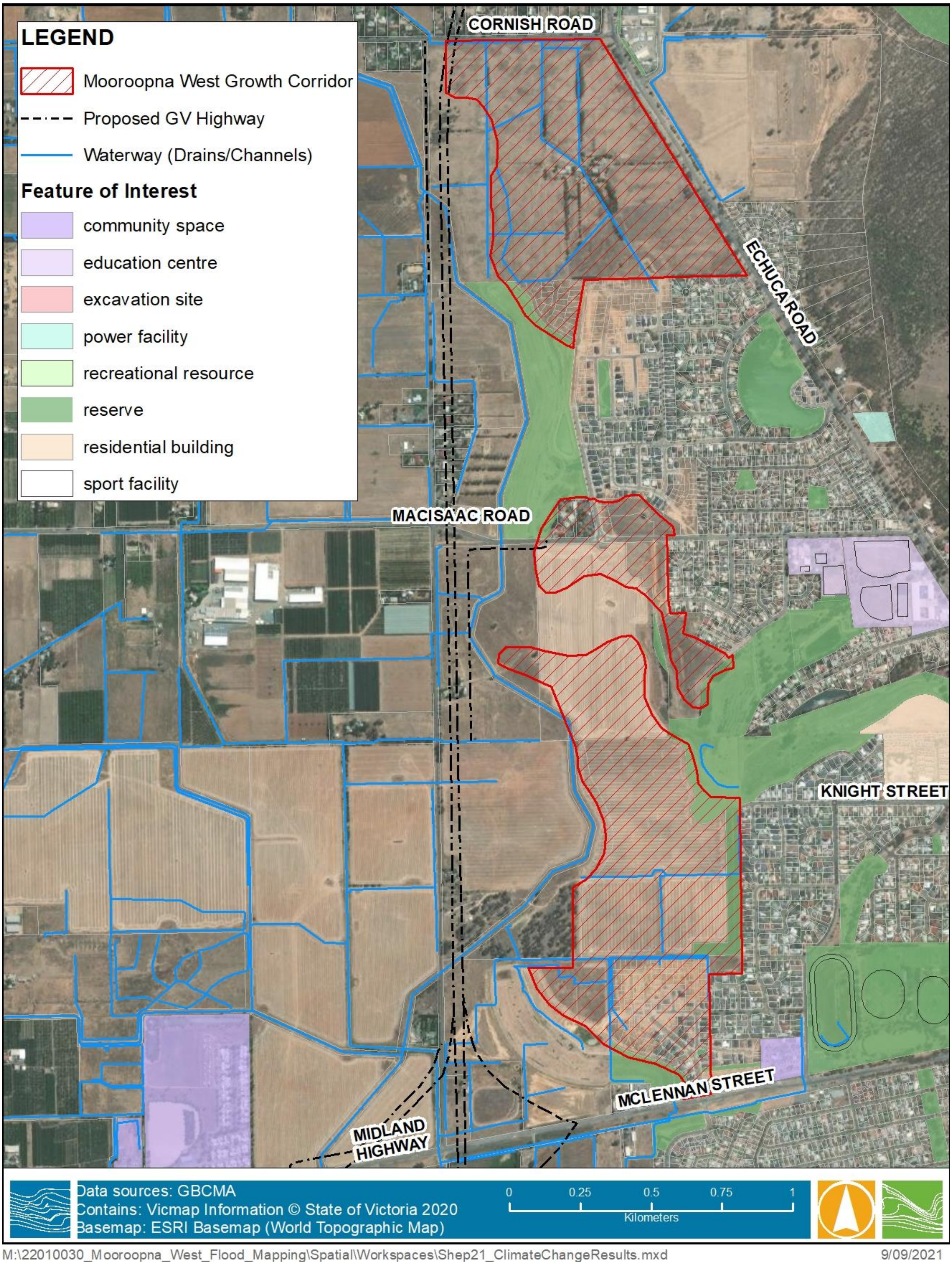

Figure 1-1 Mooroopna West Growth Corridor

1.2 Mooroopna West Growth Corridor

The MWGC was developed in 2009, as part of an investigation to establish future growth areas and contributions for future development. At the time, the development footprint established relied on flood modelling undertaken by Cardno Lawson and Treloar developed as part of the 2002 Shepparton Mooroopna Flood Study[3]. An excerpt of the growth area from the GSCC website is shown below and the corridor plan layout from 2009 is shown in Figure 1-2.

> *"..comprises 260 hectares of developable land and is bound by the established urban area of Mooroopna to the east, Cornish Road to the north, the proposed Goulburn Valley Highway (Shepparton Bypass) reservation to the west along Excelsior Avenue and the Midland Highway to the south.*
>
> *The Growth Corridor is expected to take 30 years to fully develop and is expected to support a population of 3,937 based on a total lot yield of 1,600 lots."*

Since 2009, the southern portion of the growth corridor has been developed with around 20 ha completed including the initial portion of the floodway. At the time of writing, further development was occurring in this area.

1.3 Project Objectives and Requirements

The purpose of this study is to investigate the flood implications of the proposed development within the MWGC. The main objective of this study is to provide GSCC with a revised development extent that maximises development area, without resulting in flood implications outside of the precinct. The requirement for this investigation has been brought about following the flood mapping updated within the Shepparton Flood Study. The revision of the development area was undertaken with consideration of the relevant stakeholder's requirements, which include:

- Development assessed for the 1% AEP climate change conditions, with developable areas raised above the flood level and the proposed development resulting in no significant afflux outside of the precinct.
- GBCMA have suggested that greenfield development should not be located where flood depths exceed 300mm existing conditions and 500mm under the climate change scenario.
- Typically, GBCMA would require than any loss of floodplain storage be compensated in a 1:1.3 ratio for a single private development. This assessment has assumed that GBCMA will allow a ratio of 1:1 be adopted based on the following:
  - The size of the development.
  - Flood modelling demonstrates no significant afflux outside of the precinct.
- Site egress any vehicular and/or pedestrian access must be designed and constructed to comply with the following safety criteria as indicated by the Goulburn Broken CMA:
  - Depth of flow does not exceed 0.50m; and
  - Velocity of flow does not exceed 3.0m/s; and
  - The Flood Hazard classification does not exceed H2.

The above requirements were considered throughout this investigation and are directly address within the report.

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[3] SKM (2002), Shepparton Mooroopna Floodplain Management Study, Prepared with Lawson and Treloar for the Greater Shepparton City Council.

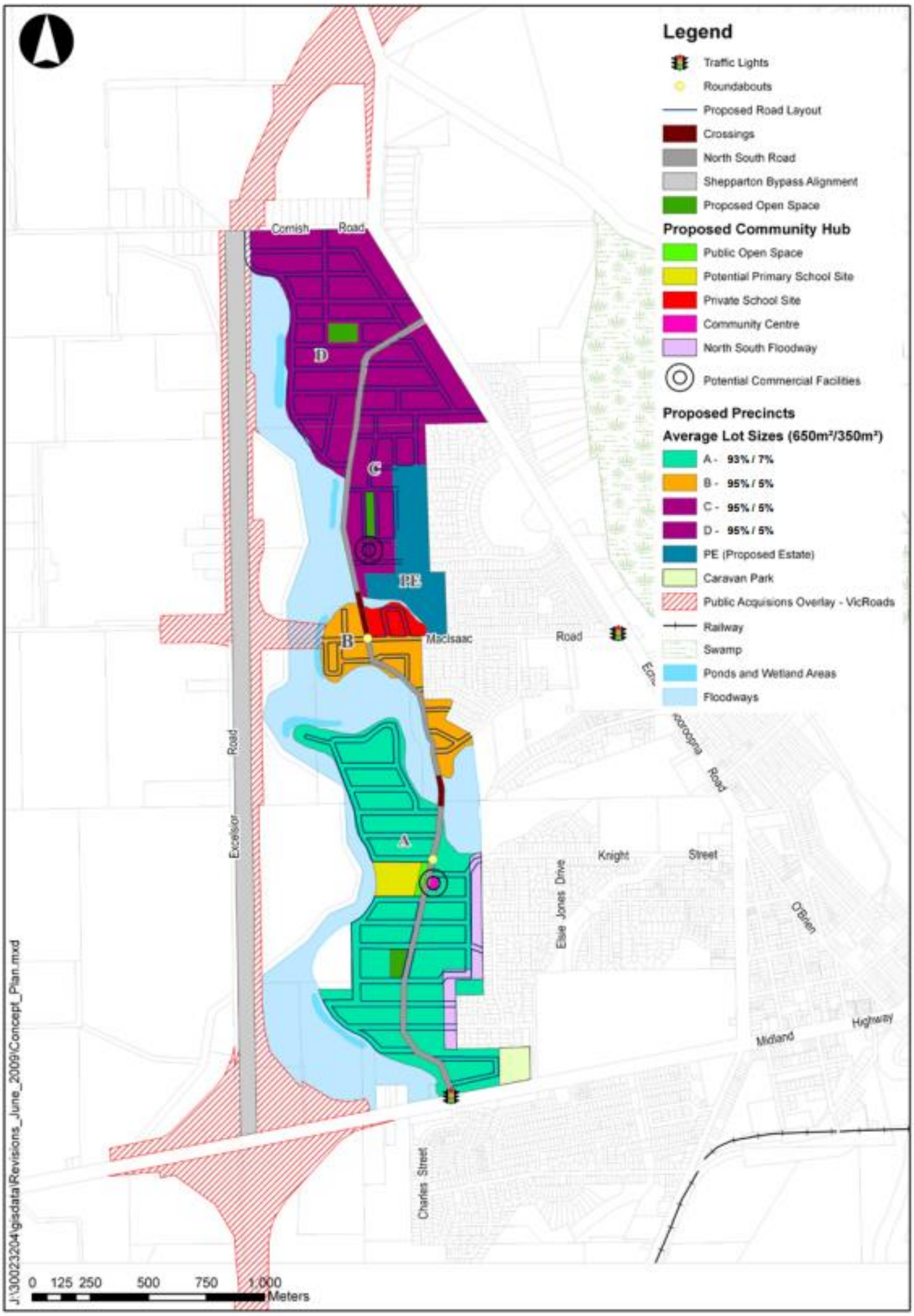

Figure 1-2 MWGC – Concept Plan

2 FLOOD MODELLING

2.1 Hydraulic Model Revision

For this investigation Water Technology revised the hydraulic model extent to reduce the model simulation time, this allowed additional development scenarios to be investigated. The revised model cut down the extent to between the Midland Highway upstream of the site and through to Echuca Road downstream of the site. The 1% AEP flood level from the cutdown model was validated against the original model l, with differences generally found to be within 100 mm. This difference is considered to be acceptable for the purposes of this investigation.

In addition to the updating the model extent, the following adaption was made to the model for all conditions:

- The Mooroopna Floodway will be constructed as proposed by AECOM[4], the proposed floodway was incorporated in both the existing and developed conditions scenarios. Water Technology received copy of the design Digital Elevation Model (DEM) provided by GSCC from the Bypassing Shepparton project undertaken for Major Roads Projects Victoria (MRPV), which was incorporated into the flood modelling.

The updated model was run for both existing and multiple developed scenarios, assessing the flood behaviour for the 1% AEP Climate Change conditions.

2.2 1% AEP Climate Change Results

The 1% AEP climate change flood modelling results from the Shepparton Mooroopna supplementary mapping project[1] were used as a primary assessment for the Mooroopna West Growth Corridor. This is based on a flood level of 12.4m at the Shepparton streamflow gauge. On average there are increases in the flood depth through the MWGC of around 150-200mm. This has significantly reduced the ‘Net Developable Area’ by increasing a significant portion of the MWGC into depths greater than 300mm and above 500mm in some cases.

It is suggested that fill levels of developable lots within the MWGC be filled to the 1% AEP climate change flood level and the Finished Floor Level (FFL) be located 300mm above this level. Access and egress levels may also be required to adopt a more lenient level when assessing climate change modelling results as opposed to existing conditions results.

The 1% AEP climate change depths are shown in Figure 2-1.

[4] AECOM (2009), Mooroopna West Growth Corridor Structure Plan, prepared with Mansuell for Greater Shepparton City Council

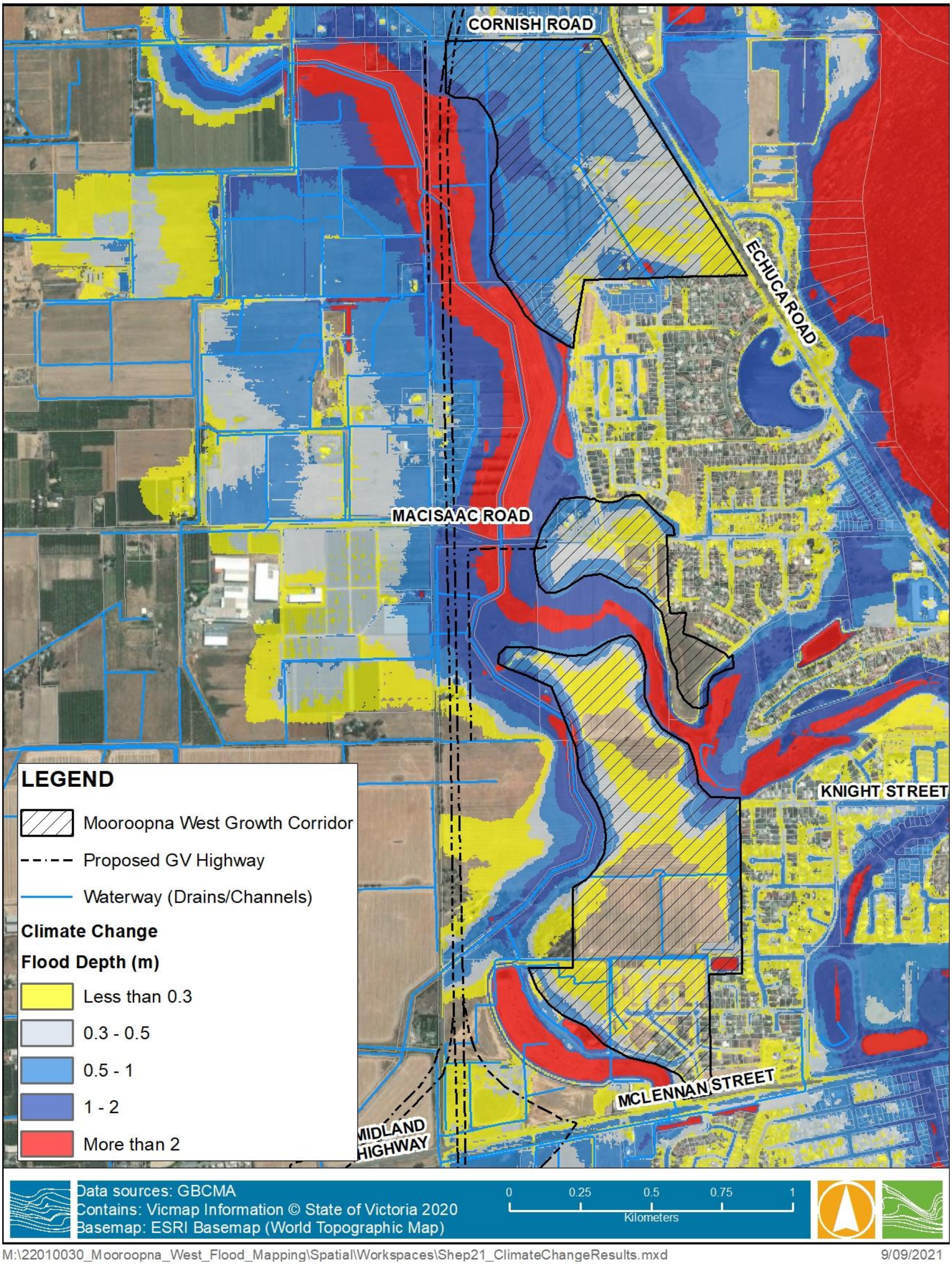

Figure 2-1 1% AEP – Climate Change Depth Plot (Existing Conditions)

3 DEVELOPMENT FLOOD RISK

The flood model was updated to include the originally proposed development (~135 ha), filled above the flood level. Currently, a large portion of the proposed development is now flooded by depths greater than 500mm in a 1% AEP climate change scenario. It is unlikely the full development footprint proposed in the 2009 layout would be achieved due to the cumulative impact of flood levels outside of the development area.

The proposed Growth Corridor (described within this report as Development Scenario 1) shown in Figure 1-2 was filled to provide flood immunity in the 1% AEP with climate change event. The fill extent was based on the MWGC development plan and 1% AEP climate change modelling was completed. The depth results are provided in Figure 3-1 and the flood level difference plot (compared with existing conditions) is provided in Figure 3-2.

The results show significant afflux outside of the precinct, which is not likely to be supported by the GBCMA. To address this the MWGC development extent was iteratively revised, as discussed in the following sections.

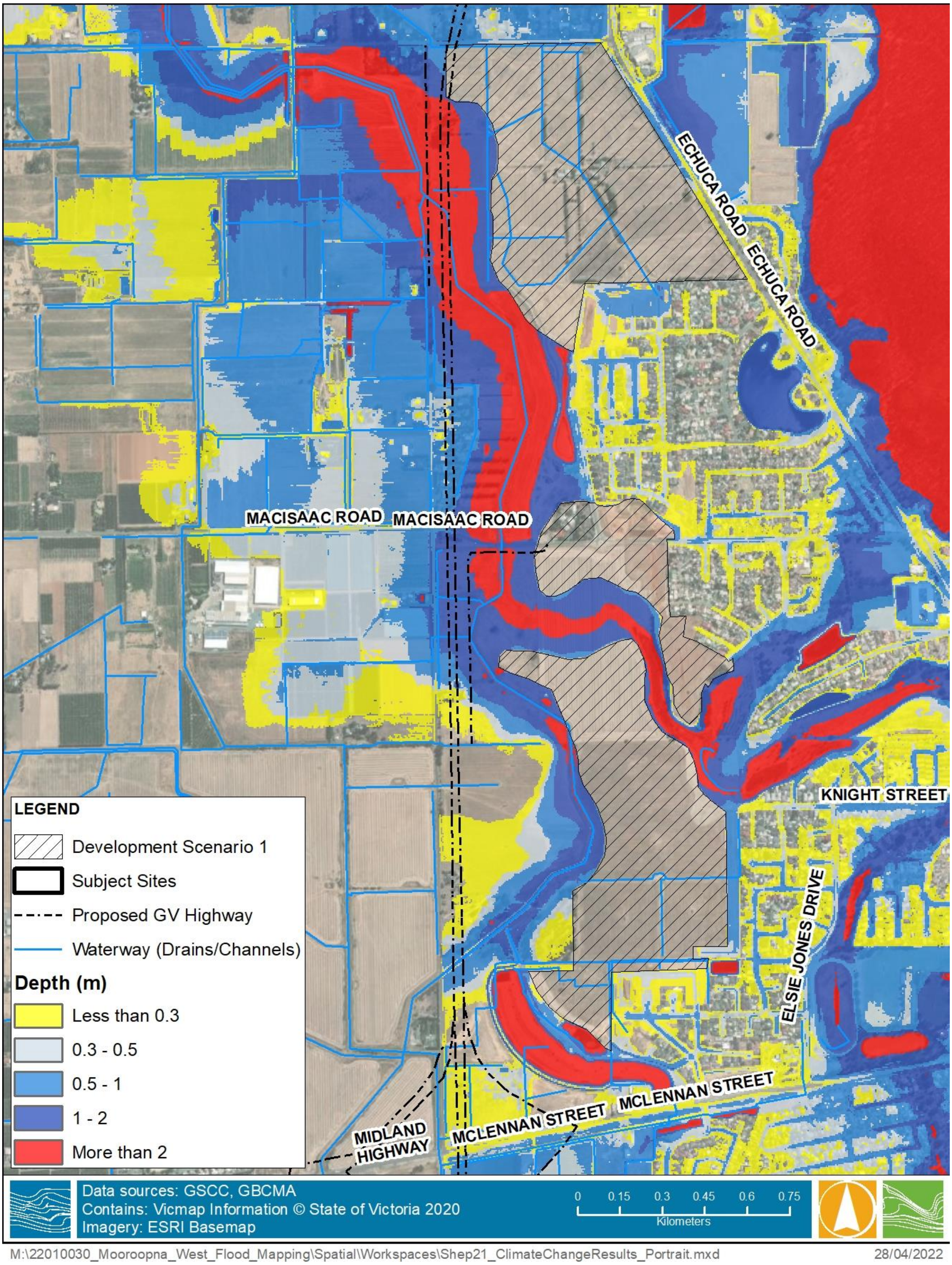

Figure 3-1 1% AEP – Climate Change Depth Plot (MWGC – Development 1)

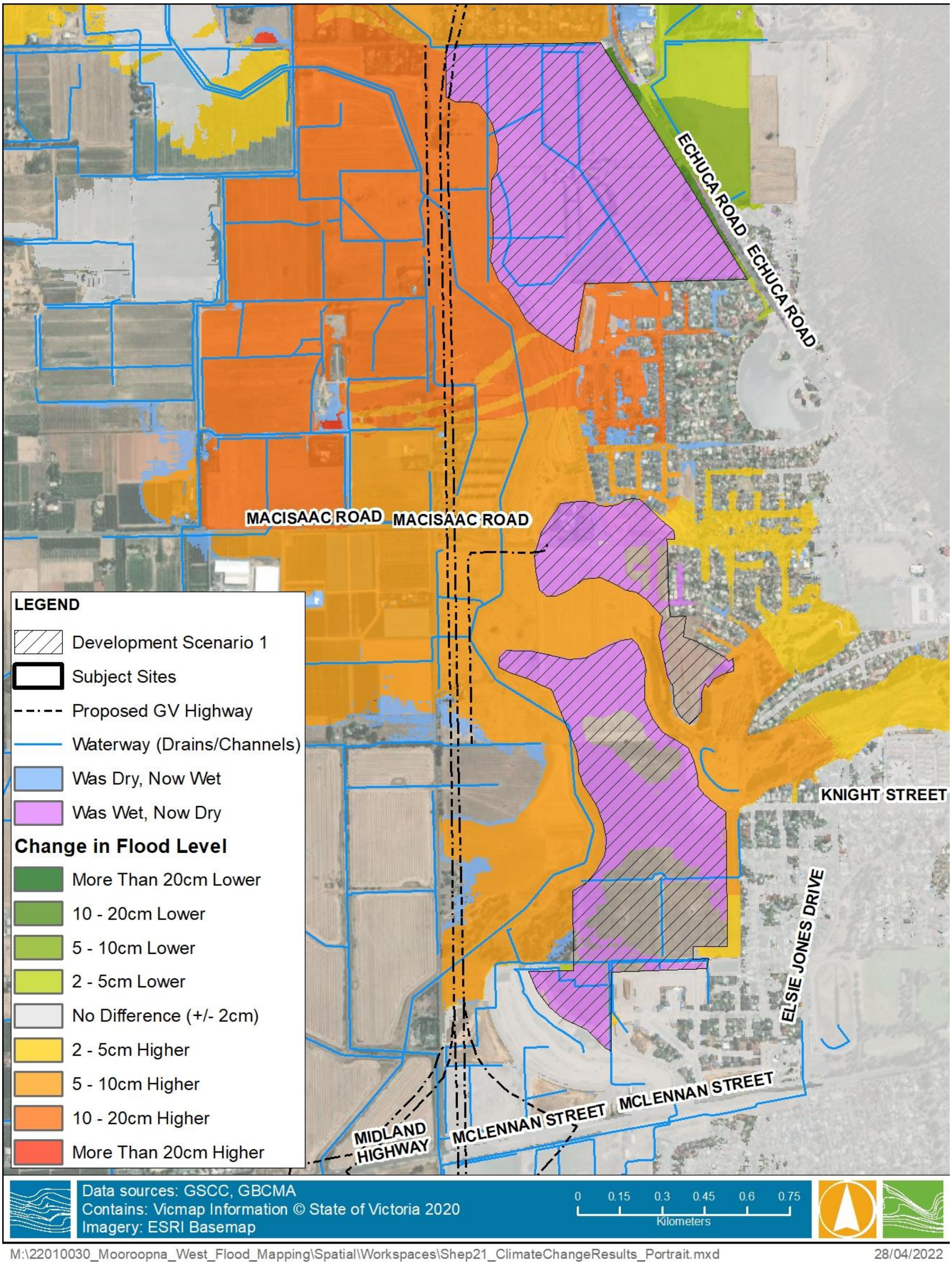

Figure 3-2 Flood Level Difference Plot – MWGC Development 1

3.1 Revised Development Footprint

Based on the flood level difference plot shown in Figure 3-2, afflux outside of the site area is significant and not likely to be accepted by the GBCMA. Several revised development footprints were assessed as part of the investigation. In total 8 variations to the development footprint area were trialled, with the following changes made to the proposed growth area to minimise afflux outside of the site:

- Reduction in overall developable area.
- Inclusion of additional floodways / flowpaths through the growth area.
- Inclusions of additional flood storage to off-set floodplain storage removal.
- Positioning of development extents to reduce flow impedance.
- Consideration of floodplain storage loss ratio.

The initial results and various design iterations were presented and discussed with officers from GSCC and GBCMA. Ultimately, when compared to existing conditions the trialled options resulted in affluxes of greater than 20 mm outside of the precinct, considered to be the likely acceptable afflux by GBCMA.

3.2 Final Development Footprint

Through the above iterations, of which were found to not meet afflux requirements, a final development scenario (Figure 3-3) was modelled. Flood depth results for the 1% AEP with climate change are provided in Figure 3-4. This scenario was shown to meet the afflux requirements (Figure 3-5) and included:

- 74 ha of development, a reduction of 59 ha from 2009 footprint, noting the 2009 footprint did not take into account additional floodways, floodplain storage requirements
- A reduction in development extent along boundary fronting major flow paths.
- The inclusion of additional flood storage (cut) at the northern end of the development precinct. This cut was designed to tie into the invert level of the Mooroopna Floodway at 109.1 m AHD, covering an area of 23 ha with a batter slope of 1 in 20 tying into the surrounding existing surface.
- The removal of fill between two development precincts located toward the northern end of the site accounting for a future roadways, which also provide a flood path (to the north) for floodwaters.

Table 3-1 Development Footprint Summary

Scenario	2009 MWGC Footprint	Revised MWGC
Development Footprint	135	74

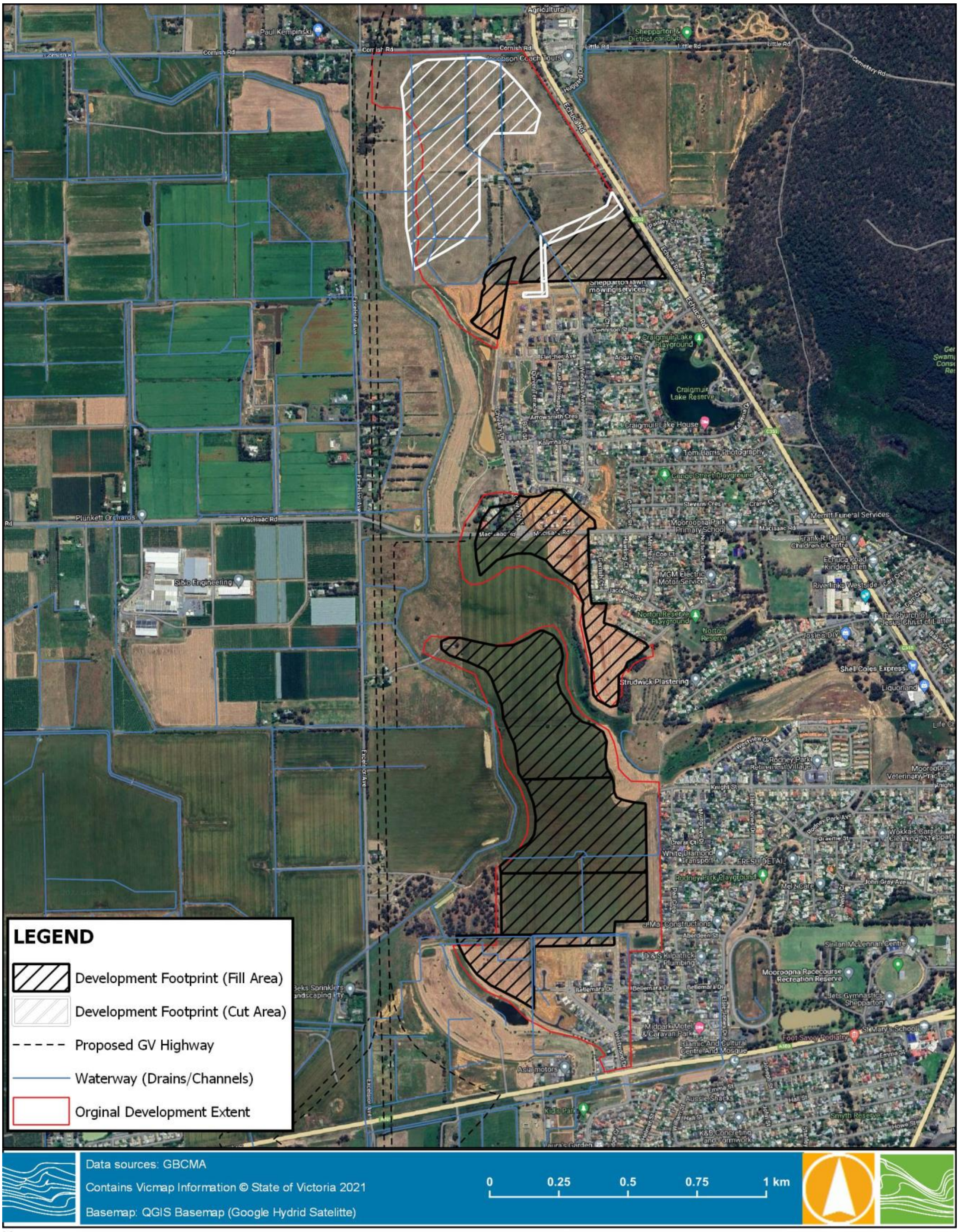

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Figure 3-3 Final Development Layout

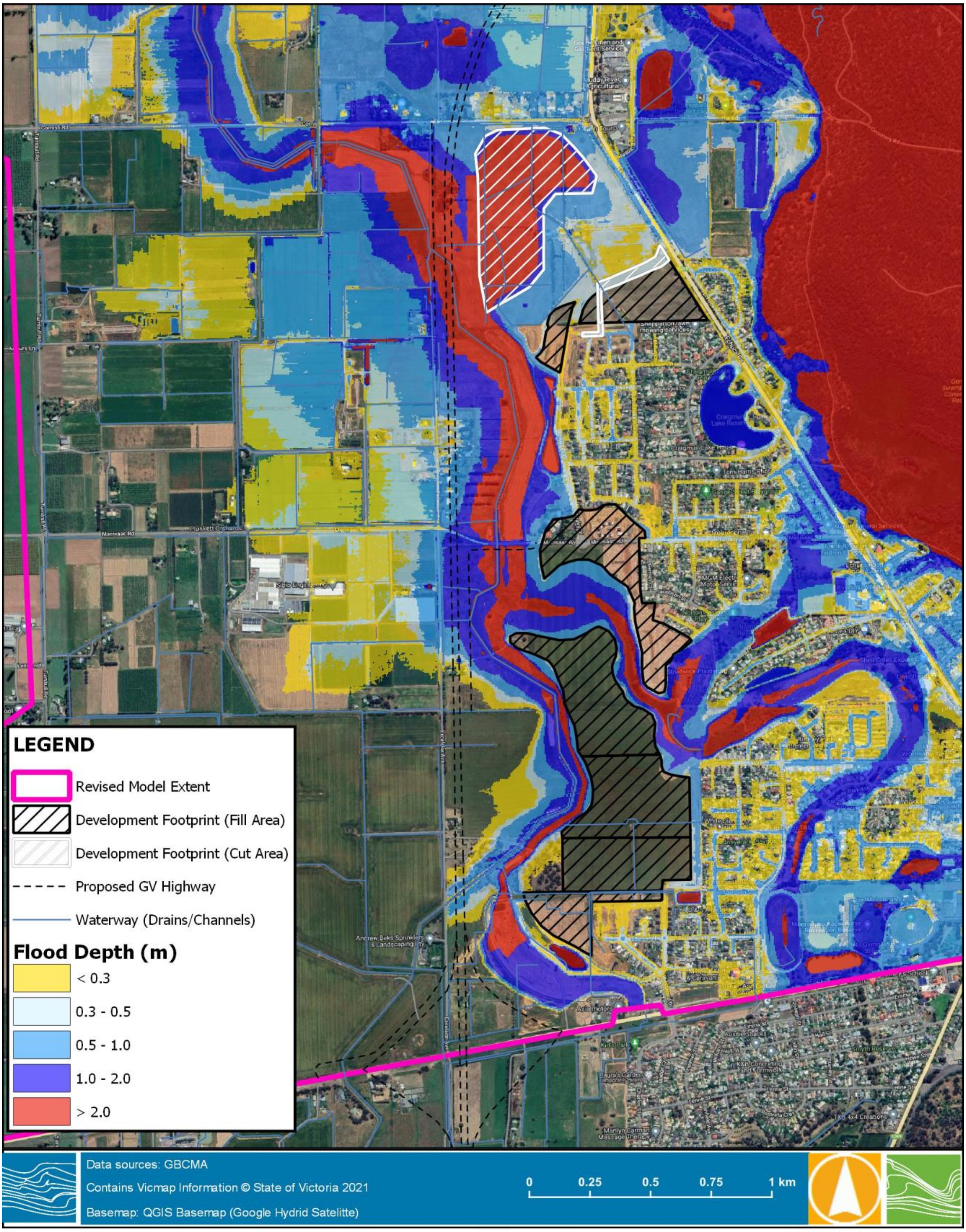

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Figure 3-4 1% AEP – Climate Change Depth Plot (Revised Developed Conditions)

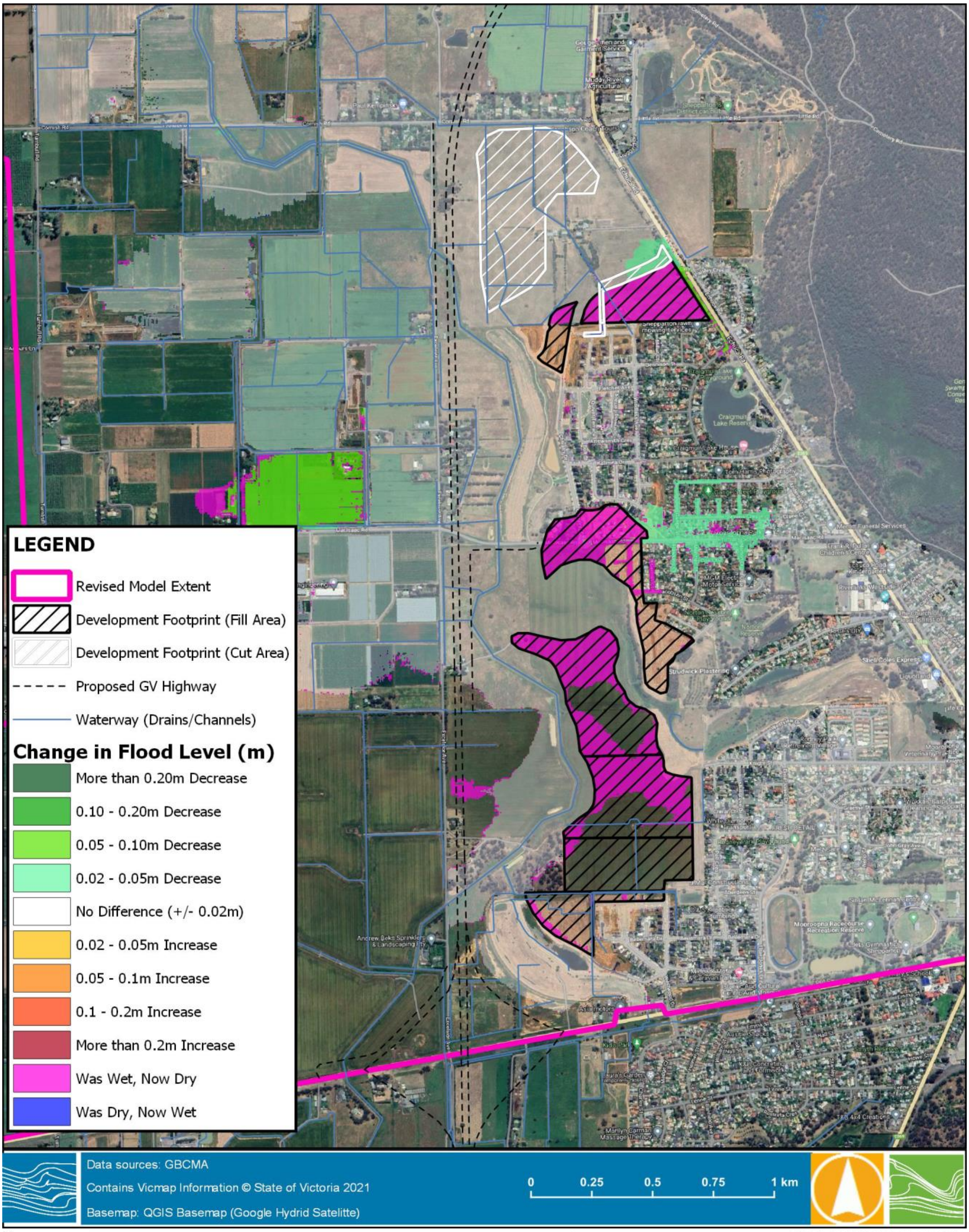

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Figure 3-5 Flood Level Afflux - Final Development Layout

4 EARTHWORKS AND FLOODPLAIN STORAGE

4.1 Earthworks

The proposed development scenario relies on filling the site above the 1% AEP (with climate change) flood level in locations where existing flood depths are less than 0.3 m. This requires significant volumes of fill to be imported into the development precinct, which can be somewhat offset by 'cut' taken from within the site.

The finished levels used for the flooding modelling are not final design levels and are based on a grid resolution of 5m x 5m. These volumes are an estimate and are to only be used as an estimate of total earthworks required. The cut and fill volumes quoted are likely to change slightly at a further detailed design stage; the addition of road levels into the design will see further changes to the quoted volumes.

The total cut and fill calculated from the development layout is shown in Table 4-1 below and shows that a surplus of material (~240,000 m^3) based on the assumptions adopted in the model. The total volume of cut required for flood mitigation could be further reduced as discussed further below.

Table 4-1 Cut/Fill Earthworks Summary

	Fill Required (m^3)	Cut Required (m^3)	Net Balance (m^3)
2009 MWGC Footprint	884,918	50,028	834,890
Final Development Footprint	118,937	356,314	-237,377

4.2 Floodplain Storage

As the flood modelling undertaken demonstrates that the proposed development has no significant afflux outside of the precinct, it has been assumed GBCMA will accept a floodplain storage loss based on a 1:1 ratio. A summary of the loss of floodplain storage (based on a 1:1 ratio) is shown in Table 4-2, with the floodplain area calculated west of Echuca Road between the Midland Highway and Cornish Road. This shows that the proposed fill extents will result in a floodplain storage gain of approximately 190,000 m^3, which equates to an additional 3% of volume stored within the subject site under existing conditions. Modifications to the final cut volume to get the net balance closer to zero could be further investigated to reduce the size of the proposed flood mitigation. The volumes of earthworks balance discussed above suggest there is a need to provide more fill than cut and sourcing this material (if suitable) from on site may provide a more cost-effective option as opposed to importing fill material.

Table 4-2 Floodplain Storage Summary

Storm Event	Floodplain Storage		Net Balance (m^3)
	Existing Conditions (m^3)	Developed Conditions (m^3)	
2009 MWGC Footprint	5,534,796	5,506,395	-28,401
Final Development Footprint	5,534,796	5,723,785	+188,989

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5 FLOOOD HAZARD

5.1 Potential Flood Risk with Development

Modelling of flood behaviour developed by Water Technology has shown that areas within the MWGC may be suitable for residential development from a floodplain management perspective; however, there is still a need to assess the broader flood hazard risk. The updated design has not considered drainage requirements from stormwater generated within the site. Mapping of the 1% AEP (with climate change) velocity and water surface elevation are provided in Figure 5-2 and Figure 5-3 respectively.

The combined impact of depth and velocity is often provided as a representation of flood hazard. The ARR2019 recommendations provide a further assessment of flood hazard through the Flood Hazard categories as outlined by Australian Emergency Management Institute (2014). The categories in

Table 5-1 provide recommendations for suitable design criteria based on a value from 1 to 6. The results of the developed flood hazard conditions are shown in Figure 5-4. The plot shows the residential areas filled above the flood level are unsurprisingly not impact by flood hazard. The areas flowing to and within Ardmona Main Drain, experiences a peak classification of H5, with the floodwaters abutting the development generally classified below H3. While this assessment has not modelled roadways within the precinct, it is noted that existing roadways (within existing residential development) in general are classified as H2 which will likely be representative of future conditions within the proposed precinct.

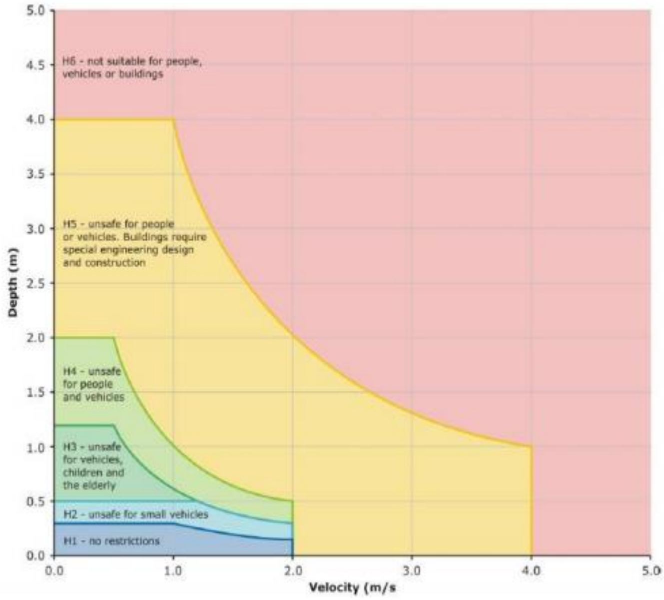

Figure 5-1 Flood Hazard Classification (ARR2019)

Table 5-1 Flood Hazard Classification Summary

Hazard Classification	Description
H1	Relatively benign flow conditions. No vulnerability constraints.
H2	Unsafe for small vehicles.
H3	Unsafe for all vehicles, children and the elderly
H4	Unsafe for all people and all vehicles
H5	Unsafe for all people and vehicles. Buildings require special engineering design and construction.
H6	Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.

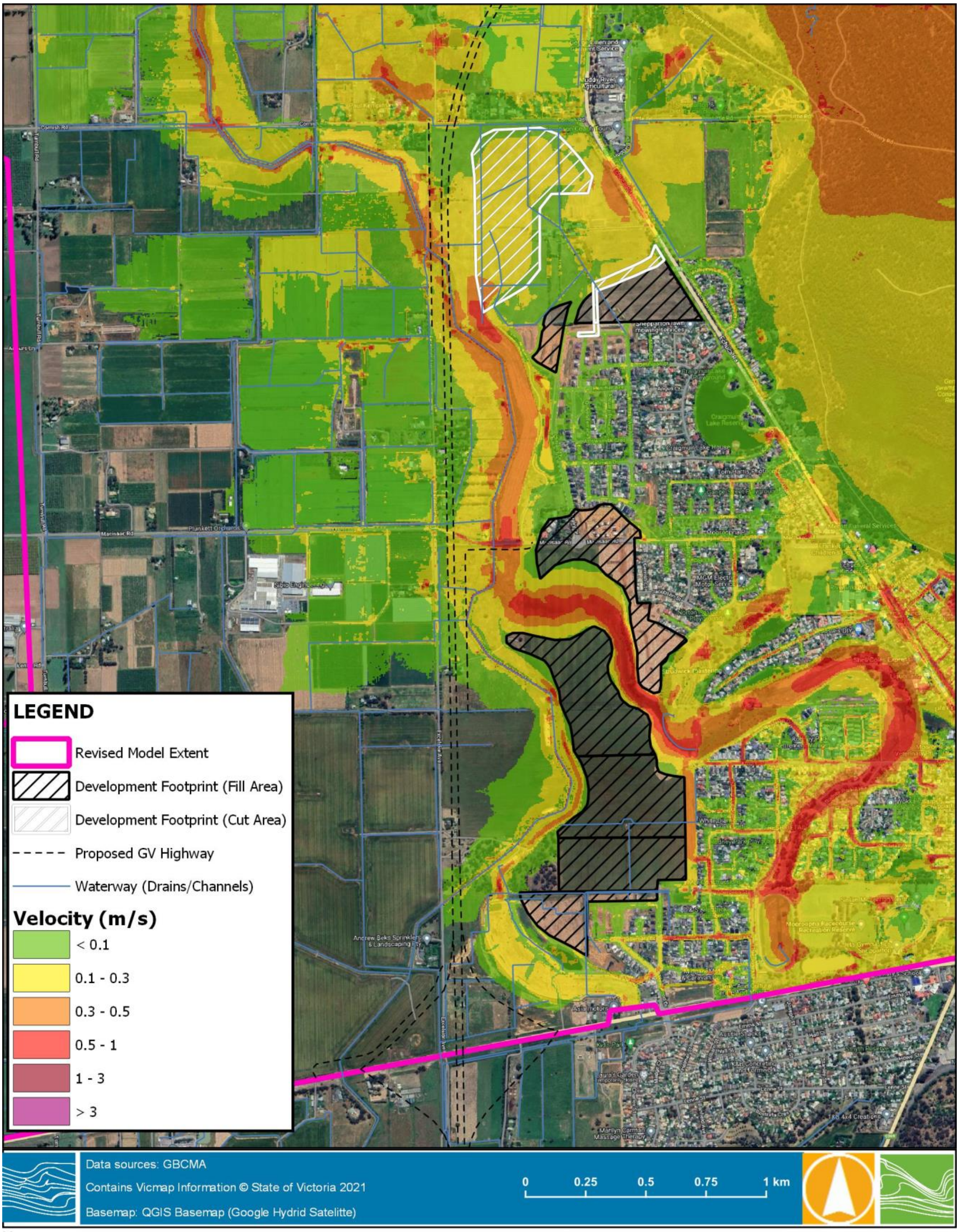

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Figure 5-2 Development Scenario – 1% AEP Velocity Plot

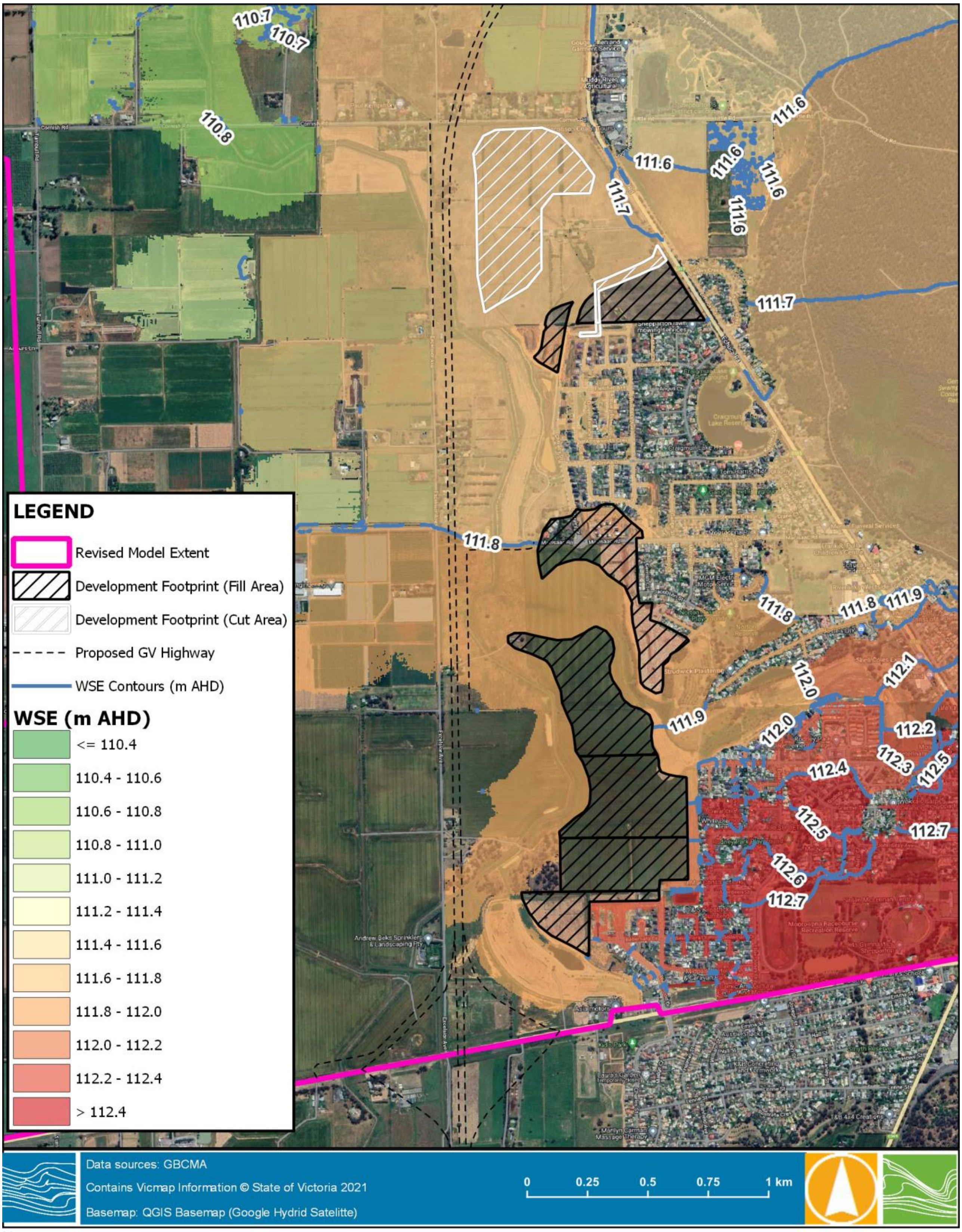

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Figure 5-3 Development Scenario – 1% AEP Water Surface Elevation Plot

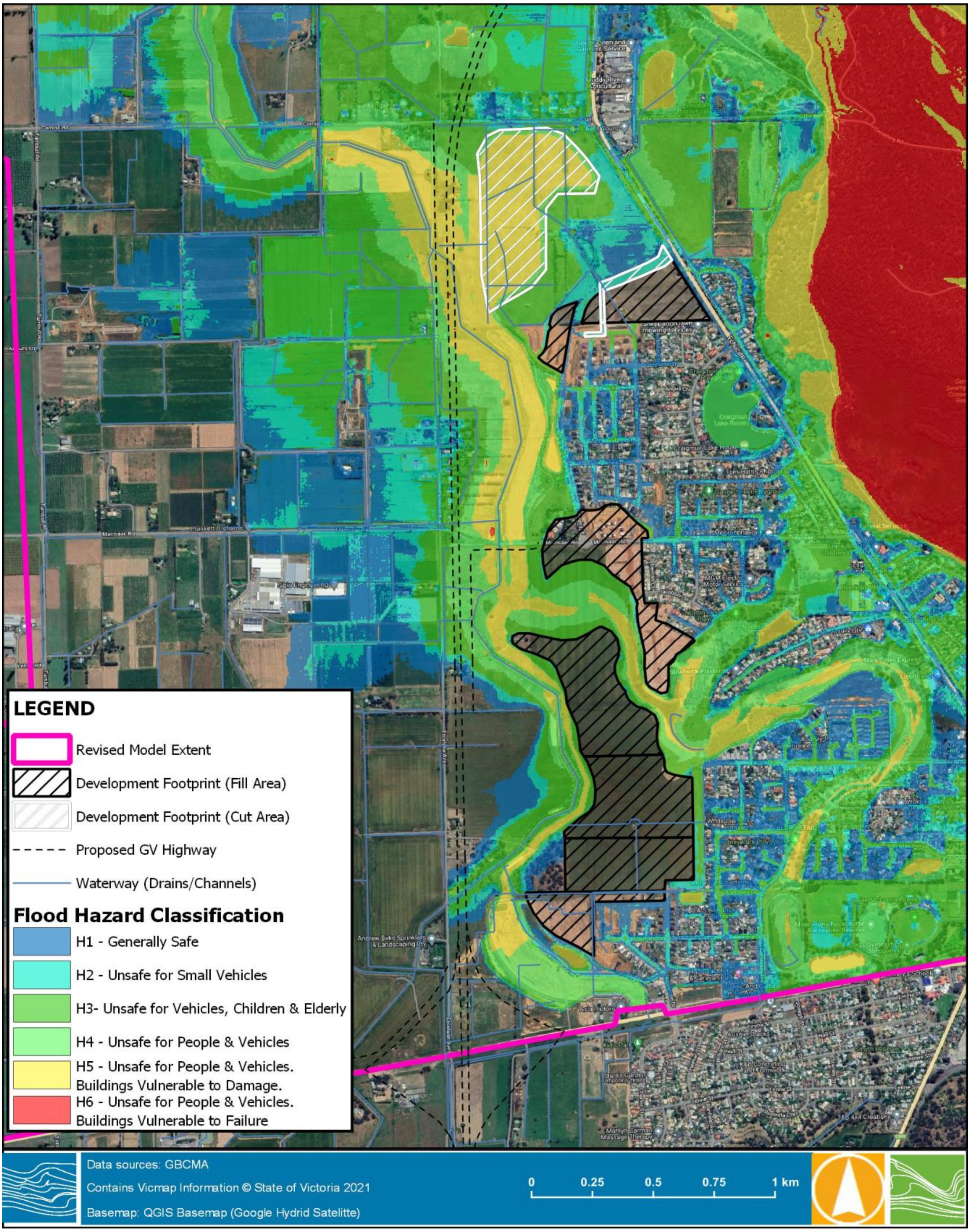

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Figure 5-4 Development Scenario – 1% AEP Flood Hazard Plot

5.1.1 Flood Warning Time

The site has considerable flood warning time from a Goulburn River or Broken River flood. Both rivers have multiple upstream gauges, which will allow emergency services to forecast flood events in real-time, well before the MWGC is inundated from floodwaters.

The Goulburn River at Shepparton (located just upstream of the site) is part of the Bureau of Meteorology Flood Warning Network and flood level predictions for this gauge are provided. The Mooroopna floodway and areas adjacent to the site are not expected to be inundated until the Goulburn River at Shepparton Gauge reaches 11.7 metres (noting that local runoff from the immediate catchment and Drain 11 may contribute local catchment flows through this precinct). The Goulburn River at Murchison and Broken at Orrvale gauge (located upstream Shepparton) are also part of the of Bureau of Meteorology Flood Warning Network and predicted flood levels are provided for these gauges. Flood peak travel times from these gauges are provided below:

- Goulbourn River at Murchison to Shepparton is estimated to be between 18 to 30 hours, with the travel time around 36 hours during the 1992 and 2010 events.
- Broken at Orrvale gauge Shepparton is estimated to be between 4 to 40 hours.

5.1.2 Site Egress

The original MWGC plan was to have a connecting road through the development precinct from the Midland Highway to Echuca Road. This will provide two access routes for the development precinct which can be accessed from the following significant roadways:

- Midland Highway.
- Echuca Road.

Assessment of the developed conditions flood results along these roadways and existing internal roadways, indicate that safe access will be able to be achieved, even though some areas along these roadways are significantly impacted by floodwaters. Under the 1% AEP climate change development conditions, flooding along the mentioned roadways and internal road networks is:

- Generally, below depths of 0.5 m.
- Flow velocity does not exceed 3 m/s, with in areas generally below 1 m/s.
- Each development precinct has access via existing internal roadways that are below a flood hazard category of H2.

6 SUMMARY

Flood modelling was undertaken to provide mapping outputs and highlight an area marked for development from a purely floodplain management perspective. Update to the climate change modelling suggests there is significantly more of the site inundated when using climate change modelling as the design scenario.

The proposed development plan developed in 2009 was assessed against the 1% AEP climate change scenario on the Goulburn River. The initial development footprint was found to not meet acceptable afflux requirements. Through an iterative process with feedback provided by GSCC and the GBCMA, the design layout was modified to modify the proposed fill areas.

Earthworks estimates indicate significant volumes of fill are required to be imported and there is an overall net loss of floodplain storage within the precinct. Further refinement and detailed flood modelling are expected to be completed at later stages of the design process, that includes incorporation of stormwater drainage assets, an internal road network and the production and inclusion of a detailed design surface to further assess the development footprint.

There is a significant reduction in the development footprint area when compared with the 2009 MWGC footprint (135 ha down to 74 ha). It is noted that the development area in the 2009 footprint did not take into account additional floodways, floodplain storage requirements. It is also noted that if the 2009 footprint were to proceed (regardless of the afflux issues outside of the site), the development would require significant amount of imported fill compared to the final development layout produced as part of this study.

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