



WYNDHAM VALE – SUNDRY IWMP TASKS:

PSP92, PSP40, PSP42 North, PSP42 South and PSP43

March 2012

Document history

Revision:

Revision no.	V01
Author/s	S. Cleven M. Stacey K. Travis A. Backstrom (Australian Ecosystems) J. Liester (WBM BMT)
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Revision no.	V02
Author/s	S. Cleven M. Stacey K. Travis A. Backstrom (Australian Ecosystems) J. Liester (WBM BMT)
Checked	S. Cleven
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Revision no.	V03
Author/s	S. Cleven M. Stacey K. Travis A. Backstrom (Australian Ecosystems) J. Liester (WBM BMT)
Checked	S. Cleven
Approved	K. Travis

Distribution:

Revision no.	V03
Issue date	1 March 2012
Issued to	Tim Peggie (Growth Areas Authority)
Description:	Final document

Citation:

Please cite this document as: Alluvium. (2012).
Wyndham Vale Sundry Tasks. Report P111069_V011
for the Growth Areas Authority.

Ref:
L:\Projects\2011\069_Wyndham_Vale_IWMP_Tasks\1_Deliverables\
P111069_Wyndham Vale IWMP Tasks_Final Report_V12.docx

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Abbreviations

ARI	Average Recurrence Interval
CRZ	Core Riparian Zone
DEM	Digital Elevation Model
DSS	Development Service Schemes
DSE	Department of Sustainability and Environment
EPA	Environmental Protection Authority
GAA	Growth Areas Authority
IWMP	Integrated Water Management Plan
MW	Melbourne Water
PSP	Precinct Structure Plan
VB	Vegetated Buffer
VBZ	vegetated buffer sub- zones
VPP	Victorian Planning Provisions
WCC	Wyndham City Council

1 Introduction

Alluvium Consulting has been engaged by the Growth Areas Authority (GAA) to deliver a range of sundry tasks associated with the development of the following precinct structure plans (PSP):

- PSP40
- PSP92
- PSP42 North
- PSP42 South, and
- PSP43.

The geographic locations of these PSP areas are provided in Figure 1.

This project is part of background investigations that will inform the preparation of precinct structure plans for the Wyndham Vale area.

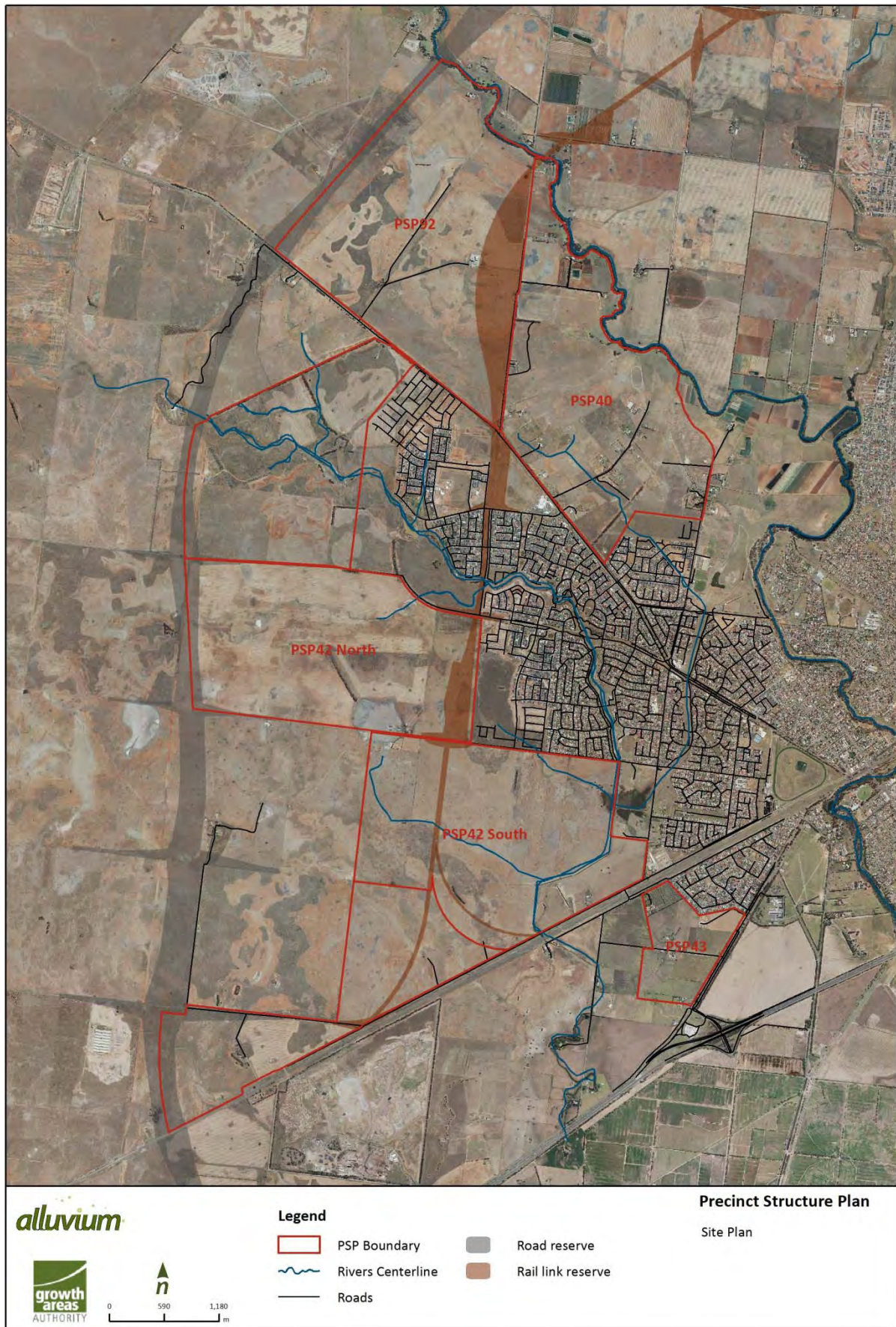


Figure 1. Site plan

2 Development in PSP40 and PSP92 and implications to the Werribee River

The proximity of PSP40 and PSP92 to the Werribee River has meant that a number of tasks must be undertaken in order to assess the implications of development in these areas. The tasks undertaken include:

- Development of a hydraulic 100 year Average Recurrence Interval (ARI) model for the Werribee River and optimisation of land for development for PSP40 and PSP92
- Clarification on the drainage reserve widths and waterway setback distances and the activities that can be undertaken within the PSP40 and PSP92
- The assessment of an eroded gully in PSP40 to determine its potential to be excluded from the Werribee river flood shape and its potential for integration into future development
- An Investigation of an existing ephemeral wetland in PSP92 and to provide guidance on its future role/value in a developed landscape. We will accurately describe the future state and its footprint so GAA can confidently plan around it as a constraint or as a developable area of land and,
- Identify the biodiversity values including the potential presence of native flora and fauna along the Werribee River corridor throughout PSP92.

2.1 100 year ARI flooding assessments for the Werribee River

Modelling of the 100 year ARI flood extents for the Werribee River, under both existing and proposed developed conditions, were undertaken by BMT WBM in both PSP40 and PSP92. As part of this modelling, BMT WBM determined the flood impacts associated with future development and the range of possible fill scenarios.

A 2D/1D dynamically linked TUFLOW hydraulic model of the study area was developed to assess the flooding conditions under both the existing and developed scenarios. Hydrology input into the TUFLOW hydraulic model was based on a RORB model of Werribee River obtained from Melbourne Water.

The hydraulic model was designed to cover the section of the Werribee River floodplain that could potentially be influenced by the development of the combined PSP40 and PSP92 sites. The area modelled extended sufficiently upstream and downstream from the site to minimise boundary effects and ensure adequate representation of the floodplain storage. LiDAR data obtained from the GAA and Melbourne Water was combined to form a digital elevation model (DEM) of the study area for input into the TUFLOW model.

To determine the area of potential development the DEM was modified to include fill platforms that would effectively stop sections of land from being inundated by floodwaters. The model was run for various fill platform scenarios with the preferred scenario based on an acceptable flood level increase of 0.05 m. This is generally in line with acceptable impacts by Melbourne Water standards. However, this should only be used as a guide and will need to be more accurately assessed on an individual development basis and approved by Melbourne Water. Thus the hydraulic modelling provides a preliminary assessment of what could potentially be achieved.

2.1.1 PSP40 100 year ARI flooding assessment results

The results from the hydraulic analysis undertaken for PSP40 are presented graphically in Figure 2 and 4. These flood extent maps show the flood extent under existing and developed conditions (including freeboard) and show indicative flooding depth (Figure 4). The flood impacts associated with the development scenarios are presented in the full modelling report contained in Appendix A.

The results from this analysis show that the development of the PSP40 region (Figure 2) can be extended either side of the Werribee River flood runner. This includes a significant portion of land to the east of flood runner, which would effectively form an island in the 100 year ARI flood event. The development scenario represents a gain an extra 63 ha of developable land that would have previously been flood affected. However approximately 15 ha of this land will fall within the proposed new regional park, therefore only 48 ha is

deemed developable. Based on a flood depth of approximately 0.25 m it would require approximately 120,000 m³ volume of fill (not including freeboard and the regional park area). When the PSP40 fill platform is extended further east, the flood impacts are significantly increased, and deemed to be unacceptable.

2.1.2 PSP92 100 year ARI flooding assessment results

The 2D/1D dynamically linked TUFLOW hydraulic model for the Werribee River was also used to determine the flood impacts associated with future development in PSP92 and the range of possible fill scenarios.

The results from the hydraulic analysis undertaken for PSP92 are presented graphically on the following pages. Flood extent maps showing the flood extent under existing and developed conditions are presented in Figure 3 and 4 (Flood Depth). The flood impacts associated with the development scenarios are presented in the full modelling report contained in Appendix A.

The results from this analysis show that the development of the PSP92 region is limited due to the confined waterway and significant depth of flow. When the PSP92 fill platform is extended further east or west, the flood impacts are significantly increased, and deemed to be unacceptable.

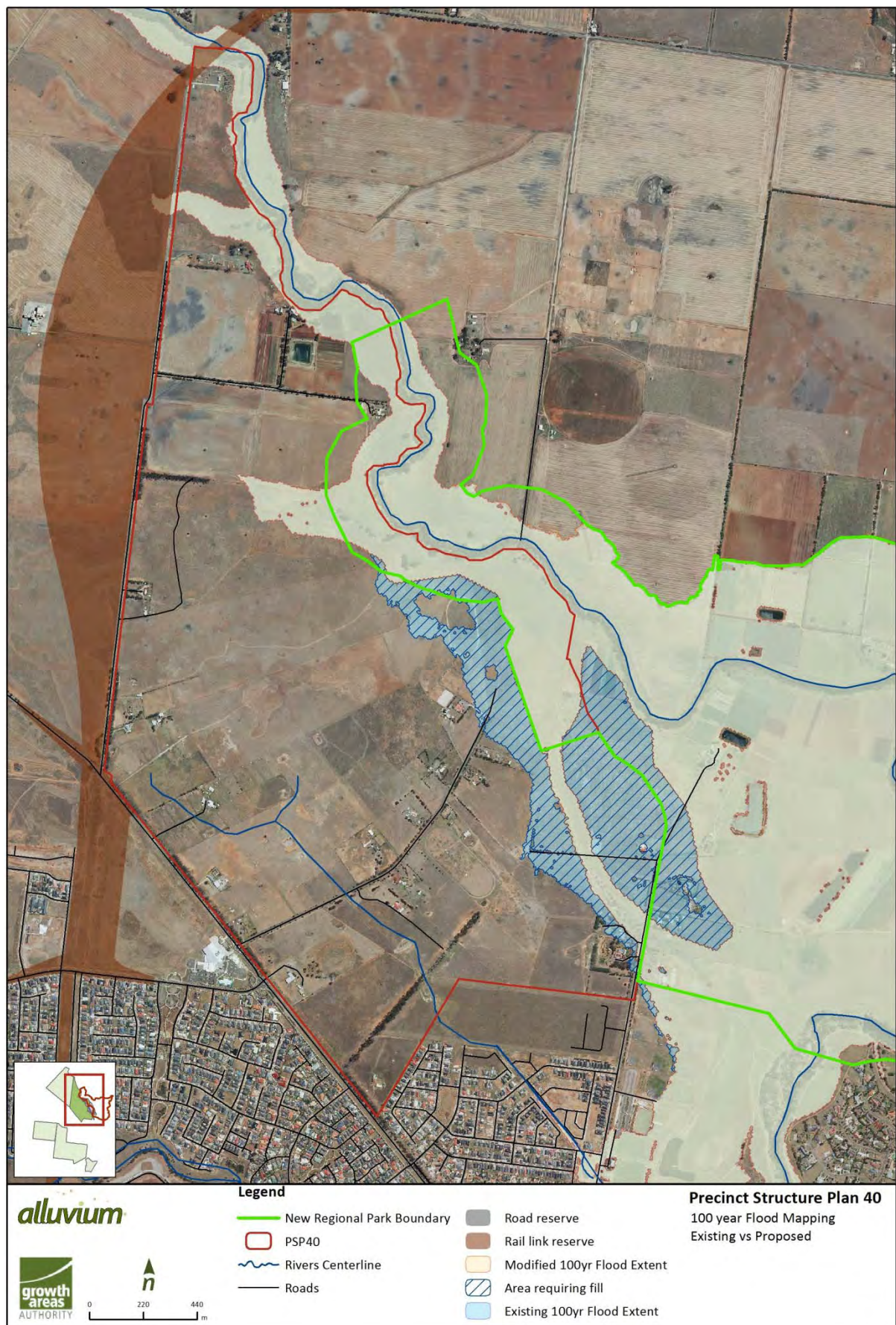


Figure 2. Existing and Developed Scenarios for Werribee River in **PSP40** (100 year ARI Flood extent)



Figure 3. Existing and Developed Scenarios for Werribee River in **PSP92** (100 year ARI Flood extent)

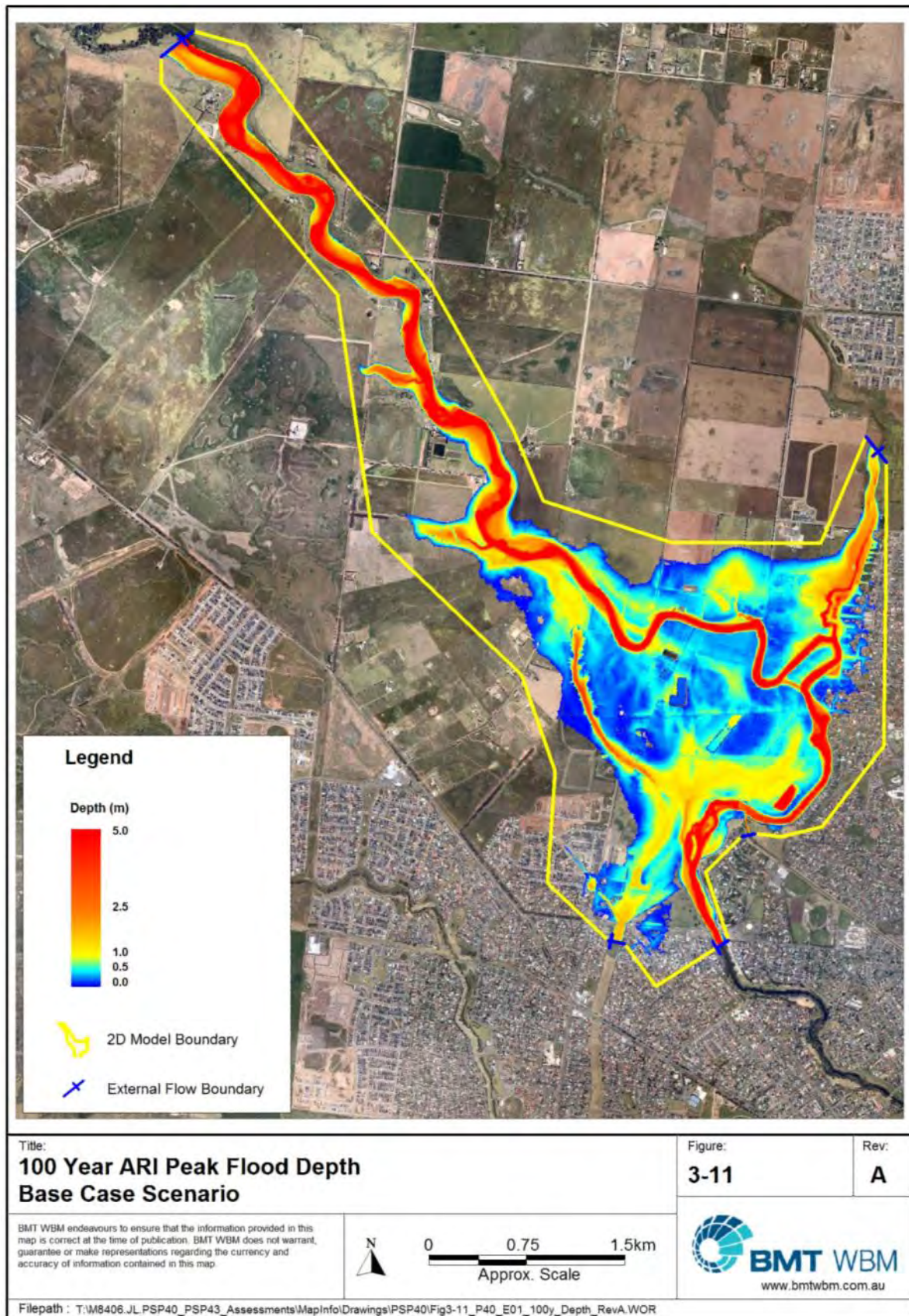


Figure 4. Flood depths in *PSP 40* and *PSP92* (extracted from Appendix A)

2.2 Werribee River flood runner assessment (PSP40)

A large gully located within a flood runner of the Werribee River on the eastern boundary of PSP40 has been subject to past vegetation clearance and agricultural pressures, and as result the GAA was concerned on the potential for instabilities including bed and bank scour to occur. As indicated in the flood modelling this gully roughly coincides with the current 100 year ARI flood boundary, with the western bank forming the floodplain edge in the developed scenario (Figure 2).

A geomorphic assessment was undertaken, including a site inspection to identify the potential of instability within the gully. The site inspection found the gully to be a well defined channel, with relatively gentle, battered banks and bedrock inserts along most of its length. There were no signs of major erosion and no signs of recent knick point retreat evident, to indicate it has any active erosion present.

A summary of the gully geomorphic assessment is provided in Figure 5 including field note annotations. Images of the gully displaying channel form and key features are provided in Figures 6 to 10.

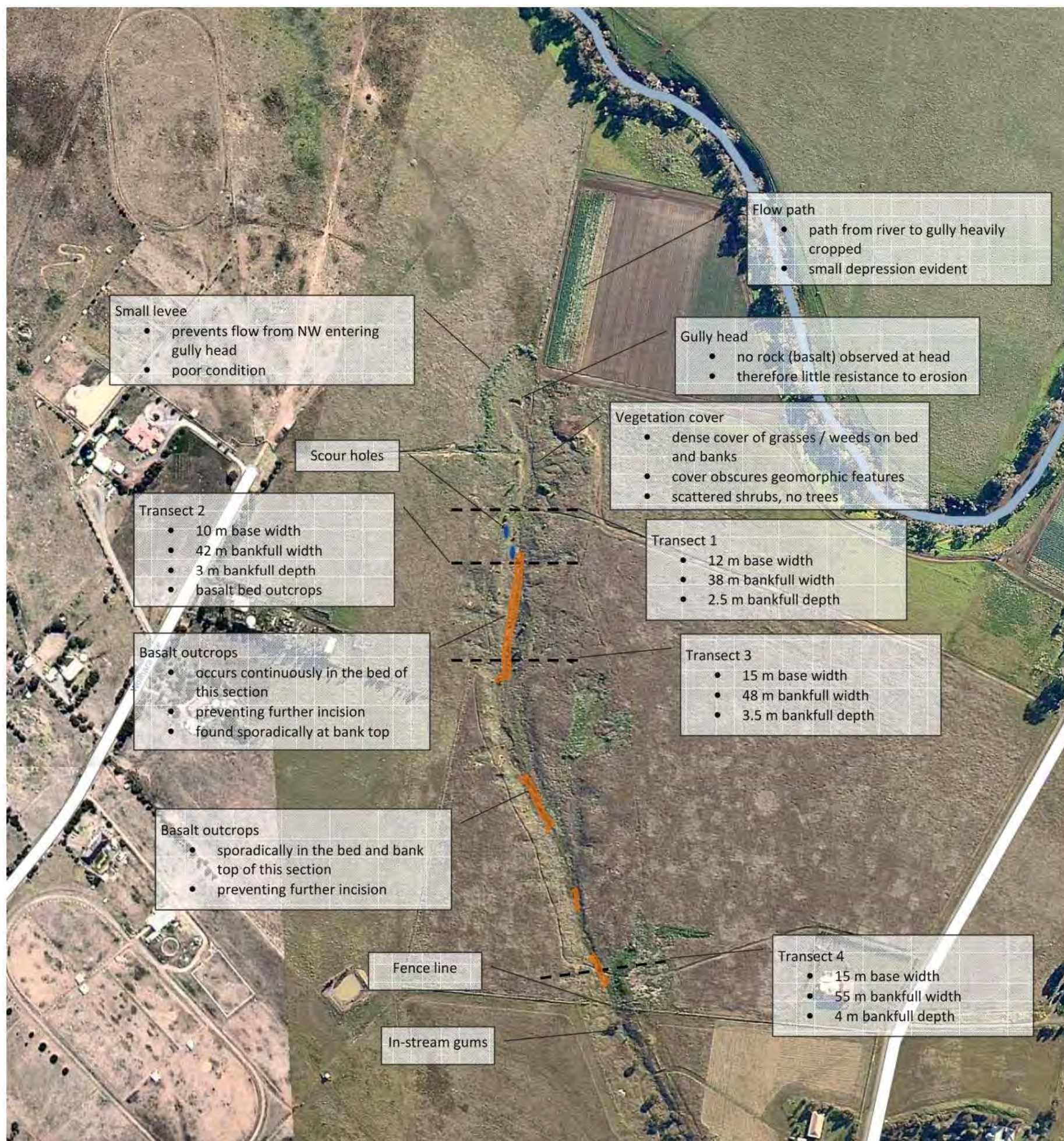


Figure 5. Geomorphic assessment of Werribee River flood runner gully in PSP40



Figure 6. *Top of gully facing south (Werribee River flood runner gully in PSP40)*



Figure 7. *Gully head (Werribee River flood runner gully in PSP40)*



Figure 8. *Transect 1 facing south (Werribee River flood runner gully in PSP40)*



Figure 9. *Transect 2 facing south (Werribee River flood runner gully in PSP40)*



Figure 10. *Transect 4 – facing south (Werribee River flood runner gully in PSP40)*

The field inspection revealed significant amounts of basalt outcrops in the bed and occasionally in the bank profile and we would not expect any further incision along the gully. It was noted that none of the gully head/finger heads had any observable rock (basalt outcrops nor rock rip rap) and it is expected that there may be a slow retreat of the gully head and finger heads from the local catchment flows (i.e. when not engaged with the Werribee River).

The gully is wide (up to 50 m bank full width) and relatively deep, but with relatively gentle banks. We estimated an average cross sectional area of around 80 m^2 , equating to a space of more than $50,000 \text{ m}^3$ over the 700 m length.

Eucalyptus Camaldulensis (Red gum) trees in the bed of the lower section (downstream of 575 McGrath Road and at McGrath Road crossing) were healthy and provided a valuable feature to the landscape.

Following field assessment we are unsure if this is a natural feature or a man-made channel created many decades ago and then modified over time by flows events to reach a stable condition (grade, bank slope, depth). The Red gums in the base of the lower part of the gully are however in the order of 40 or 50 years old. Recent discussion with GAA has revealed that a more recent flora assessment has been documented the presence of threatened flora species in the bed of the channel. These factors tend to suggest less land disturbance and more likely it is a natural feature.

There were three key questions posed to as part of this assessment.

Question 1 - How can the erosion be managed?

Our field assessment revealed there is no erosion that should be of concern to the GAA and the minor likely retreat of the gully head and finger heads can very easily be dealt with as part of standard land development activities.

Question 2 - Can we fill in the gully?

While it may be feasible to fill in the gully, it would require more than 50,000 m³ of fill. However as this gully provides an important flood conveyance function, and intrinsically is a unique feature in the landscape we do not recommend filling.

The possibility of filling the gully was also raised with Melbourne Water who also communicated their view that it should not be filled.

Question 3 - Can the gully be used to locate water quality treatment assets?

The gully being quite deep does provide an opportunity to drain stormwater collected from the local developed catchment. The development of the gully of this nature however faces two main obstacles;

- sustainability of the assets when the gully is engaged as a flood runner in a 30 year event, and
- presence of important flora species restricting where earth works may be able to take place.

Generally most constructed water quality treatment assets are designed to flood out and maintain velocities below 1 m/s to avoid damage to the structure and vegetation. The recent modelling as presented in Figure 11 identified an indicative velocity in excess of 1.5 m/s and up to 3 m/s. Therefore, it is generally not an appropriate location for any water quality treatment assets, unless capable of being designed to withstand such velocities.

A more logical use of this gully is to create a unique waterway feature. The depth of the gully means it is easy to drain the local catchment to it and the installation of minor pool and riffle system would provide a degree of variation and various habitats for native plants and animals.

The only complexity of this approach would be the native flora that has been identified and what a change of water regime may mean for this species, and there is no defined outlet channel that links back within the Werribee River. It is recommended that prior to development a hydraulic study and Master Plan for the gully is developed that considers these issues.

The Master Plan should identify the desired hydrology outcome for the asset (volume, timing and flow duration) and the catchment hydraulic study should give guidance on the design of the stormwater system to achieve the objective.

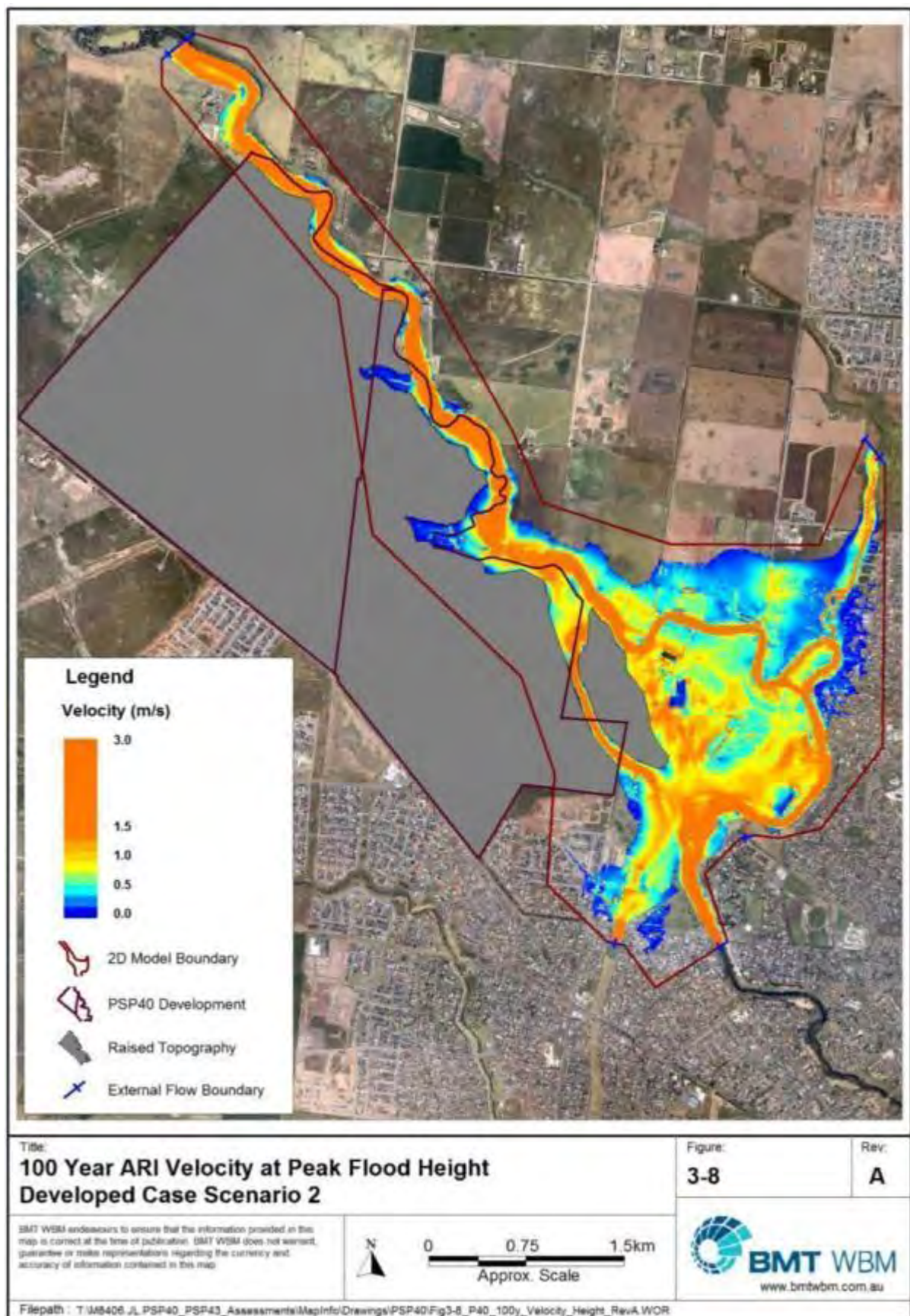


Figure 11. Developed Case Scenario for Werribee River (100 year ARI velocities)

2.3 Wetland Values (PSP92)

An investigation into the ephemeral wetland in PSP92 was undertaken by Australian Ecosystems. They found no significant indigenous vegetation communities. Evidence of heavy grazing through extensive pugging was observed throughout the wetland area (Figure 12).

The site assessment found no patches of remnant wetland vegetation (where indigenous vegetation comprises greater than 25 percent of the ground cover), which correlated with 2005 DSE EVC mapping, and mapping presented in the *Biodiversity Assessment Report (Native Vegetation) PSP 40: Wyndham Australian Ecosystems DRAFT Wetland and Riparian Biodiversity Values of Wyndham Vale Precinct* (GAA, 2010).

As such the wetland currently has no environmental values that would be considered important from a development impact perspective.



Figure 12. Degraded ephemeral wetland located in PSP92.

2.4 Werribee corridor values (PSP92)

Werribee River is the major watercourse of the Werribee River Catchment and provides an important link between various remnant wetland and riverine habitats, and numerous terrestrial habitats, which range from Shrubby Foothill Forest and Healthy Dry Forest in the catchment's north to Plains Grassy Woodland, Plains Grassland and Treeless Private Land in the south.



Figure 13. Werribee River riparian frontage.

The proposed corridor along the Werribee River would provide connectivity through the landscape and has been identified as a *strategically important habitat area* for Growling Grass Frog (*Litoria raniformis*) (DSE, 2011c).

The importance of connectivity between wetlands in the landscape for movement of Growling Grass Frogs and indeed other species of frogs, and biota in general, is well documented. A key document guiding the protection of the species is the federal government's *Draft EPBC Act Policy Statement 3.14: Significant Impact Guidelines for the Vulnerable Growling Grass Frog (Litoria raniformis)* (DEWHA, 2009: p. 10). It states that a significant threat to Growling Grass Frog is the "permanent removal or degradation of terrestrial habitat – for example, between ponds, drainage lines or other temporary or permanent habitat – within 200 metres of a water body in temperate regions [such as the Werribee River study area], that results in the loss of dispersal or overwintering opportunities for an important population."

The area is considered suitable habitat for Growling Grass Frog, including the provision of dispersal and breeding. Generally Growling Grass Frog terrestrial habitat includes grasslands, woodlands and areas of improved pasture, comprising vegetation (tussocks and grasses), rocks, logs, soil cracks and other ground debris.

The inspection of the river showed that the current state consists of remnant vegetation of moderate quality, comprising structurally intact Floodplain Riparian Woodland (EVC 56), occupied a riparian zone, ranging

between, approximately, 40 and 60 m wide through the study area. Beyond this point although the quality and extent of the Floodplain Riparian Woodland rapidly deteriorates, the predominantly treeless vegetation still does provide habitat value for Growling Grass Frog populations; for example, dispersal, foraging and overwintering opportunities. Generally there are no major natural or manmade barriers along the study reach that would be a major obstacle to prevent the Growling grass frog from accessing these areas. It should be noted that in some specific locations there are existing dwellings that would fall within the 200m setback distance.

Any habitat buffer zone of Werribee River is better considered as an unobstructed habitat corridor for the protection and potential enhancement of Growling Grass Frog populations and other frog species. There are some existing dwellings that fall within this area that obviously would not comply with any new habitat requirements.

The maps produced in this document have an indicative frog habitat setback as recommended from the existing Draft EPBC Act Policy Statement 3.14. However DSE has recently released a document titled 'Sub-regional Species Strategy for the Growling Grass Frog, Draft for Public Consultation'. We expect that at the end of this consultation the habitat setback will change. We recommend that GAA consider the indicative setback requirements for the Werribee Corridor in this document.

2.5 Waterway setbacks

Melbourne Water has developed **draft** guidelines on setbacks from waterways for the land development industry that apply to Melbourne Water existing waterways. Flood depths and constructed waterways define as having a catchment greater than 60 ha. Wyndham City Council shall determine setbacks for constructed waterways with a catchment smaller than 60 ha. The Melbourne Water guidelines are currently still progressing through an extensive consultation process.

These guidelines are considered to be Best Practice and as such have been used to guide the recommendations in this report. Please note that the extraction of detail from Melbourne Water has been an evolutionary process and we have attached the correspondence paper trail which presents the dialogue with Melbourne Water on this issue. This is provided in Appendix C of this report.

The draft setback guidelines divide the requirements into two separate categories; Setbacks for Existing Waterways, and Setbacks for Constructed Waterways. This is discussed in detail below.

Existing Waterway Setbacks

Based on the draft guidelines, the setback that applies to an existing waterway at a particular location depends on the position of the site in the stream channel network. The underlying principle is that smaller waterways require a smaller setback to meet the objectives for setbacks, larger streams require a larger setback and major waterways require the largest setback.

The Strahler stream ordering system is used to define a particular location in the stream channel network. The Strahler stream order is a simple method of defining stream size based on a hierarchy of tributaries. A small stream with no tributaries is defined as a first order stream. When two first order streams come together, they form a second order stream. When two second order streams come together, they form a third order stream. Streams of lower order joining a higher order stream do not change the order of the higher stream. So if a first order stream joins a second order stream, it remains a second order stream.

The Melbourne Water system uses the terms Core Riparian Zone (CRZ) and Vegetated Buffer (VB). The CRZ riparian zone is fully vegetated with native vegetation and provides the main river health and biodiversity functions of the riparian buffer. It is the area immediately adjacent to the waterway and provides the shading, nutrient and wood inputs to the stream required for healthy instream ecosystem function.

The VB protects the CRZ from edge effects that will impact on vegetation and fauna in the CRZ. These edge effects generally include; weed invasion from adjacent areas, light penetration, micro-climate changes, litter/pollution and trampling.

Under the Melbourne Water system the setback is measured from the physical top of bank. This is defined as the point at which the waterway channel and floodplain meet. In many instances it is straightforward to identify as there is a clear change in slope between the steeper channel bank and the flatter floodplain.

For all waterways (regardless of size) there is a 10 m wide VB running immediately adjacent and parallel to the CRZ. On top of this minimum requirement the stream order is then used to define the setback that applies to an existing waterway within a development site.

The three categories of setback width are assigned to stream orders as follows:

- First and second order streams have a minimum 20 m setback on both banks
- Third order streams have a minimum 30 m setback on both banks
- Fourth order and greater streams have a minimum 50 m setback on both banks

An example of how this applies to the Werribee River is discussed below and shown in Figure 16.

Constructed Waterway Setbacks

The draft guidelines define the required waterway corridor width for constructed waterways as the hydraulic width of the main channel of the waterway plus an additional waterway corridor width, which is made up of the CRZ and VB sub- zones. Hydraulic width is defined as the width of the water surface in metres at the 100-year ARI flow level in the channel.

The draft waterway corridor widths are scaled based on catchment size. This is consistent with the underlying principle that smaller waterways, which carry smaller flows, require a smaller setback to meet the objectives for setbacks. Larger streams carry more flow and will require a larger setback and major waterways require the largest setback in order to meet both hydraulic and ecological objectives.

The sub-zones have different roles in meeting the overall setback objectives and different activities and infrastructure requirements, as described for existing waterways above. The waterway corridor widths and sub-zone widths for a range of hydraulic widths in constructed waterways are shown in Table 1.

Table 1. Sliding scale for calculating constructed waterway corridor widths

100 yr ARI Hydraulic width (m)	Additional waterway corridor width required (m)	Total waterway corridor width required (m)	CRZ width included in total corridor width (m)	VB width included in total corridor width (m)
5	20	25	20	0
10	20	30	20	5
15	20	35	20	10
20	20	40	25	10
25	20	45	30	10
30	20	50	30	15
35	15	50	30	15
40	10	50	30	15
45	5	50	30	15
50	0	50	30	15
55	0	55	30	20
60	0	60	35	20
65	0	65	40	20
70	0	70	45	20

Opportunities within setbacks

Although the definition of the core riparian and vegetation buffer zones are clear in the Melbourne Water guidelines, there perhaps is still some interpretation on the ability to locate assets in these areas. Alluvium engaged with Melbourne Water to document their view of what activity may be able to take place within the setback area. Alluvium did speak to Wyndham City Council about capturing their input to this table, however and despite multiple attempts to gather feedback, none was forthcoming. Table 2 provides Melbourne Water's feedback on preferred activity within the setback areas.

Table 2. Melbourne Water and Wyndham Council feedback

Questions raised by GAA	Melbourne Water
Will there be a need for a vehicle access path for waterway maintenance activity along the Werribee River?	No
Will there be a need or a shared access path?	No. However if there is a shared path it should be constructed to allow vehicle use
Can the shared access path be located within the setback?	Wherever possible, shared pathways should also be located outside the CRZ and should meet the standards defined in Shared Path Guidelines (available on the Melbourne Water website). While Melbourne Water has a strong preference for the assets and features listed above to be wholly located outside of the CRZ partial placement of assets within this zone will be considered in situations where this is not possible or where a clear benefit to the community and/or environmental health can be demonstrated.
Is there need for passive open space?	No specific feedback on this from Melbourne Water
Is there the ability to locate water treatment assets in the reserve?	Stormwater treatment systems such as constructed wetlands and bioretention systems can be located within the CRZ but should form a relatively small proportion of the area of the CRZ so as not to degrade its ecological function.
Is there the ability to locate playgrounds or other community assets in the reserve?	Sports ovals, playgrounds, and maintenance tracks should also be located outside the CRZ, as they may create a barrier to faunal movement, despite being vegetated.
Is there the ability to locate major canopy trees in the reserve (based on EVC map)?	If the proposed revegetation is based on native, indigenous EVC listed species and densities Melbourne Water would review the planting schedule and placement for the specific site. Generally however the re-establishment of native vegetation for habitat purposes is encouraged.

Werribee River setback requirements

The Werribee River is a large major waterway, with a catchment greater than 60 ha and Strahler stream order of 4 or greater. It is important for flood conveyance and flora and fauna habitat. There are three considerations for the setback to the Werribee River.

- Flood extent – The 100 year ARI will determine the land subject to inundation and hence setback to constructed assets
- Melbourne Water Draft Setback Guidelines – The guidelines produced by Melbourne Water provide for an overall setback width of 50 m, containing a CRZ width of 40 m and VB of 10 m, and
- Growling Grass Frog which indicates the need for a 100 m for a Growling Grass Frog terrestrial habitat zone (from the normal water surface level) and another 100 m as an adjacent buffer zone.

The spatial layouts of these requirements are provided in Figure 14 and Figure 15. In the upstream area of the study area, the Growling Grass Frog sets the main setback requirement, while downstream the flood extent is the main factor in setting the setback. Generally the Melbourne Water setback matches in with the 100 year ARI flood extents.

Based on the 100 year ARI flood extent, Melbourne Water Guidelines, Growling Grass Frog requirements and further feedback from Melbourne Water and Council regarding use of land in setback areas, Alluvium has provided a conceptual cross section of the setback requirement for the Werribee River (Figure 16).

Werribee West Drain setback requirements

The Werribee West is a small waterway with no waterway values and has a catchment greater than 60 ha. The setback requirement is dictated by the 100 year ARI hydraulic width (approximately 45 m) and the draft Melbourne Water Setback Guidelines, which stipulates an additional 5 m waterway corridor width that includes a 30 m CRZ and 15 m VB. The spatial layout of these requirements is provided in the conceptual cross section provided in Figure 17.

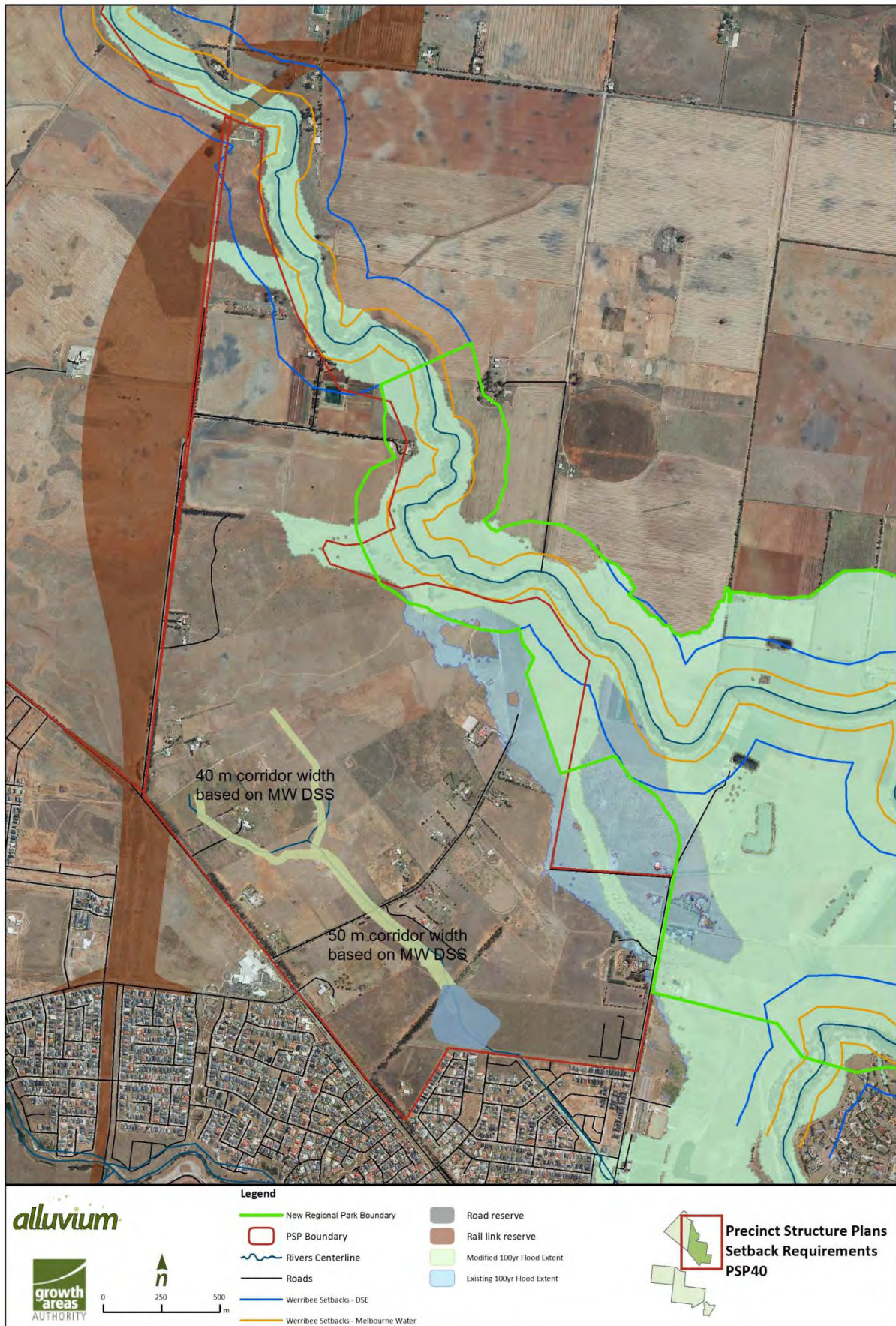


Figure 14. Werribee River PSP40 setback requirements.

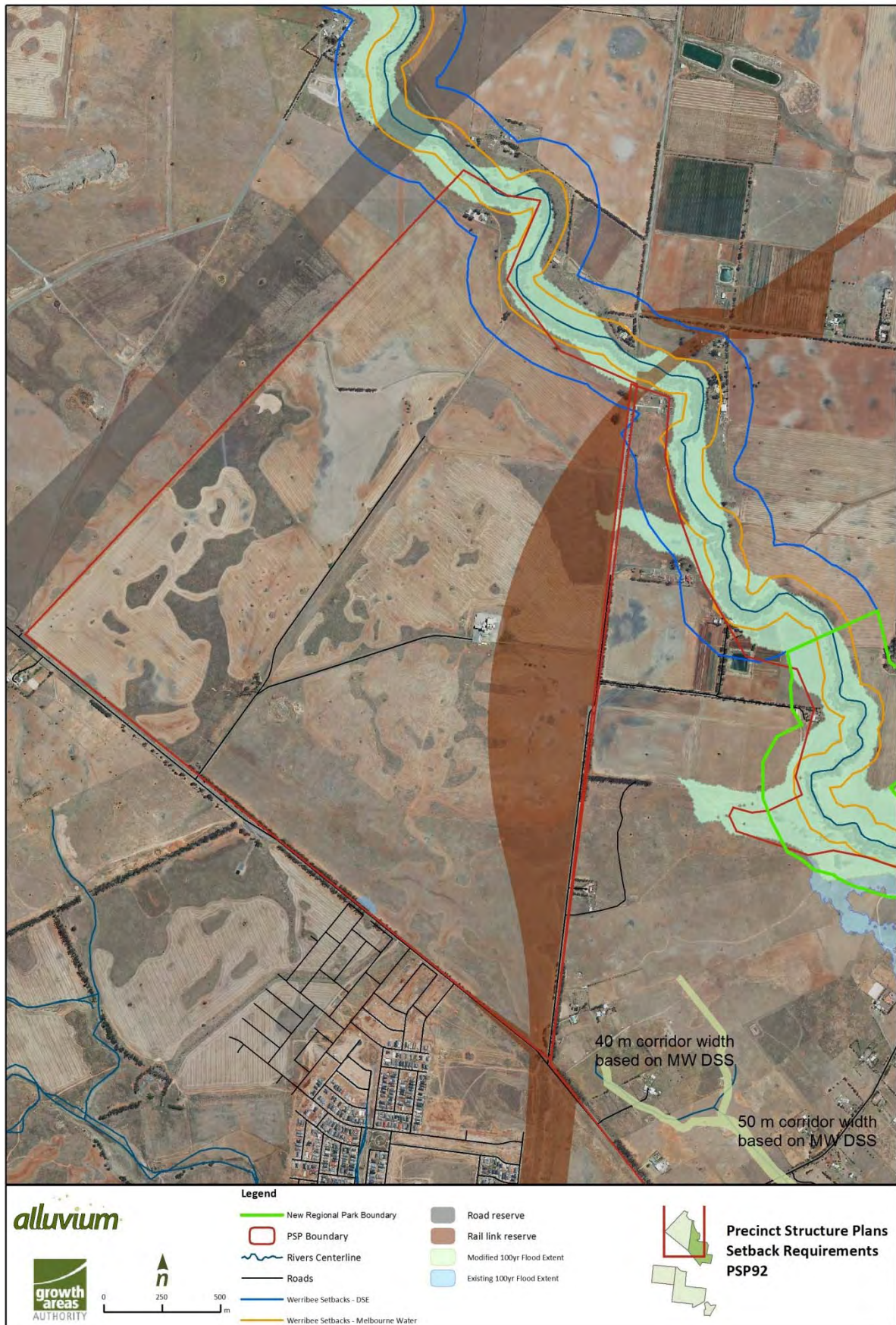


Figure 15. Werribee River PSP92 setback requirements

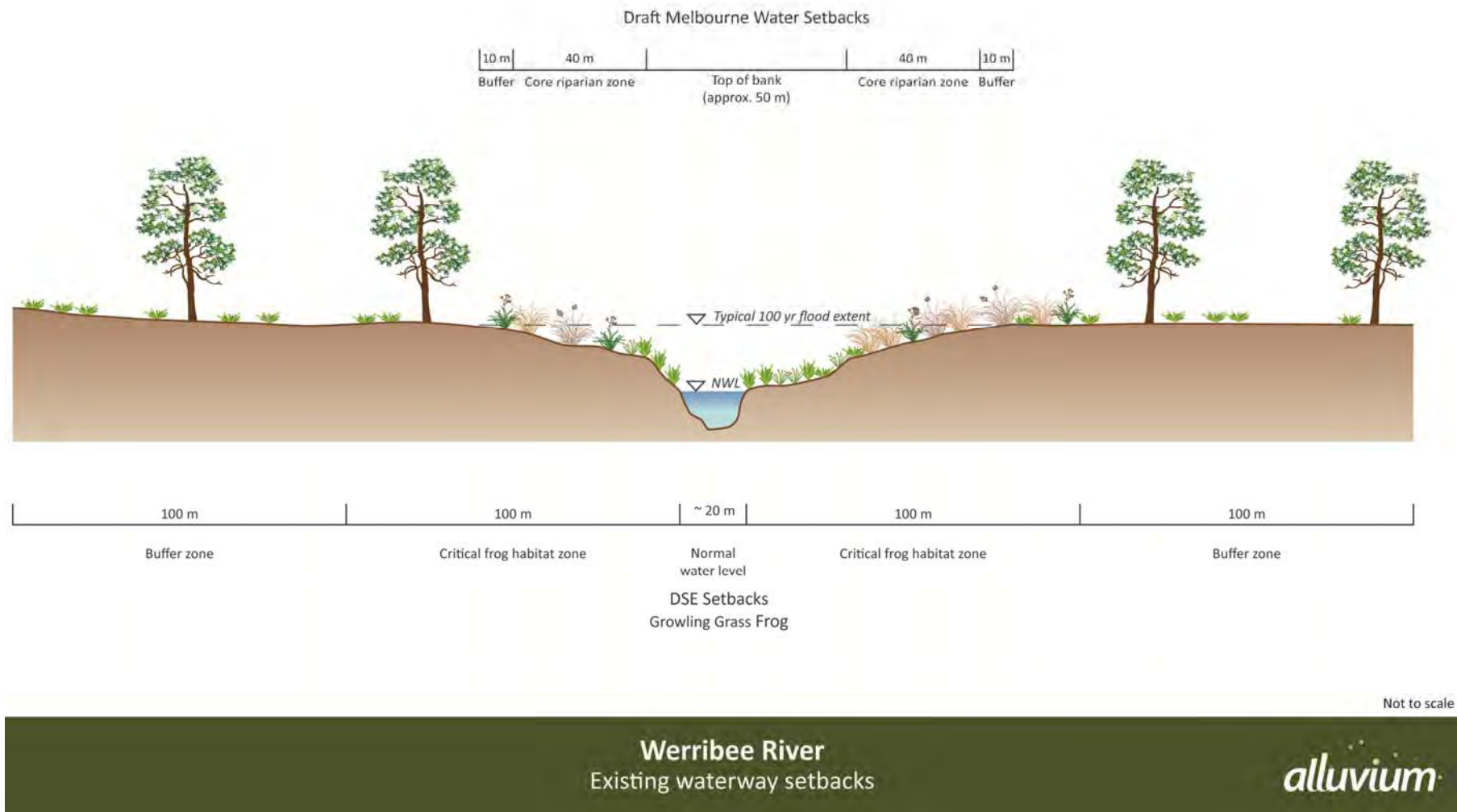


Figure 16. Conceptual cross section for Werribee River setback

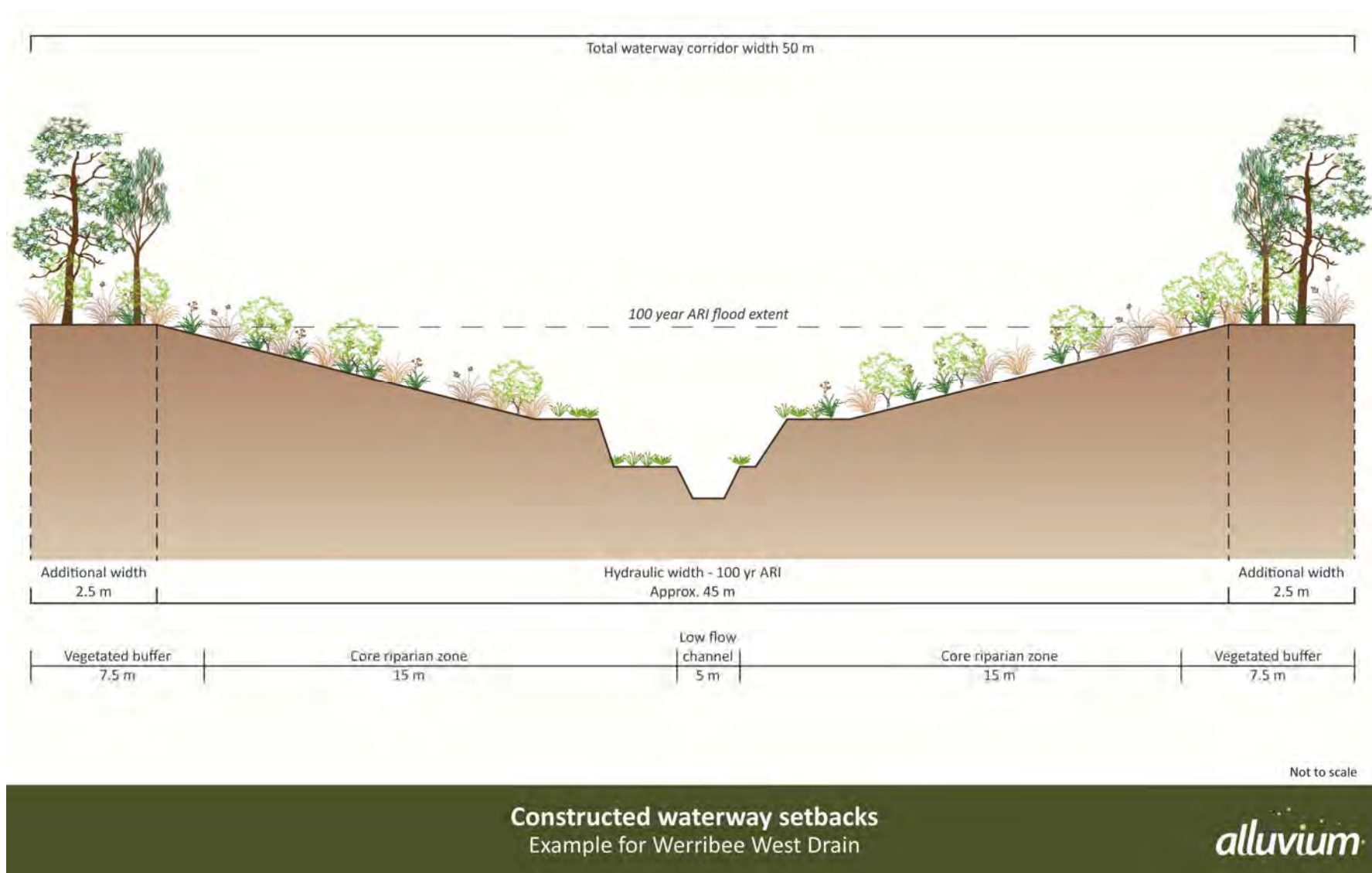


Figure 17. Conceptual cross section for Werribee West Drain

3 PSP42 North

Investigation of the PSP42 North area incorporates:

- Determine drainage reserve widths
- Solution to integration of Phileo and Stella's properties, and
- Provision of a typical cross section that communicates the shape and indicative dimensions of the conveyance channel, batter slopes, vegetation (species structure) and other assets.

3.1 Drainage solution for Phelio and Stella's property

Alluvium was asked to investigate the potential to better manage the treatment of surface water when the Phelio and Stella properties were considered together rather than individual drainage solutions. We discussed the drainage options with Breeze Pitt Dixon who are engaged by Stella as the principle development engineers. Both Alluvium and Breeze Pitt Dixon believe the most sensible outcome is to bring all the stormwater into Stella's property and locate a large regional wetland in the degraded depression. This option has also been discussed with Melbourne Water and it is their preferred option also.

The combined catchment area would result in a wetland approximately 4.2 ha in size and would need to be located in an area of the depression that currently have no environmental values. The wetland design should first and foremost be focused on achieving water quality objectives, but in addition the design should consider how best it could replicate the original EVC (where appropriate) and provide suitable habitat for Growling Grass Frog (where appropriate). Figure 18 provides an overall conceptual layout of the catchment area and location of the wetland.

3.2 Specific Setback requirements

There is a small unnamed tributary of Lollypop Creek running through PSP42 North. The tributary has been heavily degraded through agricultural practices, has limited waterway values and has a catchment greater than 60 ha. As such the setback requirement is dictated by the 100 year ARI hydraulic width (approximately 35) and the draft Melbourne Water Setback Guidelines, which stipulates an additional 15 m waterway corridor width that includes a 30 m CRZ and 15 m VB.

The spatial layout of these requirements shown in Figure 18 and the conceptual cross section provided in Figure 19.

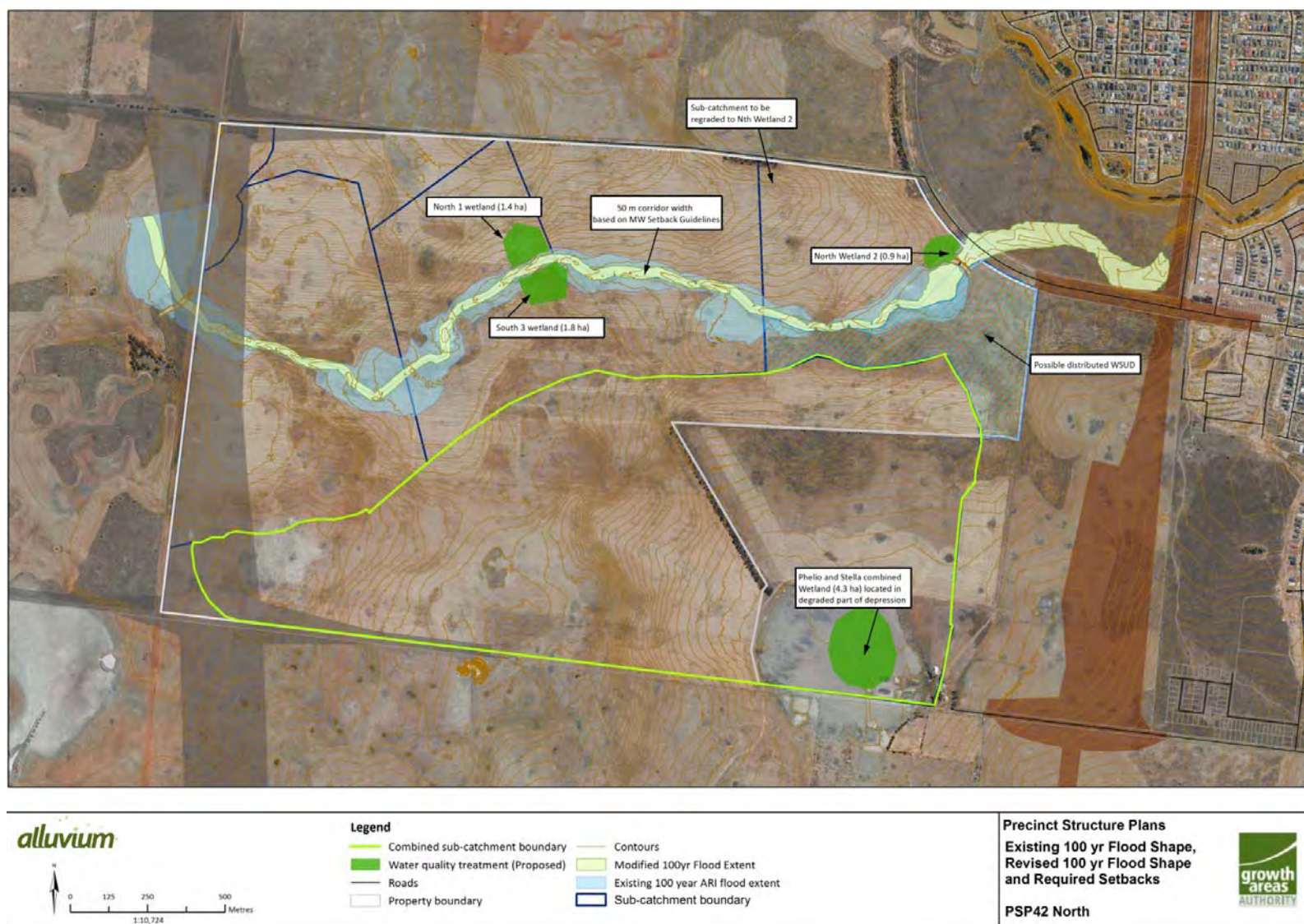


Figure 18. PSP 42 North surface drainage plan

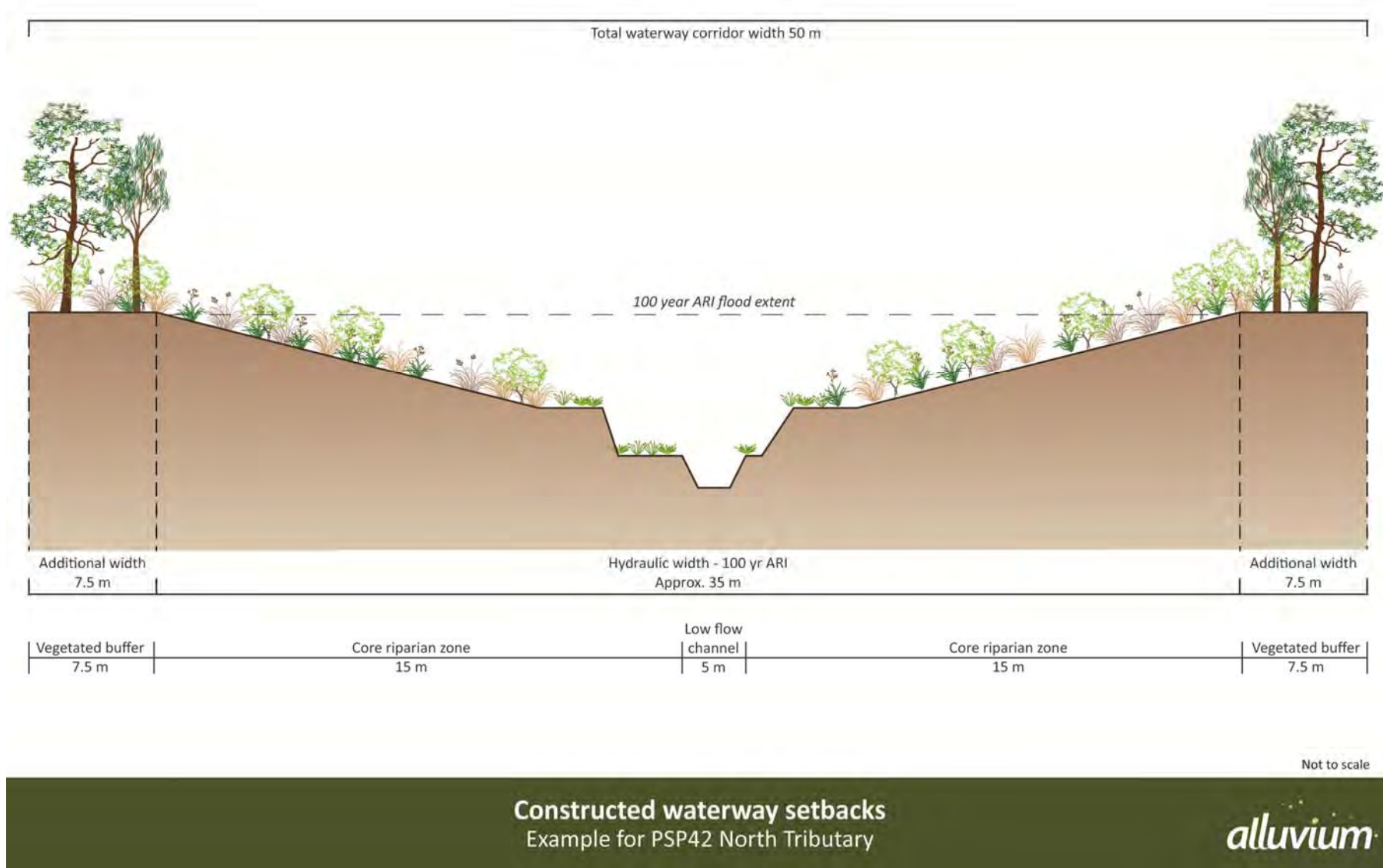


Figure 19. Conceptual cross section for unnamed tributary (PSP42 North)

4 PSP42 South

Investigation of the PSP 42 South area incorporates:

- Definition of drainage reserves and setback required for waterways in PSP42 South.

4.1 Specific Setback requirements

Lolly Pop Creek (including Black Swamp) as well as a small unnamed tributary of Lollypop Creek, runs through PSP42 South. The tributary has been heavily degraded through agricultural practices and has limited waterway values. Lollypop Creek itself has some high value vegetation including the Black Swamp area.

As the Lollypop Creek waterway is second order stream the setback requirement will be dictated by the 100 year ARI flood extent and Melbourne Water guidelines which stipulates a 20 m setback, incorporating a 10 m CRZ and 10 m VB. The spatial layout of these requirements is provided in Figure 20 and conceptual cross section provided in Figure 22.

As the unnamed tributary has a catchment greater than 60 ha, the setback requirement is dictated by the 100 year ARI hydraulic width (approximately 35) and the draft Melbourne Water Setback Guidelines, which stipulates an additional 15 m waterway corridor width that includes a 30 m CRZ and 15 m VB. The spatial layout of these requirements is provided in the conceptual cross section provided in Figure 22.

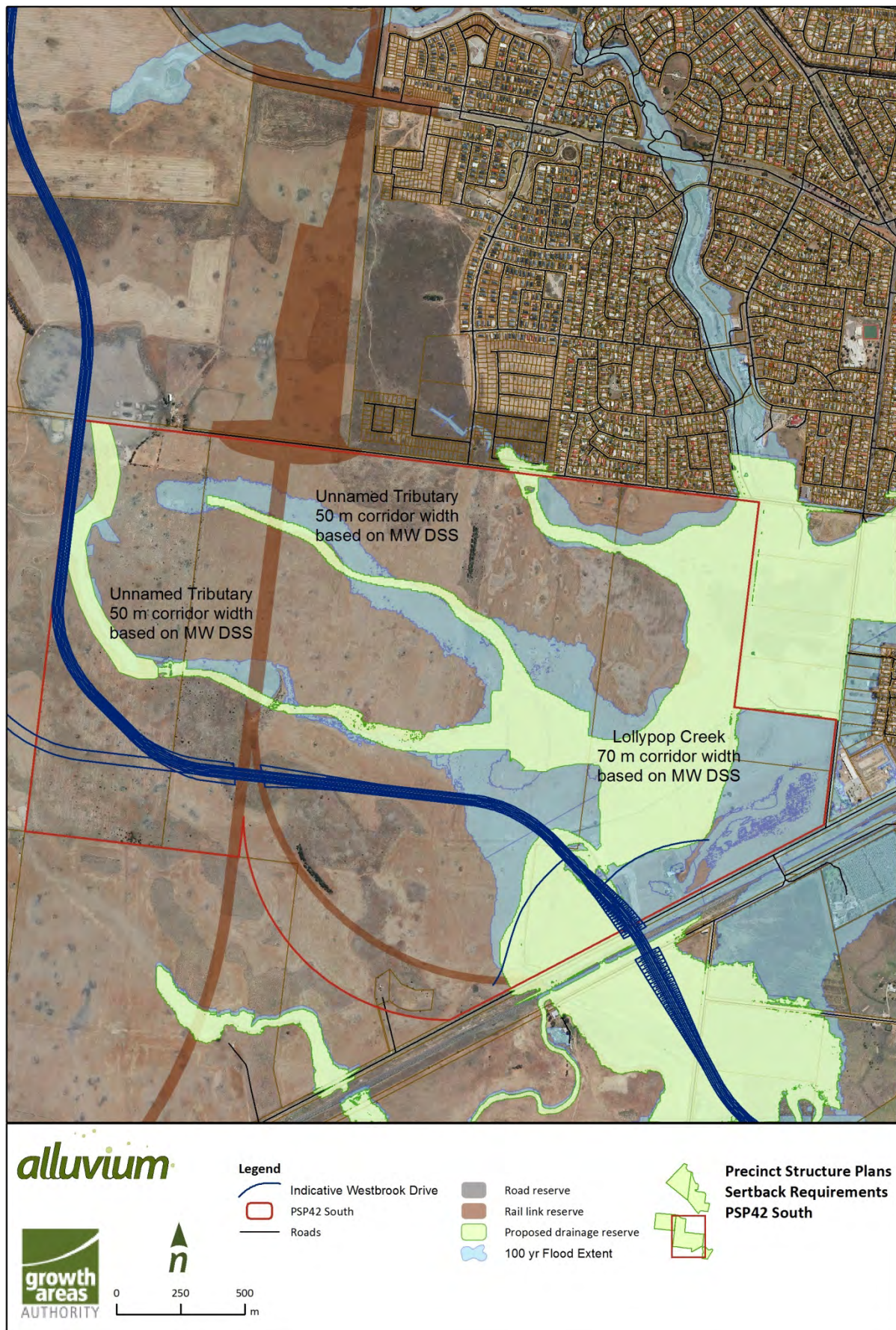
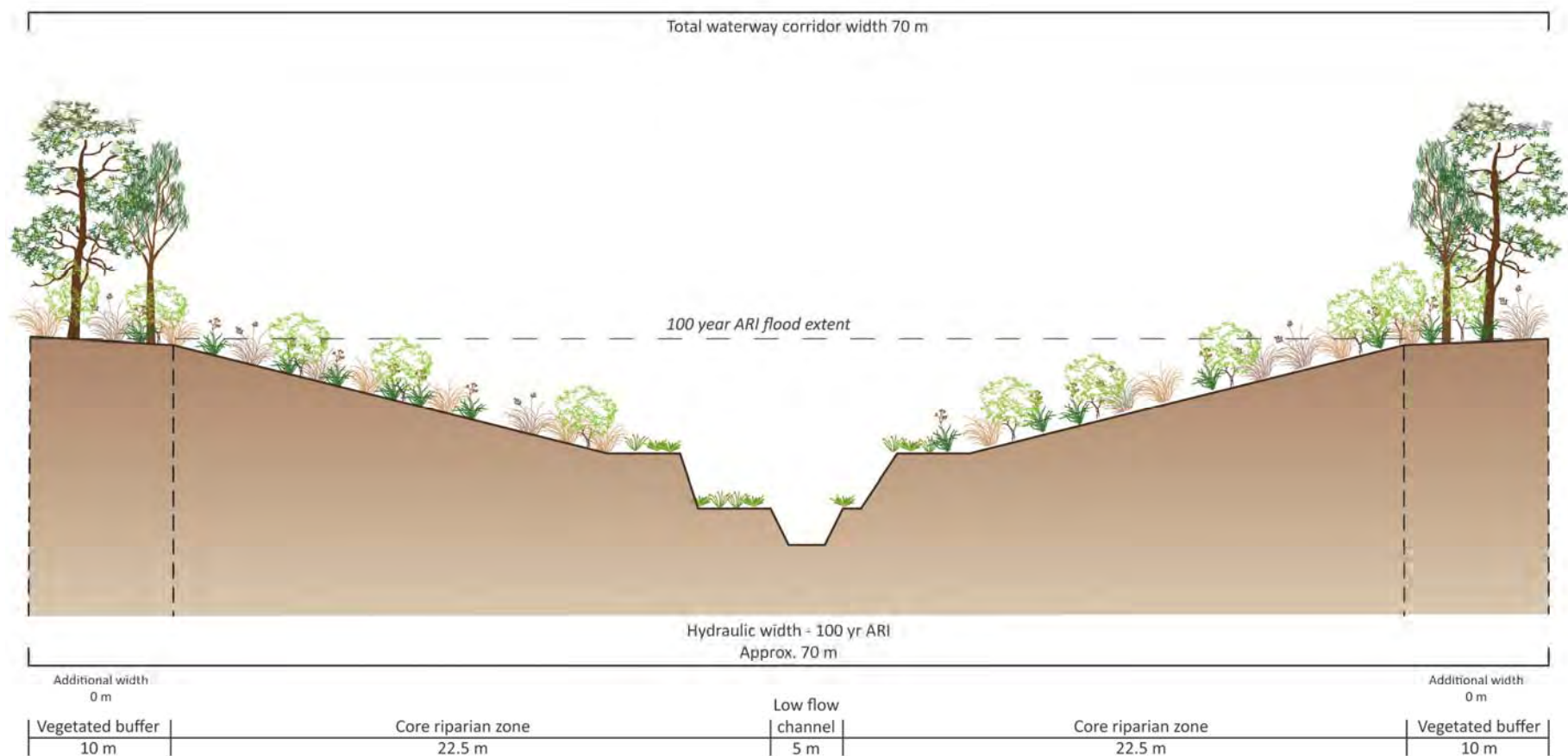


Figure 20. Spatial layout of setbacks required in PSP 42 South



Not to scale

Constructed waterway setbacks Example for Lollypop Creek

alluvium

Figure 21. Conceptual cross section for Lollypop Creek (PSP42 South)

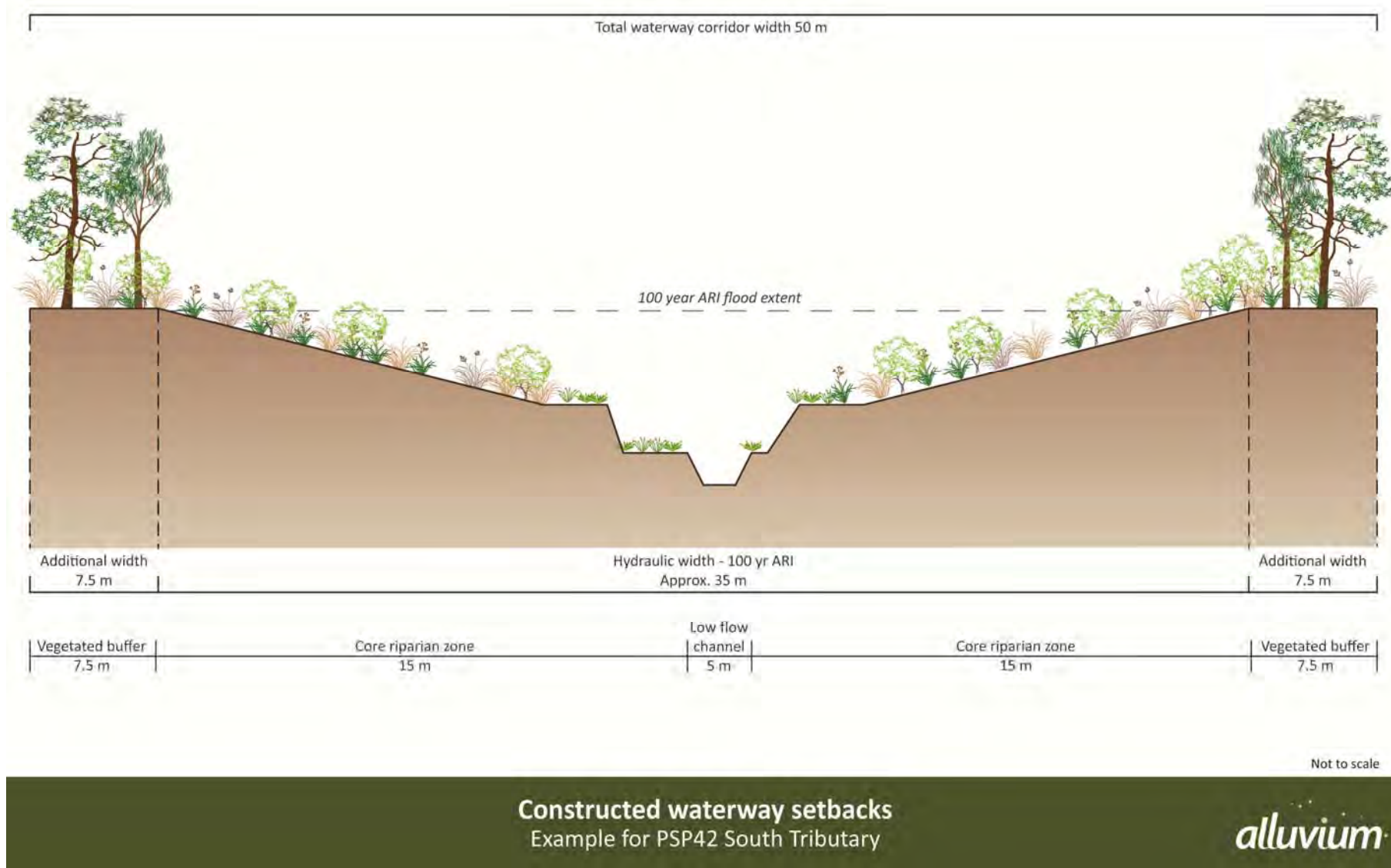


Figure 22. Conceptual cross section for unnamed tributary (PSP42 South)

5 PSP 43

There was one task s undertaken in PSP 43 East and included;

- Development of a 100 year ARI model for Lollypop Creek and optimisation of land for development (Section 6.1)

5.1 Develop 100 year ARI models for PSP43 East

Modelling of the 100 year ARI flood extents for Lollypop Creek in the vicinity of PSP43 under both existing and proposed developed conditions were undertaken by BMT WBM to determine the flood impacts associated with future development and the range of possible fill scenarios.

A 2D/1D dynamically linked TUFLOW hydraulic model of the study area was developed to assess the flooding conditions under both the existing and developed scenarios. Hydrology input into the TUFLOW hydraulic model was based on a RORB model of Lollypop Creek obtained from Melbourne Water.

The hydraulic model was designed to cover the section of the Lollypop Creek floodplain that could potentially be influenced by the development of the PSP43 site. The area modelled extended sufficiently upstream and downstream from the site to minimise boundary effects and ensure adequate representation of the floodplain storage. This included modelling of the proposed Delfin development in PSP42 South, Melbourne Water drainage scheme proposed 100 year ARI drainage channel through PSP43, the Princess FWY to the south and Melbourne-Geelong Railway to the north.

LiDAR data obtained from the GAA and Melbourne Water was combined to form a digital elevation model (DEM) of the study area for input into the TUFLOW model. The Delfin proposed fill platforms and Melbourne Water drainage scheme channel was added into the DEM to represent the developed scenario.

To determine the area of potential development the DEM was further modified to include fill platforms that would effectively stop sections of land in PSP43 from being inundated by floodwaters. The model was run for various fill platform scenarios with the preferred scenario based on an acceptable flood level increase of 0.05 m. This is generally in line with acceptable impacts by Melbourne Water standards. However, this should only be used as a guide and will need to be more accurately assessed on an individual development basis. The hydraulic modelling provides a preliminary assessment of what could potentially be achieved.

The results from the hydraulic analysis undertaken for PSP43 are presented on a series of maps on the following pages. Flood extent maps showing the flood extent under existing and developed conditions are presented in Figure 23, whilst the flood impacts associated with the development scenarios are presented in the full modelling report contained in Appendix B. Figure 24 provides flooding depths under the proposed conditions for the Lend Lease works and existing conditions within PSP43.

The results from this analysis show that the development of the PSP43 region (Figure 23) will result in some minor impacts to the west of the site. However, these impacts are located within farm land and do not extend north of the Melbourne-Geelong railway or south of PSP43 and affect the Princess Freeway. The development scenario represents a gain an extra 18.5 ha of developable land within PSP43 and extra 16 ha of land to the northwest outside of PSP43 that would have previously been flood affected. As majority of the flooding through PSP43 is dealt with by improved drainage in the Delfin property and the constructed waterway within PSP43 itself there is only a small section of fill required on the south western boundary. This would require approximately 0.5 m (average varies – not including freeboard) depth of fill, which equates to a volume of 18,000 m³ of fill.

When the PSP43 fill platform is extended further west, the flood impacts are slightly increased, although they still do not extend beyond the railway line to the north.

It is noted that Westbrook drive interacts with the flood shape and the design of Westbrook drive must be able to convey the 100 year ARI.

5.2 Specific setback requirements

As part of the Melbourne Water proposed drainage scheme for PSP43 a constructed waterway is to be built through the centre of the PSP43 area. The channel will have an upstream catchment area greater than 60 ha, and as such the setback requirement is dictated by the 100 year ARI hydraulic width (approximately 25) and the draft Melbourne Water Setback Guidelines, which stipulates an additional 20 m waterway corridor width that includes a 30 m CRZ and 10 m VB. The setback requirements are presented in Figure 23 and a conceptual cross section provided in Figure 25.



Figure 23 Existing and Developed Case Scenario for Lollypop Creek (100 year ARI Flood extent).

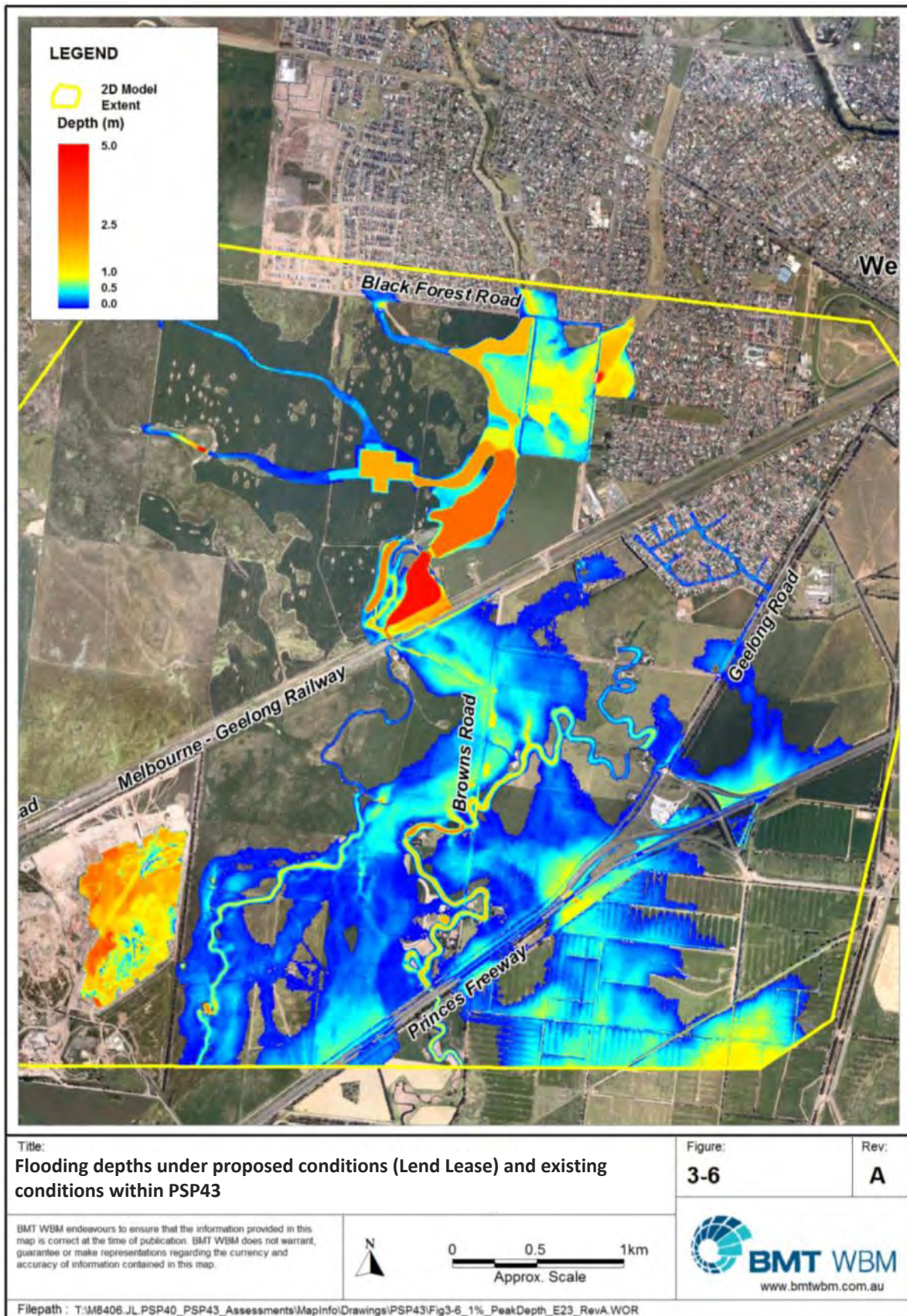


Figure 24. Flooding depths under proposed conditions for the Lend Lease works and existing conditions within PSP43 (extracted from Appendix A).

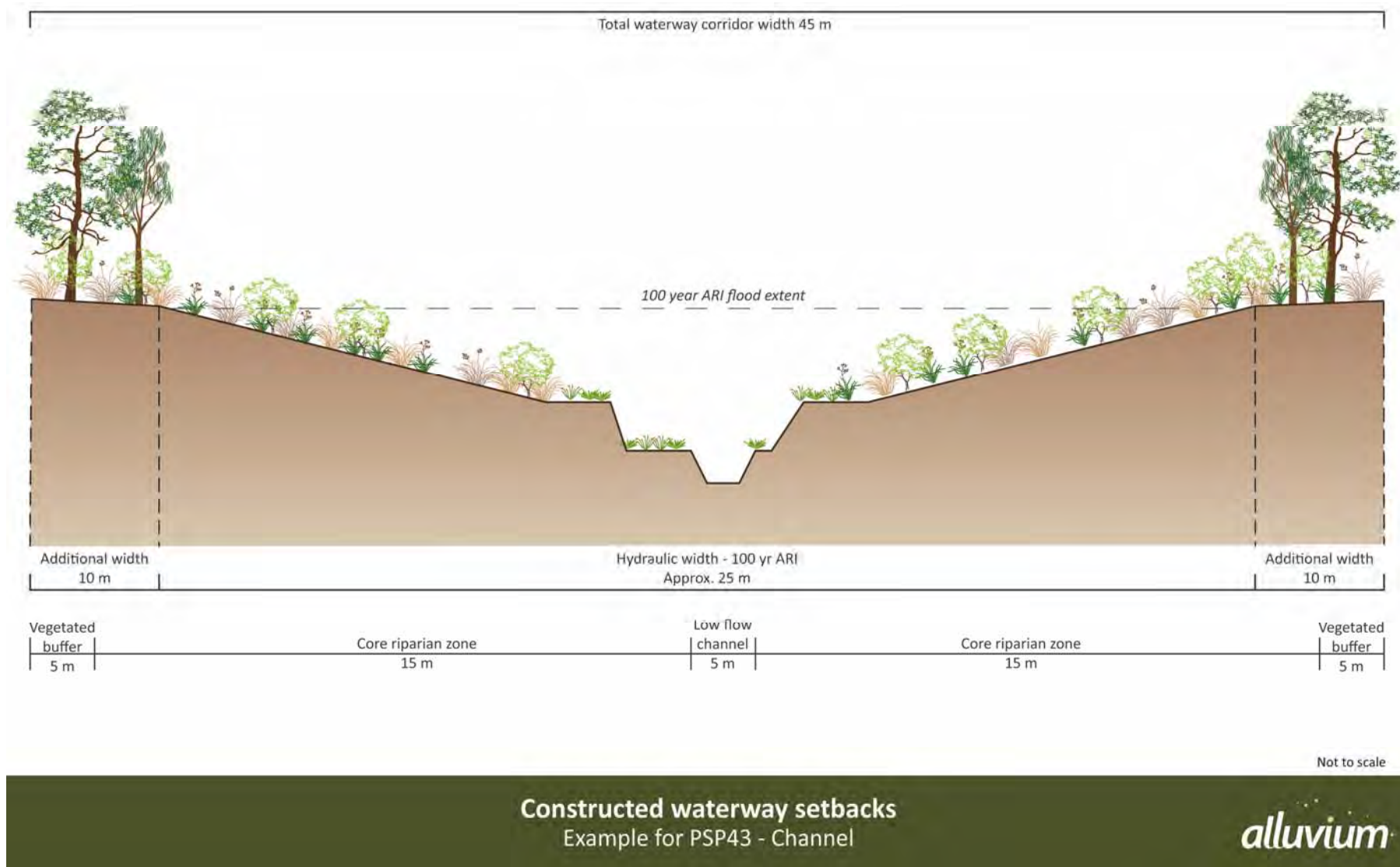
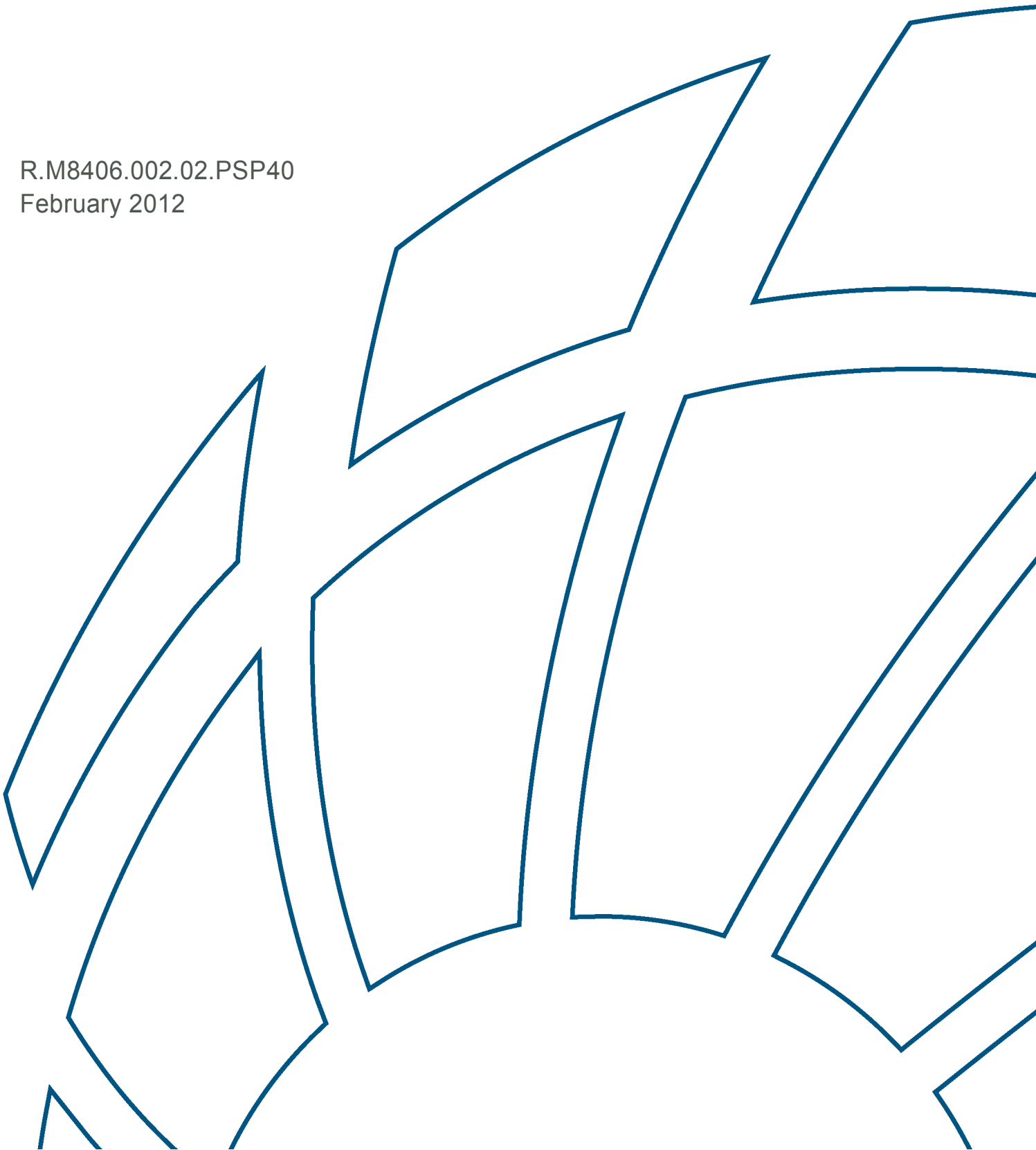


Figure 25. Conceptual cross section for constructed channel (PSP43)

Appendix A. PSP92 and East modelling report

PSP40 Hydraulic Assessment Final Report

R.M8406.002.02.PSP40
February 2012



PSP 40 Hydraulic Assessment Final Report

Prepared For: Alluvium

Prepared By: BMT WBM Pty Ltd (Member of the BMT group of companies)

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Project Manager :	Joel Leister										
Client :	Alluvium										
Client Contact:	Stuart Cleven										
Client Reference											

Title :	PSP40 Hydraulic Assessment
Author :	Joel Leister
Synopsis :	This report documents the methodology and results for the hydraulic assessment of PSP40.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY		ISSUED BY	
0	02/12/2011	DR		JGL	
1	23/12/2011	DR		JGL	
2	15/02/2012	PAP		JGL	

DISTRIBUTION

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1 INTRODUCTION

1.1 Background

BMT WBM Pty Ltd (BMT WBM) was commissioned by Alluvium Consulting Pty Ltd (Alluvium) to assess the flood impacts of the proposed precinct structure plan known as PSP40 in a section of the Werribee River floodplain.

PSP40 is one of several residential projects within the Wyndham growth area, which is administered by the Growth Areas Authority (GAA). As shown in Figure 1-1, PSP40 is located on the outskirts of Werribee which is approximately 40km west-south-west of Melbourne's CBD. Werribee River flows along the eastern boundary of PSP40.

The study area is currently rural or semi-rural land, functioning as open pasture and forms a significant volume of floodplain prior to Werribee River entering Werribee Township.

This report describes the development of the hydraulic model and presents the flood mapping for the PSP40 Assessment.

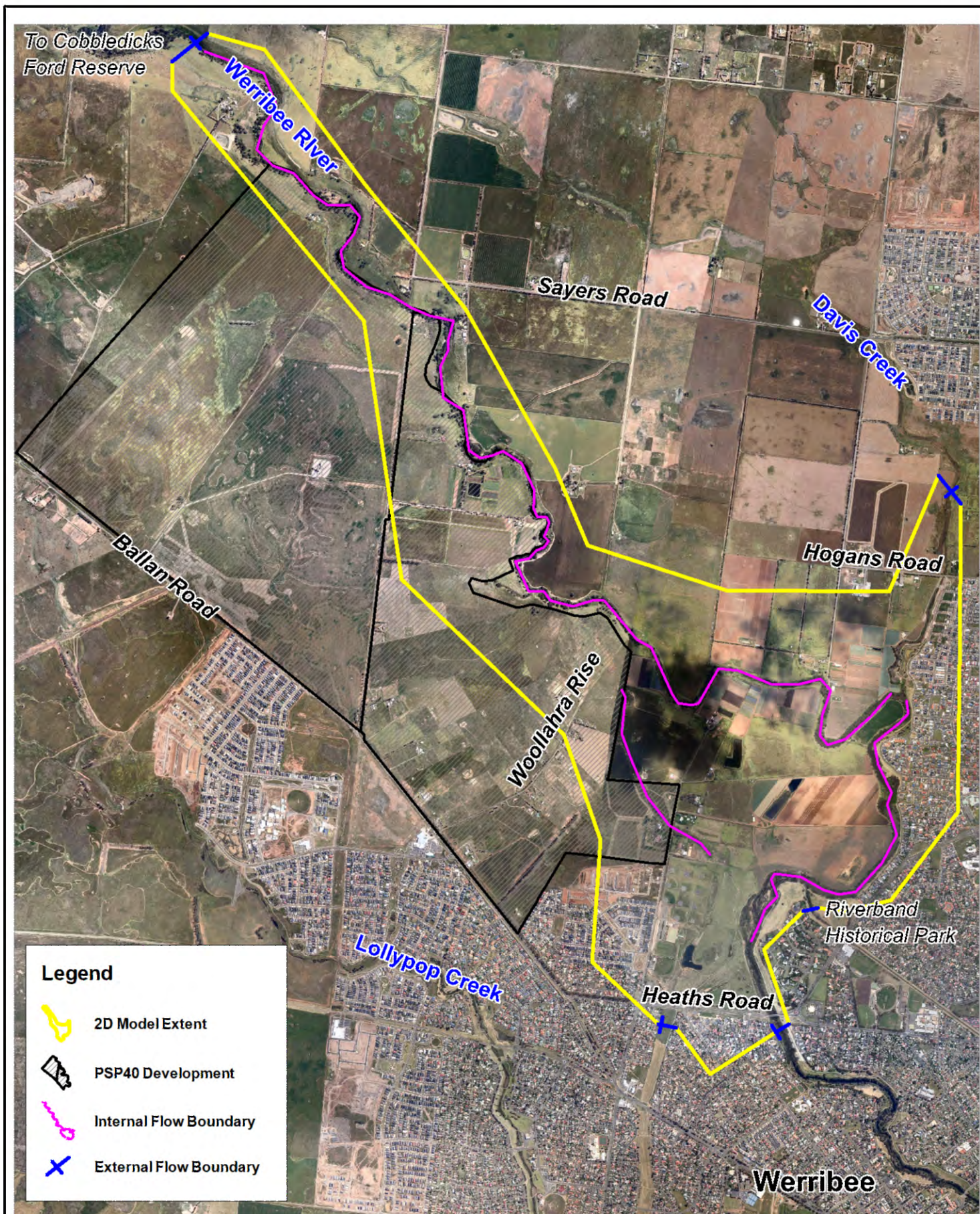
1.2 Study Area Description

The study area, as shown in Figure 1-1, includes approximately 11.6 km² of the Werribee River floodplain that is bounded by Heaths Road to the South, Ballan Road to the West and top of bank of the Werribee River to the East.

Upstream of Wollahra Rise, the Werribee River exists as a confined channel before opening into floodplain extending to Heaths Road. A former river channel exists on the western edge of the floodplain. Davis Creek is a tributary of Werribee River that enters the study area from the east and provides flow to the lower reach of the floodplain prior to Heaths Road.

1.3 Objectives

The objective of the study was to determine the 1 in 100 year ARI flood extents for the Werribee River in the vicinity of PSP40 under both existing and developed conditions and determine the flood impacts associated with this development.



Title:
PSP40 Assessment Model Schematisation

Figure:
1-1

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2 HYDRAULIC MODELLING

This section provides a description of the TUFLOW modelling process for the PSP40 Assessment. A 2D TUFLOW hydraulic model of the study area was developed to assess the flooding conditions under both the existing and developed scenarios.

Hydrographs for the 100 year ARI storm event with durations ranging from 10 minutes to 72 hours were provided by Alluvium from an existing RORB model. These hydrographs were applied as inflow boundaries to the hydraulic model and assumed to be accurate.

The following sections detail the development of the hydraulic model used to produce the flood mapping for the PSP40 Assessment.

2.1 Model Schematisation

The PSP40 Assessment model was schematised as a 2D TUFLOW model. The model was designed to cover the section of the Werribee River floodplain that could potentially be influenced by the development of the PSP40 site. The area modelled extended sufficiently upstream and downstream from the site to minimise boundary effects and ensure adequate representation of the floodplain storage.

The floodplain topography was represented within a 2D domain with an 8m grid resolution. This grid size was determined to accurately represent the study area for the purposes of this study, whilst maintaining a reasonable and practicable model run time. Elevation data was derived from the 1m gridded LiDAR data provided by the Growth Areas Authority to Alluvium.

Details of the model setup and application are described in the following sections and shown in Figure 1-1.

2.2 TUFLOW Version

Model runs were simulated using the 2010-10-AF-iDP-64 build of TUFLOW. The nature of the model necessitated the use of the 64 bit double precision version.

2.3 Design Event Modelling

The RORB model hydrographs identified the key inflows occurring in the 9 hour event and 36 hour event for Davis Creek and Werribee River respectively. To ensure the hydraulic model represented the peak flood event, the 6, 9, 12, 30, 36 and 48 hour durations were run, to allow for any routing and storage within the floodplain.

2.4 Model Extent

The TUFLOW model domain extends to just south of Cobbledicks Ford Reserve on Werribee River to the North and to Heaths Road on the outskirts of Werribee to the South. Davis Creek enters the model just above Hogans Road to the East of the study area.

2.5 2D Domain

The model domain is shown in Figure 1-1. The domain covers an area of approximately 11.6 km². The geometry of the 2D model was established by constructing a uniform grid of square elements. One of the key considerations in establishing a 2D hydraulic model relates to the selection of an appropriate grid element size. Element size affects the resolution, or degree of accuracy, of the representation of the physical properties of the study area as well as the size, and thus memory request, of the computer model and its resulting run times. Selecting a very fine grid element size will result in both higher resolution results and longer model run times.

The adopted 8m grid size resulted in approximately 200,000 grid elements and provided a good definition of topography and floodplain storage, whilst keeping run times to an acceptable length. Each square grid element contains information on ground topography sampled from the DEM at 4 m spacing as well as surface resistance to flow (Manning's 'n' value).

To maintain an acceptable Courant number, the 2D domain of the model was run on a 4 second time-step.

2.5.1 Significant Topography Features

Significant topographic features, such as road embankments that affect flood flows, should be incorporated into the 2D domain. Conversely, where the original data underlying the DEM is erroneous due to the procedure in which the data is collected and/or filtered, it is good practice to correct these issues.

The DEM created from the provided LiDAR data gave a good representation of the topographical features with the PSP40 study area. The overland drainage channel adjacent Riverband Historical Park required some modification to allow connectivity to Werribee River where the walking track crossing the channel did not allow conveyance of flow.

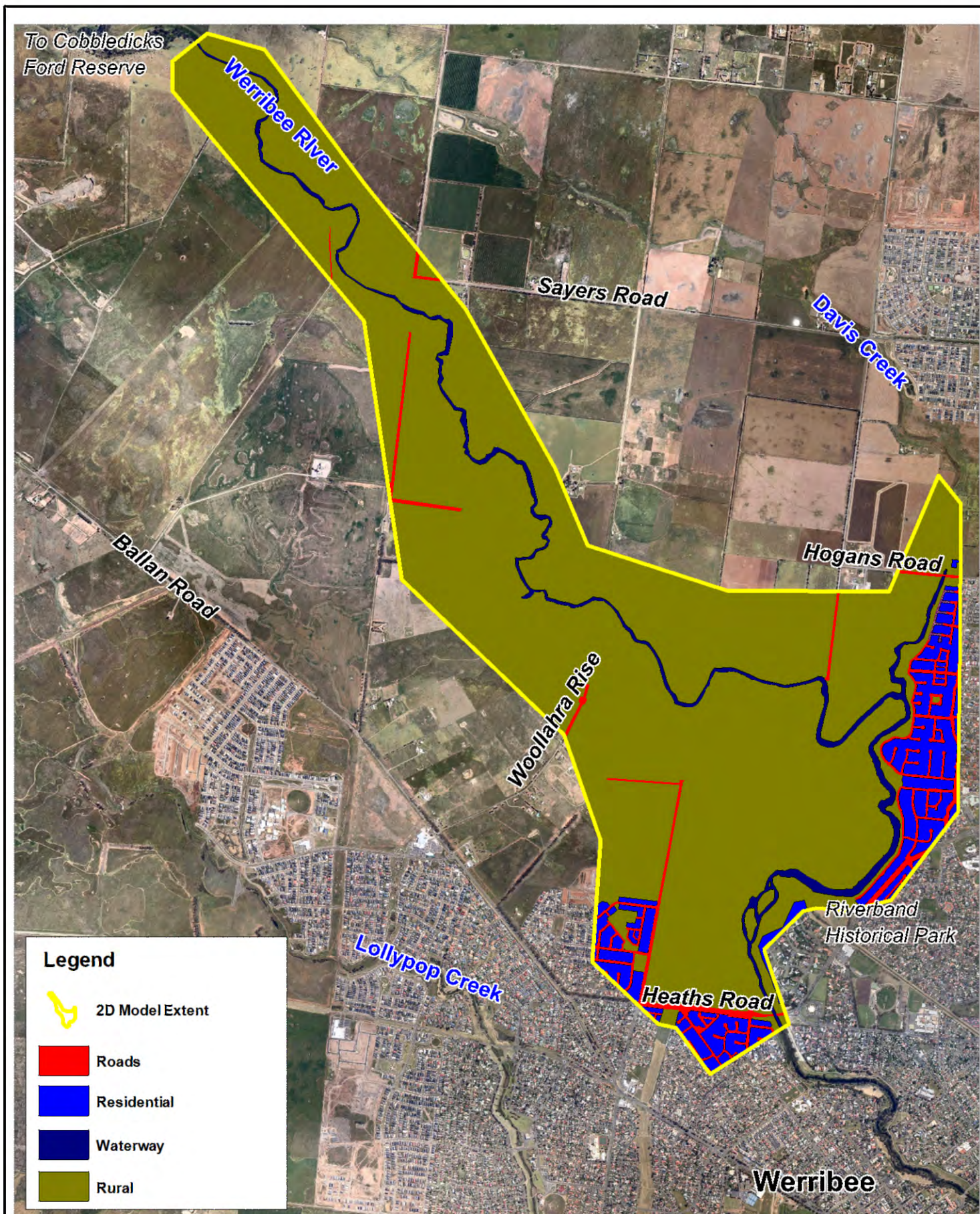
2.5.2 Roughness Layer or Manning's *n*

The roughness layer, or Manning's 'n' layer, was based on areas of different land-use type determined from aerial photography and the site inspection. The adopted Manning's 'n' values are summarised in Table 2-1 and the layer is shown in Figure 2-1. The values are based on those adopted in previous modelling of the region by Melbourne Water.

Table 2-1 2D Domain Manning's 'n' Coefficients

Land Use	Manning's 'n'
Roads	0.025
Residential	3.00*
Waterway	0.055
Rural	0.045

* Taken from a TUFLOW model provided by Melbourne Water



Title:
PSP40 Assessment Manning's Roughness Distribution

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2.6 Boundary Conditions

A hydraulic model requires the specification of inflow boundaries and outlet boundaries to allow water into and out of the model in a realistic manner. Often 2D hydraulic models will have external and internal inflow boundaries. The external inflow boundaries account for flow generated from outside of the model extents (external boundaries) whereas internal boundaries account for the runoff generated from, and to be applied within, the model extents. Flow is removed from the model through downstream boundaries, which are generally a fixed water level or a rating curve.

The PSP40 Assessment model had two inflow boundaries representing the Werribee River (at the North West limit of the model) and Davis Creek (the North East limit of the model). Downstream boundaries are located along the Southern extent of the model and are based on water surface slopes.

2.6.1 External Boundaries

The two main downstream flow boundaries was adopted from the prior Melbourne Water hydraulic model with the slope and rating curve assumed to be correct. The boundary on the open channel adjacent Riverband Historical Park was added to the model with slope determined from the average gradient of the channel at the boundary of the 2D domain.

2.6.2 Internal Boundaries

Internal inflow boundaries represent runoff occurring within the model bounds. For the PSP40 Assessment TUFLOW model, the internal boundaries were applied by distributing the flow directly into the 2D domain as appropriate, to represent the catchment contained entirely within the 2D model domain.

These internal boundaries were distributed along the low points within each sub-catchment to ensure accurate representation of the flow paths.

2.7 Development Scenarios

BMT WBM modelled three distinct development scenarios for the PSP40 development and these scenarios were as follows:

- **Original PSP40 Area:** A development footprint as developed by Melbourne Water as part of some modelling that they have undertaken. Total development footprint of 1020 hectares.
- **Extended PSP40 Area:** A development footprint based upon MW's footprint but extended further North towards the Werribee River. Total development footprint of 1024 hectares
- **Extensive PSP40 Area:** A development footprint based upon the extended PSP footprint but extended further East. Total development footprint of 1042 hectares.

3 RESULTS

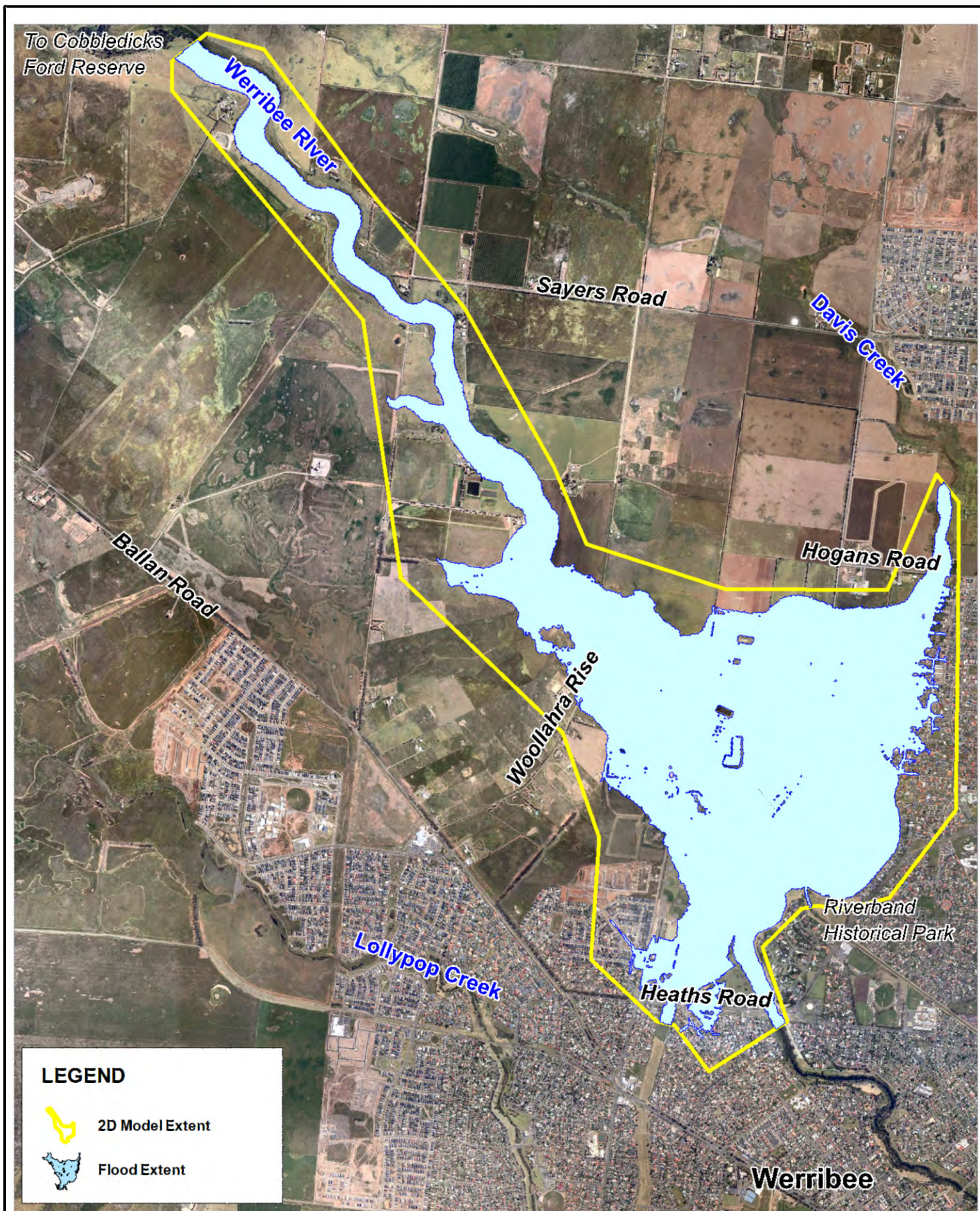
TUFLOW produces geo-referenced datasets defining peak water levels, depths, velocities, depth-velocity (i.e. hazard) and critical duration throughout the model domain. The data was imported into GIS to generate the required flood mapping outputs.

The results from the hydraulic analysis undertaken for PSP40 are presented on a series of maps on the following pages. Flood extent maps showing the flood extent under existing and developed conditions are presented in Figure 3-1 to Figure 3-4 whilst Figure 3-5 to Figure 3-7 shows a comparison of the existing and developed condition flood extents.

The flood impacts associated with the proposed development of PSP40 are shown in Figure 3-8 to Figure 3-10 for the analysed scenarios. In these figures, the colours indicate the flood extent and the change in flood level in accordance with the magnitude indicated in the legend. The pastel yellow colour indicates areas where there is no change within a ± 50 millimetre modelling tolerance; the darkening yellow/orange colours indicate increases in flood level and the light green indicate decreases.

Figure 3-11 and Figure 3-12 show the peak flood depths that occur during the 100 year ARI flood event under both existing and extended developed conditions

Figure 3-13 and Figure 3-14 show the peak flood velocities that occur during the 100 year ARI flood event under both existing and extended developed conditions.



Title:

Base Case Scenario 100 Year ARI Peak Flood Extent

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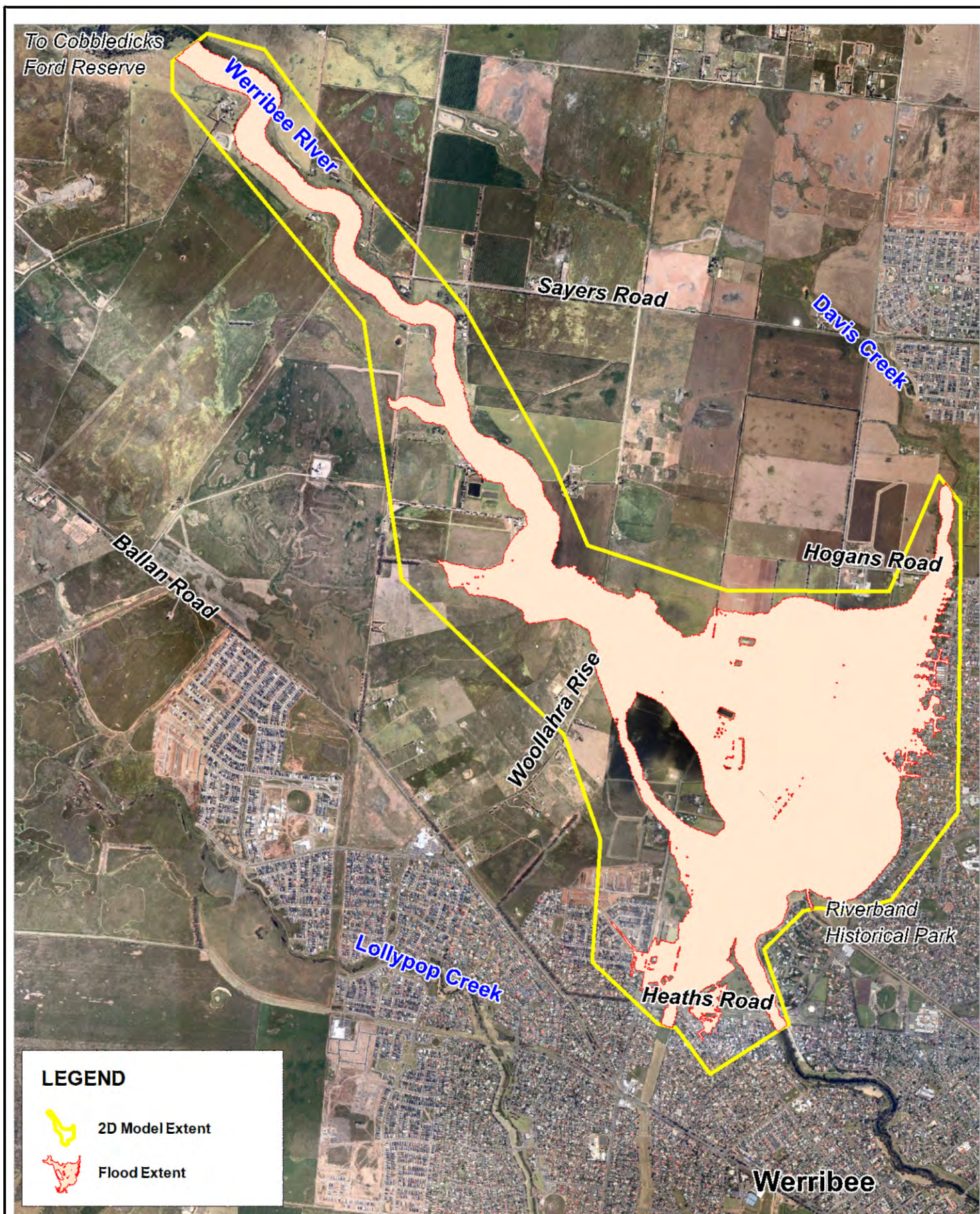
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Title:
Developed Case Scenario - Original PSP40 Area
100 Year ARI Peak Flood Extent

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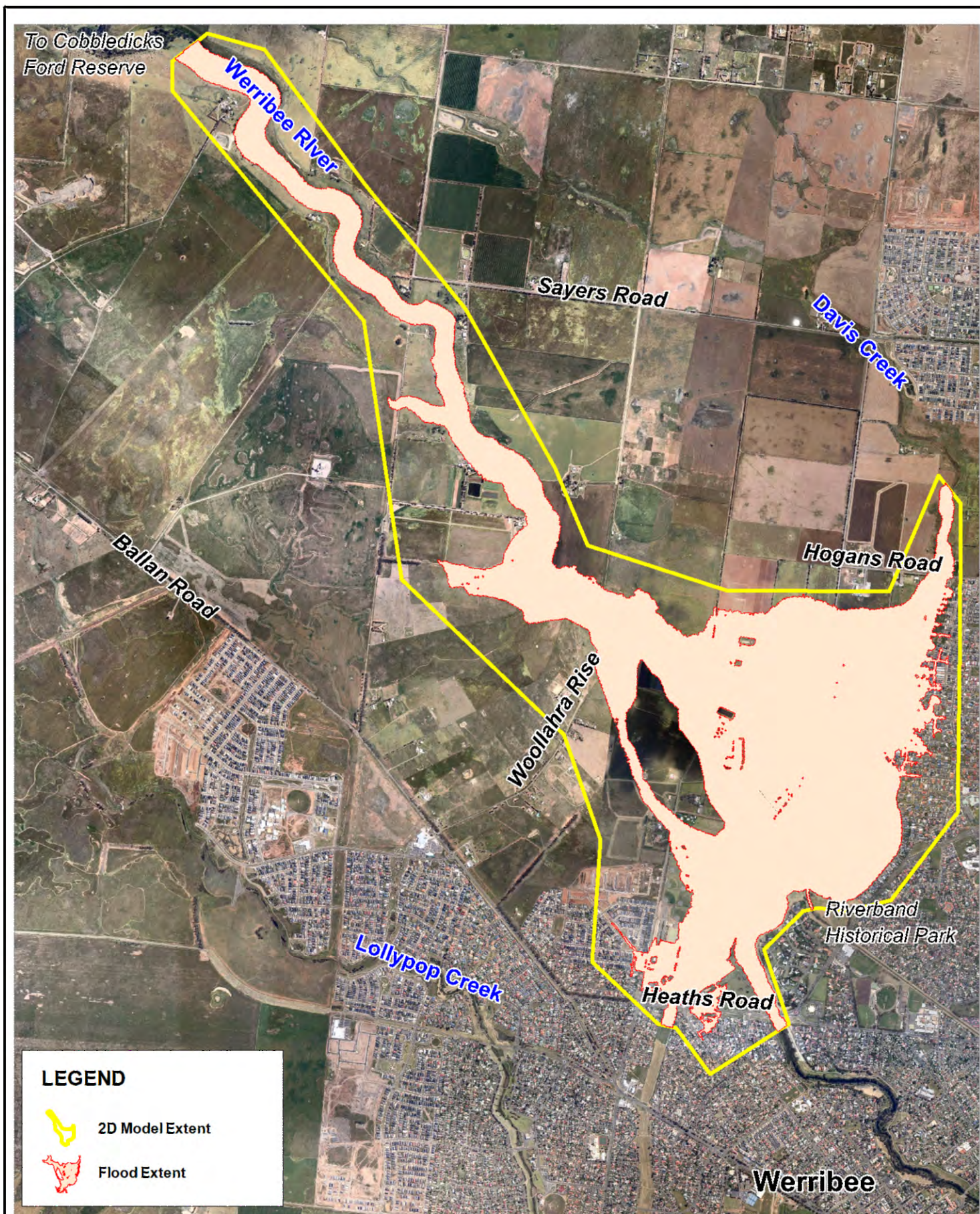
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Title:
Developed Case Scenario - Extended PSP40 Area
100 Year ARI Peak Flood Extent

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Title:
Developed Case Scenario - Extensive PSP40 Area
100 Year ARI Peak Flood Extent

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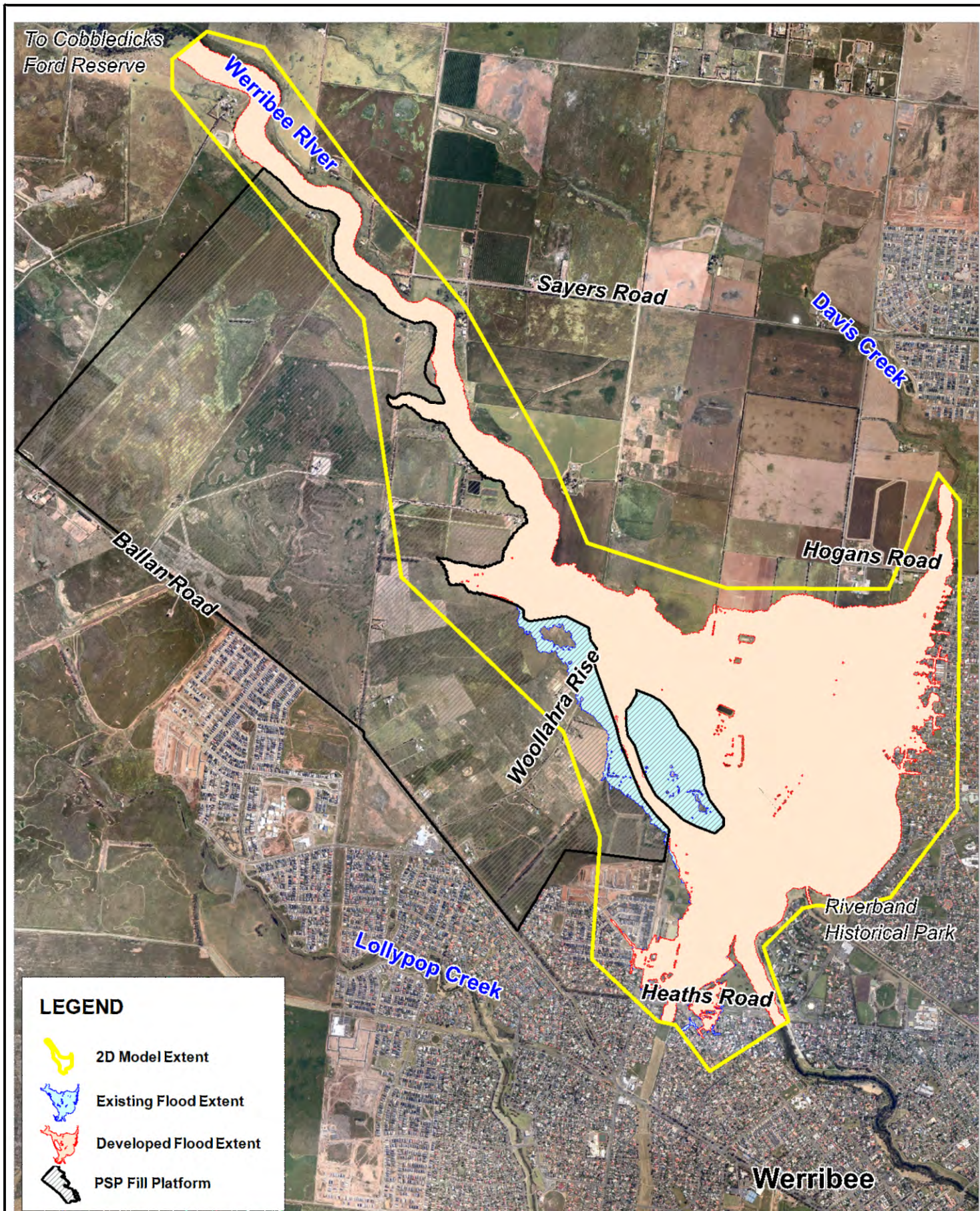
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Title:
**Comparison of Flood Extents - Original PSP40 Area
 100 Year ARI Peak Flood Extent**

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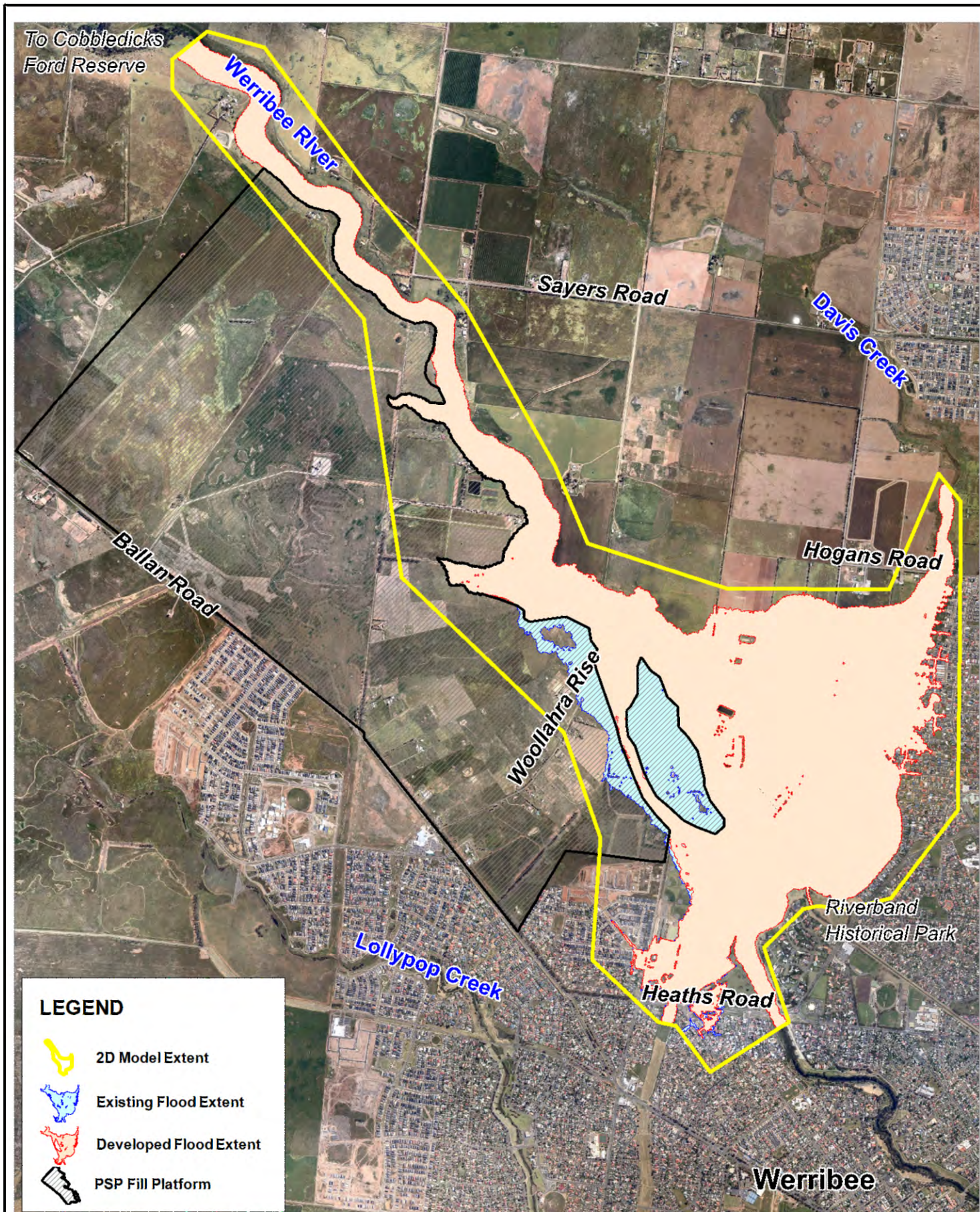
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Title:

Comparison of Flood Extents - Extended PSP40 Area 100 Year ARI Peak Flood Extent

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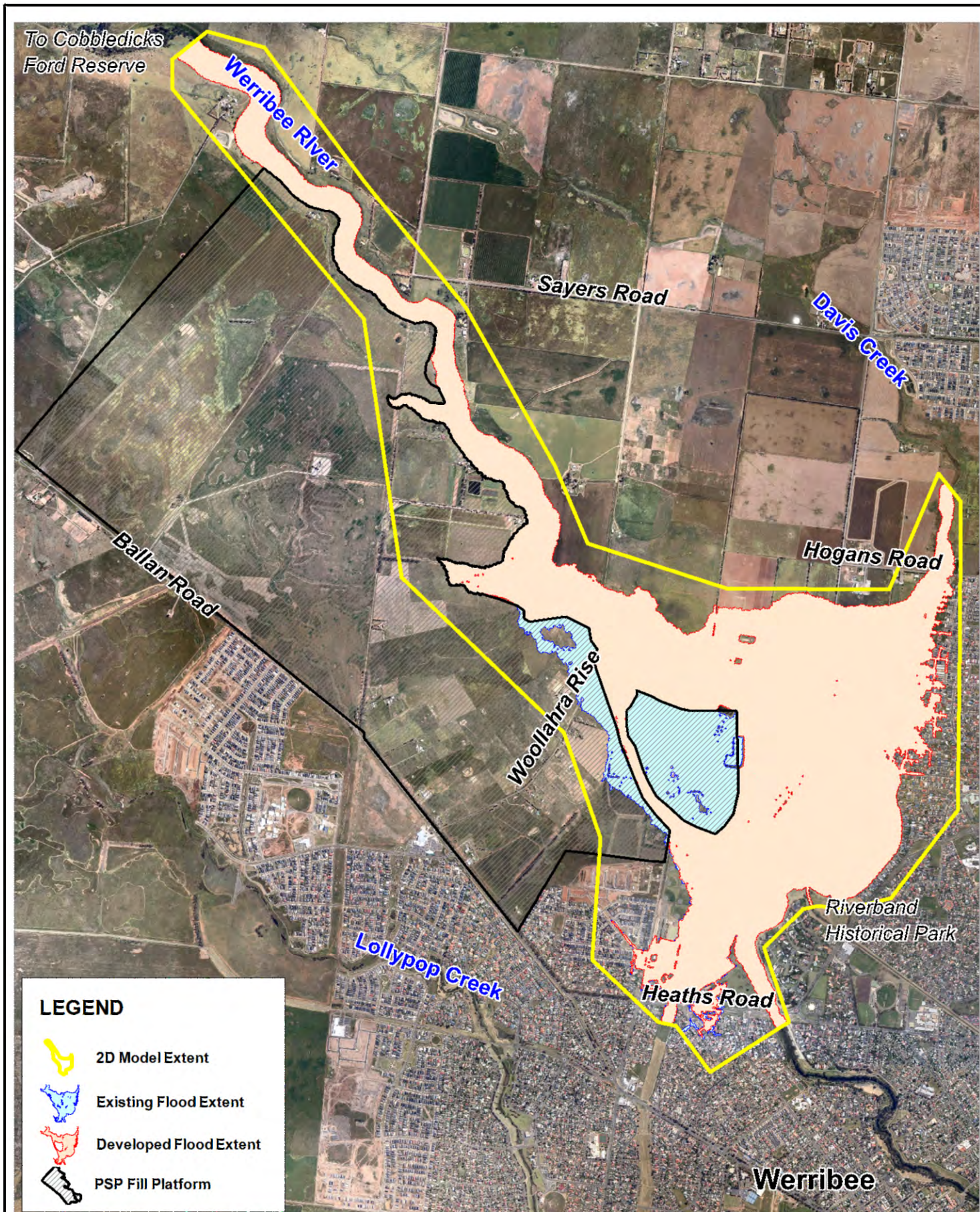
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Title:
**Comparison of Flood Extents - Extensive PSP40 Area
 100 Year ARI Peak Flood Extent**

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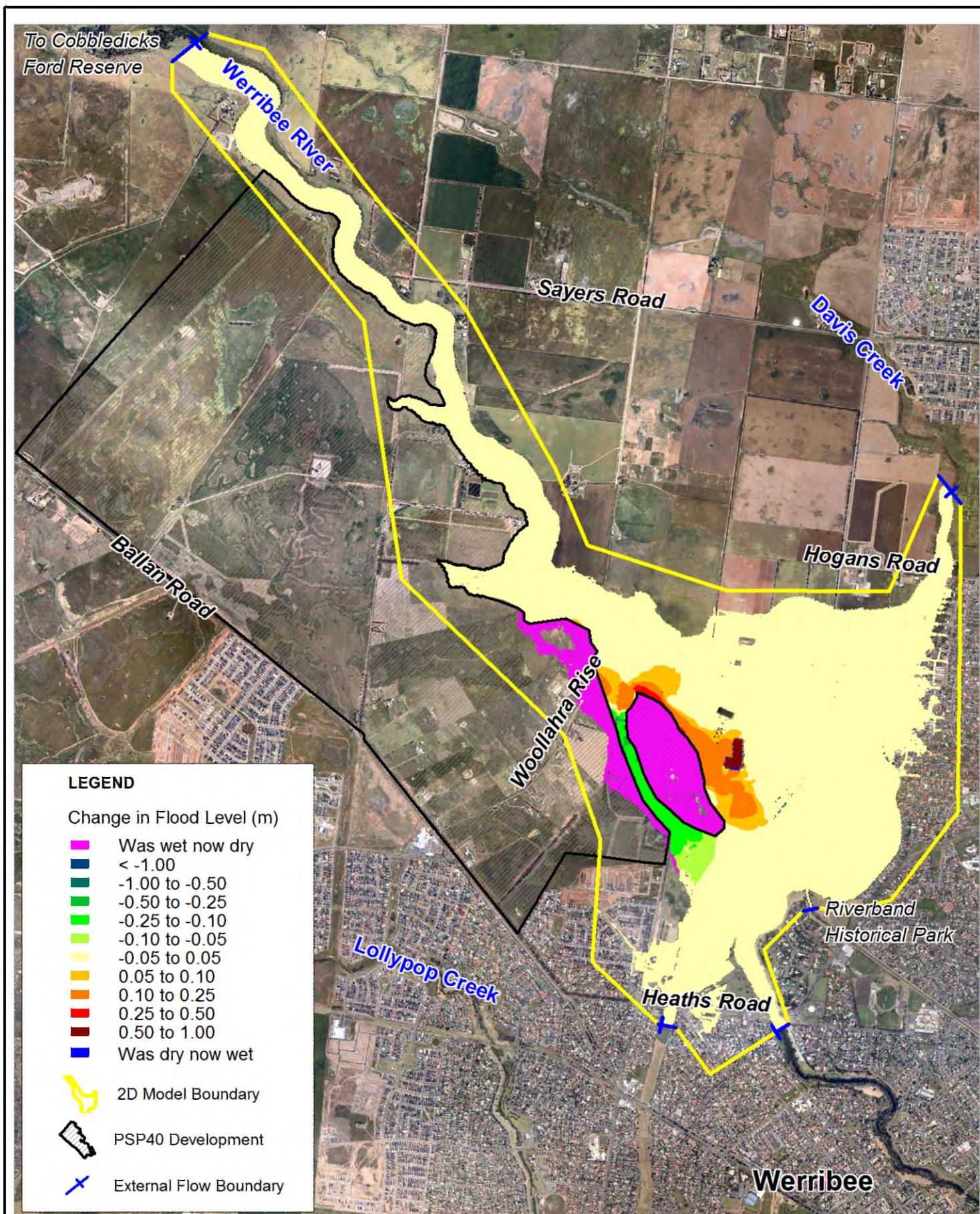
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Title:
Flood Impact - Original Area
100 Year ARI Peak Flood Event

Figure:
3-8

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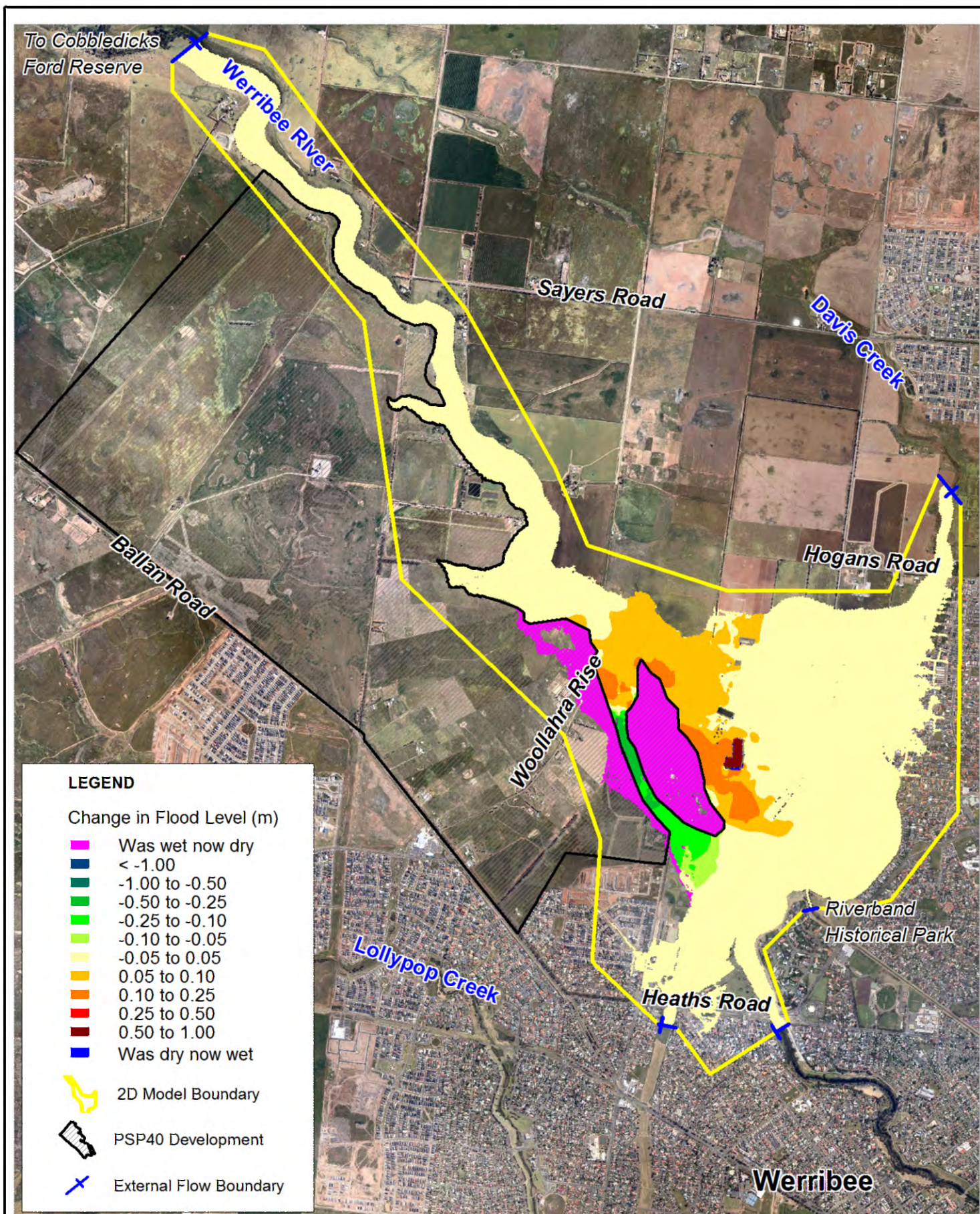
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Title:

Flood Impact - Extended Area 100 Year ARI Peak Flood Event

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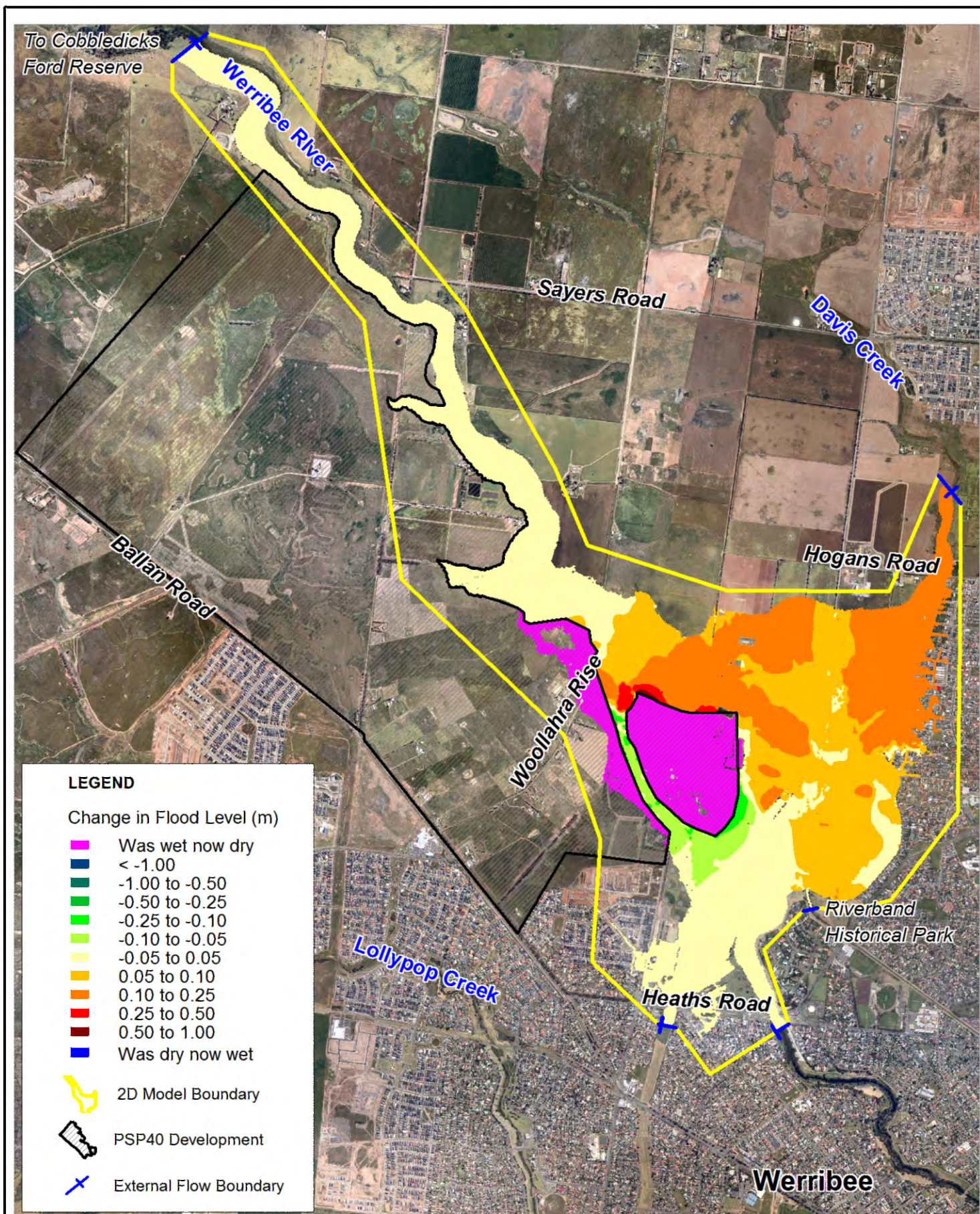
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Title:

Flood Impact - Extensive Area 100 Year ARI Peak Flood Event

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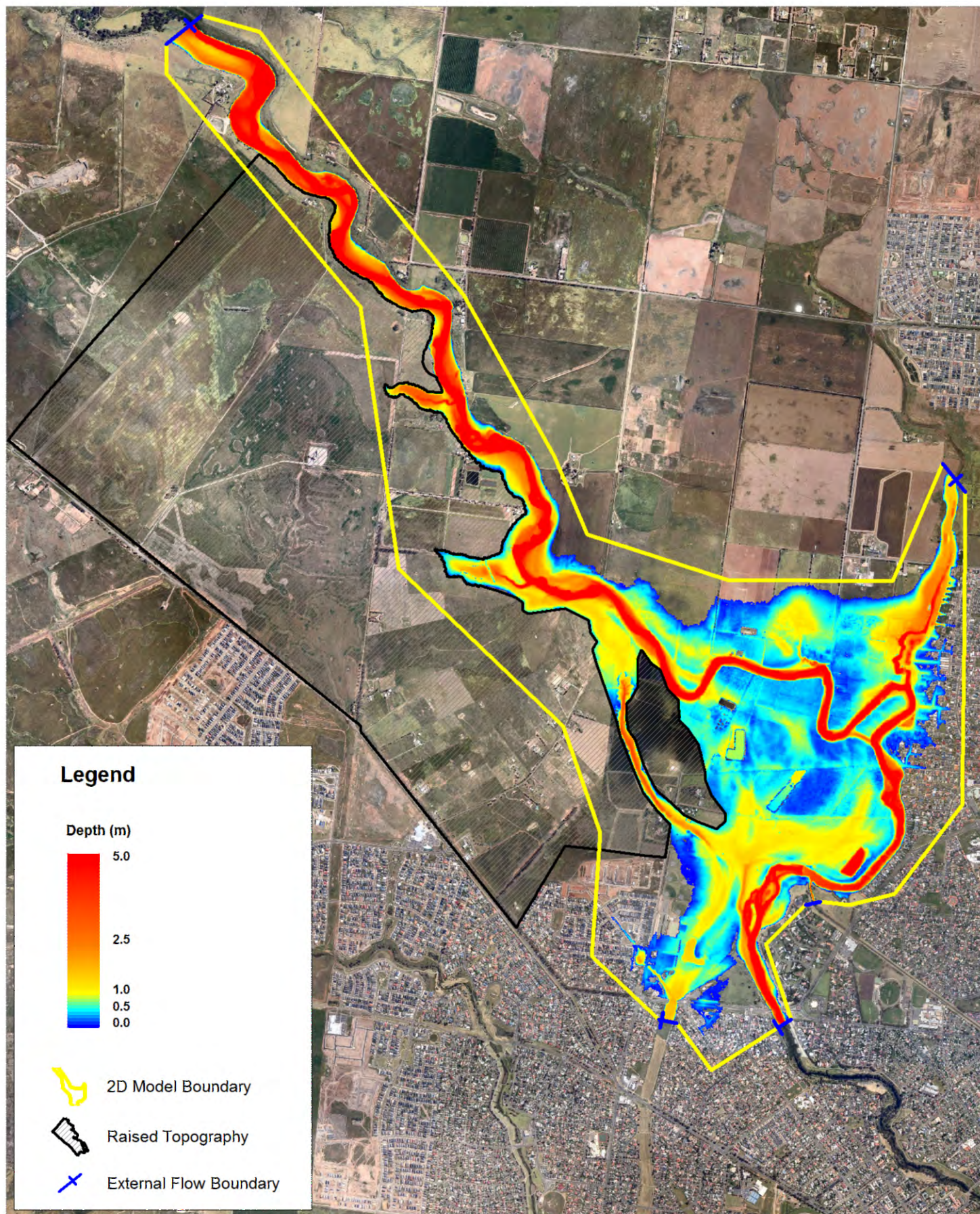
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3-10

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Title:

100 Year ARI Peak Flood Depth Extended PSP40 Development

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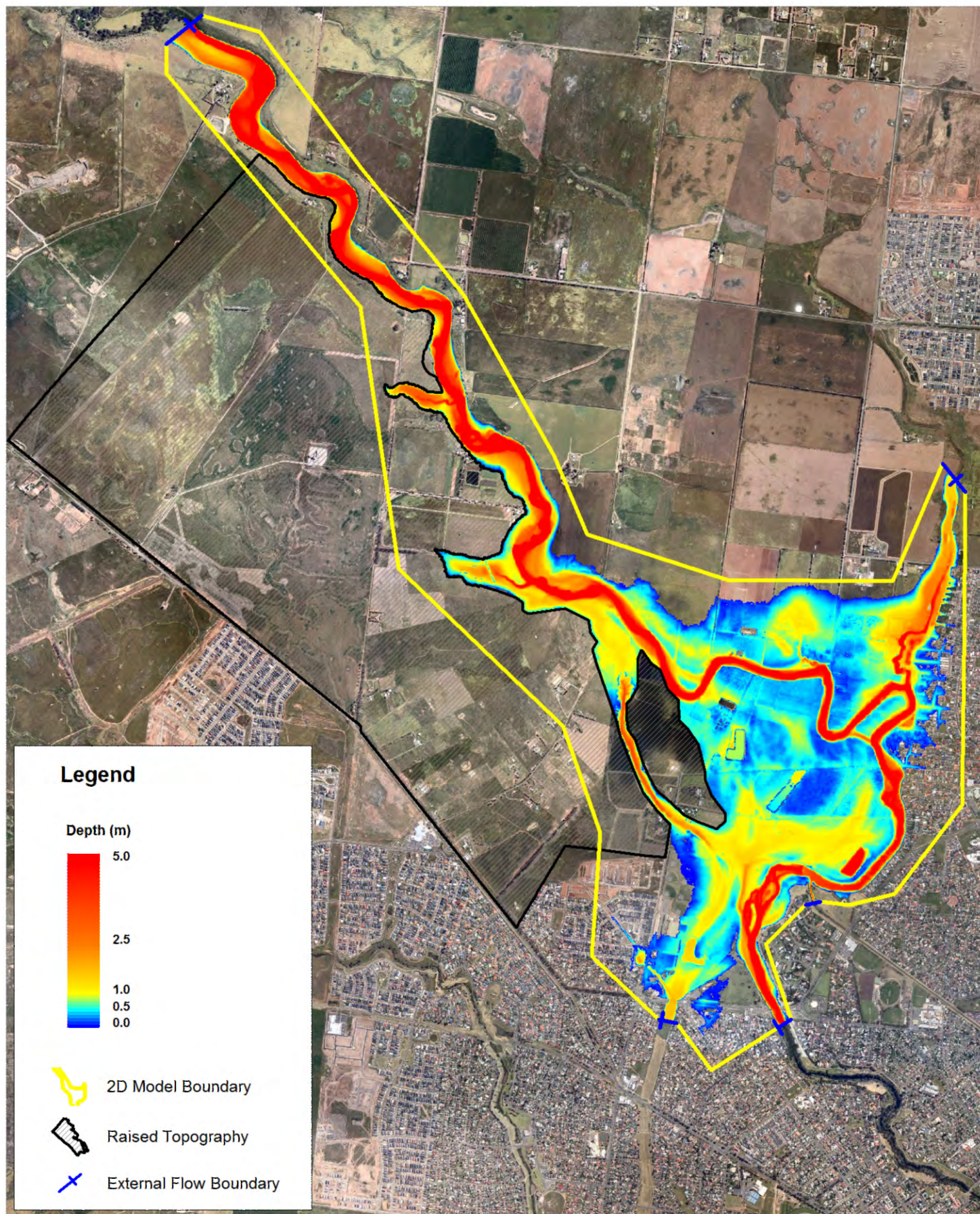
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Title:

100 Year ARI Peak Flood Depth Extended PSP40 Development

Figure:

3-12

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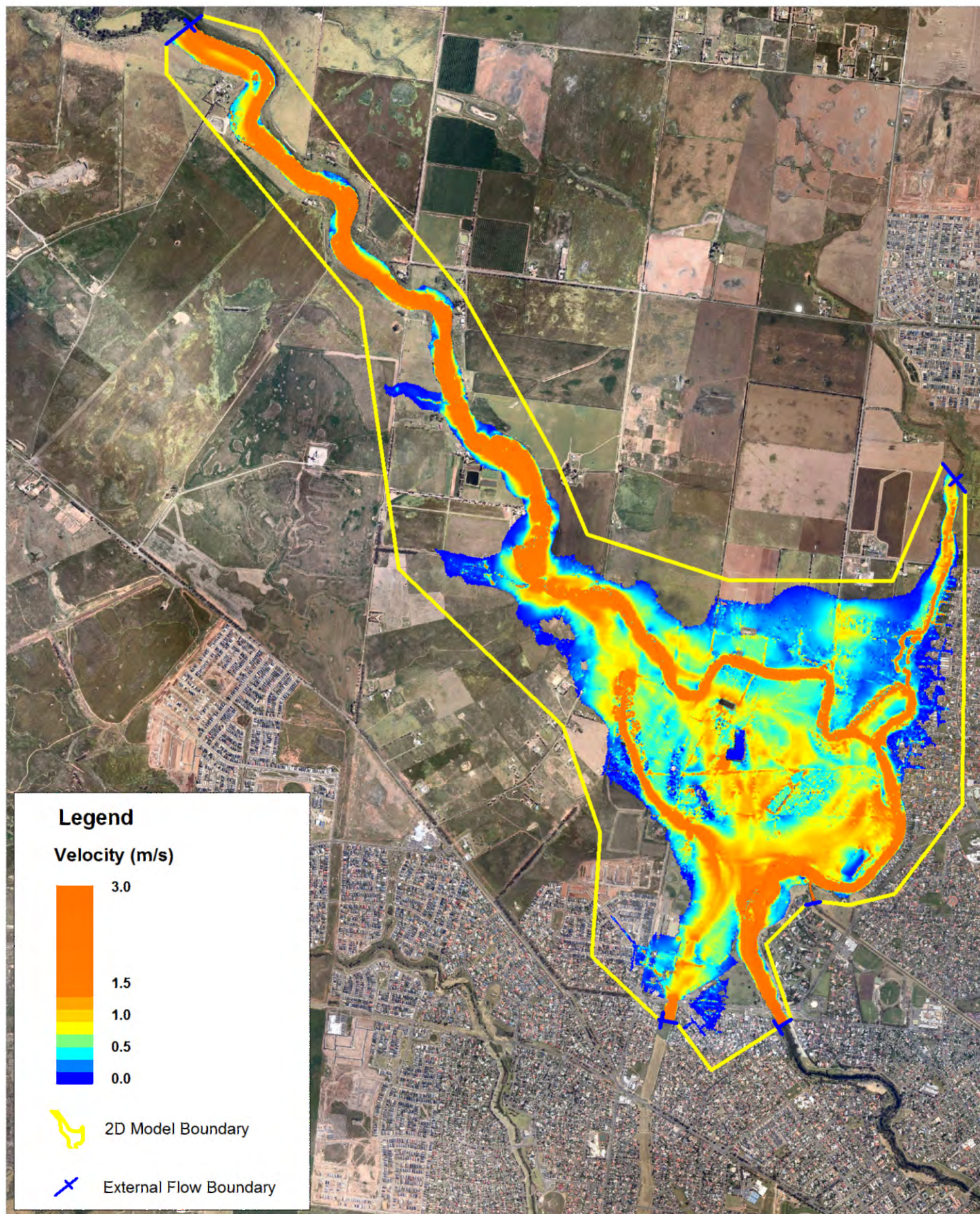
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Title:
**100 Year ARI Velocity at Peak Flood Height
 Base Case Scenario**

Figure:
3-13

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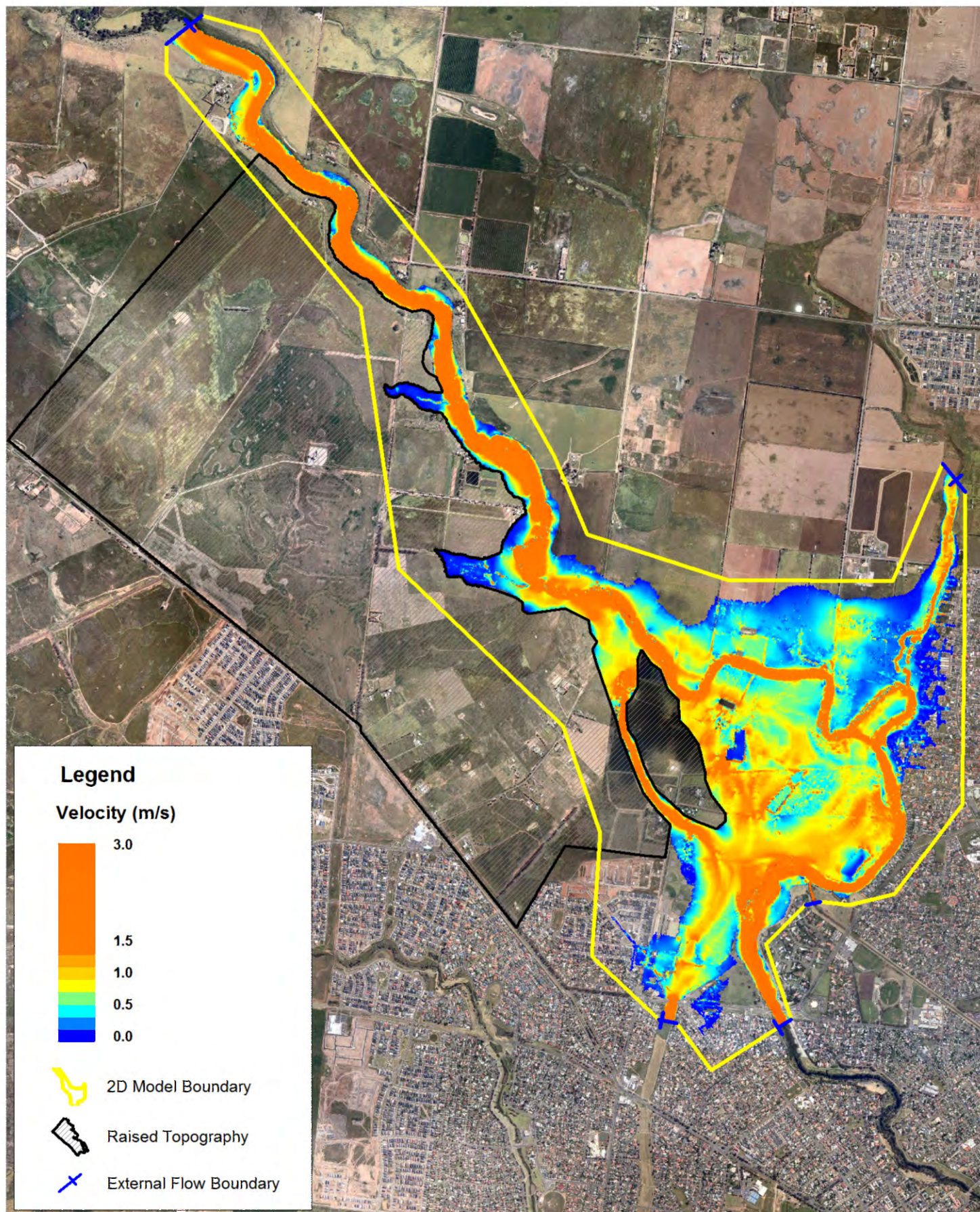
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Title:

100 Year ARI Velocity at Peak Flood Height Extended PSP40 Development

Figure:
3-14

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4 DISCUSSION

4.1 Flood Impacts

The results from this analysis show that the development of the PSP40 region using either the original or extended development scenario (Figure 3-5 and Figure 3-9) will result in impacts adjacent to development locations. However, all impacts are confined within the floodplain and do not extend to residential areas downstream of the study area, or influence levels within Werribee River upstream of the study area.

Under the extensive development scenario, when the PSP40 fill platform is extended further east (Figure 3-10), the flood impacts are significantly increased across the floodplain and impact on residential areas to the downstream of the study area.

4.2 Limitation of the Assessment

There are a number of limitations to the assessment that has been undertaken that need to be considered when reviewing the results presented in this report. These limitations include:

- The hydraulic modelling is based upon boundaries provided to BMT WBM by Alluvium from the Werribee River RORB model. Future changes to the Werribee River catchment that influence the RORB model and result in changed flow hydrographs will impact the results of the hydraulic model.
- The hydraulic model does not account for any increases in runoff as a result of development of PSP40. However, it is understood that development controls would limit runoff from any future development to existing conditions.
- The hydraulic modelling does not account for any future development north of PSP40.
- The hydraulic modelling is based upon the 100 year ARI event.
- The hydraulic modelling does not include any internal drainage details of the PSP. Internal drainage networks, including floodways and retarding basins, have the potential to decrease the level of flood impact observed external to the PSP site, however, only further modelling will be able to determine this.

4.3 Future Assessments

PSP40 will require additional modelling to address potential internal flooding issues and ensure that the internal drainage system adequately addresses the external flood impacts.

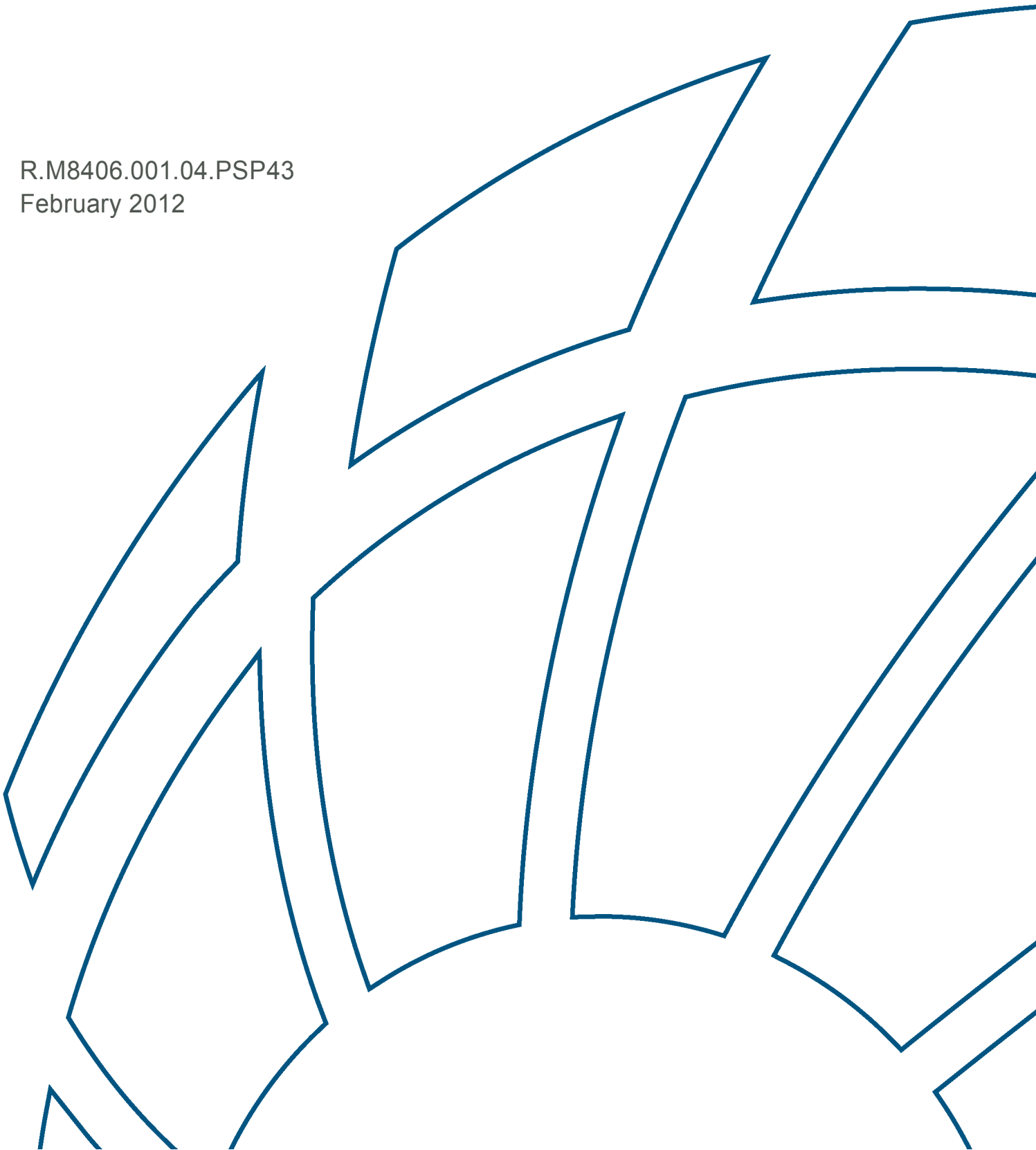


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Appendix B. PSP 43 modelling report

PSP 43 Hydraulic Assessment Final Report

R.M8406.001.04.PSP43
February 2012



PSP 43 Hydraulic Assessment Final Report

Prepared For: Alluvium Pty Ltd

Prepared By: BMT WBM Pty Ltd (Member of the BMT group of companies)

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Document :	R.M8406.001.04.PSP43										
Project Manager :	Joel Leister										
Client :	Alluvium										
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Client Reference											

Title :	PSP43 Hydraulic Assessment
Author :	Joel Leister
Synopsis :	This report documents the methodology and results for the hydraulic assessment of PSP43.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY		ISSUED BY	
0	9/11/2011	PAP		JGL	
1	29/11/2011	PAP		JGL	
2	02/12/2011	DR		JGL	
3	23/12/2011	DR		JGL	
4	15/02/2012	PAP		JGL	

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1 INTRODUCTION

1.1 Background

BMT WBM Pty Ltd (BMT WBM) was commissioned by Alluvium Consulting Pty Ltd (Alluvium) to assess the flood impacts of the proposed precinct structure plan known as PSP43 in a section of the Lollypop Creek floodplain.

PSP43 is one of several residential projects within the Wyndham growth area, which is administered by the Growth Areas Authority (GAA). As shown in Figure 1-1, PSP43 is located on the outskirts of Werribee which is approximately 40km west-south-west of Melbourne's CBD. Lollypop Creek flows north-south, approximately 1km to the west of PSP43.

Most of the study area is currently rural or semi-rural land, functioning as open pasture. Some areas in the north-east of the study area are residential zones.

This report describes the development of the hydraulic model and presents the flood mapping for the PSP43 Assessment.

1.2 Study area Description

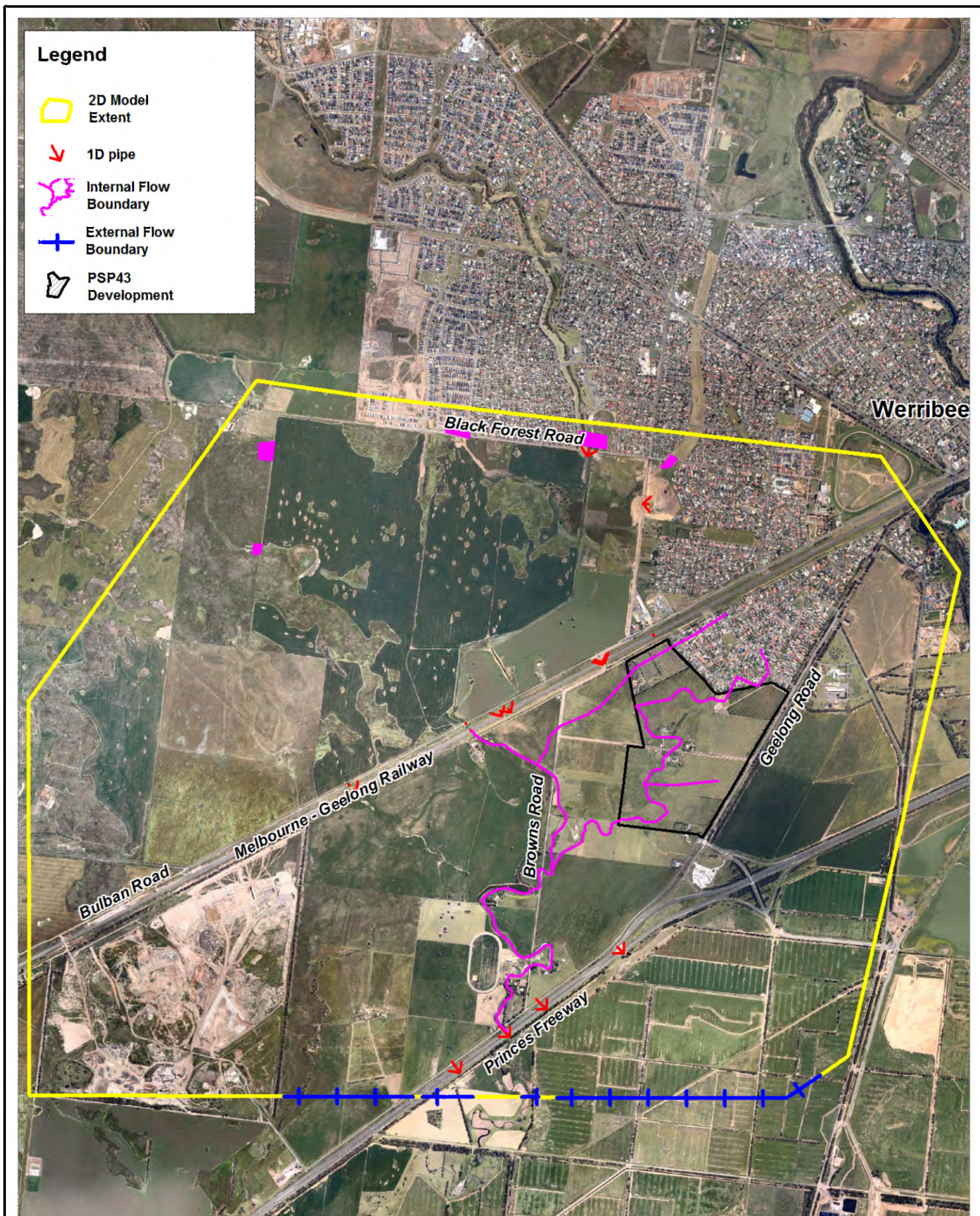
The study area, as shown in Figure 1-1, is the approximately 25.5 km² section of the Lollypop Creek floodplain that is bounded by Browns Road to the West, Bulban Road to the North and the Princes Freeway to the East and South.

The Melbourne-Geelong railway runs along Bulban Road and together these form a significant barrier to flow from the north. As such, flooding of Lollypop Creek within the study area is controlled by the structures underneath the railway and the embankment itself should the railway be overtopped. Similarly, to the south, flow is partially inhibited by the Princes Freeway and as such, it is controlled by structures underneath the freeway as well as the freeway itself at high flows.

The Werribee River is located to the north-east of the study-site and under high flow conditions, a flow diversion exists from the Werribee River to Lollypop Creek contributing additional floodwater to the Lollypop Creek floodplain.

1.3 Objectives

The objective of the study was to determine the 1 in 100 year ARI flood extents for the Lollypop Creek in the vicinity of PSP43 under both existing and developed conditions and determine the flood impacts associated with this development.



Title:
PSP43 Assessment Model Schematisation

Figure:
1-1

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Approx. Scale



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2 HYDRAULIC MODELLING

This section provides a description of the TUFLOW modelling process for the PSP43 Assessment. A 2D/1D dynamically linked TUFLOW hydraulic model of the study area was developed to assess the flooding conditions under both the existing and developed scenarios.

The hydrologic RORB model of Lollypop Creek for the 100y ARI 36 hour storm duration event was provided by Alluvium. Hydrographs from this model served as inflows to the hydraulic model at required locations. It is understood that the RORB model includes break-out flows from the Werribee River to the north-east of the study area and is representative of the Lollypop Creek catchment.

The following sections detail the development of the hydraulic model used to produce the flood mapping for the PSP43 Assessment.

2.1 Model Schematisation

The PSP43 Assessment model was schematised as a dynamically linked 1D/2D TUFLOW model. The model was designed to cover the section of the Lollypop Creek floodplain that could potentially be influenced by the development of the PSP43 site. The area modelled extended sufficiently upstream and downstream from the site to minimise boundary effects and ensure adequate representation of the floodplain storage.

A number of drainage structures exist underneath the Melbourne-Geelong Railway and the Princes Freeway to convey flow from Lollypop Creek, its tributaries and the floodplain. These structures were included in the model to enable accurate representation of the flooding behaviour of the floodplain.

The floodplain topography was represented by a series of regular square elements of 5 metres in width. TUFLOW samples the underlying elevation data at 9 locations within each element to define the topography. The topography data was based upon a series of LiDAR tiles provided the Growth Areas Authority to Alluvium.

Details of the model setup and application are described in the following sections and shown in Figure 1-1.

2.2 TUFLOW Version

Model runs were simulated using the 2011-09-AB-iDP-64 build of TUFLOW. The nature of the model necessitated the use of the 64 bit double precision version.

2.3 Design Event Modelling

The TUFLOW model was only run for a single event for the Lollypop Creek catchment, namely, the 100 ARI 36 hour storm.

It must be noted that whilst this event is deemed critical for the major inflow of Lollypop Creek, other durations will be critical in other parts of the catchment. Most notably this will occur in the small catchment directly north-east of the PSP43 site, where smaller duration storms will be critical due to the smaller catchment size and increased fraction impervious.

2.4 Model Extent

The TUFLOW model's 2D domain extends from north of Black Forest Road to the downstream boundary, south of where Lollypop Creek flows under the Princes Freeway. The modelling includes the Delfin land to the immediate north of the railway line.

2.5 2D Domain

The 2D model domain, along with the 1D pipe network, are shown in Figure 1-1. The 2D domain covers an area of approximately 25.5 km². The geometry of the 2D model was established by constructing a uniform grid of square elements. One of the key considerations in establishing a 2D hydraulic model relates to the selection of an appropriate grid element size. Element size affects the resolution, or degree of accuracy, of the representation of the physical properties of the study area as well as the size, and thus memory request, of the computer model and its resulting run times. Selecting a very fine grid element size will result in both higher resolution results and longer model run times.

The adopted 5m grid size resulted in approximately 1,000,000 grid elements and provided a good definition of topography and floodplain storage, whilst keeping run times to an acceptable length. Each square grid element contains information on ground topography sampled from the DEM at 2.5 m spacing as well as surface resistance to flow (Manning's 'n' value).

To maintain an acceptable Courant number, the 2D domain of the model was run on a 1 second time-step.

2.5.1 Significant Topography Features

Significant topographic features, such as road embankments that affect flood flows, should be incorporated into the 2D domain. Conversely, where the original data underlying the DEM is erroneous due to the procedure in which the data is collected and/or filtered, it is good practice to correct these issues.

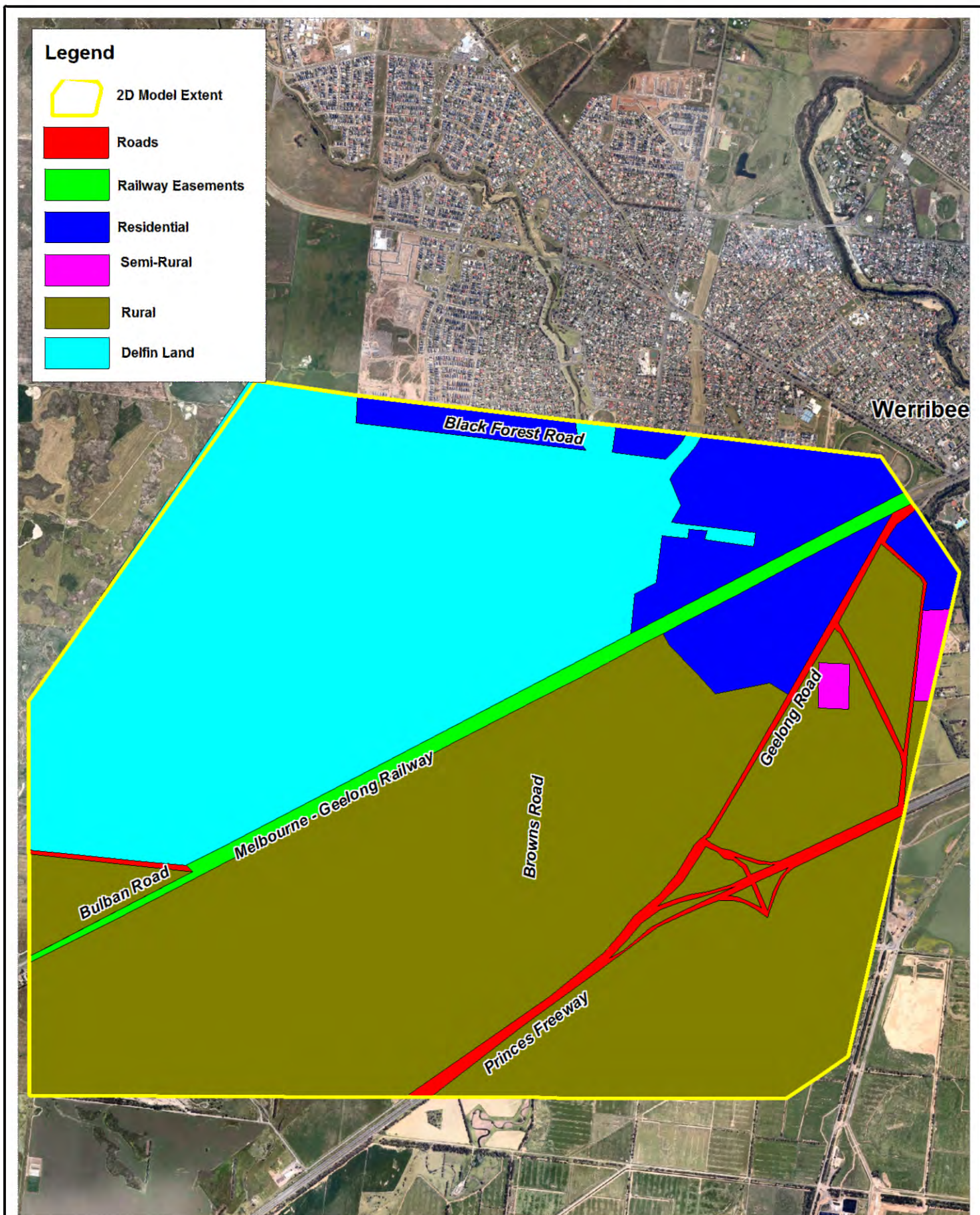
In the case of PSP43, the LiDAR had been filtered to remove a couple of the drainage structures along the Melbourne-Geelong railway and the Princes Freeway resulting in an incorrect representation of the available flow area. The terrain in these areas was modified to ensure a continuous blockage existed across the floodplain with the drainage structures being appropriately represented.

2.5.2 Roughness Layer or Manning's n

The roughness layer, or Manning's 'n' layer, was based on areas of different land-use type determined from aerial photography and the site inspection. The adopted Manning's 'n' values are summarised in Table 2-1 and the layer is shown in Figure 2-1. The values used are based on standard texts such as *Open Channel Hydraulics* (Chow, 1959).

Table 2-1 2D Domain Manning's 'n' Coefficients

Land Use	Manning's 'n'
Roads	0.02
Railway Easements	0.02
Residential	0.1
Semi-Rural	0.06
Rural	0.035
Delfin Land	0.031



Title:
PSP43 Assessment Manning's Roughness Distribution

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2.6 1D Network

The underground pipes in the PSP43 Assessment study area play a significant role in controlling the flooding of the Lollypop Creek. The pipes include the circular and rectangular culverts underneath the Melbourne-Geelong railway as well as underneath the Princes Freeway. The pipes were modelled in 1D, which were dynamically linked to the 2D domain. A Manning's 'n' of 0.013 was adopted for all of the pipes. The pipe dimensions and invert levels were taken from existing hydraulic models in the region.

In some instances the GIS pipe data was also altered. This occurred where the location of the 1D network did not align with 2D topography allowing for proper representation of the 1D/2D linking.

The 1D domain of the model was run with a 0.5 second time-step for each of the scenarios modelled. These time-steps were required to keep Courant numbers within the range recommended in the TUFLOW manual.

2.7 Boundary Conditions

A hydraulic model requires the specification of inflow boundaries and outlet boundaries to allow water into and out of the model in a realistic manner. Often 2D hydraulic models will have external and internal inflow boundaries. The external inflow boundaries account for flow generated from outside of the model extents (external boundaries) whereas internal boundaries account for the runoff generated from, and to be applied within, the model extents. Flow is removed from the model through downstream boundaries, which are generally a fixed water level or a rating curve.

The PSP43 Assessment model has a series of external and internal inflow boundaries and a downstream water level boundary.

2.7.1 External Boundaries

The upstream external boundaries were based upon inflows used in the Delfin Flood Model which had been previously developed and used in this assessment.

The downstream flow boundary was modelled as a series of fixed water levels based upon flood levels determined as part of the Western Treatment Plant flood mapping project. The downstream boundaries are constant over time but are far enough downstream of the subject site to not influence local flood levels.

2.7.2 Internal Boundaries

Internal inflow boundaries represent runoff occurring within the model bounds. For the PSP43 Assessment TUFLOW model, the internal boundaries were applied by distributing the flow directly into the 2D domain as appropriate, to represent the catchment contained entirely within the 2D model domain.

These internal boundaries were distributed along the low points within each sub-catchment to ensure accurate representation of the flow paths.

Under developed conditions, the sub catchment representing the PSP43 site were applied immediately downstream of the site (into the drainage low point). This method is conservative as it does not account for any retardation or attenuation of flows that will occur as part of the internal drainage system for PSP43.

2.8 Delfin Flood Model

Alluvium provided BMT WBM with a flood model developed by Water Technology for the Delfin Land immediately North of the railway line. BMT WBM included the topographic and roughness information from this model into the TUFLOW model as well as the proposed pipes and weirs included in the provided Mike Flood model.

The upstream boundaries from this model were also utilised in the TUFLOW model to ensure the results from the current modelling were representative of the previous modelling undertaken in the area.

BMT WBM assumes that the information contained within the provided model is representative of the planned development of the Delfin land.

2.9 Developed Case Model

Alluvium provided BMT WBM with a digital terrain model representing a drainage channel through the PSP43 area. This drainage channel is used to convey flow from the upstream catchments through the PSP43 development. The developed case model does not include any drainage infrastructure (entry pits, pipes, etc) that may be required to capture and the upstream flows and allow them to drain into the drainage channel.

3 RESULTS

TUFLOW produces geo-referenced datasets defining peak water levels, depths, velocities, depth-velocity (i.e. hazard) and critical duration throughout the model domain. The data was imported into GIS to generate the required flood mapping outputs.

The results from the hydraulic analysis undertaken for PSP43 are presented on a series of maps on the following pages. Flood extent maps showing the flood extent under existing and developed conditions are presented in Figure 3-1 (existing conditions, pre Delfin development), Figure 3-2 (existing conditions, post Delfin development) and Figure 3-3 (developed conditions)

Figure 3-4 shows a comparison of the existing (post Delfin development) and developed condition flood extents. A direct comparison to the existing (pre Delfin development) and developed conditions cannot be made due to different model setups between the models.

The flood impacts associated with the proposed development of PSP43 are shown in Figure 3-5. In Figure 3-5, the colours indicate the flood extent and the change in flood level in accordance with the magnitude indicated in the legend. The pastel yellow colour indicates areas where there is no change within a ± 50 millimetre modelling tolerance; the darkening yellow/orange colours indicate increases in flood level and the light green indicate decreases.

Figure 3-6 and Figure 3-7 show the peak flood depths that occur during the 100 year ARI flood event under both existing (post Delfin development) and developed conditions

Figure 3-8 and Figure 3-9 show the peak flood velocities that occur during the 100 year ARI flood event under both existing (post Delfin development) and developed conditions.

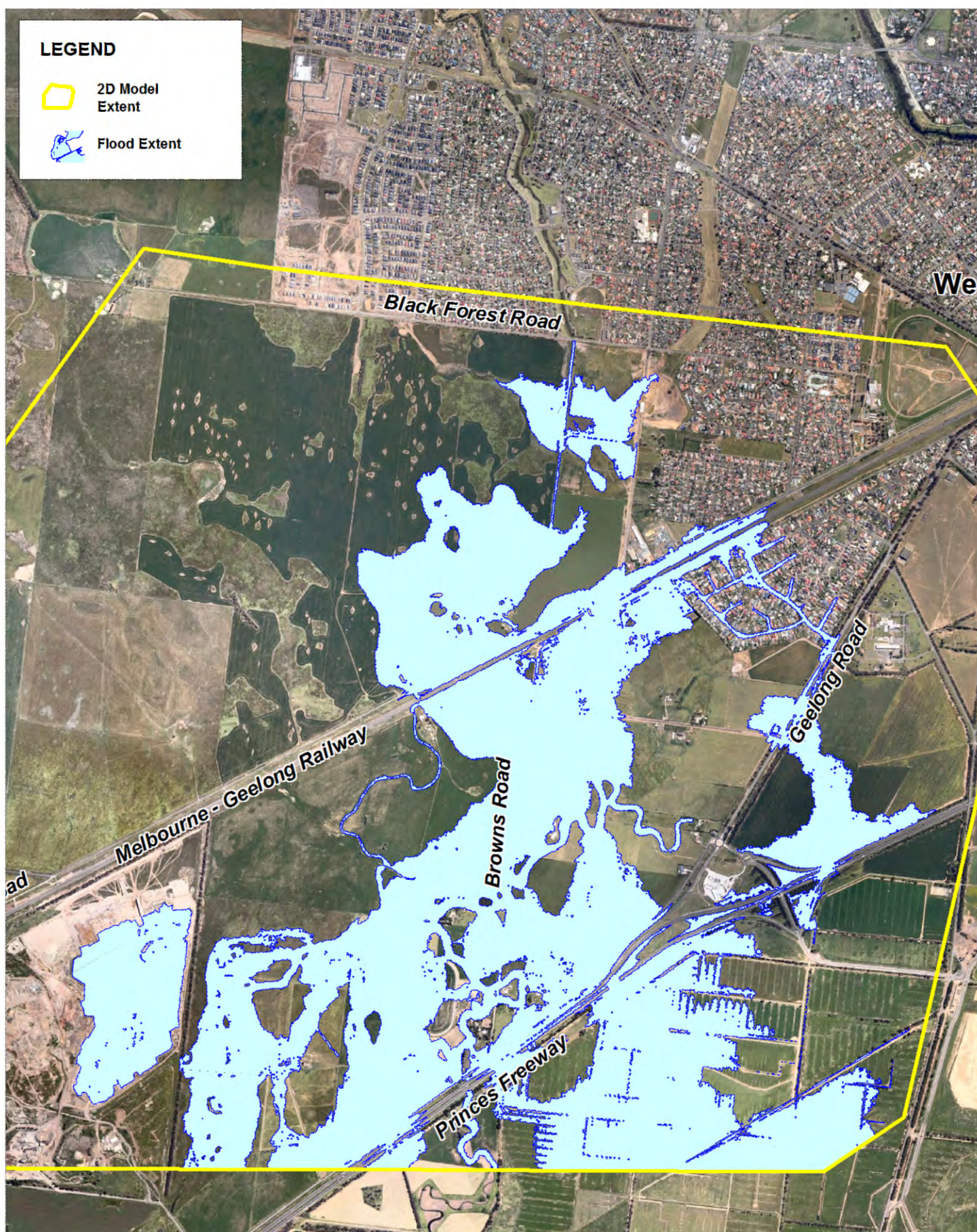
LEGEND



2D Model
Extent



Flood Extent



Title:
Base Case Scenario (Pre Delfin Development)
100 Year 36 Hour ARI Flood Extent

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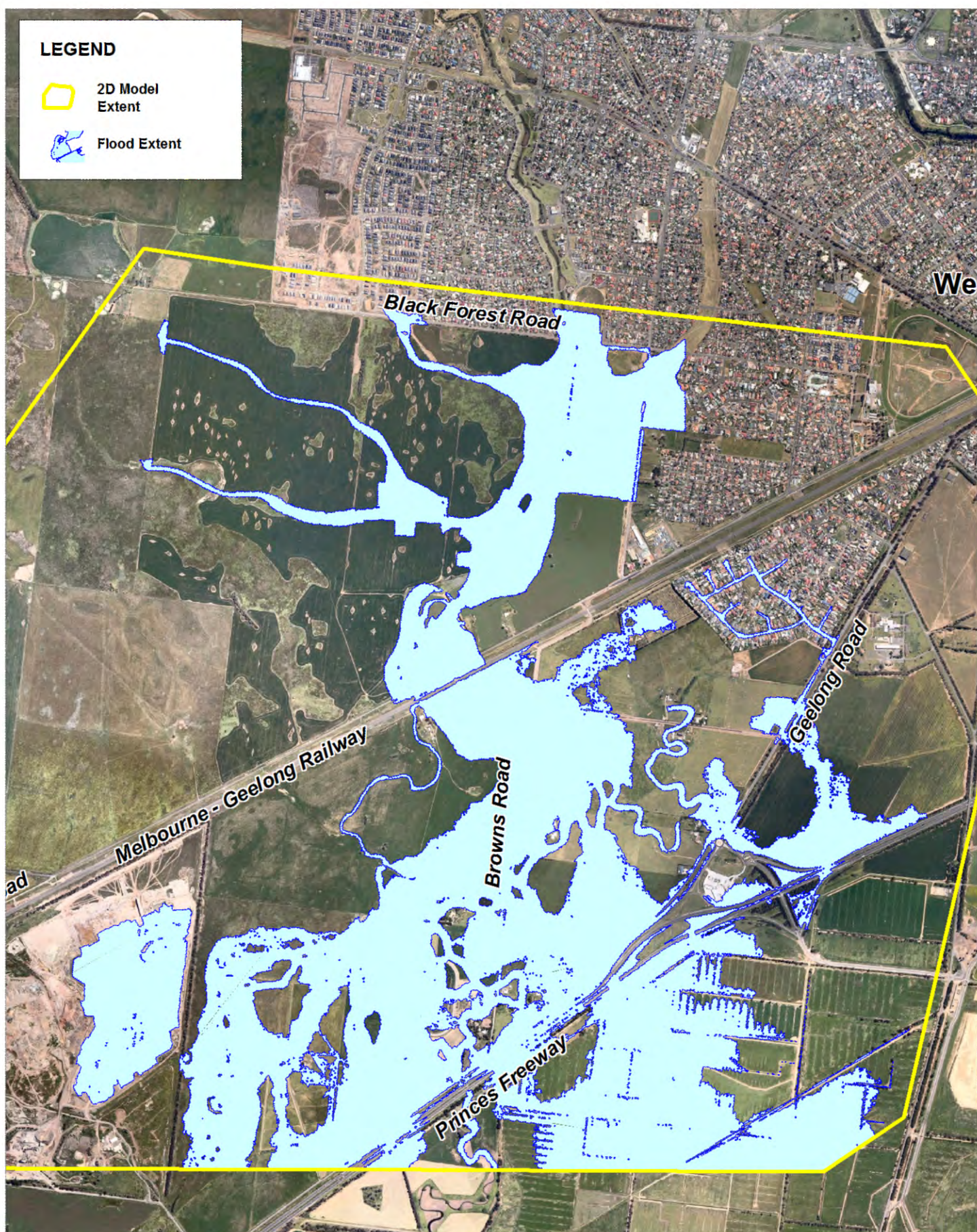
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2D Model
Extent



Flood Extent



Title:
**Base Case Scenario Post Delfin Development)
100 Year 36 Hour ARI Flood Extent**

Figure:

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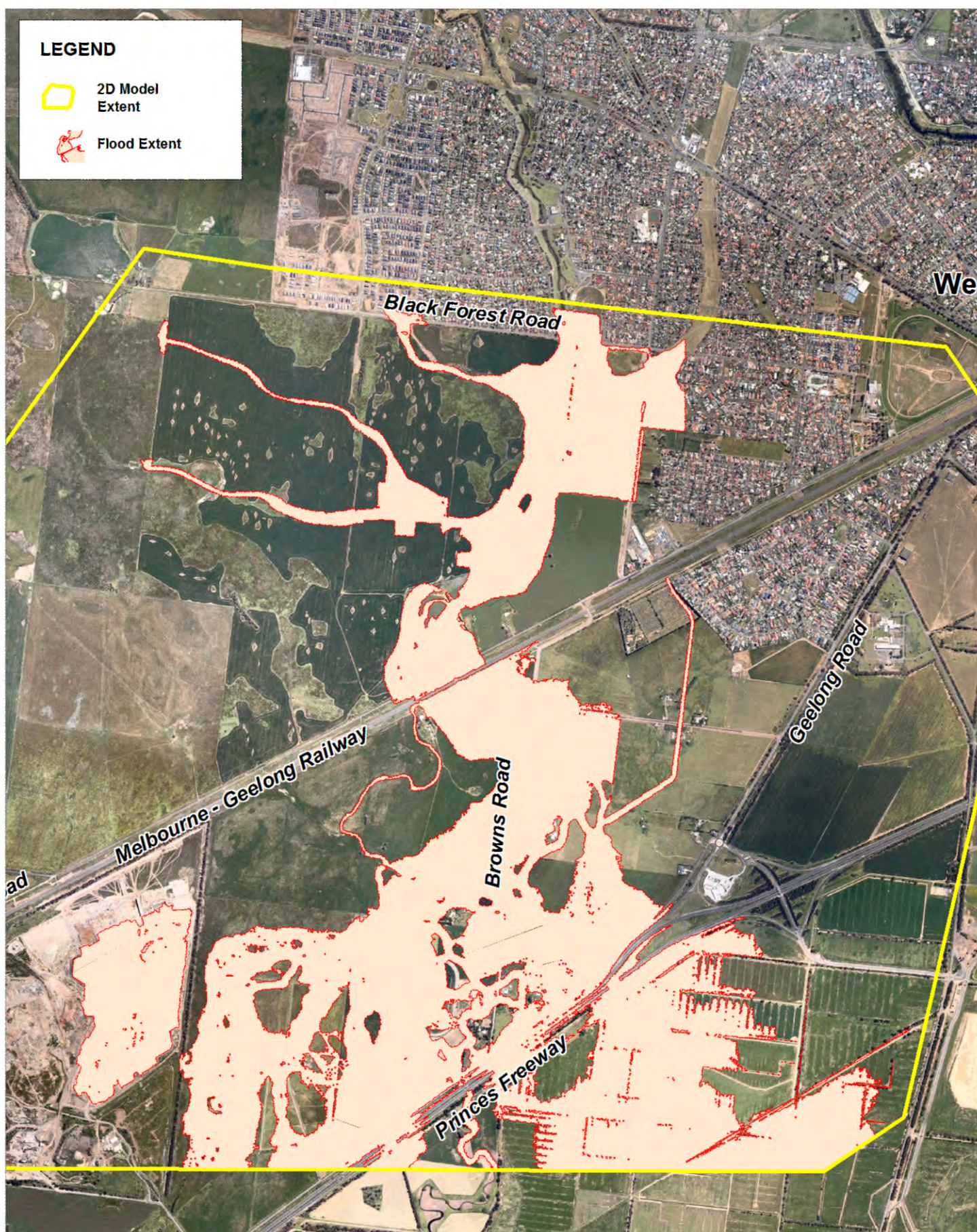
LEGEND



2D Model
Extent



Flood Extent



Title:
**Developed Case Scenario
100 Year 36 Hour ARI Flood Extent**

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3-3

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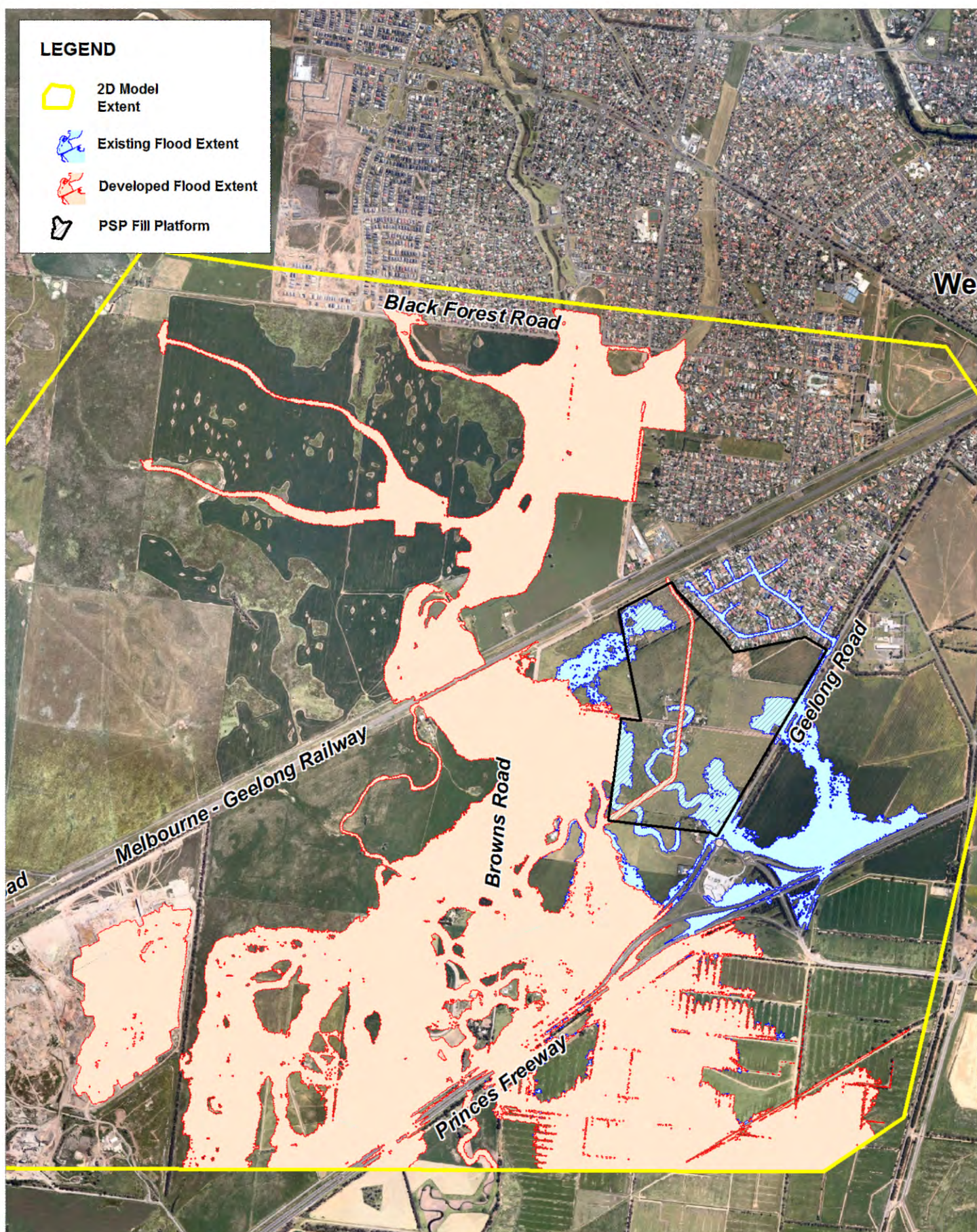
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Approx. Scale



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LEGEND

-  2D Model Extent
-  Existing Flood Extent
-  Developed Flood Extent
-  PSP Fill Platform



Title:
Comparison of PSP43 Flood Extents
100 Year 36 Hour ARI Flood Extent

Figure:
3-4

Rev:
B

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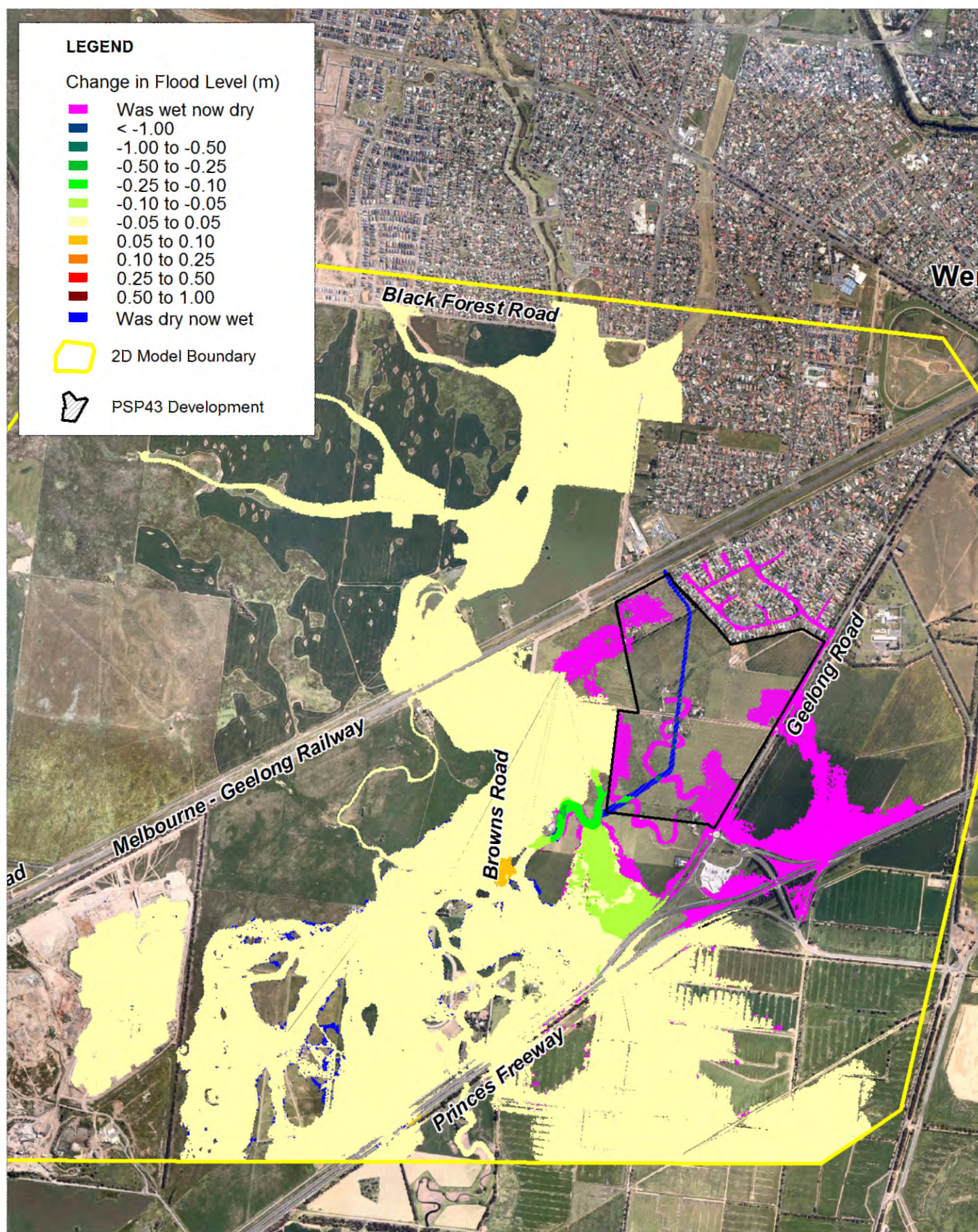
LEGEND

Change in Flood Level (m)

- Was wet now dry
- < -1.00
- 1.00 to -0.50
- 0.50 to -0.25
- 0.25 to -0.10
- 0.10 to -0.05
- 0.05 to 0.05
- 0.05 to 0.10
- 0.10 to 0.25
- 0.25 to 0.50
- 0.50 to 1.00
- Was dry now wet

 2D Model Boundary

 PSP43 Development



Title:
**Flood Impact of PSP43 on the
100 Year 36 Hour Storm**

Figure:

3-5

Rev:

B

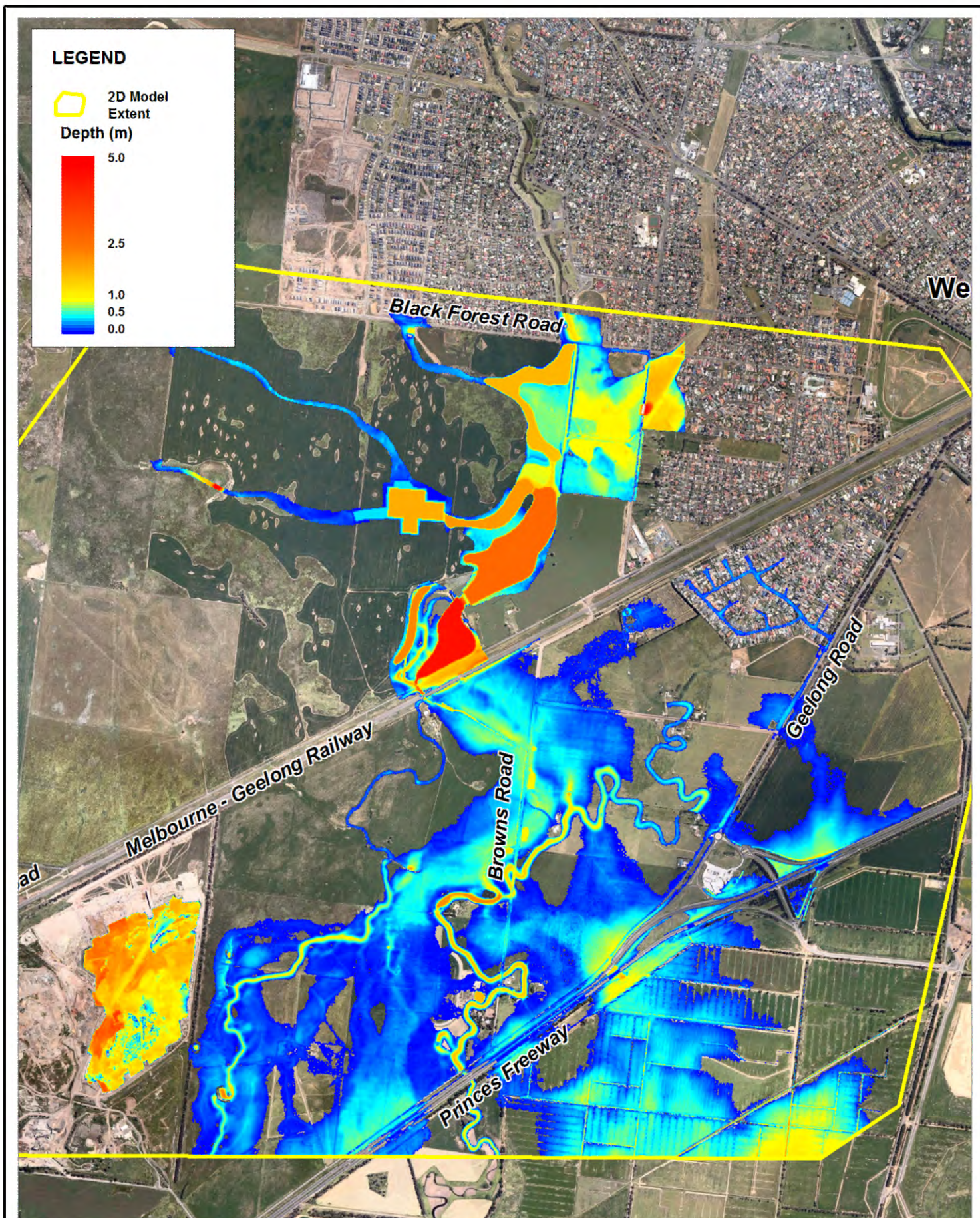
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Title:
Peak Flood Depths under Existing Conditions

Figure:
3-6

Rev:
A

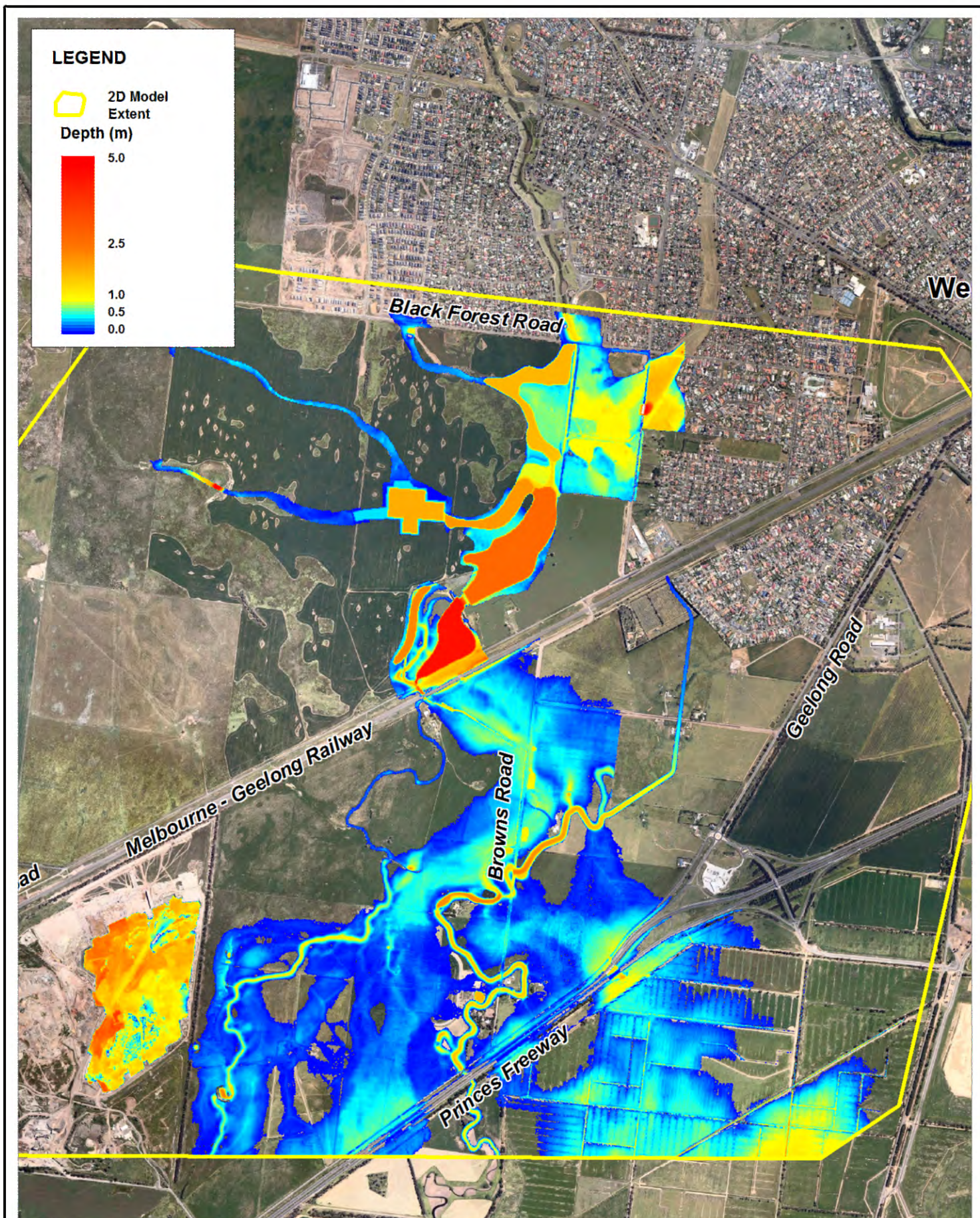
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Approx. Scale



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Title:
Peak Flood Depths under Developed Conditions

Figure:
3-7

Rev:
B

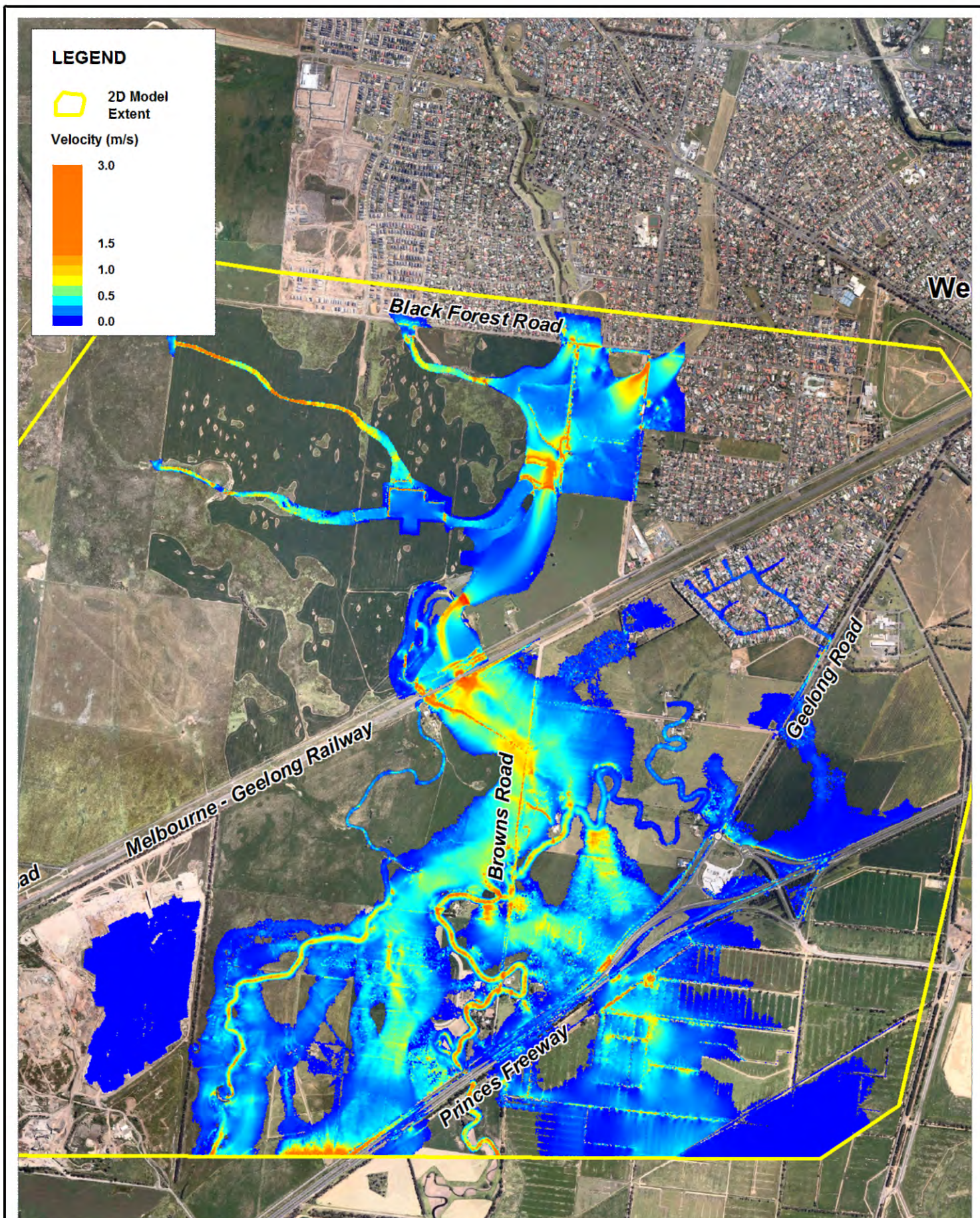
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Approx. Scale



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Title:
Peak Flood Velocities under Existing Conditions

Figure:
3-8

Rev:
A

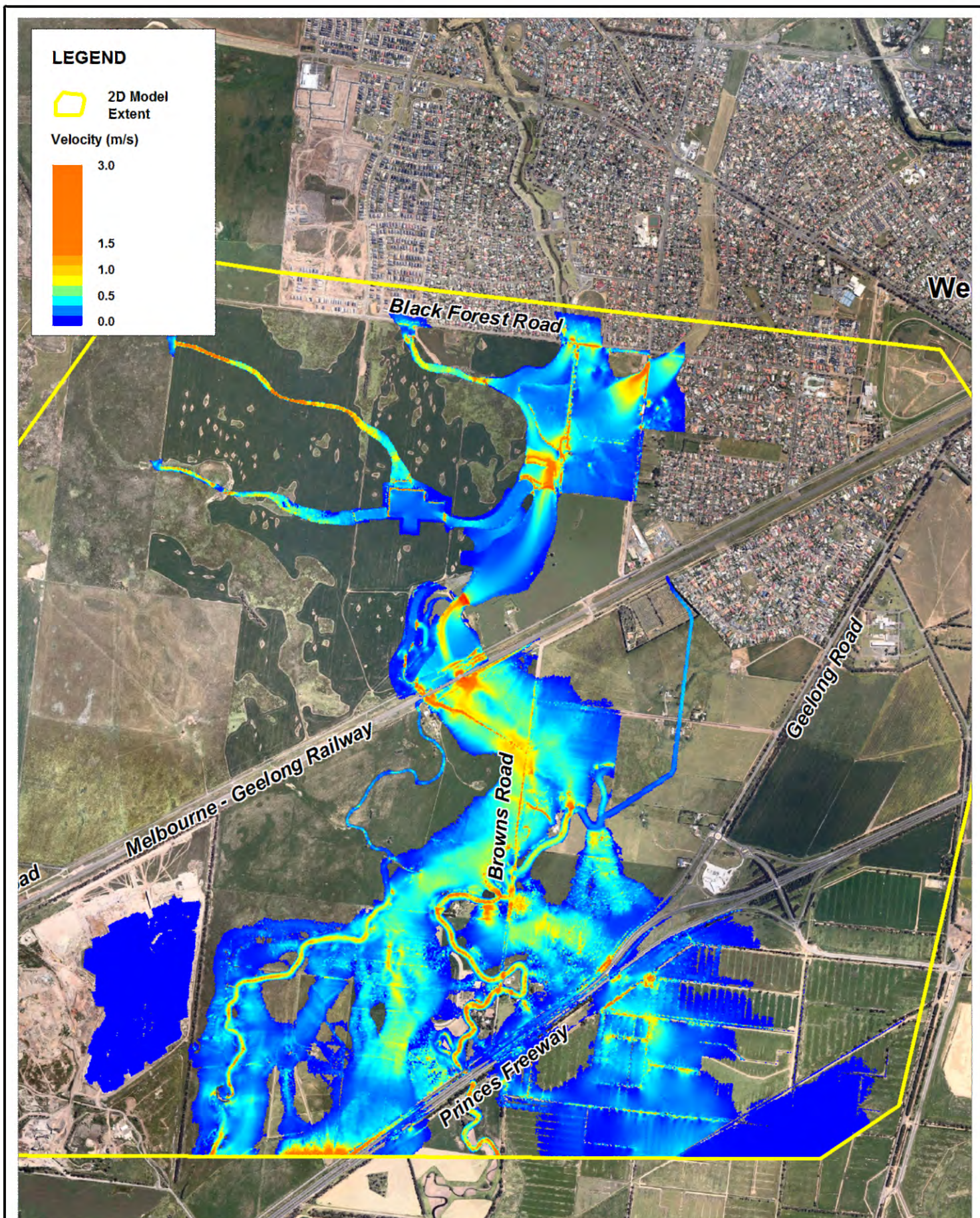
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0 0.5 1km
Approx. Scale



Filepath : T:\M8406.JL\PSP40_PSP43_Assessments\MapInfo\Drawings\PSP43\Fig3-8_1%_PeakVelocity_E23_RevA.WOR



Title:
Peak Flood Velocities under Developed Conditions

Figure:
3-9

Rev:
B

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Approx. Scale

4 DISCUSSION

4.1 Flood Impacts

The results from this analysis show that the development of the PSP43 region (Figure 3-5) will result in no significant impacts to the land surrounding the PSP43 site. Some decreases in flood levels are observed downstream of the PSP43 site and a minor flood level increase is evident. These changes in flood levels are due to changes to the flow behaviour downstream of the PSP43 site due to the presence of the drainage channel through the site.

4.2 Limitation of the Assessment

There are a number of limitations to the assessment that has been undertaken that need to be considered when reviewing the results presented in this report. These limitations include:

- The hydraulic modelling is based upon boundaries provided to BMT WBM by Alluvium from the Lollypop Creek RORB model. Future changes to the Lollypop Creek catchment that influence the RORB model and result in changed flow hydrographs will impact the results of the hydraulic model.
- The influence of the Werribee River diversion has been accounted for in the Lollypop Creek RORB model. BMT WBM has assumed that the representation of this diversion is correct.
- The hydraulic model does not account for any increases in runoff as a result of development of PSP43. However, it is understood that development controls would limit runoff from any future development to existing conditions.
- The hydraulic modelling includes the flood modelling of the site immediately north of the railway line. This data included is sourced from a Mike Flood model of the site provided by Alluvium and is assumed to be representative of the planned development of the Delfin land.
- The hydraulic modelling does not account for any influence of either Westbrook Drive or the Regional Rail Link on flooding in the Lollypop Creek floodplain.
- The hydraulic modelling is based upon a single storm duration, the 36 hour event. Whilst this may be critical for Lollypop Creek itself, other events will need to be analysed to determine the flood impact of PSP43 during a range of 100 year ARI storm durations.
- The hydraulic modelling does not include any internal drainage details of the PSP. Internal drainage networks, including floodways and retarding basins, have the potential to change the flood impacts observed external to the PSP site, however, only further modelling will be able to determine this.
- The modelling has assumed flows upstream of the PSP43 site will be diverted through the PSP43 site and associated drainage infrastructure. This is a conservative approach to determine the flood impacts downstream of PSP43.

4.3 Future Assessments

PSP43 will require additional modelling to address potential internal flooding issues and ensure that the internal drainage system adequately addresses the external flood impacts. Future modelling will also need to determine the impact, if any, of other storm durations on the flooding in and around PSP43.



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Appendix C. Melbourne Water Setbacks discussion

Hi Kane,

Here are some more words around the setback required for the Werribee River from the draft MW Waterway Corridor Guidelines:

Overall setback width (m)	Core riparian zone width (m)	Vegetated buffer width (m)
50 m	40 m	10 m

The setback for the Werribee West Drain is dependent on:

The setback that applies to a waterway at a particular location depends on the position of the site in the stream channel network. The underlying principle is that smaller waterways require a smaller setback to meet the objectives for setbacks, larger streams require a larger setback and major waterways require the largest setback.

The Strahler stream ordering system^[1] is used to define a particular location in the stream channel network. The Strahler stream order is a simple method of defining stream size based on a hierarchy of tributaries. A small stream with no tributaries is defined as a first order stream. When two first order streams come together, they form a second order stream. When two second order streams come together, they form a third order stream. Streams of lower order joining a higher order stream do not change the order of the higher stream, so if a first order stream joins a second order stream, it remains a second order stream.

The stream order is used to define the setback that applies to a development site in a particular location in the Port Phillip and Westernport stream channel network. The three categories of setback width are assigned to stream orders as follows:

1. First and second order streams have a minimum 20 m setback on both banks
2. Third order streams have a minimum 30 m setback on both banks
3. Fourth order and greater streams have a minimum 50 m setback on both banks

A 10m vegetated buffer would also be included in the above setback corridors.

Words to describe the above setback sub-zones from the draft MW Waterway Corridor Guidelines:

The core riparian zone is fully vegetated with native vegetation. The core riparian zone provides the main river health and biodiversity functions of the riparian buffer. It is the area immediately adjacent to the waterway, and the vegetation in this zone provides the shading, nutrient and wood inputs to the stream required for healthy instream ecosystem function.

The vegetated buffer protects the core riparian zone from edge effects that will impact on vegetation and fauna in the core riparian zone. These edge effects include:

- Weed invasion from adjacent areas

^[1] Strahler, AN, 1953 'Hypsometric (area altitude) analysis of erosional topology'. Geological Society of America Bulletin, 63(11), 1117 – 1142.

- Light penetration
- Micro-climate changes
- Litter/pollution
- Trampling

A 10 m wide vegetated buffer running immediately adjacent and parallel to the core riparian zone is required to protect the core riparian zone for all three standard widths.

Here are some more words around the area to measure the setback from:

The setback is measured from the physical top of bank. This is defined as the point at which the waterway channel and floodplain meet. In many instances it is straightforward to identify as there is a clear change in slope between the steeper channel bank and the flatter floodplain.

I think the above physical description is better than describing the LIDAR method or the two year flow level for these areas. Also happy for MW to be referenced to provide top of bank guidance.

I also think that the most important principle is that where the Q100 is greater than the measured standard setback, the Q100 should be applied as the waterway corridor.

The above is a very simplified method and condenses months of work and the draft setback guidelines. Obviously more ideal that the guidelines were finalised and made public but hopefully not too far off on this.

I'll give you a call to discuss.

Thanks

Mat

Mathew Kinred | Program Leader, Maintenance and Minor Capital - West | **Melbourne Water**

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Working together to ensure a sustainable water future.

From: Kane Travis [<mailto:Kane.Travis@alluvium.com.au>]
Sent: Monday, 31 October 2011 10:15 AM
To: Mathew Kinred
Cc: Megan Jericho; Alanna Wright
Subject: RE: Further inquiries from Alluvium

Hi Matt, I will give you a ring about this, but in order to keep the paper trail on this discussion I have made a couple of comments on your comments. I need to produce a report this week and I do need to nail down exactly what I can tell GAA as part of the PSP product at this time.

I have included the words I will put in our report based on where we have got to so you can see what we are saying

The one thing I am still not clear on is how I actually get lines on a map to clearly communicate there the CRZ is. I need to turn this around over the next few days and either I have to;

- default to the Q100 with words that this may change with the progression of MW setback policy
- Not provide a definitive line, but provide a clearer method that the GAA and developers can understand in regards to setting future setbacks
- formally submit the map with all surface water alignments to you shown and request MW provide a line on the map to document the CRZ.

Thanks, I will ring today

Cheers

Kane

From: Mathew Kinred [<mailto:mathew.kinred@melbournewater.com.au>]
Sent: Friday, 28 October 2011 9:50 AM
To: Kane Travis
Cc: Megan Jericho; Alanna Wright
Subject: RE: Further inquiries from Alluvium

Hi Kane,

I've gotten some further clarity from Leigh Mitchell (he's working from the US sporadically until December). There's still some work and consultation to do on the guidelines so they are draft and the answer below are based on this premise.

In terms of the questions below:

1. You are right, under the draft guidelines; the Q100 becomes the setback distance where it is greater the standard setback (derived using the Strahler order, etc). I'm not sure which is larger for the Werribee River and Werribee West Drain (standard setback or Q100).
2. As above, and as per previous response, there is potential for assets to be located within the CRZ, however, this is dependent on a range of different considerations

(threatened flora/fauna, flooding, Councils opinion on placement of POS assets etc). As the area between the Q100 and the standard setback would still be classed as “vegetated buffer”, the same principle of minimising assets is valid. For the Werribee River and Werribee West Drain the standard setback would be from top of bank (using LIDAR). This LIDAR mapping is something that MW will be working through for all waterways in the greenfield areas. **Words in our report:** The area between the Q100 and the CRZ is classed as the ‘vegetated buffer’ and similar to the location of assets within the CRZ, any assets should minimise impact. Where the asset is designed to minimise impact on the vegetated buffer area, does not impact on threatened flora and fauna, does not raise flood levels and is not degraded by flooding, and is supported by Council then it would be appropriate. **Sounds good, just might need to add further detail above on the setback sub-zones.**

- 3.
4. Maintenance tracks (where no shared pathway) may still required as they enable us to reduce our cultural heritage risk and costs. We can look at this on a case by case basis though where there is no shared path proposed. GAA are seeking clarity on MW’s need for the provision of an maintenance track to build into the PSP, but I am still actually not sure what your definitive position is. **Words in our report:** Our discussion with Melbourne Water indicates that where there is no shared path proposed Melbourne Water may require a maintenance track but does not at this time specifically request its provision in the PSP. The need for any maintenance tracks will be looked at on a case by case basis as the development progresses. **If looking to lock something into the PSP then it is “MWs preference that a track is provided to enable access for ongoing maintenance of the waterway and waterway corridor” under the PSP – where this is incorporated with a shared path MWs Shared Pathway Guidelines should be followed.**
5. I believe there is some flexibility but overall functioning of the corridor needs to be maintained and any assets in the CRZ may cause narrowing. However, there is the potential to increase the setback on the opposite bank to compensate for this. This is probably the most difficult **Words in our report:** Stormwater assets are permitted to be located in the core riparian zone, but should be a small proportion. The approval of any stormwater assets (wetlands, bioretention, infiltration systems) is dependent on the developer demonstrating to Melbourne Water that the overall functioning and integrity of the corridor (CRZ) is maintained. **Agree.**

Thanks

If you’re after a copy of the Growling Grass Frog Sub-Regional Strategy you’ll need to contact DSE as it is confidential at the moment. However, there certainly will be implications in terms of setback width and where assets can be located. The GAA are aware of this ongoing work.

Thanks

Mat

Mathew Kinred | Program Leader, Maintenance and Minor Capital - West |
Melbourne Water

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From: Kane Travis [<mailto:Kane.Travis@alluvium.com.au>]
Sent: Wednesday, 12 October 2011 4:14 PM
To: Mathew Kinred
Cc: Megan Jericho; Alanna Wright
Subject: Further inquiries from Alluvium

Thanks Mat,

Can I pls just clarify a couple of things.

1. I understand that MW's position is the setback requirement is dictated by the 100 year ARI and that this will apply consistently to both the Werribee river and Werribee West Drain.
2. The term 'core riparian zone' is more recent terminology, but I am not sure how it relates to the 100 year ARI of the Werribee river and Werribee West Drain. I understand the areas between the core riparian zone and 100 year ARI extent can be used for open space assets that do not impact on flood flows. Can you please advise specifically on the distance of the core riparian zone (& where it starts from , top of bank, 2 year ARI, waterway centre line, etc) for the Werribee river and Werribee West Drain.
3. It is noted that MW does not require an access track in these areas, but does have construction guidelines if there is anything to be built that supports maintenance vehicles. Just to clarify – if no one wants to build a formalised track at all, MW is happy with that outcome.
4. I understand that stormwater assets can be located in the core riparian zone, but should be a small proportion. Could you please provide some further advice on what this may mean in reality, or is it up to the development authority/developer to articulate it does not degrade the ecological function at time of application for a permit from MW ?

Thanks

Kane

From: Mathew Kinred [<mailto:mathew.kinred@melbournewater.com.au>]
Sent: Wednesday, 12 October 2011 3:32 PM
To: Kane Travis
Cc: Megan Jericho; Alanna Wright
Subject: FW: Setbacks on the Werribee River

Hi Kane,

Thanks for the opportunity to comment on this PSP. Hopefully the advice below is what you are after.

Give us a call if you are after any clarification.

Thanks

Mat

From: Alanna Wright
Sent: Wednesday, 12 October 2011 1:51 PM
To: Mathew Kinred
Subject: FW: Setbacks on the Werribee River

Hi Kane,

There are few elements that might influence the setbacks for The Werribee River and the Werribee West Drain outside the River Health perspective, for this area in particular the flooding considerations may alter some of the principles behind setbacks. Outside Melbourne Water there are other factors that might influence decisions such as the Growling Grass Frog Sub-Regional Strategy (currently in Draft form) that will determine Strategically Important Habitat Areas and Linkages and may also specify assets that will be restricted from within the setbacks.

Therefore I've taken some sections from the Melbourne Water - Waterway Vegetation Corridors guidelines (Draft) that state principles purely from a River Health perspective but may still be under EPBC legislation and will need to be formally approved by DSE for specific sites. This may guide you in some of your questions.

In situations where the waterway corridor width is to be less than the width of the 100 year ARI flood extent the waterway corridor and riparian sub-zone widths will be as specified in these guidelines. There will be an additional distance between the waterway corridor and the urban development line required to accommodate the 100 year ARI flood extent so that the overall corridor is sufficiently wide to accommodate this extent. The 100 year line effectively sets the waterway corridor boundary. The difference could be used as public open space, for example.

Every effort should be made to locate underground services such as power, water and sewerage outside the core riparian zone to maintain the integrity of waterway function. Similarly, sports ovals, playgrounds, and maintenance tracks should also be located outside the core riparian zone, as they may create a barrier to faunal movement, despite being vegetated.

Wherever possible, shared pathways should also be located outside the core riparian zone and should meet the standards defined in Shared Path Guidelines (available on the Melbourne Water website). While Melbourne Water has a strong preference for the assets and features listed above to be wholly located outside of the core riparian zone, partial placement of assets within this zone will be considered in situations where this is not possible or where a clear benefit to the community and/or environmental health can be demonstrated.

Stormwater treatment systems such as constructed wetlands and bioretention systems can be located within the core riparian zone but should form a relatively small proportion of the area of the core riparian zone so as not to degrade its ecological function.

Melbourne Water would generally not require access tracks to the riparian area for weed control – however, shared paths should be constructed to allow vehicle use (when necessary) that will be sufficient for our maintenance. AAV generally restricts vehicle access unless specified in a CHMP in Culturally Sensitive Zones so we would tackle this on a case by case basis.

The revegetation question is not predominately a River Health question as revegetation in channels and flood zones may affect the inundation length and height. If the proposed revegetation is based on native, indigenous EVC listed species and densities Melbourne Water would review the planting schedule and placement for the specific site but generally a re-establishment of native vegetation for habitat purposes is encouraged.

I hope this helps you.

Cheers,

Alanna

From: Kane Travis [<mailto:Kane.Travis@alluvium.com.au>]

Sent: Wednesday, 5 October 2011 4:38 PM

To: Mathew Kinred

Subject: FW: Setbacks on the Werribee River

Hi Mathew, a bounce from Leigh. Are you the right person to chat to ?

Cheers

Kane

From: Kane Travis

Sent: Wednesday, 5 October 2011 12:37 PM

To: 'leigh.mitchell@melbournewater.com.au'

Subject: Setbacks on the Werribee River

Hi Leigh

Just a follow up on my call and message. You were suggested as the best person to talk to by Graham Daff.

I am not sure of where you are up to in the finalisation of the set back policy, but we are trying to lock down some bits and pieces for the Growth Area Authority and one aspect is MW setback requirements in the area called PSP 40 (attached map)

PSP 40 has a boundary on the Werribee river and a Werribee West Drain running through it. We have the opportunity to lock down the setbacks as part of the PSP process and I would like to discuss with you;

1. What is the MW set back requirement for the Werribee river and a Werribee West Drain ?
2. Will there need to be provision made for a Melbourne Water access path ?
3. Can developers locate water treatment assets in the reserve (wetlands/WSUD) ?
4. Can developers locate playgrounds or other community assets in the reserve
5. Does Melbourne Water have any objection to revegetation of this area with major canopy (based on EVC's)

Could we pls have a chat about these when you get a chance

Thanks

Kane