

Maroondah City Council

Croydon Town Centre Structure Plan Refresh

Stormwater Management Background Report

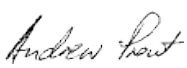


December 2019

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1. INTRODUCTION

The Croydon Town Centre, identified in Figure 1-1 below, has been nominated as a Major Activity Centre in the Metropolitan Strategy Melbourne 2030, and will be a continued focus for increased housing and activity. The Croydon Town Centre Structure Plan was originally developed in 2006 to direct and manage this increased growth and change over the next 30 years, with a vision and objectives, strategies and actions to be achieved in future development and improvements within the Town Centre (the study area).



Figure 1-1 Study area (Croydon Town Centre Structure Plan, Volume 1 : Main Report July 2006)

With respect to drainage the Croydon Town Centre study area is located within the Upper Croydon Main Drain drainage sub catchment and discharges to a Melbourne Water managed wetland / retarding basin located south of Town Park. Outflow from the wetland / retarding basin is connected to Tarralla Creek a tributary of Dandenong Creek. The Upper Croydon Main Drain drainage sub-catchment is approximately 250 hectares in area.

Responsibilities for waterway and stormwater infrastructure management within the study area are shared between Melbourne Water and Council. Melbourne Water is the regional drainage authority responsible for the management of Tarralla Creek as a major water course. Council's drainage network generally conveys stormwater from the north to south through the study area.

Melbourne Water is typically responsible for the installation and maintenance of drainage systems and flood mitigation works, for catchments with an area greater than 60 hectares unless otherwise agreed. Whilst the catchment has been estimated to be approximately 250 hectares, currently all underground drainage assets in this catchment are owned and maintained by Council upstream of the Melbourne Water owned and managed wetland / retarding basin. A map of the study area with drainage responsibilities demarcated is presented in **Appendix A**.

1.1 Original Structure Plan (2006)

The original Croydon Town Centre Structure Plan (2006) notes the following with respect to stormwater:

Redevelopment is a potential threat to health of waterways. Increase in impervious surfaces generates increased stormwater runoff volume and flow frequency and has the potential to increase the level of litter, nutrients and sediments transported in waterways.

The full assessment of the potential impact of redevelopment of the precinct on Council's drainage system requires further investigation, but initial assessments indicate that there is unlikely to be significant upgrade works required. The Maroondah City Council Stormwater Environmental Management Plan identifies actions to improve the environmental management of urban stormwater and protect the environmental values and beneficial uses of receiving environments. It identifies urban activities that may adversely affect water quality and sets in place strategies to protect water quality and beneficial uses from stormwater runoff.

Water sensitive urban design (WSUD) concepts would also form the basis of any augmentation to the drainage system.

The study area is not subject to flooding and is not located in a LSIO zone or urban floodway zone or subject to Special Building Overlay (SBO) provisions.

1.2 Objectives of this Background Report

Since the original Croydon Town Centre Structure Plan was developed a greater knowledge and understanding of stormwater, in particular flooding behaviour, within the study area has been gained as a result of severe storm events and flood modelling studies. This knowledge and understanding differs notably to that which was summarised in the 2006 Structure Plan. In light of this Council engaged Engeny to prepare this background report to summarise the current understanding of stormwater opportunities and constraints within the study area.

In preparing this background report the key objectives were to summarise the following:

- current understanding of flooding within the study area, based on recent storm event and flood modelling studies
- relevant stormwater studies and strategies that have been prepared since the 2006 Structure Plan
- existing planning controls to manage impacts of increased development within the study area on stormwater
- possible future planning controls that could be used to further mitigate impacts on stormwater and / or reduce flooding impacts
- works completed by Council in recent years to address flooding risk within the study area
- works currently under investigation by Council within the study area to manage stormwater including stormwater harvesting and flood mitigation projects
- future measures / controls being considered and implemented by Council and other drainage authorities to provide improved stormwater management outcomes
- actions for Council's consideration as part of finalising a refresh / update of the overall Croydon Town Centre Structure Plan.

2. FLOODING HISTORY AND FLOOD MODELLING

In recent years several major floods have affected residents living in the City of Maroondah, including within the Croydon Town Centre precinct. The Maroondah Storm and Flood Emergency Plan developed by VICSES and Council in 2014 provides a time record of flood events and their location within the municipality. From the Storm and Flood Emergency Plan the recorded flood events that are classified as either moderate or major within the study area include the following:

- *On 1st December 2010, 4th February 2011 and 9th November 2011 Maroondah received significant flash flooding in the Croydon Civic drainage catchment. Flood mitigation works around Civic Square and Lusher Road in Croydon have commenced to alleviate flooding in this area.*
- *In November 2004 there was a severe storm with major flooding and tree damage to all areas of the municipality.*
- *On February 2 & 3 in 2005 most of the Melbourne area sustained extensive damage to property and infrastructure as a result of a severe storm with rain levels exceeding 130 mm and strong winds.*
- *In recent years the following larger storm events occurred on 21 Aug 2009, 6-7 Mar 2010 (hailstorm), Dec 2010, 5 Feb and 5 Sept 2012 and Sept 2013.*

In response to the December 2010 flooding event Council commissioned a flood modelling study of the study area at the end of 2010 which was completed in 2011. Council subsequently commissioned a municipal wide flood modelling and mapping project in 2012, which was completed in 2013. Figure 2-1 below presents a timeline of flood modelling studies completed within the study area since 2010.

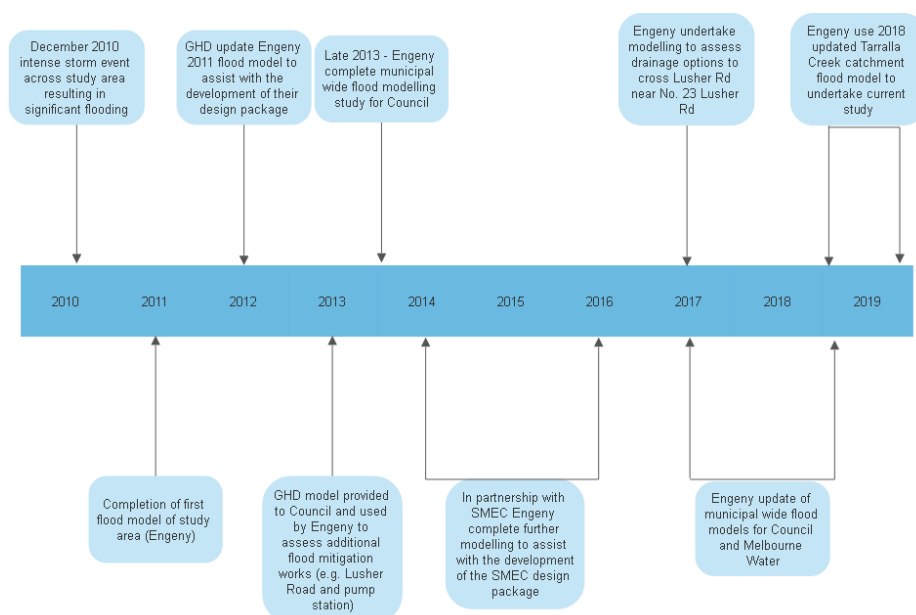


Figure 2-1 Flood modelling timeline in study area (from Croydon Civic Flood Mitigation Works – Post Construction Analysis Report, April 2019)

A range of photos were collated by Council documenting flooding during the 2010-2012 storm events across the municipality. Figures 2-2 and 2-3 below were taken in Civic Square and Birdwood Road during the December 2010 storm event.



Figure 2-2 Flooding in Civic Square 1st December 2010



Figure 2-3 Flooding in Birdwood Road 1st December 2010

The flooding photos collated by Council were valuable in validating the flood modelling results. Figures 2-4 and 2-5 below highlight flooding in Lacey Street, Croydon (located within the study area) as a result of a storm event in December 2010. This storm event was deemed to have an Average Recurrence Interval (ARI) of 60 years. Figure 2-2 shows the flood modelling results for the peak 100 year ARI event whilst Figure 2-3 depicts a photo taken during the December 2010 storm event to highlight the extent of flooding in Lacey Street. Note the location of the blue arrow in both figures indicating a close match between the flood modelling results and the actual flooding behaviour.



Figure 2-4 Flood modelling results for Lacey Street, Croydon (100 year ARI results)



Figure 2-5 Looking west along Lacey Street to Windsor Street, Croydon (December 2010)

A significant rainfall event also occurred on the 29th of December 2016 which led to flooding of the study area. As per advice received from Melbourne Water the 29 December 2016 rainfall event was estimated to be a 70 year Average Recurrence Interval (ARI) event at the Heathmont and Mooroolbark rainfall gauges.

Figures 2-6 and 2-7 present a range of photos from Council and residents taken during the 29 December 2016 storm event.



Figure 2-6 Flooding in Birdwood Road (29 December 2016)



Figure 2-7 Flooding in Lusher Road (29 December 2016)

A large portion of Council's drainage system was designed and constructed without regard for larger flows, as drainage standards at the time did not consider minor and major flows.

As documented in the *“Croydon Flood Mitigation Investigation – Design Options Assessment and Concept Design Independent Review, Preliminary Report, Aquatic*

Systems Management Pty Ltd in association with Neil M Craigie Pty Ltd (October 2012),”
“The flooding of the Civic Square area has been a contentious issue since flooding due to intense rainfall events in 2010 and 2011. Flooding has occurred due to a number of compounding factors including the following;

- *Low surface gradients due to original topography of the subject area being part of the former swamp and creek floodplain.*
- *The design and top surface water levels in the Melbourne Water Croydon Main Drain Retarding Basin in the 1 in 100 year ARI flood flow conditions.*
- *The inlet arrangements to the Melbourne Water Retarding Basin at the Norton Road Sediment trap whereby the capacity to take flows is impeded by the MWC water supply pipes across the inlet structure, a cut throat channel arrangement and frequent blockage of the outlets into the wetland and retarding basin, all causing tailwater conditions that impede pipe flows.*

Figure 2-8 highlights the blockage of the sedimentation pond outlet pit at Melbourne Water’s Croydon Main Drain noted on the day of a site inspection in May 2018.



Figure 2-8 Blockage of sedimentation pond outlet pit at Melbourne Water’s Croydon Main Drain

- *The increase in impervious areas and therefore increased runoff arising from redevelopment and intensification of land use without the imposition of onsite runoff storage and or flow retarding requirements.*
- *Non-declaration of the land subject to inundation or Special Building Overlay in the Municipal Planning Scheme.”*

Existing stormwater assets, including demarcation of ownership, are depicted on a map attached in **Appendix A**.

The extent and depth of existing conditions flooding within the study area for the 20 % AEP and 1 % AEP events is depicted in flood maps attached in **Appendix B**.

3. RELEVANT STUDIES / STRATEGIES

In recent years a number of relevant stormwater management studies and strategies have been completed and prepared by Council which are directly applicable and relevant for the future management of the study area.

3.1 Flood Management Plan and Storm and Flood Emergency Plan

The Maroondah Flood Management Plan (FMP) outlines roles and responsibilities and describes, at a high level, Council and Melbourne Water's key flood management activities across the City of Maroondah. The 2016 update of the Flood Management Plan identifies specific actions to improve flood management across the municipality over the next five years. The next review of the FMP and associated actions is due in May 2021.

The Victoria State Emergency Service (VICSES) has also developed the Maroondah Storm and Flood Emergency Plan (MSFEP). This independent but complimentary document focuses on flood preparedness, community awareness, flood response, recovery and coordination as a component of broader municipal emergency management.

The overarching goal of the FMP is to contribute to reducing the risk and impacts of flooding on local communities. The objectives in developing and maintaining the FMP are to:

- enhance collaboration
- identify 'hotspots' and flood risks
- provide opportunities for information sharing
- identify achievable improvement actions
- clarify contacts at other agencies, and
- align with the Flood Management Strategy, Port Phillip and Westernport, 2015.

A core component of the FMP is the improvement plan. The improvement plan identifies key issues under the following themes:

- Flooding and flood risk
- Asset management and maintenance
- Community education and awareness
- Improved communication and collaboration between all stakeholders

The MSFEP details arrangements agreed for the planning, preparedness / prevention, response and recovery from flood incidents within the Municipality. It is a sub-plan to the Municipal Emergency Management Plan. The plan is consistent with the Emergency

Management Manual Victoria (EMMV), which defines VICSES as the control agency during floods.

As documented in the FMP, Council, Melbourne Water and VICSES are committed to working together to improve community education and awareness around flood risks. VICSES implement and are responsible for a number of flood management education programs including StormSafe and FloodSafe. It is intended that flood response plans will be developed for the worst affected properties as identified in the Storm and Flood Emergency Plan. It is important that key stakeholders collaborate to develop key flood education messages that can be shared with the local community through various means including street meetings or targeted door knocking.

3.2 Water Sensitive Strategy

The Maroondah Water Sensitive City Strategy was developed in 2015 and considers the issues and opportunities associated with potable water, stormwater and wastewater in one document. The Strategy consists of two documents; a 'Vision and Outcomes' document, which is a summary of the vision for a Water Sensitive Maroondah, and a 'Toolkit' document, which is a suite of documents designed to provide key information for Council to progress opportunities to support the vision.

The Strategy outlines the vision and the steps required to achieve Council's goal of becoming a water sensitive city by 2040. The vision of the Strategy is as follows:

"By 2040, Maroondah will be a water sensitive city. Positioned at the top of several creek catchments, Maroondah's waterways will be clean, ecologically rich, and beautiful recreational corridors that define the character of Maroondah. Our residents, workers and visitors will treasure water as a valued resource and enjoy green leafy neighbourhoods and high quality open spaces that are supported by sustainable water sources. Maroondah will have good water security and be resilient to drought and flood. Our homes and other buildings will demonstrate good practice in water management and will benefit from well-designed streets and green corridors where flood waters are conveyed safely. In partnership with government, community and relevant authorities, Council will actively seek opportunities to deliver environmental, community and economic benefit through continual improvement of the local water cycle using an integrated approach."

The Strategy documents and summarises the following four key outcomes which Council aim to achieve in creating a Water Sensitive Maroondah. Figure 3-1 presents the four key outcomes.

We aim to achieve four key outcomes in creating a Water Sensitive Maroondah.



Figure 3-1 Key outcomes of creating a water sensitive Maroondah

Priority actions are documented and targets have been assigned in the Strategy to enable progress to be measured in 10 years time (e.g. 2025). Targets which are relevant to the study area include:

- Mitigate flood impacts on a minimum of 50 of the 800 dwellings subject to flooding in a major storm.
- Increase Council's use of alternative water sources by 20 ML.

A priority action relevant to the study area is to prioritise and deliver flood mitigation works, in partnership with Melbourne Water, to reduce risk of damage to properties and key assets.

4. EXISTING PLANNING CONTROLS

Council has a range of existing planning controls to manage stormwater as part of development within the study area as detailed in the following sub-sections.

4.1 Planning Scheme Flood Overlays / Building Regulations

Whilst there are flood overlays denoted within the Maroondah City Council planning scheme there are currently no overlays within or adjacent to the study area. If the extent of flooding within the study area was to be defined within the planning scheme it would be designated as a Special Building Overlay. Special Building Overlays identify areas prone to overland flooding and set appropriate conditions and floor levels to address any flood risk to developments. These overlays require a planning permit for buildings and works.

Planning information, including flooding overlays is disclosed to prospective purchasers through planning certificates issued under Section 199 of the Planning and Environment Act, 1987 and included as a compulsory part of the vendor's statement issued under Section 32 of the Sale of Land Act, 1962. In the absence of flood overlays within the study area the community are currently not aware of flood prone areas when purchasing properties.

In the absence of flood overlays Council is currently reliant upon the conditions of Clause 153 of the Victorian Building Regulations (2018) to enforce conditions on developments where Council deem that those developments are located in areas liable to flood. Clause 153 of the regulations details the requirements of 'Report and consent for building in areas liable to flooding.' This creates some issues for Council as some building types are exempt from this clause and it is understood that the requirements generally do not provide the enforcement power that overlays can. The provisions of the Building Regulations may not be made known to purchasers and may not be considered at the time of assessment of a Planning Permit, when building footprints and floor levels may be approved.

We are aware of the positions of Melbourne Water and a number of Councils on the relative merits of using Special Building Overlays compared with the Building Regulations for controlling development in areas subject to overland flow. We understand that the planning and legal advice provided to Melbourne Water and a number of Councils has advised that the use of SBOs through the planning scheme has a number of advantages compared with the use of the Building Regulations, including transparency, timeliness of application and enforceability. Melbourne Water has used SBOs to manage development along overland flow paths for their drains for approximately 20 years.

4.2 Croydon Town Centre Residential Development Policy

The Croydon Town Centre Residential Development Policy is documented within the Maroondah City Council Planning Scheme (Clause 22.13). With respect to stormwater management the following is documented in this Clause and is applicable to the Town Centre:

- The rate of stormwater discharge should not exceed the rate that currently leaves the site based on 35 % site coverage or otherwise to the satisfaction of Council.
- Stormwater collection systems are designed to ensure that litter and sediment is detained on site and does not enter the stormwater system.

4.3 Amendment VC154 Stormwater Management

Planning reforms, recommended by the Stormwater Management Advisory Committee, were announced on 19 October 2018 and came into effect when they were gazetted on Friday 26 October 2018 as part of amendment VC154. They include:

- new provisions, under the Victoria Planning Provisions (VPP), to expand the current stormwater management requirements to:
 - commercial subdivisions and developments
 - industrial subdivisions and developments
 - public use developments
 - residential multi-dwelling subdivisions and developments
- a new Integrated water management clause in the state's Planning Policy framework (PPF) to embed IWM objectives and strategies into urban land-use planning.

Further details of amendment VC154 are available at: https://www.planning.vic.gov.au/__data/assets/pdf_file/0033/398715/PAN75-Amendment-VC154-Stormwater-Management.pdf.

4.4 Council Planning Permit Process / Development Guidelines

Whilst Council's Planning Scheme does not currently contain any flood overlays within the study area Council has been utilising the results of the 2013 municipal flood modelling study to influence the planning permit process. When planning permits are referred to Council's engineering department data / results from the municipal flood modelling study are reviewed to identify if the property that is the subject of the planning permit is at risk of overland flooding the 1 % Annual Exceedance Probability (AEP) or 100 year ARI flood event. Where Council's data suggest that the property is at risk of flooding the following advice presented in Figure 4-1 below is provided to the permit applicant requesting further information in the form of a flood mitigation study.

1 Further Information Required: YES

In order to properly assess the application, it will be necessary for the applicant to provide further information. In particular:

- If the applicant would like to construct on the above property address, they would be required to provide a formal drainage report including calculations, prepared by a suitably qualified Civil Engineer experienced in hydrology, must be submitted to and approved by Council's Engineers. The drainage report must include two-dimensional flood modelling using TUFLOW or an approved equivalent software product to demonstrate that the proposed development is protected from the impact of overland flow path and does not adversely impact neighbouring properties. Flood modelling works need to be completed to Melbourne Water's best practice principles and/or to the satisfaction of the Responsible Authority. Council can assist by providing our flood modelling data if requested by the applicant.

Figure 4-1 Request for further information for properties affected by 1 % AEP overland flooding

The applicants are required to demonstrate that the proposed development meets the following criteria:

- Does not adversely impact neighbouring properties in relation to flooding in events up to and including a 1 % AEP flood event
- Floor levels are 300 mm above the 1 % AEP flood levels
- Garage floor levels are 150 mm above the 1 % AEP flood levels
- Safe access and egress with depth and hazard limited to acceptable limits.

Several properties within the study area have had to address these requirements in recent years including, but not limited to:

- Redevelopment of Croydon Shopping Centre
- 35 Jackson Street
- 36 Jackson Street
- 38 Jackson Street
- 21 Plumer Street.

In granting a planning permit Council place conditions on multi dwelling developments and subdivisions to ensure that a range of stormwater management requirements are met. These requirements are documented in Council's Engineering Development Design Guidelines and include details of stormwater treatment and on-site detention requirements for example.

5. FUTURE LAND USE AND PLANNING CONTROLS

In 2019 Engeny worked closely with Council to develop draft flood overlays for the entire Maroondah municipality. The outcomes of this work are summarised in a report titled, *Development of the Council Flood Extent: Technical Report*, Engeny (March 2019).

A map depicting the extent of proposed flood overlays within the study area is contained in **Appendix C**. The proposed overlays on the plan in Appendix C are overlaid on a layout plan of proposed future land use across the study area from the 2006 Structure Plan.

The draft flood overlays cover many residential properties and thus are likely to have a large bearing on the nature and extent of development within the study area. The draft overlays could be incorporated into the Planning Scheme and then used to ensure that a satisfactory planning and engineering outcome is achieved as part of any development proposal. Several drainage authorities, including Melbourne Water, view flood overlays as a measure that has the potential to manage flooding more effectively than drainage upgrades. Flood overlays do not have a capital cost for drainage works and ensure that any new development is appropriately sited to limit flood risk / damages.

In the absence of planning scheme controls there is a risk that inappropriate development is allowed which could increase flooding risk within the study area. Also the positions of Melbourne Water and other Councils and Maroondah's desire to effectively manage flood risks all point to a strong preference for the use of flood overlays across the study area.

Flood modelling completed in 2019 for Council and Melbourne Water across the Maroondah municipality included a climate change scenario whereby the rainfall intensity across the modelled areas was increased in accordance with advice available at the time of the study. An increase of 16.1 per cent was allowed for in this scenario and is based on the high emissions 'RCP8.5' global warming scenario which predicts a 3.21 degrees Celsius increase in temperature by the year 2090. A comparison of the 1 % AEP flood extent for existing conditions and climate change is provided in **Appendix D**. There is a minor increase in the flood extent as a result of accounting for climate change. It is noted that some drainage authorities across Greater Melbourne are preparing flood overlays accounting for climate change.

6. STRUTURAL STORMWATER MANAGEMENT WORKS

The flood modelling undertaken by Council has been used in recent years to assess the effectiveness of a range of flood mitigation works. Some of these works demonstrated a significant improvement with respect to reductions in flooding and subsequently designs for these works were prepared and construction undertaken and completed.

To date the most significant flood mitigation works completed within the study area has been the 'Croydon Civic Precinct Flood Mitigation Works.' The works constructed as part of this project consisted of the following elements:

- Lusher Road reshaping, provision of new drainage within the road and upgrade of existing drainage crossing at the low point in Lusher Road
- Birdwood Road reshaping
- Civic Square reshaping
- 14-16 Civic Square carpark and bioretention system / retaining wall construction
- Detention system within private property at 18 Civic Square
- Retaining wall construction, including:
 - along northern boundary of Scout Hall,
 - behind properties on the northern side of Birdwood Road
 - side and rear of Lusher Road properties (south of Birdwood Road)
- Aquahub carpark reshaping and associated drainage works (including demolition of tennis courts and lowering of the former tennis court area to improve the overland flow path)
- Pump station construction at the south western corner of Aquahub carpark within existing retarding basin
- Swale / overland flow channel through existing drainage easement located along northern boundary of 25-35 Lusher Road
- Swale / overland flow channel at the southern end of Civic Square with low flow drainage system beneath channel
- Swale / overland flow channel around Fred Geale Oval with low flow drainage system beneath channel and outlet into Melbourne Water's Croydon Main Drain.

These works are described in greater detail in a report titled, *Croydon Civic Flood Mitigation Works – Post Construction Analysis*, Engeny (April 2019). Included within this report are details of minor improvement works and maintenance provisions for Council's consideration to optimise the performance of the drainage network.

A number of other flood mitigation / stormwater harvesting projects are currently being investigated by Council within or adjacent to the study area and include:

■ Silcock Reserve Stormwater detention and harvesting

As part of a feasibility assessment it has been demonstrated that this project has a range of integrated water management benefits including:

- Reduced flooding equating to an estimated annual reduction in flood damages of estimated of \$138,000 within the study area.
- Protection of up to 11 properties at risk of flooding from above floor level in the 20 % AEP event.
- Removal of approximately 30 kg of Nitrogen per year from runoff directed to Dandenong Creek .
- Reduction in potable water demand by approximately 8.7 ML per year.

Further details can be in the report titled, *Silcock Reserve Stormwater Detention / Harvesting Concept Design Report*, Engeny (November 2019).

■ 'Reimagining Tarralla Creek'

Whilst this project is located just outside of the study area boundary it has significant potential to benefit the local community who live and interact within the study area.

The project is one of five trial sites for Melbourne Water's new program of works titled 'Reimagining Your Creek'. This program aims to convert existing concrete / grassed channels and pipes into more naturalised waterways complemented by a blend of natural habitat and open space which is underpinned by innovative urban design to showcase the potential for creating places where blue (waterways) meets green (parklands).

The Croydon wetland, immediately downstream of the study area is proposed to be enhanced significantly to provide improved stormwater treatment and allow for improved interaction by the community (e.g. lookouts and education zones).

■ Gross Pollutant Trap at Norton Road / Mt Dandenong Road

Council is considering installing a Gross Pollutant Trap (GPT) near the intersection of Norton Road / Mt Dandenong Road. This asset will be a complementary asset to the Fred Geale stormwater harvesting project noted below, however is not reliant upon the stormwater harvesting project to realise its benefits.

■ Fred Geale Oval stormwater harvesting

This project has evolved as part of the 'Reimagining Tarralla Creek' project. It has the potential to remove approximately 40 kg of Nitrogen per year from runoff directed to Dandenong Creek and reduce potable water demand by approximately 12 ML per year.

The locations of these projects under consideration are depicted on a map in **Appendix E**.

7. FUTURE STORMWATER MANAGEMENT OPTIONS

There are a range of alternative stormwater management measures being investigated / adopted by Council and other drainage authorities across Greater Melbourne to manage stormwater. These measures include but are not limited to those documented in the following sub-sections.

7.1 Flood Warning / Alert Systems

Flood warning systems exist for many of the large waterways across Greater Melbourne. Within large catchments there is an ability to use gauged water level data to provide flood warnings to local communities. However, due to the nature of urban flooding which is characterised by overland flooding resulting from short / intense rainfall events there is generally not enough time to use gauged information to provide a meaningful warning.

However, with the continual improvement of weather forecasting some drainage authorities, including Melbourne Water, are investing in flood alert systems, using Bureau of Meteorology data / predictions. These systems utilise rainfall forecasts to send alert messages, via SMS or email, to residents which are predicted to be at risk of flooding for particular rainfall thresholds. This enables the residents to plan for possible flooding which could include moving valuables (e.g. cars) to higher ground to limit damages. There is potential to utilise the flood modelling results available across the study area to setup flood alerts for residents affected by flooding within the study area.

A range of non-structural / flood warning options for Council's consideration within the study area are documented in the report titled, *Croydon Civic Flood Mitigation Works – Post Construction Analysis*, Engeny (April 2019). The following is an extract from that report:

Engeny understands that Council have identified the following actions for further consideration which revolve around flood warning measures and development of Flood Management Plans:

- *Investigate depth gauge for visual assessment during storm / flood events;*
- *Arrange for marking of 1 % AEP flood level on Lusher Road retaining walls for future indication;*
- *Consider 'flood warning' signs i.e. road subject to flooding; and*
- *Consider development of Flood Management Plan for Aquahub.*

Engeny consider each of these actions to be appropriate measures to increase awareness of flooding with the study area. Given the high visitation rates by the community to Aquahub the development of a Flood Management Plan or Flood Warning

and Response Plan (FW&RP) is considered the highest priority action for consideration by Council.

A FW&RP provides a means of managing existing as well as future flood risk. It details the measures that need to be implemented in relation to the continued use and future development in the study area to ensure best possible preparedness as well as appropriate response and recovery measures (i.e. those things that need to be done before, in the lead up to, during and after a flood – the planning, training, monitoring, warning and associated procedures and accountabilities) in the event of a significant flood in the study area.

7.2 'Talking Tanks' Technology

In many regions around the world, rainwater tanks have been used as a form of distributed storage because they provide a range of benefits. These include providing an alternative water supply source for increasing water supply security, improving the quality of receiving waters, and mitigating floods. Recent developments also include the use of smart tank technology to reduce flood peaks. For example, products such as South East Water's 'Talking Tanks' allow rainwater tanks fitted with a remote-controlled outlet orifice to purge retained water prior to a forecasted rainfall event to maximise storage capacity with the aim of minimising peak outflows during storm events.

Within highly urbanised drainage catchments a significant portion of catchment area is held in private ownership (e.g. residential properties). Many flood mitigation studies across Greater Melbourne have recognised that due to a lack of available open space / Reserves for implementation of possible flood mitigation works (e.g. retarding basins) it is increasingly difficult to mitigate flooding impacts associated with major storm events (e.g. the 1 % AEP event). This is heightened when accounting for increasing development and current climate change projections which are both acting to increase runoff volumes. As such flood mitigation opportunities within residential properties is increasingly being investigated to assist with flood mitigation.

Engeny recently completed a study with the aim of determining the effectiveness of the 'Talking Tanks' Technology within a sub-catchment of a neighbouring municipality. The key finding of this study was that implementation of 'Talking Tanks' across the sub-catchment was able to fully resolve the flooding impacts associated with climate change and also provide a reduction in the base case flooding for all AEP events.

Further investigations into the opportunities and constraints to the implementation of this technology with the study area are required. As such implementation of this technology is considered a long-term consideration.

7.3 On-Site Detention Requirements

The primary purpose of On-Site Detention (OSD) Systems is to limit the rate of discharge from a development site to the legal point of discharge, freeing up capacity in the Council

drainage network to reduce flooding during more extreme rainfall events. This is achieved by controlling post development flow rates to a pre-determined level, and temporarily storing excess runoff in storage tanks or pipes within a site boundary. The key elements of an OSD system are:

- A runoff collection system consisting of gutters, downpipes, pits and pipes.
- A runoff storage area (Oversized Pipe, Tank, etc.)
- A flow control device (Multicell, Orifice Pit or Pump) to allow discharge to the Legal Point of Stormwater Discharge at the predetermined rate

Council's requirements with respect to OSD are outlined in Council's Engineering Development Design Guidelines and an extract is presented in Figure 7-1 below.

'Limit the Permissible Site Discharge (PSD) to the equivalent of a 35% impervious site coverage, or the pre-developed discharge rate, if it is less than 35% impervious site coverage, to the satisfaction of the Responsible Authority'; and

'Provide appropriate stormwater detention storage to limit the maximum discharge rate to the PSD'.

Onsite detention volume requirements

All developments that require onsite detention must detain a minimum of 1 in 10 year storm event; however there may be cases where a property is required to store a 1 in 20 year or 1 in 100 year storm event. The following table outlines the detention requirements for various property situations:

Slope of property & LPD location	Treatment of overland flow path (Q100 from site)	Detention requirements (1 in x storm event)
Forward or side sloping with LPD in road reserve	A safe overland flow path can be provided to the road reserve without detrimentally affecting other properties	10 year
Forward or side sloping with LPD in road reserve	No safe overland flow path can be provided to the road reserve without detrimentally affecting other properties	100 year
Rear or side sloping with LPD in rear or side easement	A safe overland flow path or piped system can be provided to the easement without detrimentally affecting other properties	20 year
Rear or side sloping with LPD in rear or side easement	No safe overland flow path can be provided to the easement without detrimentally affecting other properties	100 year

Table 4 - Detention requirements

Figure 7-1 Maroondah City Council OSD Requirements

The City of Melbourne Stormwater Drainage Design Guidelines (2019) outline the OSD requirements for developments within the City of Melbourne. These guidelines stipulate different OSD requirements for different areas of their municipality. For example, within the Melbourne CBD and growth areas of the City of Melbourne, the Site Storage Requirement (SSR) must be calculated from the post development runoff generated from

the 1 % AEP rainfall event. For non-growth areas the SSR must be calculated from the post development runoff generated from the 10 % AEP rainfall event.

Due to the extent of flooding across the study area it is recommended that Council adopt a requirement that SSR within the study area must be calculated from the post development runoff generated from the 1 % AEP rainfall event. This will help to minimise the impact of development within the study area regardless of whether the proposed flood overlays are adopted or not.

7.4 Greening the Greyfields

Greening the Greyfields is a project conceived by Professor Peter Newton (Swinburne University) and Professor Peter Newman (Curtin University) and funded by the CRC for Spatial Information in 2011.

The term 'greyfields' refers to the middle suburbs of Australian cities where housing stock is ageing and being replaced by newer, more intensive housing developments. Unlike greenfield (urban fringe housing developments) and brownfield (ex-industrial housing development), greyfield redevelopment occurs on small, individual lots of land and to date has occurring in a piecemeal / ad hoc fashion.

The overarching principle of greening the greyfields is that a new logic for urban development is required to direct population and investment inwards to brownfields and greyfields precincts, rather than outwards to the greenfields.

Redevelopment at a precinct scale represents significant potential to improve sense of place, an opportunity to create an attractive physical neighbourhood and social community setting, with a distinctive look and feel. With respect to stormwater integrated urban water systems involving water sensitive urban design are best implemented at precinct scale, enabling an appropriate mix of technologies for local water capture, storage, treatment and reuse. Figure 7-2 below presents an example of a possible 'greening the greyfields' precinct redevelopment.



Figure 7-2 Possible Greening the Greyfields precinct redevelopment (Source: Maroondah Housing Strategy 2016)

Engeny worked closely with Council in 2018 to undertake a pilot study, and the first of its kind in Melbourne, to assess the stormwater management advantages of a ‘greening the greyfields’ approach to redevelopment of a residential precinct in Ringwood, north of the Ringwood Metropolitan Activity Centre. Flow paths through the precinct are subject to flooding which places conditions on future development and there is a lack of stormwater treatment prior to discharge to Mullum Mullum Creek.

A layout plan of stormwater management assets was developed and modelling undertaken to assess the benefits of a “greening the greyfields” layout. This assessment demonstrated the following advantages compared to existing conditions:

- No flooding of dwellings in a 1 % AEP storm
- Safe conveyance of 1 % AEP overland flows along a road network
- Stormwater treatment (to best practice requirements)
- Landscape values, green corridor, shade and linear open space within road reserves
- Pond and bioretention areas, including planting and stormwater treatment
- Passive watering of streetscape green areas and evapotranspiration utilising 3 ML/year of stormwater
- Harvesting of 60 ML/year of roofwater for indoor water use
- Overall reduction in demand for potable water in the catchment of 63 ML/year
- Reduced impacts on Mullum Mullum Creek, with reduced volumes of urban runoff and reduced pollutant loads.

Comparisons were made to a brownfields development scenario which assumed that the existing urban structure and property ownership would form the basis for the start of the redevelopment. Redevelopment would then occur over a number of years / decades mainly on an individual site basis. Therefore, there would be limited scope for changes to land uses. With a brownfields redevelopment scenario it is expected that Council would be involved in upgrading drains to reduce flooding risks to acceptable levels. Works may or may not be funded by monies collected from the redeveloping properties. Compared to the brownfields scenario a “greening the greyfields” redevelopment of the study area has the following major advantages:

- achievement of best practice stormwater treatment
- provision of a stormwater drainage system that is not reliant upon drainage and inlet capacity for conveyance of flow generated from major storm events (i.e. the 1 % AEP storm event)

- more water is retained within the catchment thereby minimising the hydrological impact of development on downstream environments
- less potable water needs to be supplied to the catchment.

7.5 Development Applications: Improving Stormwater Treatment Outcomes

The majority of drainage authorities understand that planning permit applicants often lack knowledge of what is best practice water resources and stormwater management objectives and how to demonstrate achievement of best practice. This slows down the planning permit process for the developer and Council and may lead to poor stormwater treatment outcomes. For example, raingardens in tight urban environments are rarely simple, especially so in smaller developments due to a lack of upfront engineering design, lack of expertise of consultants undertaking the work, and a lack of physical space.

Many Councils are attempting to improve the planning permit process with respect to stormwater treatment and provide improved outcomes for Council with respect to treatment effectiveness and ongoing maintenance requirements. Moreland City Council is an example of a Council who have addressed this by compiling a set of guidelines for their development community to streamline the assessment of Water Sensitive Urban Design (WSUD) assessments, have greater assistance and guidance for Council's Urban Planners, provide clarity for all and ultimately achieve improved outcomes.

Figure 7-3 below is an extract from a conference paper prepared by officers at Moreland City Council for the Stormwater Victoria Conference, 2019 which outlines the WSUD hierarchy for Moreland.

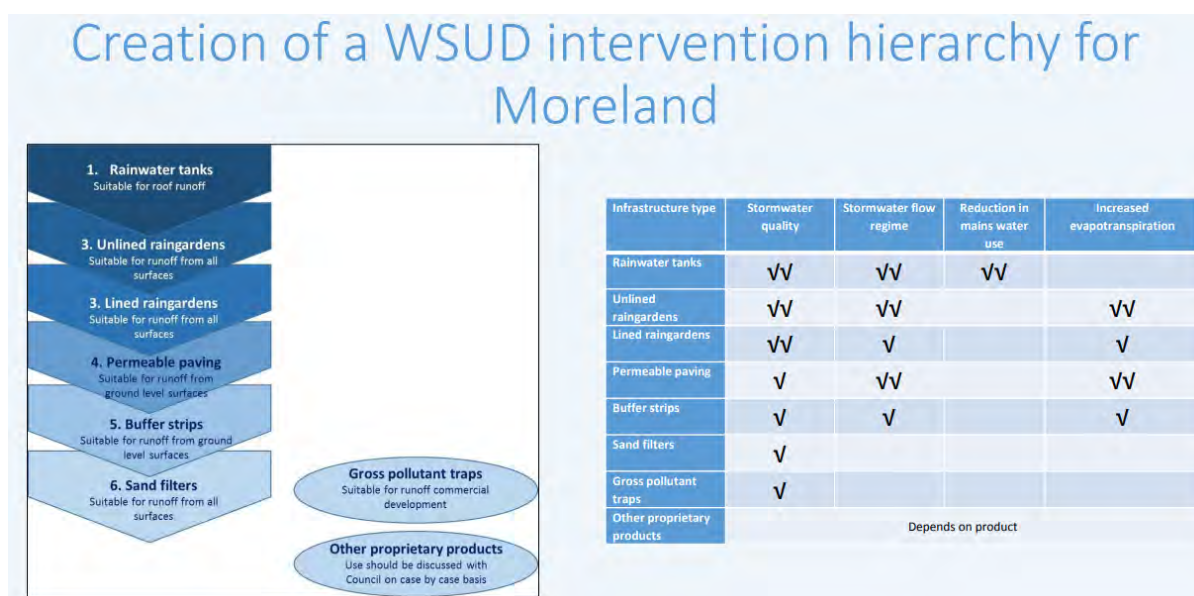


Figure 7-3 WSUD hierarchy for Moreland (Vaughn Grey and Kathryn Skidmore, 2019)

Maroondah City Council have a range of documents available online outlining the requirements of stormwater treatment including:

- <http://www.maroondah.vic.gov.au/files/assets/public/documents/integrated-planning/strategic-planning/imap-04-stormwater-management.pdf>
- <http://www.maroondah.vic.gov.au/files/assets/public/documents/engineering-building/engineering/engineering-development-design-guidelines.pdf>

It is expected that some benefits could be achieved by adopting a similar process to Moreland City Council where additional information is provided online specifically to:

- Outline how to respond to the planning requirements
- Provide a checklist of information required for lodgement
- Provide examples of applications.

7.6 In-lieu Development Contributions

In 2018 Kingston City Council, with the backing of Melbourne Water, introduced a stormwater quality in lieu mechanism which allows medium and high density residential developers to 'opt-in' to pay a fee to Council in-lieu of meeting all or a portion of their stormwater compliance obligations on-site. Council then uses these funds to invest in WSUD assets off-site that deliver equivalent or better stormwater quality outcomes than those required under Best Practice standards (BPEMG).

The Contributions Scheme applies to all privately owned residential and non-residential properties in the City of Kingston and is available to persons who are required to deliver stormwater quality works on-site in accordance with a planning permit or any relevant policy forming part of the Kingston Planning Scheme. The objectives of this scheme are to provide:

- Flexibility for new developments in Kingston to meet Best Practice stormwater management.
- Council with the opportunity to raise revenue from one or more sources towards costs of providing medium-scale stormwater treatment projects, in a manner that does not put upwards pressure on rates or create cross-subsidies.
- An alternative pathway to achieve Best Practice stormwater management for the whole of the municipality.
- A mechanism that is easy to calculate, simple to implement and streamlines the planning permit application and engineering assessment process.

The Stormwater Quality In-lieu Contributions Scheme presents two alternative pathways for applicants to achieve Best Practice stormwater management:

- The applicant may opt to undertake stormwater works on-site in accordance with an approved Stormwater Management Plan (Drainage). The type and complexity of information required to accompany each permit application would be proportionate to the type of development taking into consideration the risks and opportunities associated with each.
- If the applicant prefers not to achieve the required Victorian Best Practice stormwater management objectives on-site they 'opt in' to pay a nominated stormwater quality contribution in-lieu of the on-site works. The in-lieu contribution is determined by Council using a set formula and is paid to Council prior to the development commencing. All other stormwater related conditions remain unchanged.

It is understood that an opt-in approach may not require complex planning amendments to implement and can, in principle, be implemented quickly compared to developer charges.

As recommended by other Council's, including Moonee Valley City Council, it is important that a balance is struck between on-site and centralised treatment to provide the best overall outcome.

7.7 Developer Contribution Plans

Developer Contribution Plans (DCPs) enable Council to require new developments to make a monetary contribution towards the provision or upgrading of services or facilities where that development places a greater demand on those services or facilities.

Bayside City Council has developed a Drainage Development Contributions Plan (DCP) to:

- respond to a need to fund essential improvements and upgrades to the drainage network to support expected population growth in Bayside to 2031
- ensure the cost of drainage network upgrades is equitably shared between existing and new development
- provide details of the financial contribution to be made by proponents of new development toward projects that will service the catchment in which development is undertaken.

The Bayside DCP has been prepared acknowledging the following strategic issues:

- Growth is planned and supported within Bayside, in accordance with the Bayside Housing Strategy

- The current drainage infrastructure in Bayside cannot support additional growth without further capacity upgrades
- Drainage is a basic and essential infrastructure item required to support development
- A DCP enables new development to contribute to part of the cost of drainage capacity upgrades
- Given the nature of infill development there is a high level of uncertainty regarding where growth is likely to occur, and where capacity upgrades will be required. This means that a flexible and adaptable DCP is required.

Further details available on Bayside City Council's website:
<https://www.bayside.vic.gov.au/drainage-development-contributions-plan>

Given the significance of flooding within the study area and capacity of the existing drainage network a DCP could be considered for implementation within the study area.

8. SUMMARY

Since the original Croydon Town Centre Structure Plan was developed in 2006 a greater knowledge and understanding of stormwater, in particular flooding behaviour, within the study area has been gained as a result of recent severe storm events and flood modelling studies. This knowledge and understanding differs notably to that which was summarised in the 2006 Structure Plan and included the following statement, *“The study area is not subject to flooding and is not located in a LSIO zone or urban floodway zone or subject to Special Building Overlay (SBO) provisions.”*

The recent flood events and modelling have demonstrated that flooding is a key constraint to redevelopment within the study area and must be considered strongly as part of a refresh of the Croydon Town Centre Structure Plan.

This background report summarises the significant work undertaken by Council in recent years with respect to stormwater management in the study area including:

- Detailed flood modelling
- Construction of structural flood mitigation works within the Croydon Civic precinct of the study area
- Development of draft flood overlays for possible in the Maroondah Planning Scheme
- Investigation of the costs and benefits of stormwater harvesting projects at Silcock Reserve and Fred Geale Oval
- Investigation of the costs and benefits of flood detention works within Silcock Reserve.

The two stormwater harvesting projects (Silcock Reserve and Fred Geale Oval) under current investigation have the potential to provide a combined saving of 20.7 ML of potable water per year. As such these projects alone would meet Council’s target use of alternative water sources, 20 ML, by the year 2025 as documented in Council’s Water Sensitive Strategy. These projects have also helped Council address action number 2 in the 2016 Maroondah FMP which was to investigate feasibility of stormwater harvesting projects for reuse to mitigate flooding issues.

Whilst there are a range of existing planning controls that can be used to be used by Council to achieve a range of stormwater management requirements, the absence of flood overlays has the potential to create issues for Council. Currently there is a reliance on the building regulations and opportunities to review planning permit applications to enforce development requirements with respect to development within areas liable to flooding. It is understood that this current process lacks the planning enforcement strength that flood overlays can provide.

This report documents a range of future stormwater management measures that can be considered by Council for implementation in the short and long term:

- Flood Warning / Alert Systems
- 'Talking Tanks' technology
- Changes to On-Site Detention (OSD) requirements
- Greening the Greyfields
- Improvements to Development Application Process
- In-lieu development contributions
- Developer Contribution Plans (DCPs)

It is possible to adopt some of the measures listed above without a need to undertake significant additional works. For instance, Council could change OSD requirements for development within the study area and stipulate that the Site Storage Requirement (SSR) must be calculated from the post development runoff generated from the 1 % AEP rainfall event. Updates to Council's Engineering Development Guidelines would be required to accommodate this change.

9. PRIORITY ACTIONS TO BE CONSIDERED IN STRUCTURE PLAN REFRESH

The following actions are recommended for inclusion in the refresh of the overall Croydon Town Centre Structure Plan:

1. Amend the Maroondah Planning Scheme to include flood overlays for the study area
 - This action is consistent with action number 1 of the 2016 Maroondah FMP.
2. Resolve ownership and identification of flood mitigation works within the study area in collaboration with Melbourne Water
 - This action is consistent with action number 3 of the 2016 Maroondah FMP. As documented in the FMP, currently drainage assets in this catchment are owned and maintained by Council, however Council want to clarify future asset ownership with Melbourne Water given the catchment is well in excess of 60 hectares.
3. Update Council's Engineering Development Guidelines to stipulate that for development within the Croydon Town Centre Structure Plan the Site Storage Requirement (SSR) must be calculated from the post development runoff generated from the 1 % AEP rainfall event regardless of development type.
 - Implementation of the draft flood overlays will assist to demonstrate to developers why this increased storage requirement is necessary within the study area.
4. Update Council's website to provide additional information with respect to the development approval process for stormwater treatment measures.
 - It is important to note that innovation with respect to stormwater treatment is to be encouraged. Knowledge regarding WSUD is continuing to expand. What is best practice now will not necessary be considered best practice in say ten years' time. As such Council should invite innovation as part of future best practice stormwater treatment and management.

The following considerations are recommended for further thought by Council during the refresh of the Structure Plan. Where warranted, additional actions will likely be included in the Structure Plan to ensure that these considerations are implemented:

- Consider the opportunities and constraints to construction of the Silcock Reserve flood mitigation / stormwater harvesting project and the Fred Geale Oval stormwater harvesting project which both have the potential to realise significant integrated water management outcomes.
- Consider the opportunities and constraints of adopting a 'Greening the Greyfields' approach to redevelopment within the Croydon Town Centre Structure Plan.
- Consider adoption of an in-lieu development contribution scheme to provide funding of centralised stormwater treatment assets.

- Consider adoption of a Developer Contributions Plan (DCP) to assist in funding drainage improvement works in the study area. A DCP could potentially help to fund capital works such as the flood mitigation works at Silcock Reserve.
- Consider actions listed in other relevant Council documents / strategies that have relevance to stormwater management. For example, Council's draft Vegetation Strategy (August 2019) includes the following actions:
 - *Amend the planning scheme to strengthen planning controls to preserve high levels of permeability on private residential land.*
 - *Apply WSUD where practicable within public works in locations where benefits such as passive irrigation of street trees or reduction of localised flooding can be achieved.*
 - *Incorporate into a new Maroondah Municipal Planning Strategy (requirement of VC148) clear supporting policy statements, objectives and strategies around biodiversity and vegetation (including its health, habitat, and neighbourhood character benefits), the importance of streams, wetlands, permeability and WSUD for vegetation, and the importance of connecting people with nature. Ensure integration with the objectives of VC154 Stormwater Management and other recent key amendments.*
- Consider the actions documented in the report titled, *Croydon Civic Mitigation Works – Post Construction Analysis* (April 2019) which a range of structural and non-structural measures, including maintenance provisions, to reduce flood risk within the Croydon Civic precinct.
 - *As documented in that report, Given the high visitation rates by the community to Aquahub the development of a Flood Management Plan or Flood Warning and Response Plan (FW&RP) is considered the highest priority action for consideration by Council.*

10. REFERENCES

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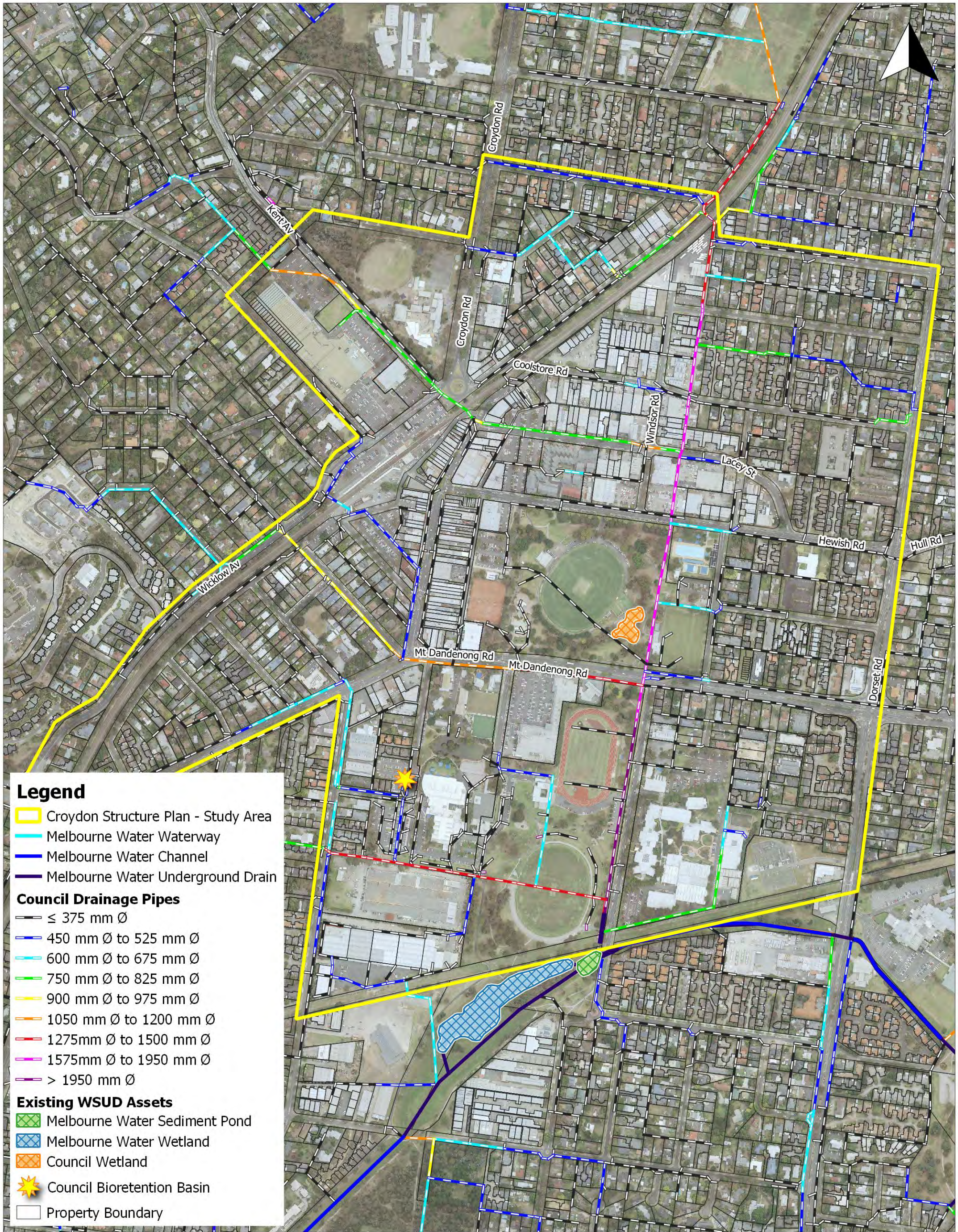
Engeny Water Management, 2018 *Greening the Greyfields: Notlen Street Catchment Discussion Report*, Rev 1, February 2018.

11. 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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- g. This report does not provide legal advice.

APPENDIX A

Drainage / WSUD Assets and Ownership within Study Area



Legend

- Croydon Structure Plan - Study Area
- Melbourne Water Waterway
- Melbourne Water Channel
- Melbourne Water Underground Drain

Council Drainage Pipes

- ≤ 375 mm Ø
- 450 mm Ø to 525 mm Ø
- 600 mm Ø to 675 mm Ø
- 750 mm Ø to 825 mm Ø
- 900 mm Ø to 975 mm Ø
- 1050 mm Ø to 1200 mm Ø
- 1275mm Ø to 1500 mm Ø
- 1575mm Ø to 1950 mm Ø
- > 1950 mm Ø

Existing WSUD Assets

- Melbourne Water Sediment Pond
- Melbourne Water Wetland
- Council Wetland
- Council Bioretention Basin
- Property Boundary

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Scale in metres (1:6000 @ A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

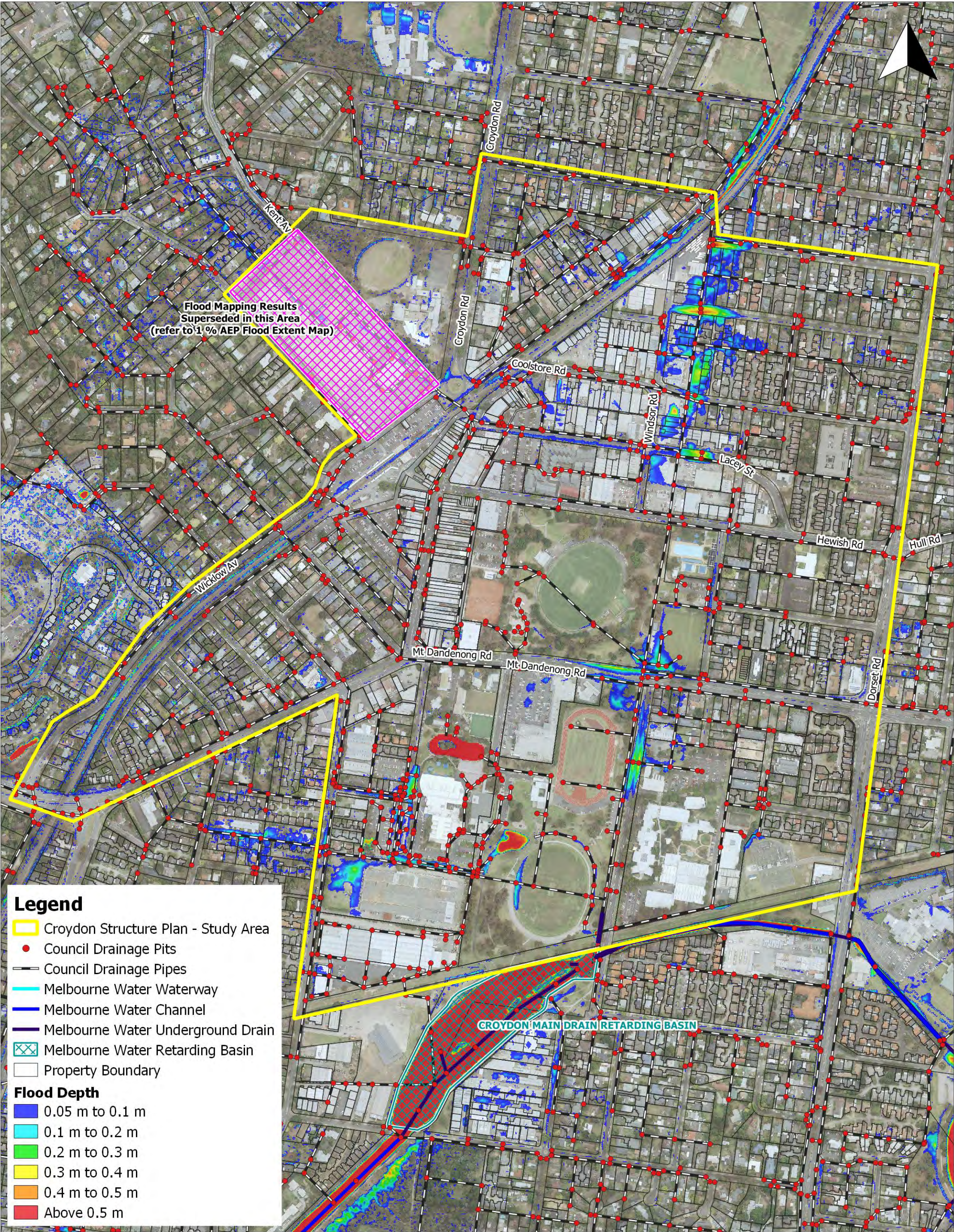
Croydon Structure Plan

Existing Drainage and WSUD Assets

Job Number: V2009_068
Revision: 1
Drawn: VW
Checked: SD
Date: 4/12/2019

APPENDIX B

Existing Conditions Flood Maps



Legend

- Croydon Structure Plan - Study Area
- Council Drainage Pits
- Council Drainage Pipes
- Melbourne Water Waterway
- Melbourne Water Channel
- Melbourne Water Underground Drain
- Melbourne Water Retarding Basin
- Property Boundary

Flood Depth

- 0.05 m to 0.1 m
- 0.1 m to 0.2 m
- 0.2 m to 0.3 m
- 0.3 m to 0.4 m
- 0.4 m to 0.5 m
- Above 0.5 m

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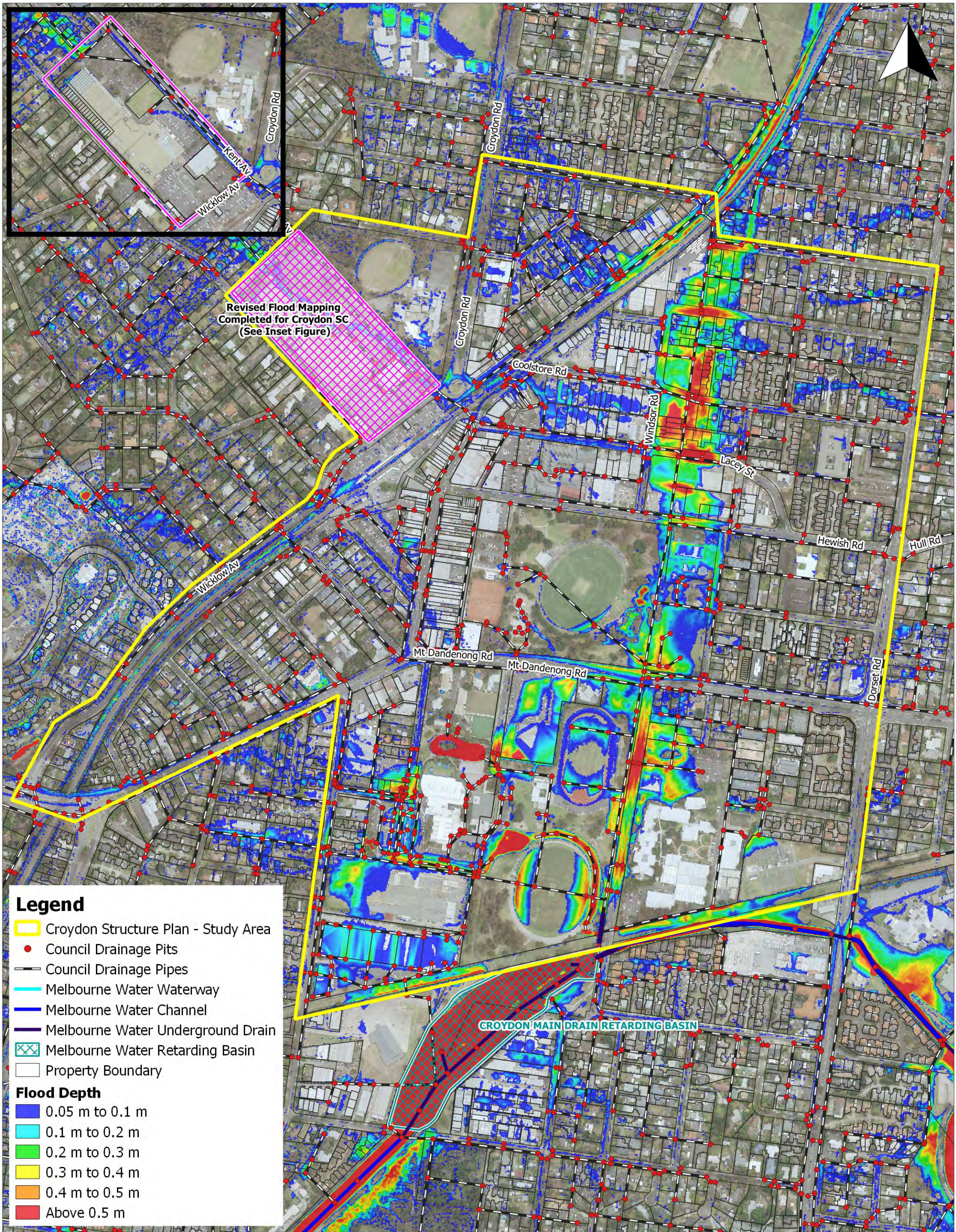
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Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Croydon Structure Plan

20 % AEP Flood Extent
Existing Development Conditions

Job Number: V2009_068
Revision: 1
Drawn: VW
Checked: SD
Date: 4/12/2019



Legend

- Croydon Structure Plan - Study Area
- Council Drainage Pits
- Council Drainage Pipes
- Melbourne Water Waterway
- Melbourne Water Channel
- Melbourne Water Underground Drain
- Melbourne Water Retarding Basin
- Property Boundary

Flood Depth

- 0.05 m to 0.1 m
- 0.1 m to 0.2 m
- 0.2 m to 0.3 m
- 0.3 m to 0.4 m
- 0.4 m to 0.5 m
- Above 0.5 m

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Scale in metres (1:6000 @ A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

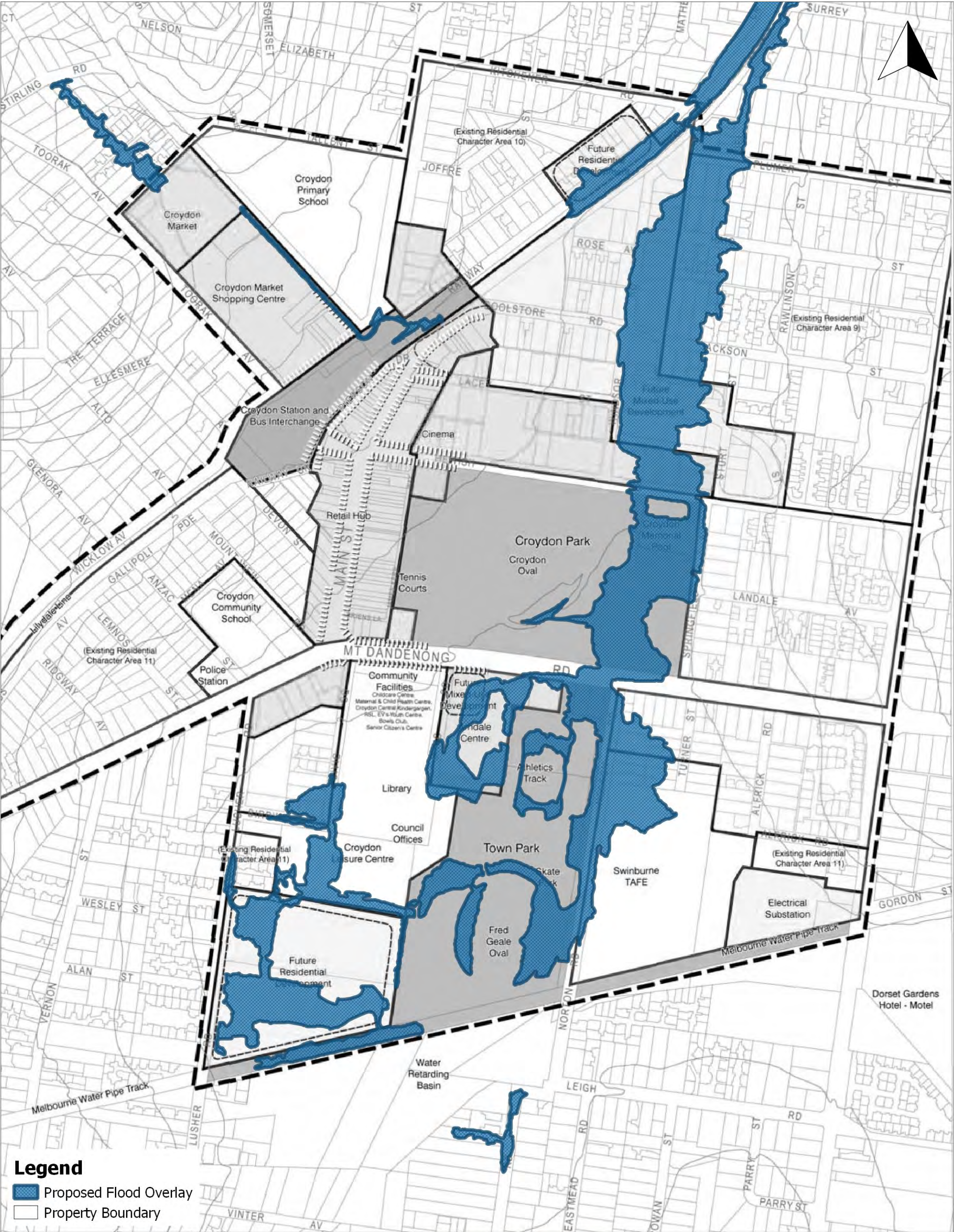
Croydon Structure Plan

1 % AEP Flood Extent
Existing Development Conditions

Job Number: V2009_068
Revision: 1
Drawn: VW
Checked: SD
Date: 4/12/2019

APPENDIX C

Proposed Flood Overlays for Study Area



Legend

- Proposed Flood Overlay
- Property Boundary

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100 0 100 m

Scale in metres (1:5000 @ A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

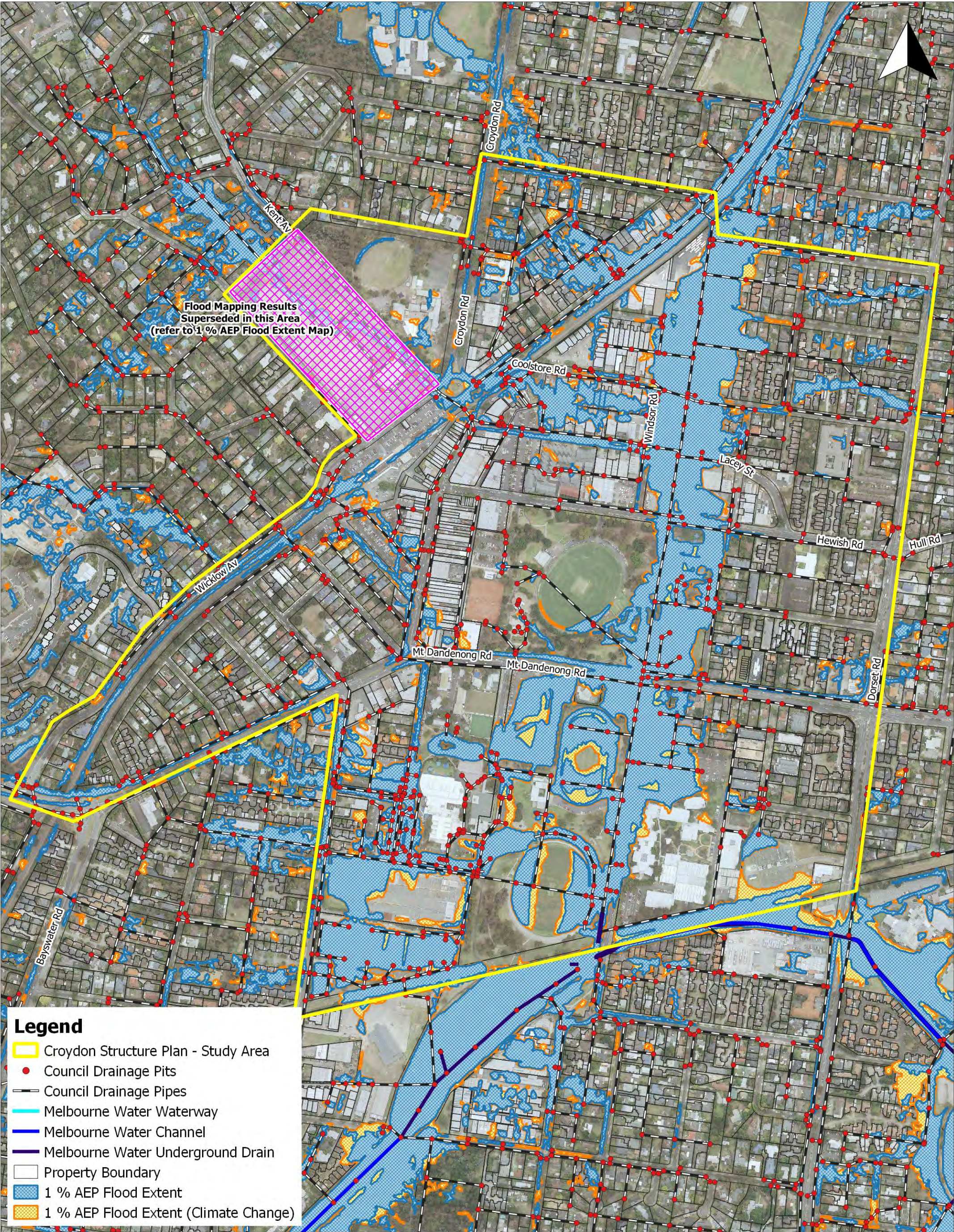
Croydon Structure Plan

Proposed Flood Overlay
(Basemap: Croydon Town Centre Structure Plan,
July 2006)

Job Number: V2009_068
Revision: 0
Drawn: VW
Checked: SD
Date: 3/12/2019

APPENDIX D

Comparison of 1 % AEP Flood Extent – Existing Conditions vs Climate Change



Legend

- Croydon Structure Plan - Study Area
- Council Drainage Pits
- Council Drainage Pipes
- Melbourne Water Waterway
- Melbourne Water Channel
- Melbourne Water Underground Drain
- Property Boundary
- 1 % AEP Flood Extent
- 1 % AEP Flood Extent (Climate Change)

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Scale in metres (1:6000 @ A3)
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Croydon Structure Plan

1 % AEP Flood Extent
Existing Development Conditions versus Climate
Change - Increased Rainfall Scenario
(Flood Extent developed using Melbourne Water's
standard filtering parameters)

Job Number: V2009_068
Revision: 1
Drawn: VW
Checked: SD
Date: 4/12/2019

APPENDIX E

Locations for Future Works Being Investigated



Legend

- Croydon Structure Plan - Study Area
- Council Drainage Pits
- Council Drainage Pipes
- Melbourne Water Waterway
- Melbourne Water Channel
- Melbourne Water Underground Drain
- Property Boundary
- ★ Potential Future Works

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120 0 120 m

Scale in metres (1:6000 @ A3)

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 55

Croydon Structure Plan

Potential Future Works (Drainage Improvements and WSUD Assets)

Job Number: V2009_068
Revision: 1
Drawn: VW
Checked: SD
Date: 4/12/2019