



Development Victoria

621 Burwood Highway, Knoxfield

Preliminary Stormwater Management Strategy

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1 INTRODUCTION

Engeny Water Management (Engeny) was engaged by Development Victoria (previously Places Victoria) to review the current onsite stormwater conditions and provide recommendations regarding the stormwater and drainage requirements of the future residential and mixed use development of the site at 621 Burwood Highway, Knoxfield. Figure 1-1 provides an overview of the development location.

621 Burwood Highway, Knoxfield is the disused Institute of Horticultural Development site. Commercial and industrial properties are located to the west and the DELWP Precinct is located to the site's immediate south-west. The Fairhills High School and residential properties lie to the east of the site.

The site is bounded to the north by the Blind Creek waterway. A large dam, spanning approximately 1.4 hectares is situated in the site's north-west corner and connects to the waterway corridor. Currently, this dam provides a water storage function, with limited treatment. The dam was built for water supply for previous use of the site for agricultural purposes. Ecological studies of the site (Ecocentric Environmental Consulting, 2015) have identified the presence of the endangered, Victorian Flora and Fauna Guarantee Act 1988 (FFG Act) listed Blue Billed Duck within this dam. Given the sizeable portion of land currently occupied by the dam and a number of significant existing problems with the dam, Engeny has considered future options for the dam as part of this study.

This report proposes a stormwater management strategy for the site that will achieve multiple benefits for the existing community, open space, the environment and future residents of the site. Aspects of the proposed layout in relation to water management that are described in this report include:

- Improved habitat
- Improved open space
- Improved public access
- Integrated water management to reduce potable water demand, reduce wastewater discharges and reduce stormwater discharges
- Improved integration of Blind Creek and it's corridor with the site
- Improved stormwater quality (the layout includes provision of a system to treat stormwater runoff from the new development, in accordance with the *Urban Stormwater Best Practice Environmental Management Guidelines* (BPEMG)).



This report was first prepared in 2017 but has been updated based on the revised design work by PGA, updated master planning and to account for the update to Australian Rainfall and Runoff. The general concept for treatment is still largely unchanged.

Figure 1-1: Knoxfield Development Locality Map



Legend

- ▭ Site Boundary
- ▭ Watercourse
- Parcel Boundary
- Roads

<p>Suite 15, 333 Canterbury Rd, Canterbury VIC 3128 PO Box 452 Canterbury VIC 3128 www.engeny.com.au P: 03 9888 6978 F: 03 9830 2601</p> 	 <p>Scale in metres (1:2500 @ A3)</p> <p>Map Projection: Transverse Mercator Horizontal Datum: Geocentric Datum of Australia Vertical Datum: Australia Height Datum Grid: Map Grid of Australia, Zone 55</p>	<p style="text-align: center;">50 0 50 m</p> <hr style="width: 100%; border: 0.5px solid black;"/> <p style="text-align: center;">621 Burwood Highway, Knoxfield</p> <p style="text-align: center;">Stormwater Management Plan Locality Map</p> <div style="float: right; border: 1px solid black; padding: 2px; font-size: 0.8em;"> Job Number: V6000_002 Revision: 0 Drawn: VW Checked: GO Date: 17/5/2017 </div>
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2 STORMWATER QUANTITY MANAGEMENT

The proposed development will comprise of medium density residential development mixed with open space reserves over most of the site with a mixed use precinct at its southern end and an area for water treatment and habitat adjacent to Blind Creek as shown in Figure 2-1.

Figure 2-1: Proposed Knoxfield Development



2.1 MINOR DRAINAGE SYSTEM

The minor drainage system will consist of a subsurface pipe network designed to capture and convey all stormwater runoff generated from the catchment for rainfall events up to and including the 10 % AEP (annual exceedance probability) design storm (1 in 10 year ARI).

As the local catchment is less than 60 ha, the system will be designed in accordance with the Knox City Council Stormwater Drainage Guidelines.

Allowance will be made for the conveyance of the external catchments in the pipe drainage network. There is a 28 hectare external catchment entering the development area at the rear of the Fairhills High School in an 825 mm diameter drain. The flow from this external catchment will be piped through the development area.

It is anticipated that the pipe network will discharge to Blind Creek upstream of the existing pedestrian footbridge over the creek. This discharge will be via a proposed Water Sensitive design / habitat system to treat stormwater from both the development site and the external catchment, allow for stormwater harvesting and habitat and minimise impacts on Blind Creek and downstream waterways.

2.2 MAJOR DRAINAGE SYSTEM

The primary objective of the major drainage system is to provide flood protection for the allotments based on the 1 % AEP (1 in 100 year ARI) storm event and to ensure that the overland flow can be safely conveyed through the development. This will be via overland flow paths contained within road reserves prior to discharging into Blind Creek. Flow computations indicate that overland flows generated in a major storm event can be safely conveyed within the road reserves.

The dwellings created as part of the development will also need to be constructed with 600 mm freeboard to the 1 % AEP flood levels within Blind Creek.

The existing dam provides some retardation of peak flows from the existing catchment. The effect of this dam on existing condition peak flow rates is summarised in section 2.3. When the site develops a retarding basin will be required to ensure that the peak flow discharged from the site does not increase in the 1 % AEP event based on existing conditions discharge rates, taking into account the retardation that the existing dam provides.

A catchment plan is contained in **Appendix A**.

2.3 HYDROLOGIC MODELLING

Engeny utilised the hydrologic modelling program RORB in accordance with Australian and Runoff 2019 guidelines (ARR 2019) to calculate initial and developed conditions stormwater peak flows into Blind Creek. Refer to Knoxfield Development Stormwater Management Rev 7 report for findings in accordance with ARR 87 guidelines. Four scenarios were modelled as follows:

- Existing development model – to estimate a baseline flow for the catchment
- Existing development model with dam storage – to estimate the current level of water storage provided by the northwest dam and existing peak discharge
- Future development model – to estimate the increase in flow due to the Knoxfield development
- Future development model with wetland/retarding basin – to estimate the approximate storage required in a retarding basin to offset runoff from future development.

RORB simulations were undertaken for all durations of a 1 % AEP event using the runoff coefficient method. **Appendix A** contains details of the parameters utilised within the various RORB models.

Two existing development scenarios were modelled, one inclusive of a storage feature to represent the existing dam. Table 2-1 summarises the results of the two existing development scenario models.

Table 2-1: 1 % AEP Event Existing Conditions Scenario with Dam Results

Peak Outflow from No Storage Model (m ³ /s)	Peak Outflow from existing Dam Model (m ³ /s)	Peak Storage Provided within Existing Dam (m ³)
6.2	3.6	7,090

Two future development scenarios were modelled to determine the increase in peak stormwater flow due to the development, and to provide preliminary estimation of the requisite sizing for water storage assets. Table 2-2 summarises the final simulation outputs for the modelled future development scenarios.

Table 2-2: 1 % AEP Event Proposed Development Scenario with Wetland/Retarding Basin Results

Peak Outflow from No Storage Model (m ³ /s)	Peak Outflow from Wetland Storage Model (m ³ /s)
7.0	3.4

Storage assets for the development scenario were iteratively sized to produce a peak outflow which was equal to or less than the existing conditions peak outflow. The modelling assumes that the wetland is full to the extended detention depth level and so no storage below this level is considered for flood mitigation purposes.

The modelling indicates that 7690 m³ of active storage within the wetland/ retarding basin would be sufficient to meet the flow targets. This is only slightly more than is currently available in the existing dam up to its spillway level, however the wetland/ retarding basin is configured in a much more efficient manner. This allows for the lower flows to be discharged more quickly and the higher flows to be held back, so that only the peak of the hydrograph is being retarded. This can be achieved with a weir pit with a total weir length of 8 m and single 1200 mm diameter pipe discharging flows into Blind Creek.

3 STORMWATER QUALITY

The State Environment Protection Policy (Waters of Victoria) defines the required water quality conditions for urban waterways. The aim of stormwater quality treatment is to reduce typical pollutant loads from urban areas to Best Management Practices as defined in Table 3-1 and as required by Clause 56.07-4 of the Victoria Planning Provisions.

Table 3-1: BPEMG Environmental Management Objectives for Stormwater (CSIRO, 1999)

Pollutant	Performance Objective
Total Suspended Solids (TSS)	80 % reduction from typical urban load
Total Phosphorous (TP)	45 % reduction from typical urban load
Total Nitrogen (TN)	45 % reduction from typical urban load
Gross Pollutants (GP)	70 % reduction from typical urban load

Source: Urban Stormwater: Best Practice Environmental Management Guidelines – Victorian Stormwater Committee, 1999.

To meet these objectives, Engeny propose a stormwater treatment train comprising a sediment pond and wetland, with treated stormwater flowing into a new waterbird habitat for the FFG Act listed Blue Billed Duck and other waterbirds.

The MUSIC model was designed with input parameters generally in accordance with Melbourne Water MUSIC Guidelines (2016), however the rainfall template used has been adjusted to one provided by Knox Council. **Appendix B** details the parameter inputs utilised within the MUSIC Model. The Fair and Geyer equation was used to size the sedimentation pond.

From this, it was determined that the combination of a 1,100 square metre sediment pond plus a 4,500 square metre wetland was sufficient to meet the water quality objectives for the development, as outlined in Table 3-2. The treatment system is designed to treat all runoff from the development site and has been sized to achieve best practice as if there are no external catchments flowing into the wetland. The results in Table 3-2 demonstrate that the wetland is achieving this objective. The proposed arrangement of the wetland system is shown in **Appendix C**.

Table 3-2: Treatment Train Effectiveness Development area only

Pollutant	Source (kg/yr)	Residual (kg/yr)	Percentage Removed
Total Suspended Solids	24090	4100	81 %
Total Phosphorus	48.5	14	69 %
Total Nitrogen	338	167	46 %
Gross Pollutants	4264	6	99.9 %

The wetland system will actually treat all of the runoff from the entire catchment, which includes existing developed catchments. There is no legislative requirement to treat runoff from any of the existing development catchment, however given the wetland is being constructed in a location where it can capture this flow easily, it will be treated by the wetland. Table 3-3 shows the pollutant removal that the stormwater treatment wetland and sedimentation basin achieve relative to the amount of pollutants generated by the development site. This tables shows that the development is removing significantly more pollutants than is required under the BPEMG Environmental Management Objectives.

Table 3-3: Treatment Train Effectiveness including external catchments

Pollutant	Pollutants generated by development site (kg/yr)	Pollutants removed by treatment system (kg/yr)	Percentage removed from development site
Total Suspended Solids	24090	29200	121 %
Total Phosphorus	48.5	48.7	100 %
Total Nitrogen	338	198	59 %
Gross Pollutants	4264	10141	238 %

A complementary treatment option that could be considered within the development area is the use of rainwater tanks to help to reduce the total volume of runoff from the development. Rainwater tanks could be installed or mandated on some or all dwellings and plumbed to the toilets and other appropriate locations where potable water is not required, like garden taps. This provides a constant reuse demand which reduces the total amount of stormwater runoff. By reducing the total amount of stormwater entering the drainage system there is also a corresponding decrease in the total amount of nutrients and sediment being discharged into the receiving waterways. The rainwater tanks are not proposed to be relied on to provide any flood mitigation storage and have not been included in the MUSIC modelling to date to ensure that they are not being relied upon to meet the performance targets.

3.1 WETLAND

A sedimentation basin of 1100 square metres and a stormwater treatment wetland of 4500 square metres are currently proposed. In addition to the stormwater treatment area of the wetland an additional 10,400 square metres of habitat wetland is proposed. This will provide a total wetland and sedimentation pond area with a footprint at the normal water level of 16,000 square metres. The current design allows for all of these areas to function as one large wetland area with a uniform normal water level. Water will enter the sedimentation basin in the east and then flow through the treatment wetland before passing through into the habitat wetland. This will deliver treated stormwater to the habitat wetland, improving the quality of water for the waterbirds currently using the site. The proposed wetland arrangement is shown in the functional design plans in **Appendix C**.

The sedimentation basin is separated from the wetland area to allow for more frequent maintenance without the need to disturb the wetland. A sedimentation laydown and drying area is also provided within the design. The stormwater treatment and habitat wetlands will appear to be the same continuous wetland area. A cutoff weir will be built at normal water level between the treatment area and the habitat area to allow for the treatment area of the wetland to be maintained without the need to drain the habitat wetland. Balance pipes with gate valves are also proposed between the two wetland areas to allow for even water levels to be maintained. The low flow and high flow controls on the water levels will occur in the habitat wetland near the creek to ensure that the wetland system does not short circuit (i.e. water will flow through the entire wetland system).

The design has been undertaken to minimise the required cut volume onsite while maximising the wetland surface area available. Care has also been taken to minimise the impact on the larger living trees within the northern area of the site. Two dead trees which have been identified as large or old trees will be impacted by the design. It is proposed to relocate these two dead trees into the habitat area of the wetland as part of the construction process. This would have significant habitat benefits and in the opinion of Ecocentric would actually increase the habitat value of the dead trees. As standing stags they would provide habitat for the birds using the site and even as the trees degrade further and eventually collapse would create habitat for native fauna such as frogs.

The stormwater treatment wetland will be heavily vegetated with 80 % macrophyte cover and 20 % open water. The sedimentation basin and habitat wetland area will be mainly open water. The first four meters (horizontally) from the normal water level will grade at 1 in 8 and will be vegetated with macrophytes. Beyond this all areas will be deeper open water. The sediment basin will be up to 1.5 metres deep whilst the habitat wetland will be 1.5 to 2 metres deep. This depth of water is proposed to ensure that an open waterbody is maintained and to allow for aquatic vegetation to establish and not be outcompeted

by the vegetation planted on the shallow edges. Shallower water in the habitat wetland would run the risk of vegetation cover increasing in this area.

3.1.1 Inundation Frequency

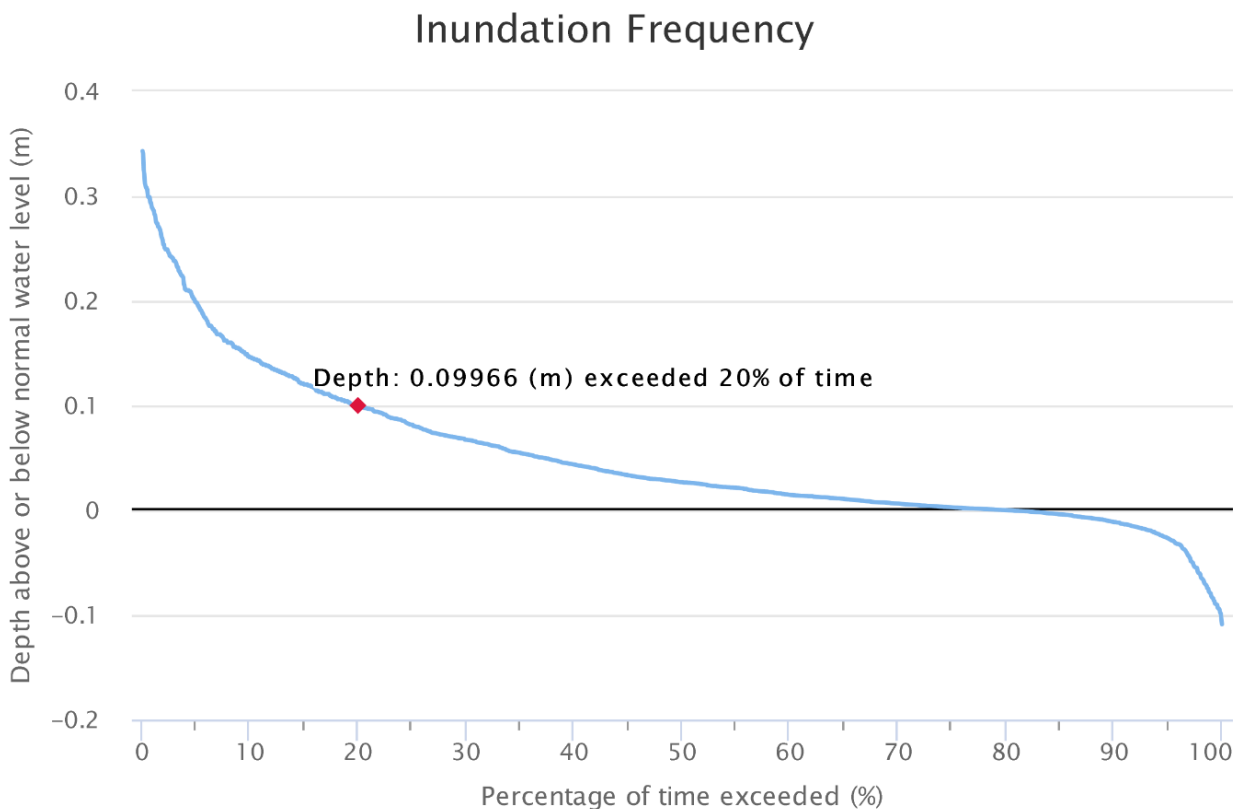
It is estimated that the total permanent pool volume of the wetland will be approximately 21,300 cubic metres. Analysis of the bathymetric survey data suggests that the volume of water storage in the current dam to spillway level is approximately 31,000 cubic metres. The existing dam is over 4 metres deep in some areas and so a reduction in total volume of water will be required as depths of 4 metres are not desirable in wetland systems. Additional information on the existing dam can be found in section 5.

A preliminary inundation frequency assessment has been undertaken on the whole wetland using cut volumes above normal water level from 12d and estimated permanent pool volumes based on proposed depths. The inundation frequency was assessed using Melbourne Water's MUSIC Auditor. A daily flux file was output for the wetland system which produced the results shown in Figure 3-1. In addition to the information displayed in the figure the:

- Water level exceeded for 20 % of time: 0.10 m
- Water level exceeded for 50 % of time: 0.0267 m. Effective water level is within 50 mm of normal water level and is acceptable
- 90th Percentile Residence Time: 8 days
- 300 mm depth in the wetland was exceeded for one day only, 13 times in the data set (10 years) analysed.

These results show that the proposed wetland setup provides an acceptable inundation frequency to provide conditions for healthy plant growth.

Figure 3-1: Inundation Frequency analysis



3.1.2 Construction staging

It is proposed that the construction of the habitat wetland occurs before the existing dam onsite is decommissioned. An establishment period would also be allowed so that the vegetation within the deeper waters of the habitat wetland are confirmed to be growing well and are healthy. This will allow the water birds that are currently using the site to transition from the existing dam to the new habitat wetland and will ensure that they will not be left without habitat during the construction process. It is expected that the construction and establishment period for the habitat wetland will take approximately 12 months. Ideally the construction would be timed to minimise the disruption to the breeding water birds at the site, however it is understood that not all water birds breed at the same time of the year and that disruption to some species is likely to be unavoidable. From an engineering perspective it would be easier if the earth moving stages of the construction could be timed to occur in summer or autumn when ground conditions will be easier to work with than in winter or early spring.

3.2 HABITAT CREATION

The existing dam on the site provides habitat for water birds and aquatic vegetation. The Ecocentric report (2017) notes that, *“water quality appears to vary at the site based on prevailing conditions, and was ostensibly relatively poor during winter surveys. Waters were very turbid during field surveys, and a thin ‘slick’ of a contaminant (i.e. hydrocarbon) was observed on part of the water surface on 5 July 2017”*. Currently the water in the dam receives no treatment prior to entering the dam. It is currently fed by an urbanised catchment of approximately 25 ha and approximately 20 ha of the existing horticulture site. The proposed wetland setup should improve the quality of stormwater entering the habitat wetland.

The Ecocentric report (2017) states that two Blue-billed Ducks, a listed species, are residing permanently at the site. It also notes that *“the site lacks the dense marginal vegetation and reed beds (i.e. for nest-building) that are generally associated with the successful breeding of this species (Marchant & Higgins 1990)”*. The report also states that Australian Wood Ducks and the Pacific Wood Ducks are breeding at the site. The proposed wetland system will significantly improve the available breeding habitat for waterbirds, with significantly more dense marginal vegetation and reed beds to be provided within both the treatment and habitat areas of the wetland. Dense screening vegetation would also be planted on the embankment batter slopes to discourage access to the wetland. This vegetation will also provide good habitat for native fauna.

3.3 ADDITIONAL BENEFITS OF WETLAND ASSETS

3.3.1 Integration and public use

The proposed sedimentation basin, stormwater treatment wetland and habitat wetland should be integrated into the development area. Consideration has been given as to how to encourage safe use of the wetland area for the public. There is currently a dual purpose access and maintenance path running between the sedimentation basin and the stormwater treatment wetland. This access path will provide an active link to the Blind Creek corridor. An additional path may be able to be provided on the western side of the sedimentation basin if this is required. A road will run along the southern boundary of the wetland and the existing Blind Creek Trial runs along the northern boundary. It is not proposed to provide a link along the eastern edge of the habitat wetland. This is at the advice of Ecocentric ecologists who have highlighted that providing a path in this location would increase the disturbance of the water birds that this habitat wetland is aiming to attract.

The advice from Ecocentric has been that minimising public access to the wetland will be beneficial for encouraging use of the area by waterbirds. The existing dam on the site currently has no public access and so the development of the site will inherently bring people and their pets closer to the creek corridor. Using dense vegetative screening around the edge wetland will help to minimise this disturbance and also create habitat for waterbirds and other animals.

3.3.2 Integrated Water Cycle Management

Consideration could be given to allowing harvesting from the wetland system. The total volume of water stored by the wetlands is very large (approximately 21 ML) and a small portion of this could be used for reuse in surrounding areas. A detailed water balance study would be needed to quantify the amount of water that would be harvested without negatively impacting on the function of the wetland area and to determine the reliability of supply to determine if this is feasible. The current design of the wetland would allow for stormwater harvesting if it is deemed feasible.

Possible demand for use of treated stormwater in the adjacent area could come from:

- third pipe system through the development
- Fairhills High School playing fields
- existing community garden on the northern side of Blind Creek
- open spaces within the development area.

In order to safely reuse the stormwater some additional treatment, such as ultra violet light filtration may be necessary.

4 FLOOD MODELLING OF BLIND CREEK

Blind Creek is a Melbourne Water managed waterway. Melbourne Water has indicated that flood modelling of Blind Creek for existing conditions and developed conditions of the site was required.

Melbourne Water provided Engeny with a RORB model and details of the Melbourne Water drainage infrastructure within the creek corridor to use in the flood modelling. Using this information and Lidar data Engeny has created a Tuflow model of Blind Creek from Scoresby Road to Lewis Road. Details of the RORB modelling and the Tuflow modelling techniques are contained in **Appendix D**.

The RORB model shows that the peak flows on Blind Creek occur in the 2 hour event. The peak 1 % AEP flow is 41.8 m³/s. The full hydrograph from RORB has been used in the Tuflow modelling for both the existing and developed Tuflow models.

A fixed tailwater level was used for the modelling set at the 1 % AEP flood level supplied by Melbourne Water downstream of the development site. This boundary condition provides a conservative estimate of downstream flood levels.

4.1 EXISTING CONDITIONS

For the existing conditions model it was assumed that the existing dam was full to its spillway level of 77.54 m AHD.

Appendix E shows the results from the Tuflow flood modelling for the existing conditions.

The Tuflow modelling results show that the dam embankment is overtopped and that there is flooding in the neighbouring industrial precinct to the west. There is a significant hydraulic control at the point where the Blind Creek Trail crosses over Blind Creek. At this point there is a drop structure and the low flows in the waterway are piped downstream of this point.

The estimated total volume of floodplain storage on the site is 21,000 m³.

Melbourne Water has provided flood levels for the subject property. These flood levels are recorded in the north west and north east corners of the property. Table 4-1 shows the flood levels provided by Melbourne Water and a comparison to the results from the Engeny flood modelling. The table shows that there is a good match between the two sets of flood levels.

Table 4-1: Flood level comparison

	North West Corner (m AHD)	North East Corner (m AHD)
Melbourne Water flood level	77.0	78.85
Engeny existing conditions flood level	77.06	78.88

4.2 DEVELOPED CONDITIONS

The same base Tuflow model was used for the developed conditions as the existing conditions. The hydrology was unchanged, as were the Manning's n roughness values in Blind Creek and all other areas not impacted by the development works.

The proposed wetlands were modelling using a design DEM from 12d to represent the surface of the proposed wetland. It was assumed that the wetland was full to normal water level at the start of the flood simulation. It was also assumed that all areas of the development site south of the proposed wetland would be filled at least 600 mm above the flood level.

Appendix E shows the results from the Tuflow flood modelling for the developed conditions and also shows an afflux map showing the differences in flood levels between existing and developed conditions.

The modelling shows that there is no change in flood levels upstream of the development area. This includes the neighbouring residential area directly to the east of the development area. The modelling also shows that there is a reduction in flood levels in Blind Creek adjacent to the development area, as a result of the increased storage provided in the floodplain by the new wetland. Downstream of the proposed wetland the modelling shows that there is an increase in flood levels within the waterway

and a decrease in both the flood level and the area flooded in the adjacent industrial areas. Directly downstream of the sedimentation basin there is a moderate increase in flood level over up to 0.2 metres but this is contained to the waterway corridor and dissipates back to zero within 75 metres.

In their predevelopment advice Melbourne Water stated that no increase in flood levels and no net loss of floodplain storage would need to be demonstrated for developed conditions. The proposed works increase floodplain storage but do increase flood levels in Blind Creek downstream of the site. Table 4-2 compares the floodplain storage during existing and developed conditions. It shows that available floodplain storage on the site is proposed to be increased by 12 600 m³.

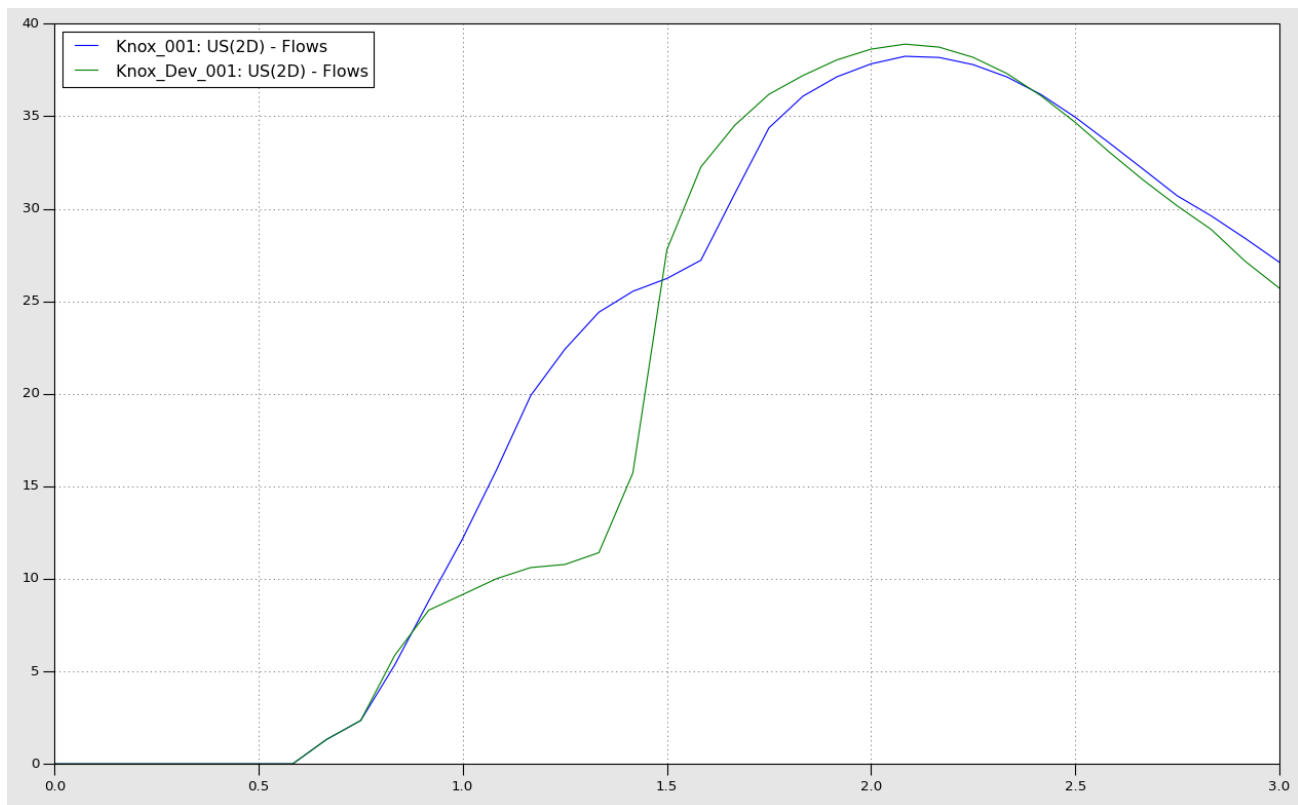
Table 4-2: Floodplain storage in 1 % AEP

	Floodplain storage (m ³)
Existing conditions	21 000
Developed conditions	33 600

The increase in flood levels in Blind Creek is occurring is due to a reduction in flooding of the industrial areas adjacent to the creek. In Engeny’s view this is an improvement on existing conditions as more water is being contained within the waterway corridor and additional properties are being protected from flooding by narrowing the flow path and preventing spills into the neighbouring industrial areas. It should be noted that the dam on the site is not a naturally occurring structure and that it is directly contributing to the flooding of some of the adjacent properties by artificially raising flood level upstream of the existing dam embankment wall.

Despite the increase in total floodplain storage there is also a slight increase in the peak flows recorded downstream of development area. Figure 4-1 shows the difference in the existing conditions hydrograph (blue line) and the developed conditions hydrograph (green line). The comparison shows that there is a slight increase in peak flows as a result of reshaping the floodplain, but that the total volume of flow discharging downstream is reduced (i.e. the area under the hydrograph is less under developed conditions).

Figure 4-1: Hydrograph from Tuflow modelling 360 m downstream of the development site



It is noted that the developed conditions flood modelling is based on a DEM from the Engeny 2017 wetland design. This developed case flood mapping will be updated once the current PGA design has been further progressed. It is not expected that there will be any significant changes once the updated design is modelled as the design concept is very similar and achieves similar volumes of excavation and cut within the site.

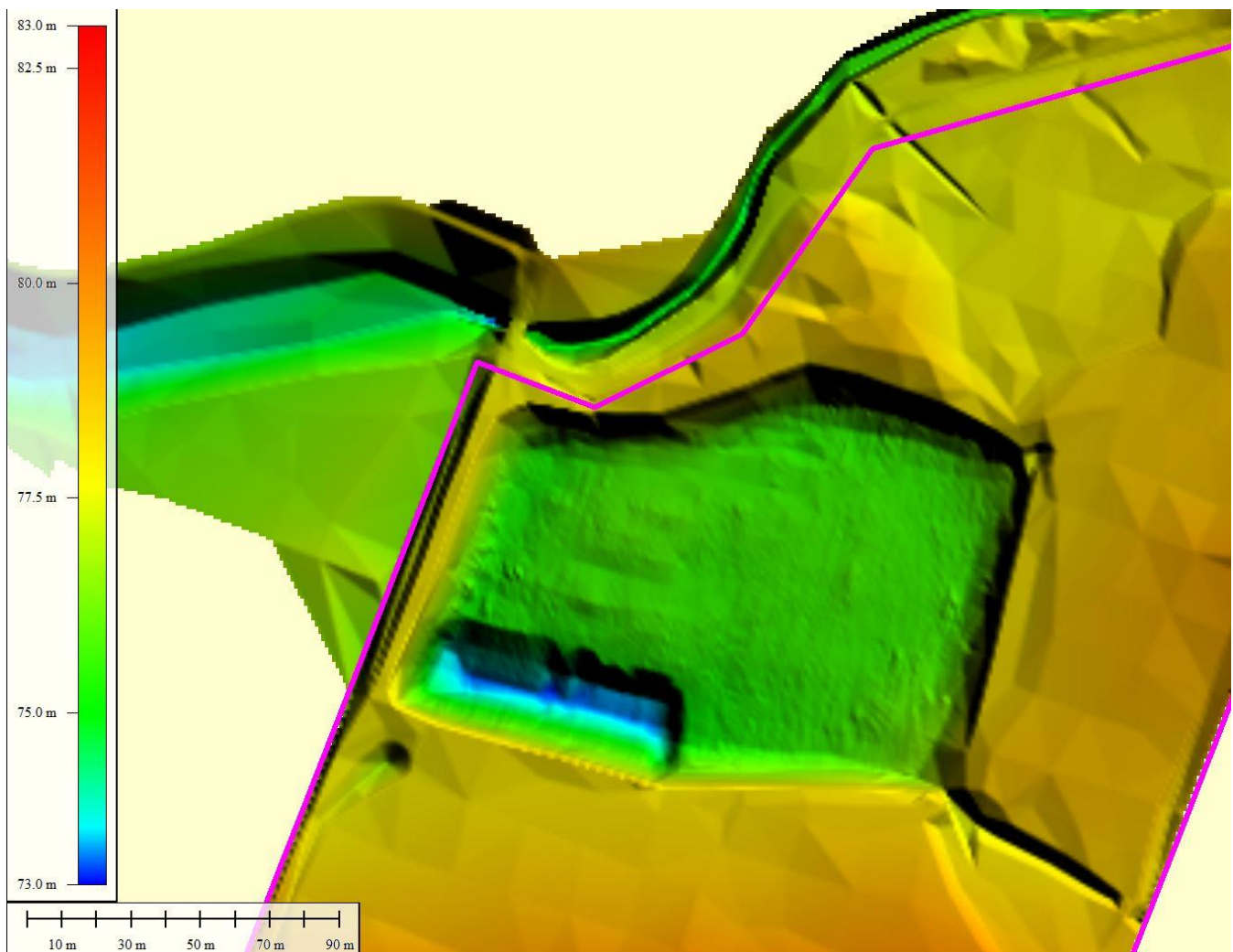
5 EXISTING DAM

A preliminary biodiversity assessment was undertaken by Ecocentric Environmental consulting (2015). The report found that *"the wetland at the site is large in area and provides habitat for wetland birds, including the threatened Blue-billed Duck, which was recorded on site during the current assessment. Any proposal to impact the wetland at the site, through the complete removal, re-design or any other wetland modification, should be undertaken with careful consideration, and planning and in consultation with an ecologist in order to avoid and minimise impacts to significant wetland species (both flora and fauna taxa)"*.

In its current form the existing dam is not engineered to provide stormwater treatment. It also currently receives untreated stormwater from the upstream urban catchment. Stormwater treatment wetlands require large areas of shallow water with a high proportion of vegetation cover. They also require gently sloped ephemeral banks which can be subject to regular wetting and drying to assist in sediment and nutrient removal. Given that the dam is over 4 m deep in some parts regrading the internal floor of the dam to be in the order of 1 - 0.5 m deep will require significant filling. Figure 5-1 shows the topography and bathymetry of the dam and surrounding area based on survey undertaken in July 2017.

Maintaining the dam on the site poses a number of challenges and it is likely that better environmental outcomes could be achieved through the removal of this dam and construction of water bird habitat in the adjacent area rather than retrofitting the dam to provide stormwater treatment.

Figure 5-1: Topography and bathymetry of the existing dam based on survey data



5.1 CURRENT CONDITION OF THE DAM

The Dam Condition Assessment Report by Engeny 2017 provides details on the current condition of the dam. The condition of the dam is summarised in that report as follows:

Based on the site inspection observations the dam is currently considered to be in fair to poor condition. A number of existing defects / deficiencies were identified which have the potential to lead to dam failure in time if left to progressively deteriorate without intervention.

The desktop failure modes assessment identified that the existing spillway doesn't have capacity to pass even the 63 % AEP event. This is significantly lower than the minimum spillway capacity of 1 % AEP recommended by industry guidelines (ANCOLD) for even low consequence category dams. Overtopping of the dam embankment crest would be expected to occur on a regular basis, which significantly increases the likelihood of dam failure.

The conclusions and recommendations of the dam conditions report state the following:

The Dam is not currently considered fit for purpose and would only be considered to be suitable for on-going use if the following upgrades / remedial works are completed:

- *Upgrade the spillway to provide capacity to convey, as a minimum, the 1 % AEP rainfall event plus the 10 % AEP wave freeboard. To provide the recommended spillway capacity will require raising or relocation of the existing dam embankment. Raising the embankment to ensure that it is not overtopped in a 1 % AEP event may impact on flooding behaviour within Blind Creek and could increase flood levels within the creek in a 1 % AEP event. This would need to be investigated and any increase in flood levels approved by Melbourne Water*
- *Undertake the following remedial works to repair existing dam embankment defects:*
 - *Modify existing uneven embankment surface levels (ruts, depressions, etc) to reduce the likelihood of rill erosion due to concentrated runoff*
 - *Repair longitudinal cracks*
 - *Repair void in downstream shoulder adjacent to pit*
 - *Repair existing erosion on downstream batter in north-west corner of dam and stabilise embankment*
 - *Protect the upstream batter slope from further erosion / steepening / slumping.*
- *Develop an operational plan for the Dam which defines roles and responsibilities, surveillance, monitoring and maintenance requirements.*

5.2 REMOVAL OF THE EXISTING DAM

The key reasons for removing the dam are that the:

- Embankment is of unknown construction materials and quality
- The current condition of the dam is fair to poor. It is unlikely that Council would consider accepting the dam as their asset to manage in its current condition
- The dam does not have a spillway with adequate capacity to pass even moderate rainfall events, with the capacity estimated to be exceeded a 63 % AEP event (1 year ARI)
- The dam embankment is very close to the existing development to the west and the water level is above some of the development, creating a potential issue should the dam embankment fail
- The dam fills with untreated stormwater and its current design is not suitable to provide stormwater treatment. Retro fitting the existing dam to provide stormwater treatment will have a significant detrimental impact on the existing fauna and flora current at the site during construction as heavy earth moving equipment will be required to be used in the dam to flatten the batters on the dam edges. The existing normal water level of the dam (77.54 m AHD) and the incoming invert of the pipe for Fairhills High School (77.88) will make it difficult to provide stormwater treatment upstream of the existing dam but within the development area as there is very little fall between these two points
- The dam provides limited flood storage as it is usually full to full supply level

- The steep batter slopes of the dam below the normal water level do not comply with safety requirements for urban public water bodies. Guidelines from the Royal Life Saving Society Australia (2004) state that safety benches with a maximum grade of 1:8 (V:H) for the first 1.5-3.0 m from the edge of the bank are required prior to transitioning to steeper grades. It also states that the *“safety bench shall be densely planted such that casual entry will be difficult and that depths gradually increase beyond 150-200 mm before deepening.”*

Engeny has discussed the existing dam with [REDACTED] from Ecocentric Environmental Consulting. [REDACTED] agreed that the current dam is not configured to provide stormwater treatment, and that the works that would be required on the dam to retrofit it to be able to provide the necessary stormwater treatment would be a significant disturbance to the existing fauna and flora. Heavy earthmoving equipment would be required to operate in and around the edge of the dam to create safer shallower batter slopes and the water quality within the dam would be significantly impacted during this works period. The option of constructing a new stormwater treatment and wetland habitat adjacent to the existing dam has the potential to minimise the disturbance to the existing fauna on the site as the construction will be staged so that the new wetland is built before the existing dam is filled in.

6 STORMWATER MANAGEMENT PLAN

This stormwater management plan for 621 Burwood Highway Knoxfield has been developed following discussions with Development Victoria, Knox City Council, Melbourne Water and Ecocentric Consulting. This plan represents a considered design response, however additional minor changes to the operation scheme of the wetlands may be required within the proposed footprints. The review and changes will consider the relevant planning controls, both zoning and overlays, along with the requirements needed to meet the best practice targets for stormwater management.

The stormwater management plan for the site has been designed to:

- Achieve multiple benefits for the environment and the community
- Comply with all environmental requirements
- Solve a number of problems with the existing dam on the site, including the existing dam embankment, poor water quality in the dam, limited flood mitigation effect of the dam, proximity of the dam to Blind Creek and safety problems with the dam water body
- Provide improved habitat compared with the existing dam for all flora and fauna
- Provide public access to a significant new open space area within the site
- Treat runoff to significantly exceed the Best Practice target requirements for treating runoff from the site
- To provide an Integrated Water Management system for the site to reduce potable water demand, wastewater discharges and stormwater runoff.

7 CONCLUSIONS AND RECOMMENDATIONS

Engeny has assessed the extent of works that are required to manage the stormwater quantity and quality issues associated with the development of the property at 621 Burwood Highway in Knoxfield.

The developer will be required to limit the peak outflows from the site to the current existing condition flows. This will require the construction of a retarding basin with approximately 3,000 m³ of active storage. The most logical location for this retarding basin is in the north of the site adjacent to Blind Creek as all of the site can be drained to this location. At this location it could also be co-located with a wetland to provide stormwater treatment.

The developer will also be required to treat the stormwater runoff from the site to meet best practice environmental guidelines. The most cost effective and lowest maintenance way to achieve this would be with a single wetland and sedimentation basin system located adjacent to Blind Creek. The design work undertaken in MUSIC suggests that a 1100 m² sedimentation pond and a 4500 m² wetland will meet this best practice targets.

The existing dam on the site has been identified as having environmental values, in particular as a habitat for waterbirds including the blue billed duck. Despite its environmental values it poses a management challenge as it was originally constructed as a dam and not designed as an urban water body with unrestricted public access. Engeny recommend removing the dam and constructing a stormwater treatment wetland and waterbird habitat wetland on the adjacent vacant land to the north east of the existing dam. The construction of the habitat wetland can be staged so that the current dam is maintained in its existing condition throughout the construction period.

Flood modelling has been undertaken to model the impact of the development on upstream and downstream flood level. Net floodplain storage is increased under the currently proposed wetland system. Flood levels upstream of the development area are not increased and while flood levels downstream do increase within a localised area of Blind Creek, there are significant reductions in flood levels in the adjacent industrial area which offsets those minor increases which are contained to the waterway corridor.

8 QUALIFICATIONS

- a) In preparing this document, including all relevant calculation and modelling, Engeny Water Management (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.
- b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.
- c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:
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 - ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.
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- g) This Report does not provide legal advice.

9 REFERENCES

CSIRO 1999, *Urban Stormwater Best Practice Environmental Management Guidelines (BPEMG)*.

Ecocentric Environmental Consulting 2015, *Preliminary Biodiversity Assessment 609-619 & 621 Burwood Highway Knoxfield*.

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Engeny, 2017 *Dam Condition Assessment Report – 621 Burwood Highway, Knoxfield*.

Marchant, S. & Higgins, P. J. (eds) (1990). *Handbook of Australian, New Zealand & Antarctic Birds*. Vol 1A: Ratites to Ducks. Oxford University Press: Melbourne.

The Royal Life Saving Society Australia, 2004, *Royal Life Saving Guidelines for Water Safety in Urban Water Developments*.

GHD 2015, *621 Burwood Highway, Knoxfield Development Assessment*.

Appendix A: Hydrologic Calculations and RORB Model Parameters

A.1 RORB MODEL SUBCATCHMENT PARAMETERS

Subcatchments within the development area were delineated using local elevation contours and the proposed development densities (Figure 2-1). An additional subcatchment was drawn over the existing dam, with the model assuming the relocation of this waterbird habitat. Catchments were also delineated to represent external inflows from the existing residential area to the east and the DELWP Precinct to the south, using elevation contours and the existing drainage network. An overview of the RORB Model layout utilised is provided in Appendix Figure A- 1.

Fraction impervious values for these subcatchments varied across the modelled scenarios. Appendix Table A- 1 summarises the fraction impervious values applied within the various models. Aerial imagery and planning zones were utilised to calculate these values in the existing development scenarios. The Development Masterplan (Figure 2-1) was utilised to assign representative fraction impervious values to select subcatchments within the future development scenarios.

Appendix Table A- 1: RORB Subcatchment Area and Fraction Impervious Values (Existing Conditions)

Subcatchment	Area (km ²)	Existing Conditions		
		Direct Fraction	Indirect Fraction	Total Fraction Impervious
A (Existing Residential)	0.033	0.367	0.633	0.611
B (Existing Residential)	0.059	0.360	0.640	0.600
C (Existing Residential)	0.071	0.360	0.640	0.600
D (Existing Residential)	0.058	0.370	0.630	0.616
E (Fairhill High School)	0.057	0.300	0.700	0.500
F (DELWP Precinct)	0.013	0.420	0.580	0.700
G (Development)	0.056	0.090	0.060	0.150
H (Development)	0.038	0.240	0.760	0.400
I (Development)	0.022	0.060	0.040	0.100
J (Development)	0.023	0.060	0.040	0.100
K (Former Dam – Development and Wetland)	0.008	0.060	0.040	0.100
L (Former Dam – Development and Wetland)	0.027	0.060	0.040	0.100
M (Proposed Wetland)	0.019	0.060	0.040	0.100

Appendix Table A- 2: RORB Subcatchment Area and Fraction Impervious Values (Developed Conditions)

Subcatchment	Area (km ²)	Existing Conditions		
		Direct Fraction	Indirect Fraction	Total Fraction Impervious
A (Existing Residential)	0.033	0.367	0.633	0.611
B (Existing Residential)	0.059	0.360	0.640	0.6
C (Existing Residential)	0.071	0.360	0.640	0.6
D (Existing Residential)	0.058	0.370	0.630	0.616

Subcatchment	Area (km ²)	Existing Conditions		
		Direct Fraction	Indirect Fraction	Total Fraction Impervious
E (Fairhill High School)	0.057	0.419	0.581	0.698
F (DELWP Precinct)	0.013	0.361	0.639	0.601
G (Development)	0.056	0.539	0.461	0.898
H (Development)	0.038	0.463	0.537	0.771
I (Development)	0.022	0.464	0.536	0.774
J (Development)	0.023	0.47	0.53	0.781
K (Former Dam – Development and Wetland)	0.008	0.12	0.08	0.206
L (Former Dam – Development and Wetland)	0.027	0.32	0.68	0.538
M (Proposed Wetland)	0.019	0.06	0.04	0.1

A.2 RORB MODEL STANDARD PARAMETERS

Local rainfall IFD data for the Knoxfield area was sourced from the Bureau of Meteorology. Standard parameters utilised across the various RORB models are sourced from ARR Data Hub, outlined in Appendix Table A- 3.

Appendix Table A- 3: RORB Model Parameters

Rural IL (mm)	Rural CL (mm)	k_c	m
23	3.8	1.03	0.8

The k_c was calculated using the Dandenong Valley Authority (DVA) k_c Equation. The catchment being modelled falls within the greater Dandenong Creek catchment. As an additional validation check a flow comparison was undertaken comparing the RORB outputs from a RORB model with no retarding basins or dams included to the DRNE flood flow regression analysis for urban catchments. Appendix Table A- 4 shows that there is a close match between the flow estimates using the RORB model under both existing and developed conditions and the DNRE regression flow value. This indicates that the k_c value selected is appropriate.

Appendix Table A- 4: Flow validation

Flow estimation method	Flow (m ³ /s)
DRNE equation	6.2
RORB model existing conditions no dam	6.2
RORB model future development no RB	7.0

Appendix Table A- 5 and Appendix Table A- 6 shows the stage storage relationships used in the RORB modelling and the overflow weir details respectively of the developed conditions retarding basin.

Appendix Table A- 5: Stage Storage curve for RORB model

Elevation (m AHD)	Storage Volume (m3)
76.850	0
76.900	912.838
77.000	2828.159
77.100	4868.025
77.200	7013.458
77.300	9229.903
77.400	11492.1
77.500	13795.9
77.600	16140.88
77.700	18526.87
77.7500	19734.38

Appendix Table A- 6: RORB outflow setup details

Crest Elevation (m AHD)	Weir Length (m)
76.85 (at EDD level)	8.0
77.70 (blockage or extreme event overflow only)	20.0

Appendix Table A- 7 shows the peak discharge and storage above the extended detention depth achieved in each AEP event under developed conditions.

Appendix Table A- 7: RORB Storages and outflows

AEP event	Peak outflow (m ³ /s)	Critical duration	Median Pattern	Temporal	Storage (m ³)	Peak Water Level (m AHD)
63 %	1.3	2 hour	Tp 4		4030	76.85
39 %	1.6	1 hour	Tp 4		3180	76.85
18 %	2.5	1 hour	Tp 5		6770	76.86
10 %	2.7	1 hour	Tp 15		6880	76.89
5 %	2.9	1 hour	Tp 15		10000	76.94
2 %	3.2	1 hour	Tp 29		12300	77.01
1 %	3.4	1 hour	Tp 27		14500	77.08

Legend

- RORB Node
- RORB Reach
- RORB Subcatchment Boundary
- RORB Catchment Boundary
- Watercourses



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Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia
 Vertical Datum: Australia Height Datum
 Grid: Map Grid of Australia, Zone 55
 Data Source: DELWP: VicMap - Sep 2016

621 Burwood Highway, Knoxfield

Stormwater Management Plan
 RORB Model Layout
 Figure 9.1

Job Number: V6000_002
 Revision: 1
 Drawn: VW
 Checked: GO
 Date: 26/7/2017

Appendix B:

Water Quality Calculations and MUSIC Model Parameters

B.1 MUSIC MODEL PARAMETERS

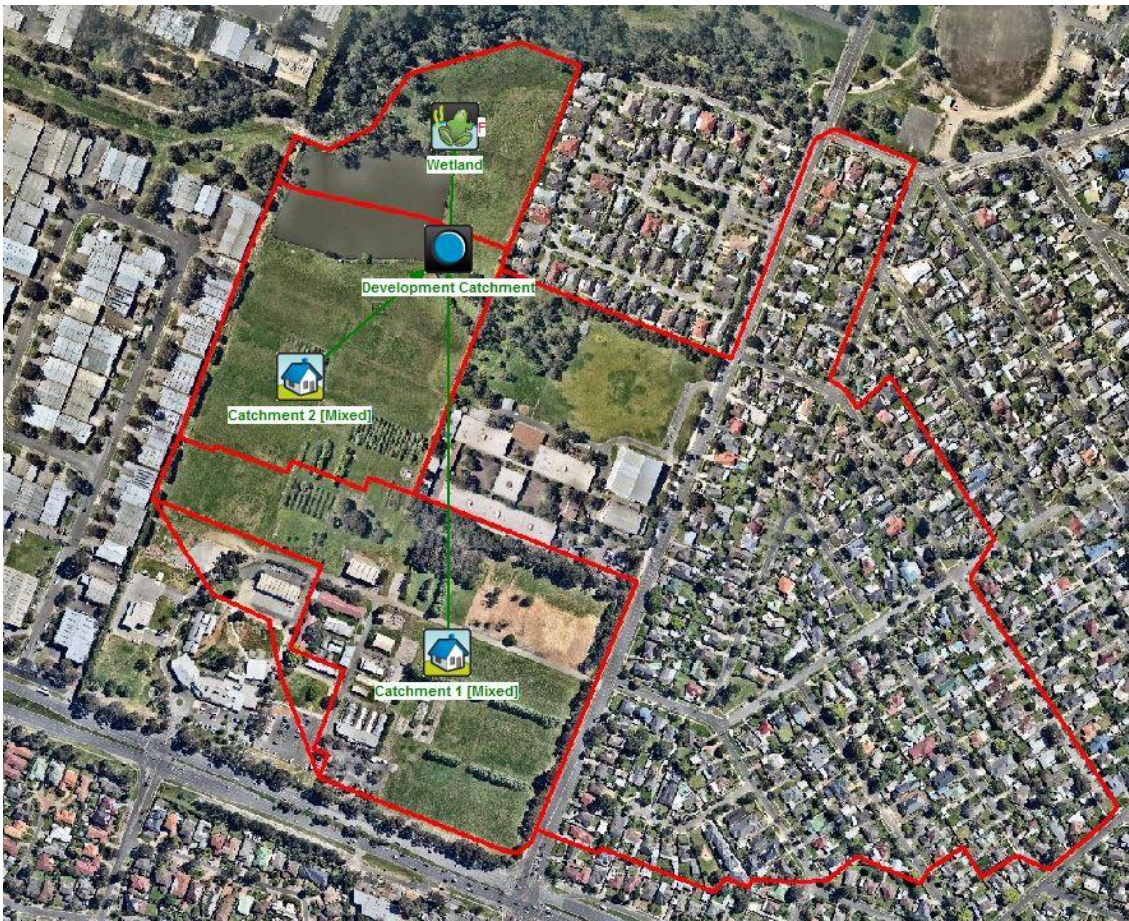
The MUSIC model was designed and input parameters specified as generally as per the Melbourne Water MUSIC Guidelines (2016). The rainfall template utilised was supplied by Knox City Council and includes five years of rainfall data.

A simplified version of the RORB subcatchment layout was used to develop the MUSIC model, external catchments with similar fraction impervious values were merged. The catchment was modelled with seven urban nodes to represent the varying residential housing densities within the Knoxfield Development, the DELWP Precinct to the south and the established residential area to the east. Appendix Figure B- 1 provides an overview of the MUSIC model setup that was used to assess the treatment for development areas. Appendix Figure B- 2 shows the MUSIC model setup for the whole catchment that was used to assess the inundation frequency of the wetland system.

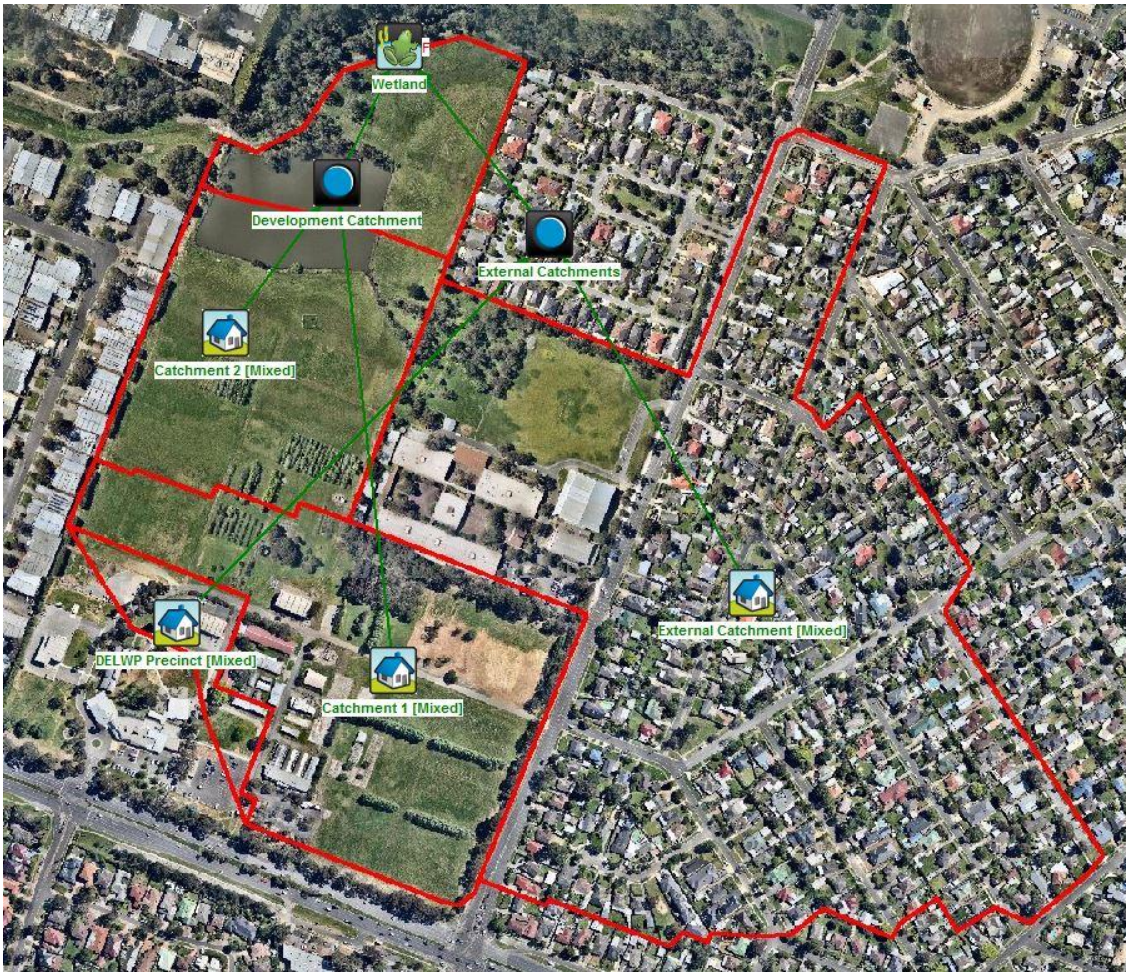
The sediment pond was sized using the Fair and Geyer Equation. A 1,100 square metre basin was calculated to meet the target of 95 % particle capture efficiency, for combined inflows from the Site and the neighbouring residential and commercial areas.

The sediment basin was subsequently modelled as an inlet pond of 707 cubic metres in volume, assuming a rectangular shape incorporating safety benches. The wetland was sized using an iterative process to achieve the BPEMG targets outlined in Table 3-1.

Appendix Figure B- 1: MUSIC Model Layout for Development Area



Appendix Figure B- 2: MUSIC Model Layout for Whole Catchment



Appendix C:

Proposed Wetland Design Plans

DEVELOPMENT VICTORIA 621 BURWOOD HIGHWAY, KNOX WETLAND AND SEDIMENTATION BASIN FUNCTIONAL DESIGN

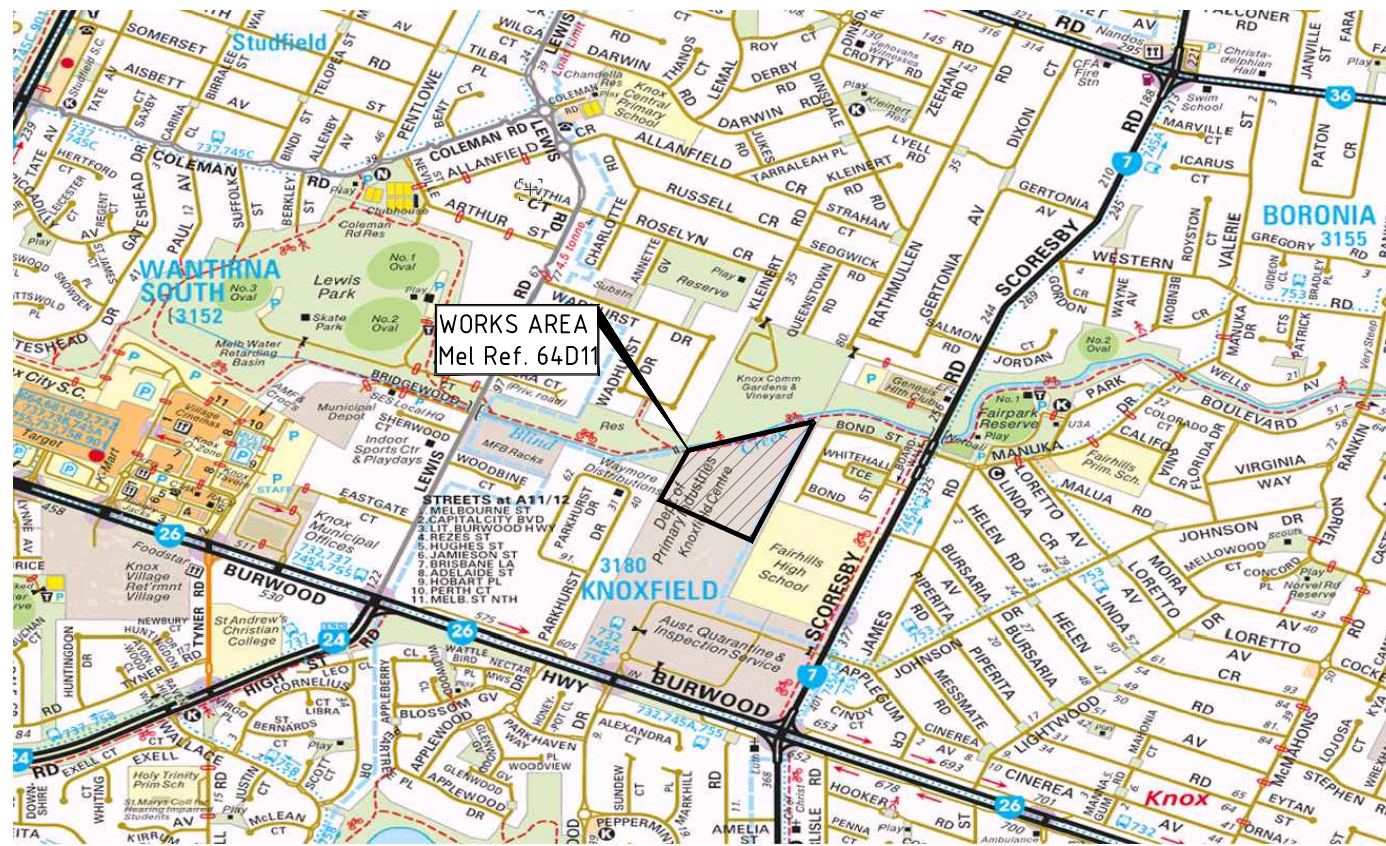


IMAGE COURTESY MELWAYS

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V6000-002-C010	LAYOUT PLAN
V6000-002-C020	PIT DETAILS
V6000-002-C021	WETLAND CONNECTION DETAILS
V6000-002-C030	DRAINAGE LONGITUDINAL SECTIONS 1 OF 2
V6000-002-C031	DRAINAGE LONGITUDINAL SECTIONS 2 OF 2
V6000-002-C040	TYPICAL CROSS SECTIONS

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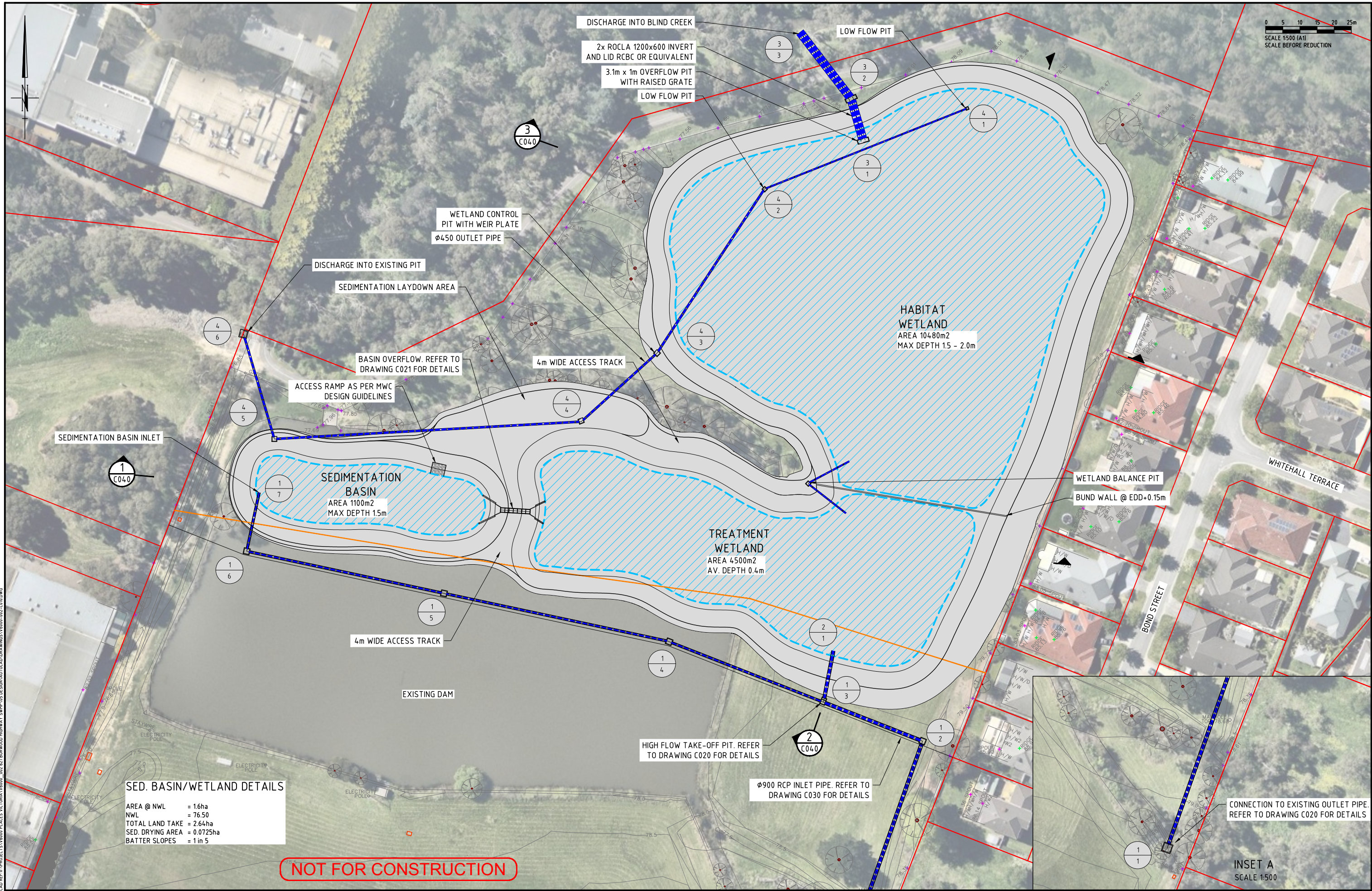
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621 BURWOOD HIGHWAY, KNOX WETLAND AND SED BASIN FUNCTIONAL DESIGN COVER SHEET AND LOCALITY PLAN	
Original Size A1	Orig No. V6000-002-C001
Rev. A	



SED. BASIN/WETLAND DETAILS

AREA @ NWL = 1.6ha
 NWL = 76.50
 TOTAL LAND TAKE = 2.64ha
 SED. DRYING AREA = 0.0725ha
 BATTER SLOPES = 1 in 5

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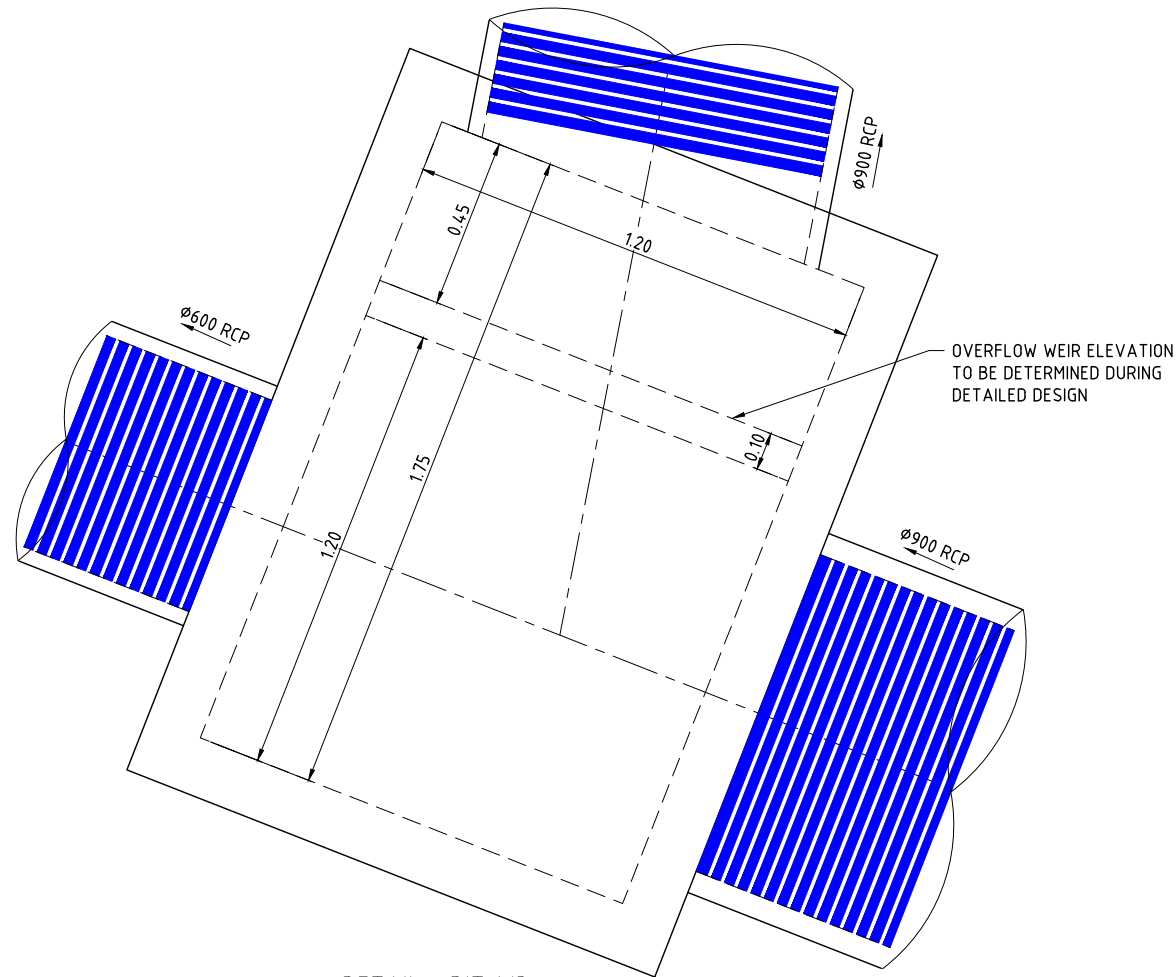
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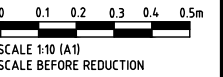


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WETLAND AND SED BASIN FUNCTIONAL DESIGN LAYOUT PLAN	
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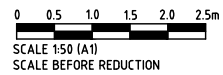
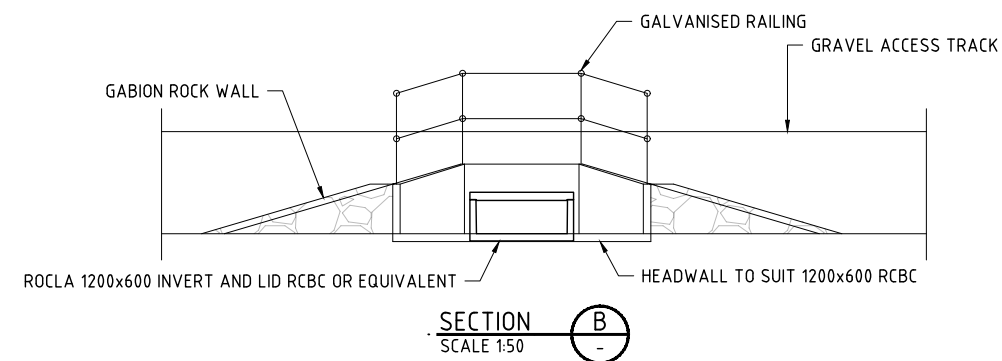
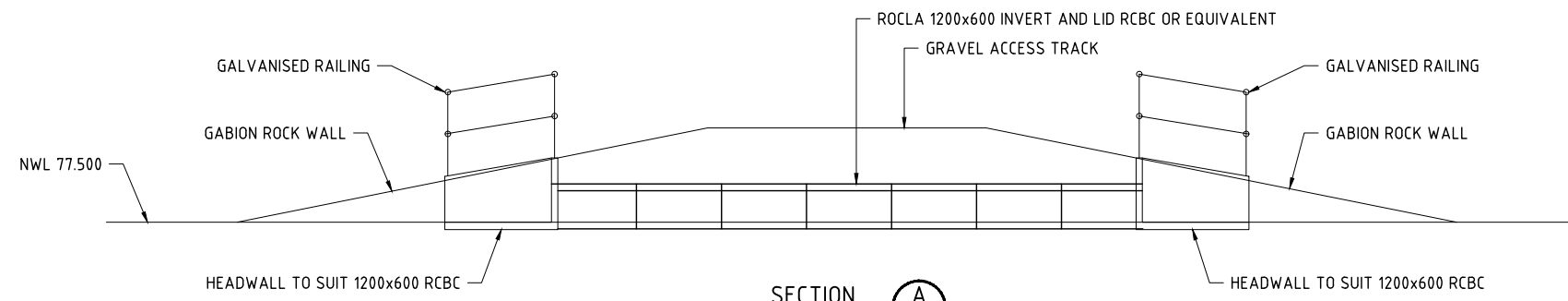
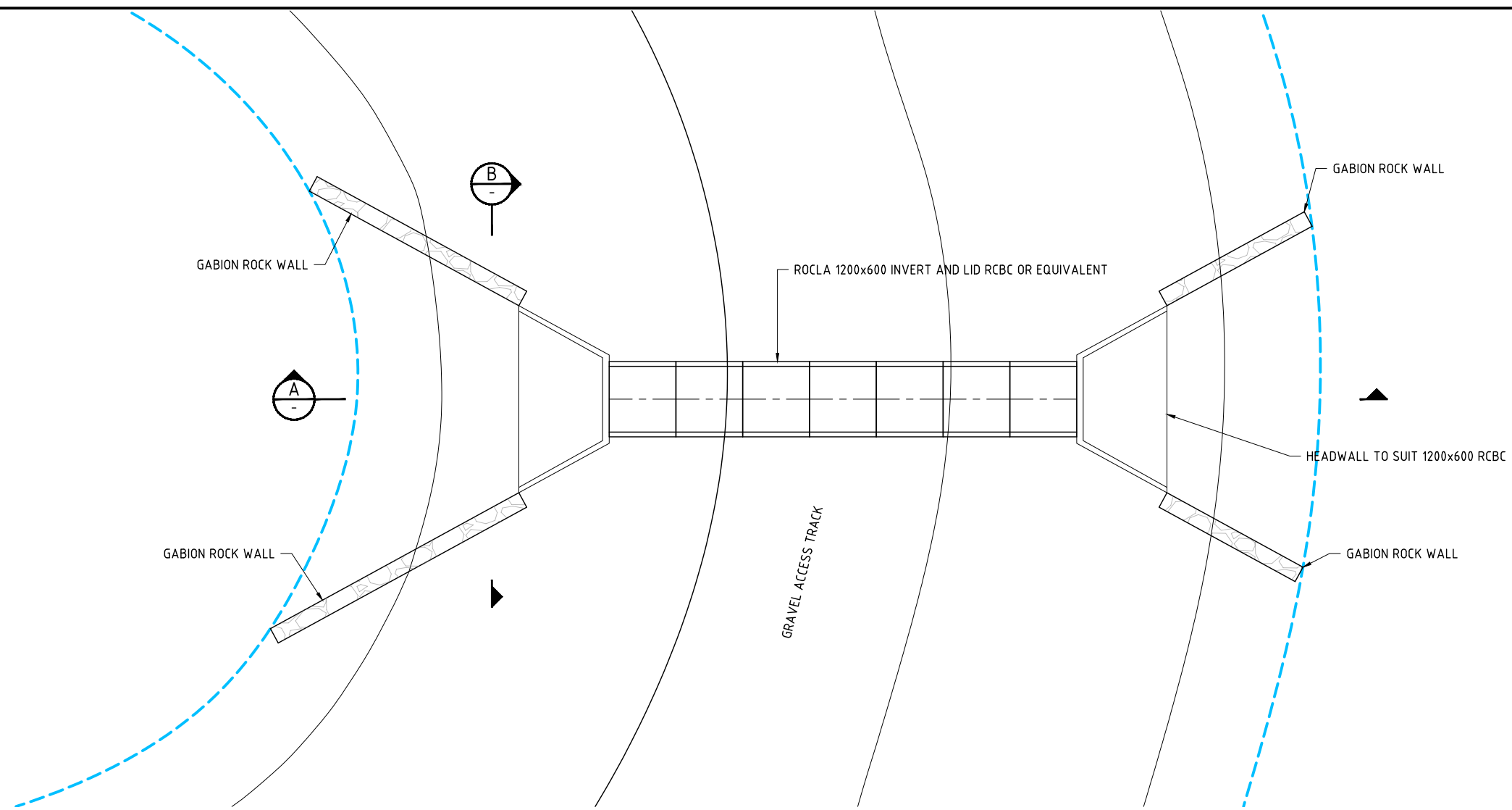
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SEDIMENTATION BASIN

TREATMENT WETLAND



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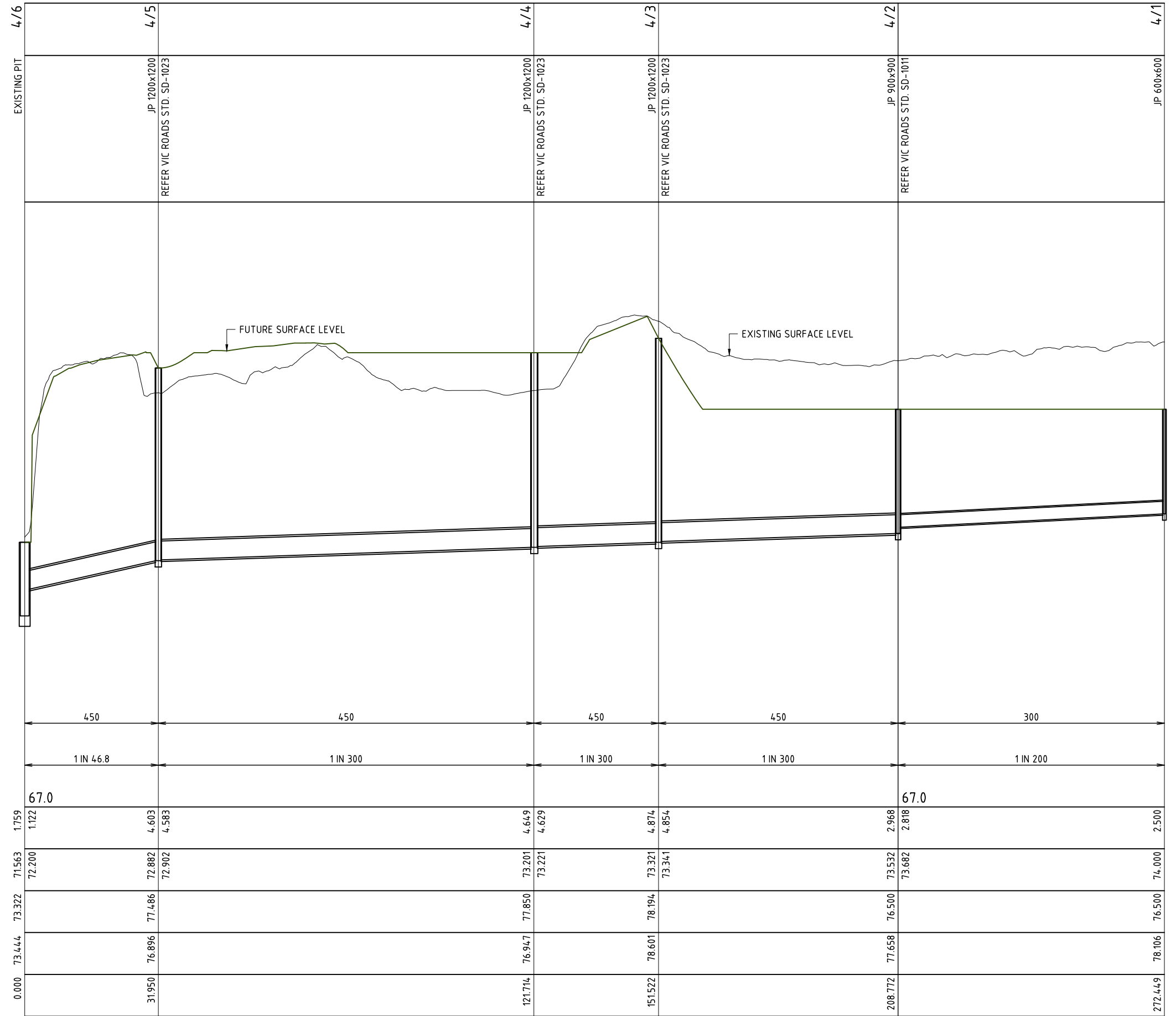


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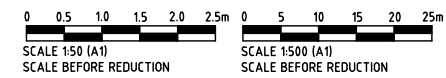
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STRUCTURE DESCRIPTION	OUTFALL	JP 3500x1000	JP 3100x1000
PIPE SIZE (mm)	(2x)1200x600	(2x)1200x600	
PIPE SLOPE (1 in X)	1 IN 200	1 IN 200	
DATUM RL	69.0		
DEPTH TO INVERT	-0.016 -0.010	2.194 2.174	0.718
INVERT LEVEL	75.582 75.576	75.698 75.718	75.782
FUTURE SURFACE LEVEL	75.566	77.893	76.500
EXISTING SURFACE LEVEL	76.907	77.988	77.836
CHAINAGE	0.000	24.421	37.131



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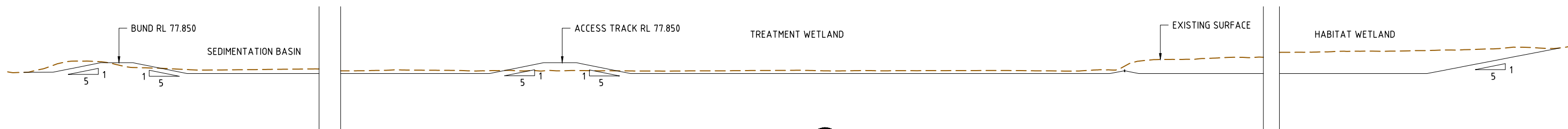
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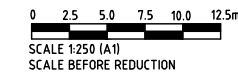
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Rev: A	

Appendix D:

Blind Creek RORB and Tuflow modelling

D.1 RORB MODEL

Melbourne Water provided Engeny with a RORB model for the Blind Creek catchment. The RORB model was run in accordance with the parameters specified in the model and as confirmed with Melbourne Water. These key parameters were:

- $K_c = 19.83$
- $m = 0.8$
- Initial Loss (IL) = 10 mm
- 1 % AEP event Runoff Coefficient = 0.6
- Filtered Temporal patterns
- Uniform Aerial Pattern
- Areal Reduction Factor in accordance with ARR87 Book 2 (replace total catchment area with a value of 20 km²)

Appendix Table D- 1: Blind Creek RORB IFD data

Variable	Blind Creek Values
2 year 1 hour intensity	18.5
2 year 12 hour intensity	4.9
2 year 72 hour intensity	1.4
50 year 1 hour intensity	36.5
50 year 12 hour intensity	8
50 year 72 hour intensity	2.5
Skew	0.36
F2	4.28
F50	15
Zone	1

The model was run for the full range of 1 % AEP storms from 10 minute to 72 hour using Australian rainfall and runoff 1987 intensity frequency duration data (as shown in Appendix Table D- 1). The 2 hour event was identified as having the greatest peak flow just upstream of the development site and so this event was used in the assessment of both existing and developed conditions.

The flow input to the TufLOW model were taken from the RORB hydrograph identified in the RORB model outputs as “59 Calculated hydrograph, Downstream Scoresby Rd”.

D.2 TUFLOW MODELLING

A TufLOW model was developed for the study area. The layout of the model is shown in Figure 1-1. The model extents from Scoresby Road to Lewis Road and was wide enough to encompass the entire floodplain. A flow vs time inflow boundary was used at the upstream end of the model to insert flows into the model and a fix level head vs time boundary was used at the downstream end of the model to drain the water out. The head level was based on Melbourne Water’s 1 % AEP flood level at Lewis Road. The Mannings roughness values were assigned back on inspection of an aerial photograph from NearMap and on observations made on the site visit. All areas were initial assigned a value corresponding to remainder of parcel (representing gardens and fences in backyards of properties) and individual values were applied based on the land use as per the aerial photography. Appendix Table D- 2 shows the Mannings n values used in the TufLOW modelling.

Appendix Table D- 2: Mannings n values used in Tuflow model
















Mannings value	Material designation in Tuflow	Land use description
0.35	1	High Density Residential
0.2	2	Low Density Residential
0.035	3	Open Paddock
0.06	4	Open Paddock with moderate Trees
0.5	5	Commercial & residential building footprints
0.03	6	Car Park/Road
0.09	7	Paddock with high density trees
0.08	8	Remainder of parcel (Residential high density)
0.12	9	Railway line

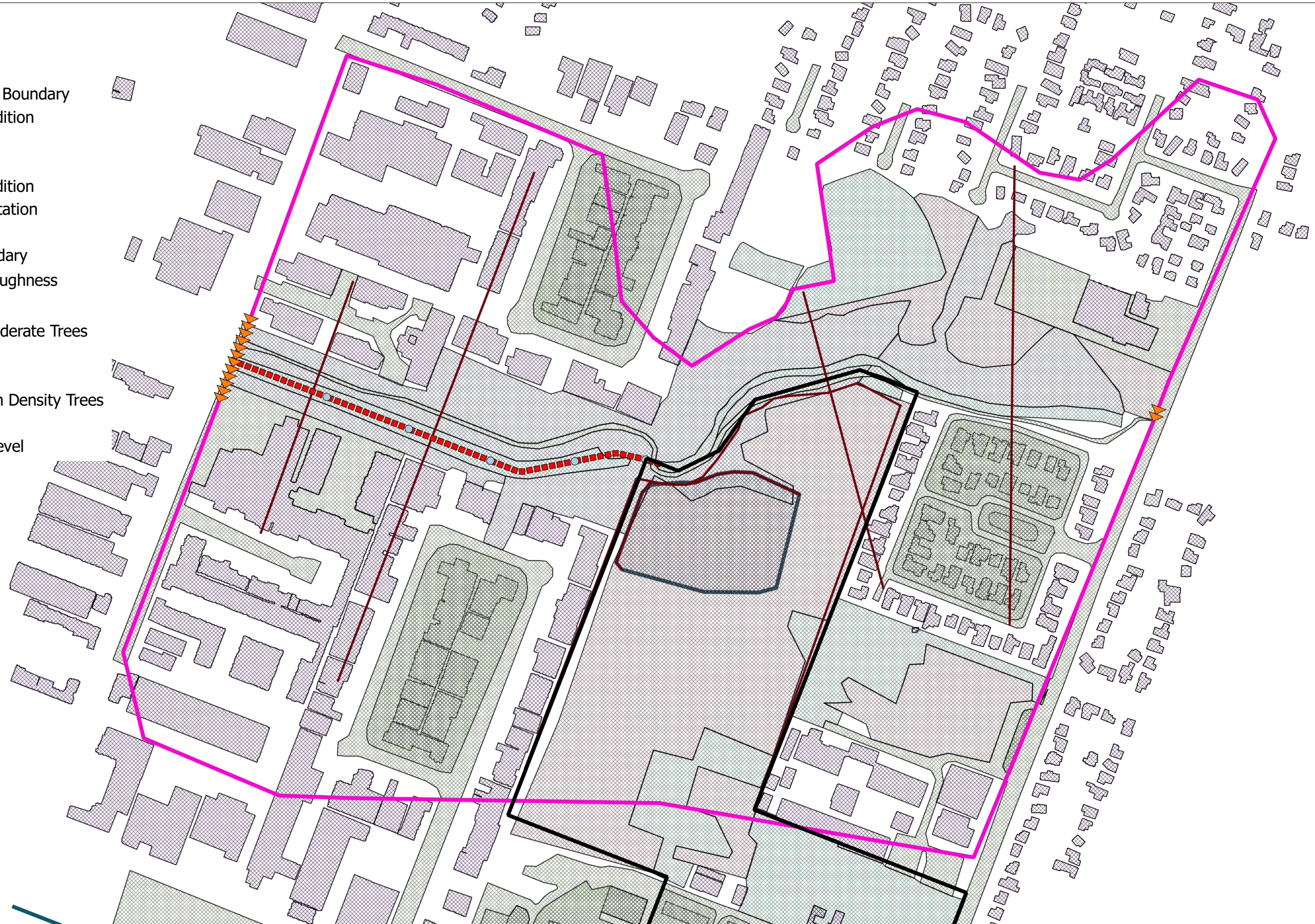
The model was run on a 2 metre grid with a 0.5 second time step. The ground surface levels were based on LiDAR data of the site for the existing conditions model. In the developed conditions model the a design DEM of the proposed wetland was input to the model from 12d and all areas on the development site south of the wetland were raised above the flood level.

An initial water level was applied to the dam in the existing model to represent that it could be full to spillway level (77.54 m AHD) in a flood level. In the develop scenario modelling the initial water level in the wetland was set to 75.85 m AHD, which matches the extended detention depth of the wetland.

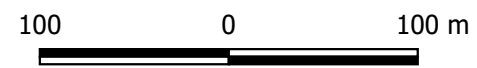
Melbourne Water confirmed during a meeting in November 2020 that the flows utilised in the original TUFLOW modelling in 2017 and documented in this appendix are still the current flow estimates for Blind Creek despite the fact that they are calculated using ARR 1987 methodology.

Legend

-  Development Site Boundary
 -  2d Boundary Condition
 -  Pits
 -  Pipes
 -  1d Boundary Condition
 -  2d Loc Line Orientation
 -  Plot Output Line
 -  Model Code Boundary
- Mannings Land Use Roughness**
-  Open Paddock
 -  Open Paddock Moderate Trees
 -  Building Footprint
 -  Road/Carpark
 -  Paddock with High Density Trees
 -  Paddock with Low Density Trees
 -  2d Initial Water Level



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Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia
 Vertical Datum: Australia Height Datum
 Grid: Map Grid of Australia, Zone 55
 Data Source: DELWP: VicMap - Sep 2016

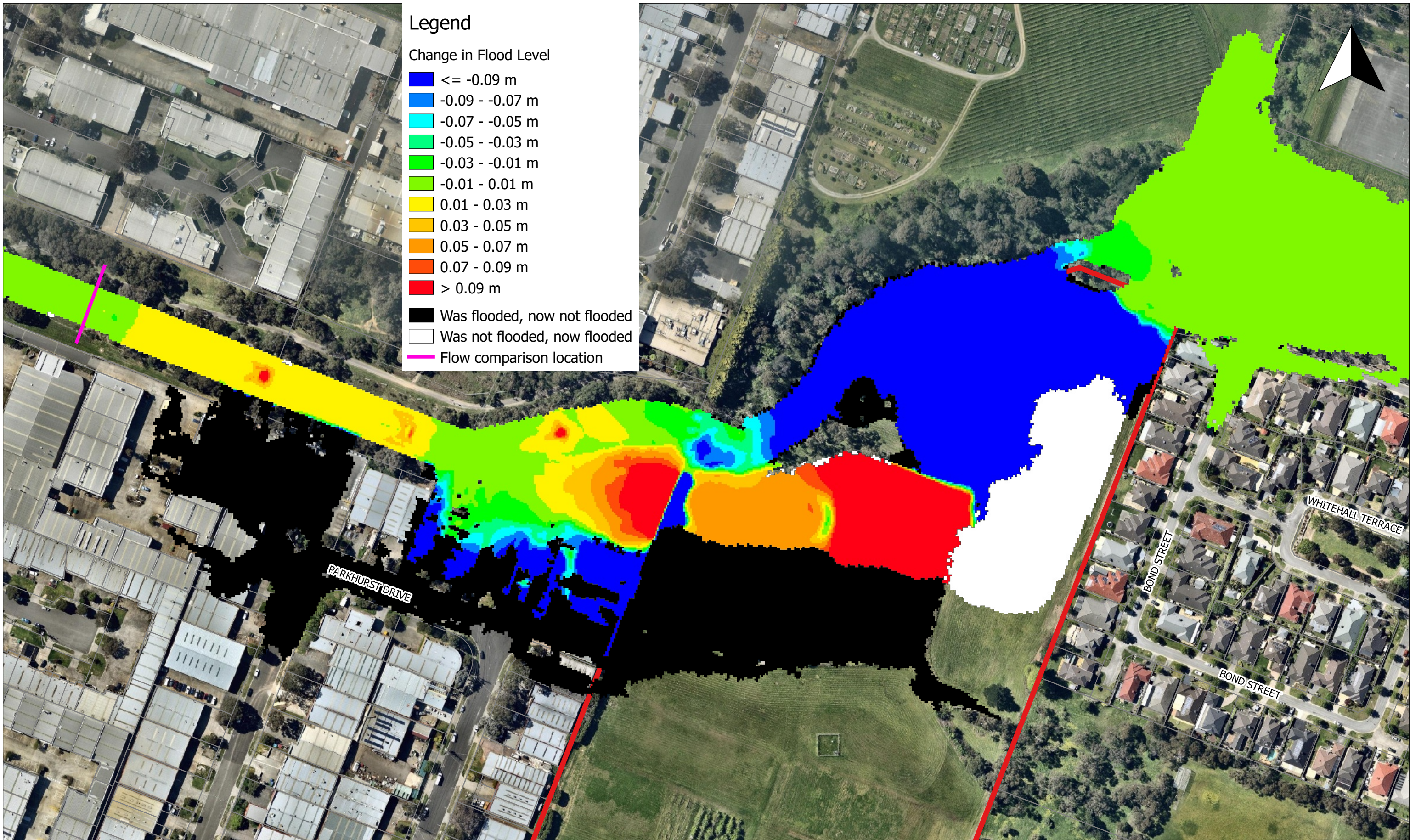
621 Burwood Highway Knoxfield

Tuflow model setup

Job Number: V1158_003
 Revision: 0
 Drawn: GO
 Checked: SD
 Date: 25/7/2017

Appendix E:

Flood Maps

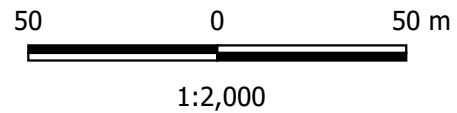


Legend

Change in Flood Level

- $\le -0.09\text{ m}$
- $-0.09 - -0.07\text{ m}$
- $-0.07 - -0.05\text{ m}$
- $-0.05 - -0.03\text{ m}$
- $-0.03 - -0.01\text{ m}$
- $-0.01 - 0.01\text{ m}$
- $0.01 - 0.03\text{ m}$
- $0.03 - 0.05\text{ m}$
- $0.05 - 0.07\text{ m}$
- $0.07 - 0.09\text{ m}$
- $> 0.09\text{ m}$
- Was flooded, now not flooded
- Was not flooded, now flooded
- Flow comparison location

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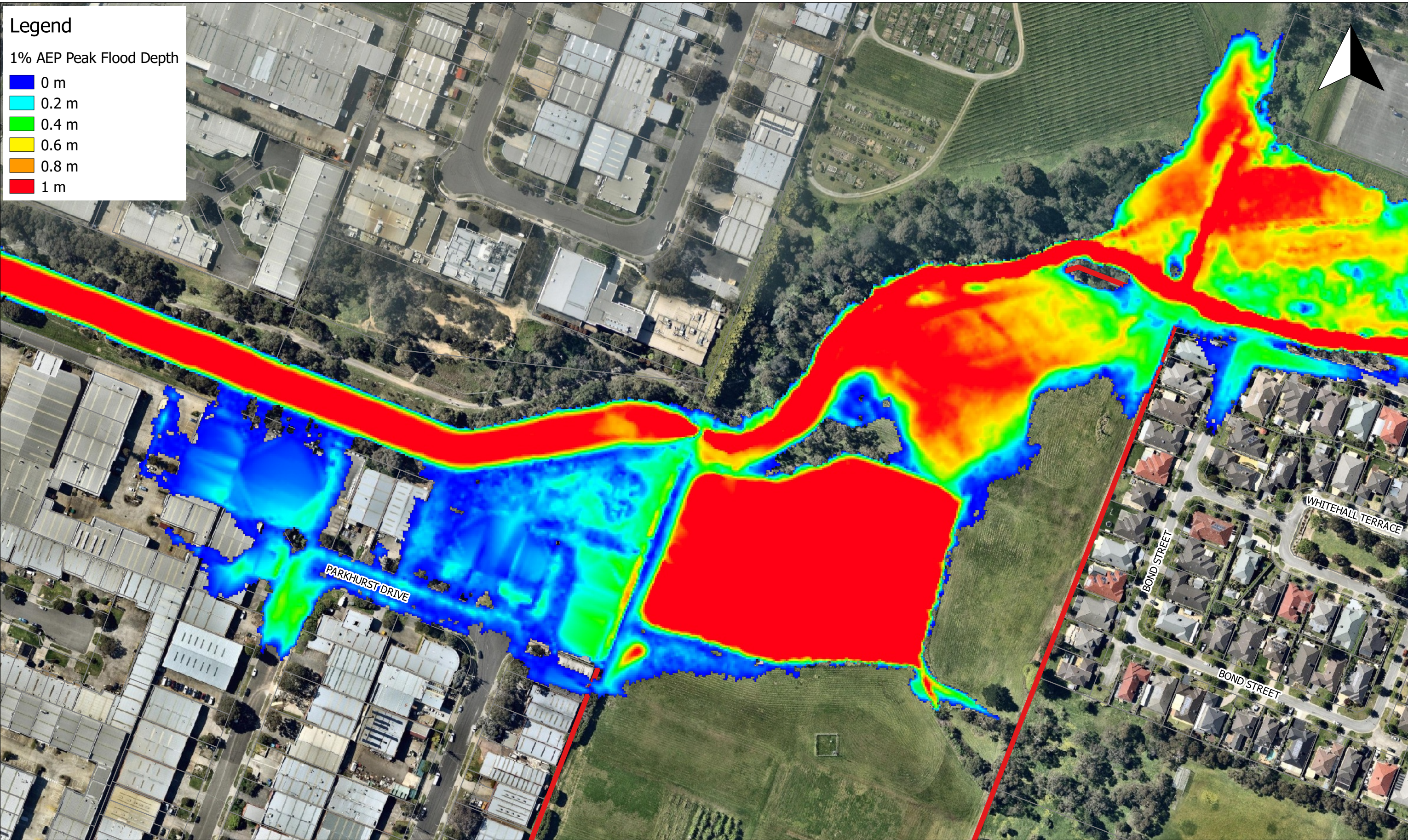


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 Grid: Map Grid of Australia, Zone 55
 Data Source: DELWP: VicMap - Sep 2016
 NearMaps Aerial Photography Dec 2017

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1% AEP Peak Flood Depth Comparison Map

Job Number: V6000_002
 Revision: 0
 Drawn: GO
 Checked: SD
 Date: 24/7/2017

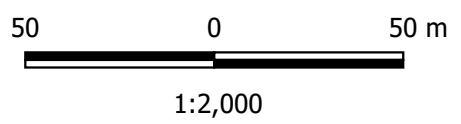


Legend

1% AEP Peak Flood Depth

- 0 m
- 0.2 m
- 0.4 m
- 0.6 m
- 0.8 m
- 1 m

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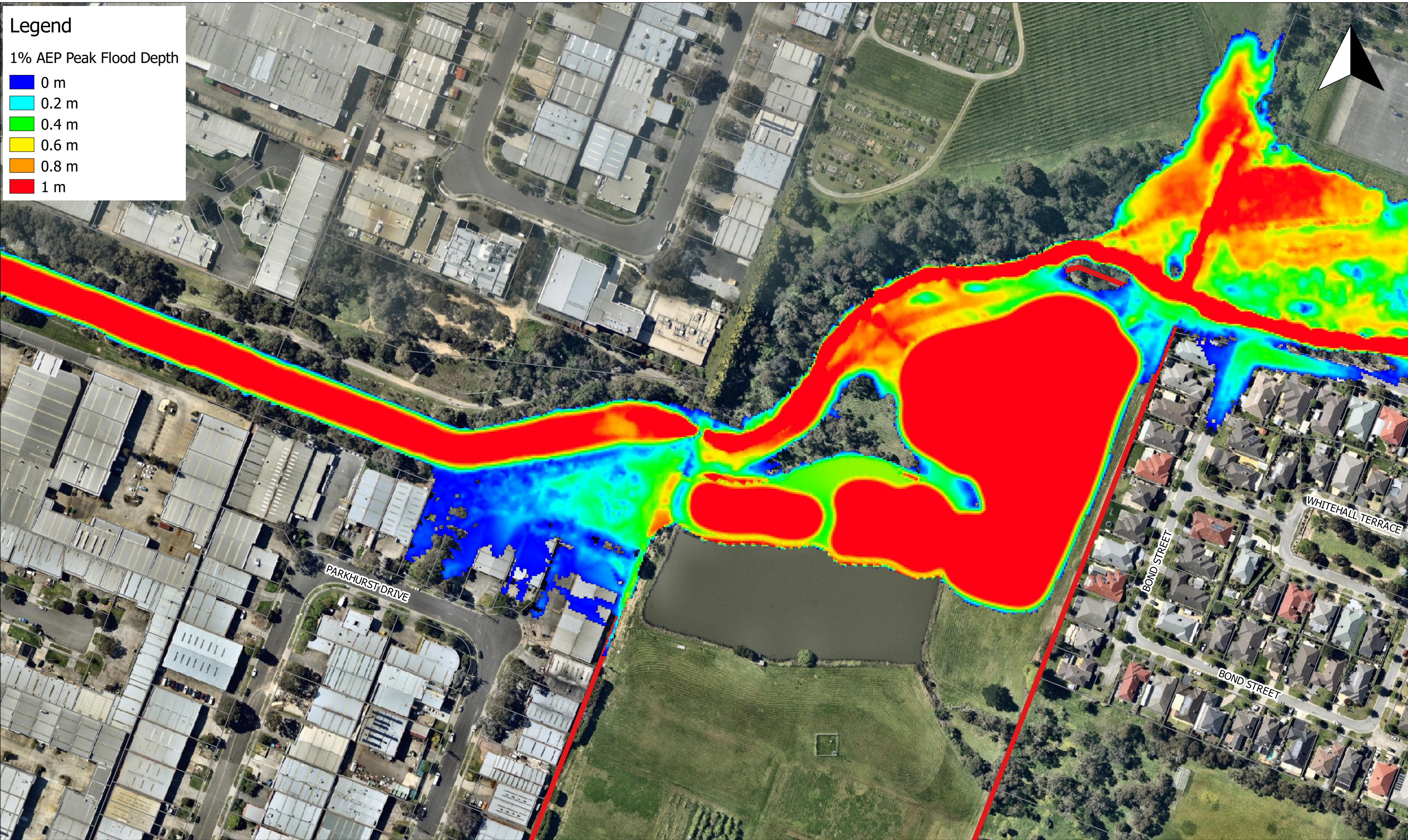


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 Data Source: DELWP: VicMap - Sep 2016
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1% AEP Existing Conditions
 Peak Flood Depth

Job Number: V6000_002
 Revision: 0
 Drawn: GO
 Checked: SD
 Date: 24/7/2017



Legend

1% AEP Peak Flood Depth

- 0 m
- 0.2 m
- 0.4 m
- 0.6 m
- 0.8 m
- 1 m

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50 0 50 m

1:2,000

Map Projection: Transverse Mercator
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 Vertical Datum: Australia Height Datum
 Grid: Map Grid of Australia, Zone 55
 Data Source: DELWP: VicMap - Sep 2016
 NearMaps Aerial Photography Dec 2017

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1% AEP Developed Conditions
 Peak Flood Depth

Job Number: V6000_002
 Revision: 0
 Drawn: GO
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