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MOTT MACDONALD

Burwood North Precinct Masterplan

Stormwater & Flood Study

August 2023

Acknowledgment of Country

We recognise the Wangal People of the Eora Nation as the Traditional Custodians of this land that is being masterplanned. We respect their enduring cultural and spiritual connections to the land and waters, and celebrate their knowledge, kinship and values.

We acknowledge that these connections, to the land and waters, have existed for millennia and will continue into the future. We respect the Elders who have gone before, together with those of today for their guidance on our shared journey.

We recognise that we are, and always will be, on Aboriginal land.

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Burwood North Precinct Masterplan

Stormwater and Flooding Report

August 2023

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1 Introduction

Burwood Council is preparing an updated masterplan and supporting studies for the Burwood North Precinct, building upon the work already undertaken as part of the Parramatta Road Corridor Urban Transformation Strategy (PRCUTS). The masterplan seeks to capture the opportunity afforded by a new metro station at Burwood North on the Sydney Metro West network.

The masterplan strives to deliver an outcome that is feasible, maximises public benefit and delivers high quality public domain, open spaces and community infrastructure. The masterplan articulates a cohesive vision for Burwood North that will underpin the growth and development of the precinct as a benchmark for sustainable urban renewal.

The masterplan is the result of a collaborative process that has been undertaken between Burwood Council, a wide range of government, institutional and community stakeholders, and the project's consultant team.

An Implementation Plan will also be prepared that outlines the recommended planning controls, policies and infrastructure necessary to enable the successful delivery of the masterplan. The recommendations may inform amendments to the Burwood Local Environmental Plan 2012 (LEP) and Burwood Development Control Plan 2012 (DCP).

As part of the process, Mott MacDonald is engaged to prepare this technical report to address flooding and water quality concerns for the Burwood North revitalisation and assist in implementing new stormwater requirements for future developments within the precinct.

1.1 Catchment and Topography

The Burwood North Masterplan Precinct, referred to herein as 'the precinct', is indicated in Figure 1-3 and is located within the St Lukes Catchment. The catchment is shared between the Canada Bay and Burwood LGAs, and is split up along Parramatta Road, which serves as the main East – West transport link. The catchment comprises largely of urban residential developments, with commercial and light industrial corridors along the major roadways. Runoff from the whole precinct discharges into the Parramatta River, via an unnamed bay located downstream of Lyons Road.

Figure 1-1 Burwood Park and Town Centre

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Figure 1-2 St Luke's Canal

1.2 Previous Studies

Burwood Council has published the *Exile Bay, St Lukes and William Street Flood Study* (2019), prepared by WMAwater as part of the first stage of the NSW State Government's policy on floodplain risk management. This study sets out the direction for floodplain risk management of the catchment, and developed detailed hydrological and flood models for use in making assessments of flood risk and impacts within the catchment.

Sydney Metro West is a prominent transport infrastructure project, currently in the design phase, with the potential to influence stormwater management and flooding at the northern end of the precinct. The approval conditions for this infrastructure require limited impacts on flooding in terms of worsening flood levels or affectation to third parties as a result of the project. The submissions for environmental approval of this project provide information on the proposed infrastructure for consideration as an interfacing project to the Burwood North precinct assessment of stormwater and flooding management.

Figure 1-3 Burwood North Masterplan Precinct

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1.3 Purpose

This report will provide recommendations for the future precinct development within the context of the planning approach in order to serve the future community of Burwood with an improved outcome in terms of flooding and stormwater management. To enable the engineering review of stormwater and flooding conditions and determine the appropriate recommendations the following scope was developed.

- Establish baseline conditions within the existing detailed precinct flood model as well as high level MUSIC model
- Review proposed climate change factors in line with Australian Rainfall and Runoff 2019 (ARR19) and inclusion of potential climate change impacts as part of the baseline flooding assessment
- Investigate the impact the proposed development may have on existing flood conditions, including flood levels and flood storage as well as identify opportunities for natural water quality enhancements and biophilic flood protection
- Integration of the proposed design for the buildings, pavement grades and levels to the preferred model in consultation with the project team
- Coordinate flooding outcomes with the project team to address unacceptable flood impacts and iterate the model based on revised urban design configurations
- Determine required Flood Planning Levels and give advice on potential flood protection measures and flood evacuation measures
- Prepare flood map outputs for relevant minor, major and extreme events including the 5% AEP, 1% AEP and Probable Maximum Flood (PMF)

1.4 Planning Context

Statutory planning regulations in NSW govern the adoption of flood planning levels for development. Adoption of flood planning levels should consider the likely life of the structure meaning that climate change uplift on flood levels is to be adopted.

- NSW Flood Prone Land Policy (2022)
- NSW Floodplain Development Manual (2005)
- Burwood Local Environmental Plan (BLEP) 2012
- Burwood Development Control Plan (BDCP) 2021

Other Council plans around the future development in the precinct including the desired community amenity also set proactive goals to manage flood risk for the community into the future, specifically by committing to *Minimise the impact of flooding to the Burwood community*. These background plans include:

- Burwood Housing Strategy (2020)
- Burwood Community Facilities and Open Space Strategy (October 2019)
- Draft Community Strategic Plan – Burwood (2036)
- The Community Strategic Plan – Burwood (2030)
- Sustainable Burwood (2022)
- The Burwood Local Strategic Planning Statement

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2 Stormwater Strategy

This section describes the intent for management of stormwater across the precinct. Information on best practice and examples of beneficial implementation of stormwater infrastructure elsewhere provides the basis for recommendations for actions within the precinct.

2.1 Stormwater Management Challenge

2.1.1 Existing Stormwater Management

The natural watercourse through the catchment has been formalised with a trunk drainage line carrying the catchment runoff from collection pit and pipe systems in the local road reserves. Figure 2-1 indicates the route of the trunk drainage main shown in blue, discharging to the north east within the major drainage easement east of Concord Oval.

Figure 2-1 Existing utilities plan indicating trunk stormwater route

Overland flow management through the precinct is fragmented, with historic development obstructing the continuous free overland flow paths along the natural valley from the south-east corner of Burwood Park to Concord Oval. The approach to stormwater management to date has focussed largely on underground pit/pipe systems to manage flows, however capacity limitations of the underground system result in undesirable ponding through the urban residential areas in moderate to large storm events.

2.2 Stormwater Management Opportunities

2.2.1 Green Corridor

With reference to the sustainability aspirations for the precinct, the opportunity to introduce a green corridor between Burwood Park and Concord Oval can offer stormwater management and flooding benefits. The potential for reinstating softer landscapes within road reserves (and potential future development lots) gives the opportunity for overland flow consolidation within the corridor, and an increased catchment flood storage potential. Additional benefits of this approach are in supporting biodiversity, recreation opportunities, and allows for additional rainfall infiltration relative to current conditions, ultimately reducing overland flow volumes.

Further opportunities also exist for “daylighting” stormwater infrastructure, where sections of the underground stormwater culverts are reinstated as natural creeks along the Green Corridor. This level of rehabilitation does require a significant corridor width and may not be feasible in many cases due to the depth of the stormwater infrastructure and space constraints.

2.2.2 Dual Use Public Domain for Flood Storage

Within the potential blue/green corridor but also local road reserves, the introduction of new storage volume within the profile of local roads and stormwater drainage features within the local road corridors can increase the resilience of development to future flood events. Current flood storage is fragmented and associated with informal ponding areas around existing flood affected properties, however re-grading local streets with civil design allowing for greater temporary ponding of overland flows in desired low points within the public domain and local road network can lower flood levels at the fringe of overland flow paths. This opportunity is considered alongside planned emergency and evacuation strategies to ensure that flood hazards are reduced;

a. in the number of hazardous locations by consolidating overland flows, or;
b. in terms of hazard severity for pedestrians and vehicles.

2.2.3 Introduction of Lot-Based Detention Infrastructure

On-site detention (OSD) is an infrastructure measure to provide flood storage to a local catchment, to reduce flooding constraints. It can take a number of forms, typically detention tanks, basins, or integrated depressions within the grading of new public domain areas. This can be considered in both a temporary or permanent approach to increasing flood storage and reducing the impacts of new development or infrastructure in the floodplain. In precinct re-development OSD can play an important role in the staging of new infrastructure, for example as temporary offset detention to be made available during the construction phase of permanent stormwater management infrastructure which would otherwise cause increases in flood hazards locally.

The provision of OSD at the lot-based or development level effectively provides the required detention as development occurs. The alternative method is the provision of regional basin type storage, consolidating the required detention volumes together. The lot-based approach is preferred to regional basin type approaches in Burwood due to the fragmented land ownership and likely development timeline, whereby the regional approach faces the challenges of staging, availability of suitable land and funding allocation.

2.2.4 Integrated Water Quality

Enhancement of water quality discharging from the catchment, both from building lots and new public domain is proposed to improve conditions in receiving watercourses and also achieve sustainability outcomes. Water quality is one of the “missing links” that is too often overlooked in current public domain design, and new precincts provide the opportunity to reset water quality to be a key part of the precinct design. With the EPA putting some of the most restrictive requirements on discharge to new development areas with Sydney (South Creek and Second Ponds Creek recently), integrated water quality treatment within the public domain form a key part of the discharge strategy while aligning with desired streetscape features within blue/green corridors. More details regarding water quality treatment measures are described in section 3.

2.3 Implementation

The masterplan design identifies the local streets subject to hazardous conditions in flood events (refer section 4) and relief of flood behaviour of these overland flows is achieved through precinct grading and open space relief areas which act to reduce the peak flows experienced in key locations across the precinct. Key locations benefiting from the provision of overland flow relief are overland flows in Esher Street and New Street.

Further optimisation for the management of local overland flows will occur through the development application process whereby detailed assessment of potential impacts from future development and the provision of mitigating measures is executed by developers through detailed design.

To assist developers in achieving the desired stormwater management outcomes, development controls have been reviewed and recommendations made regarding the relevant DCP controls. These controls assist in the mitigation of the peak stormwater discharge flows which are the key drivers of potential property damage and hazardous conditions in the upper portions of the catchment.

2.3.1 DCP Recommendation

The current DCP requirement to execute new development conforming to the Burwood Stormwater Management Code, is an appropriate mitigation for peak flows from private developments across the precinct in a lot-based approach to OSD.

Lot-based OSD

In accordance with Section 4.7 of the Stormwater Management Code, OSD is required on all types of development with impervious area exceeding 60%, regardless of the percentage of the site in its pre-development state.

OSD storages must restrict outflows from a site during 1% AEP storms to a permissible site discharge (PSD) determined from:

- *PSD (L/s) = Site Area (ha) x 150*

The volume of storage required is to be determined from:

- *Storage (m2) = Site Area (ha) x 300, where no rainwater tank is provided and.*
- *Storage (m2) = Site Area (ha) x 225, where a rainwater tank is provided as part of the NSW Government’s BASIX requirements.*

It’s recommended that the AEP terminology be adopted in preference to the previous Average Recurrence Interval (ARI) terminology, ie. 1% AEP instead of 100 year ARI. The permissible site discharge rate is appropriate to attenuate the peak stormwater flows effectively.

Overland Flow Management

The development controls note the flood planning context and previous studies Burwood Council have previously engaged consultants to carry out, being:

- Dobroyd Canal Overland Flood Study, September 2019
- Cooks River Overland Flood Study, August 2016
- Powell's Creek Overland Flood Study, March 2017
- Exile Bay-St Luke's-William Street Overland Flood Study, March 2017

Resulting from these draft studies, a draft Consolidated Flood Identification (CFI) map has been developed, which identifies properties affected by overland or mainstream flooding. The draft CFI map have been placed on Council's website which identify lots subject to flood control.

As per Section 4.3 of the Stormwater Management Code, a separate flood study will be required for developments and amalgamations within the identification area, defining depths, hazards and indicating safe levels for habitable rooms and other features.

These flood studies are to be conducted in accordance with the principles set out in the NSW Floodplain Management Manual (NSW Government, 2001).

It's recommended that references to the Flood Risk Management Manual be updated to reflect the most recent version dated 7th February 2022. This version has a number of additional parts and updated discussion on the treatment of flood hazard, particularly in regards to flooding events greater than the 1% AEP. Of particular relevance to the masterplanning and development processes is the Flood Impact and Risk Assessment guideline.

3 Water Quality

3.1 Water Quality Challenge

The Burwood North Masterplan Area is located to the south of the Parramatta River catchment, with Parramatta River a main tributary of Sydney Harbour. This catchment is highly urbanised and altered from its natural state, with pockets of open spaces and parkland.

3.1.1 Existing Water Quality

St Luke's Canal is connected to the river and located to the north east of the catchment. This waterway is concrete lined and contains to instream aquatic habitat. It is defined as a first order watercourse (as per Appendix 2 of the FBA (OEH, 2014)). This waterway is not considered to be Key Fish Habitat in accordance with the Policy and guidelines for fish habitat conservation and management – Update 2013 ((NSW Department of Primary Industries, 2013) and is classified as Class 4 (unlikely key fish habitat).

Watercourses within the precinct are influenced by several factors including:

- Current and historical polluting land uses within the catchments
- Stormwater and sewage overflows and leachate from contaminated and/or reclaimed land
- Urbanisation of the catchments and subsequent reduction in permeable area, increasing run-off and pollutant loads entering waterways
- Illegal dumping.

The watercourse is generally in poor condition and is representative of a heavily urbanised system. With water quality characteristics relevant to ANZECC/ARMCANZ (2000) indicators being the following:

- Low dissolved oxygen levels
- Elevated nutrient concentrations
- Elevated heavy metal concentrations
- High turbidity

3.2 Potential Treatment Options

Water Sensitive Urban Design is an environmental and planning measure used to integrate urban water cycles, hoping to replicate as far as possible in comparison to natural systems. It seeks to:

- Improve environmental performance by reducing the rate of runoff as well as to reduce pollutant loads.
- Enhance the recreational appeal and aesthetic of the urban environment.

WSUD can take form in various ways including:

- Stormwater detention
- Minimising stormwater pollution
- Water re-use
- Water efficiency
- Reduction in nuisance flooding
- Enhancing groundwater infiltration

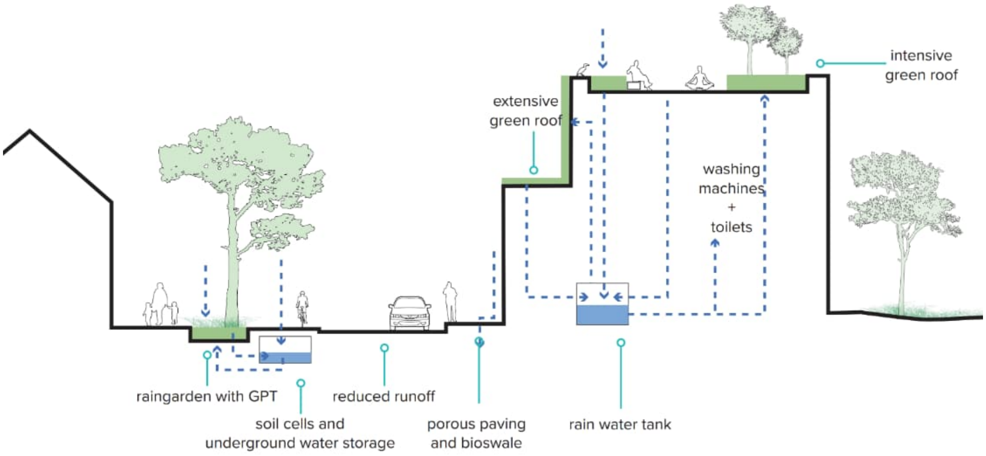

Figure 3-1 Water Sensitive Urban Design Options

Unlike many LGAs across Sydney, Burwood Council does not currently have a set water quality target within its Development Control Plan and Stormwater Management Code. As such there are significant opportunities for improvements within this area for future developments within the precinct.

Rainwater Tanks and Re-use

Rainwater tanks are a requirement of BASIX for all new residential developments, the required capacities are usually based on the total roof area. Rainwater tanks are typically used used to provide stormwater for non-potable purposes such as toilet flushing and garden watering while removing runoff from the stormwater system. Rainwater tanks can be further utilised for building cooling systems and as an alternative potable water source. Rainwater filtration and disinfection systems can be used as a way to provide safe potable drinking water from stormwater runoff. This will reduce the required water demand from potable water mains by providing an alternative means of supply.

Gross Pollutant Trap (GPT)

Gross Pollutant Traps are proprietary devices used primarily for the capture and retention of larger sediments and gross pollutants from stormwater runoff generated by developments. They are a common method of treating stormwater runoff where space is limited, a Cascade Separator is usually provided within pits, which removes sediment, hydrocarbons, trash, and debris from runoff.

Cartridge Devices

Cartridge based stormwater treatment is a precast system typically located within detention tanks, these are used to remove suspended solids and other water pollutants from stormwater runoff. Each filtration cartridge provides a membrane surface area which allows runoff to travel through the membrane while removing the pollutants. Off the shelf products such as StormFilter are advantageous when there is limited space in the project site.

Bioretention/Raingardens

Bioretention/raingardens are planted filtration system allowing water to temporarily pond and permeate through the ground whilst removing pollutants throughout the process. These treatment systems are planted with nutrient removing plants which provide an effective means of extracting dissolved nitrates and phosphates. Raingardens are usually end-of-line treatment of stormwater runoff from larger catchments, and are a more environmentally friendly ‘soft’ treatment device suitable for developments within the green corridor and new open space.

Green Roofs

Providing green roofs of at least 30% of the available rooftop will aid in reducing high nutrient loaded runoff from the roof space. Additional advantages include providing heating and cooling insulation, improved air quality, increase renewable energy efficiency, and increasing biodiversity in the area.

Permeable Paving

Permeable paving allows runoff to drain through the pavement and infiltrate to the under-lying base-course. Water drains through the sand and gravel and is then collected by standard subsoil drains. Particulates and other pollutants are removed by filtration and absorption by the filter media. Porous paving reduces the amount of directly connected impervious areas and increases the amount of surface water penetrating into the underlying soil to replenish groundwater.

3.3 Assessment

The water quality analysis has been undertaken by understanding the existing catchment environment, water quality and water users within each area, and identifying the environmental values for receiving waterways. Potential water quality controls have been identified, and appropriate and achievable water quality targets selected to minimise the potential impacts of future development and protect water quality.

Urban water quality modelling is generally undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software to simulate urban stormwater systems operating at a range of temporal and spatial scales. MUSIC models the total amounts of gross pollutants, phosphorus, nitrogen and total suspended solids produced within various types of catchments.

3.3.1 Potential Water Quality Targets

Water Quality targets are typically assessed on an individual basis for developments. Examples from regional councils and authorities can be found in Table 3-1 below:

Table 3-1 Water Quality Targets and Controls

	Percentage Retention of Post-development Loads			
	Total Suspended Solids (TSS)	**Total Phosphorous (TP)**	**Total Nitrogen (TN)**	**Gross Pollutant (GP)**
Canada Bay Development Control Plan	80%	45%	45%	70%
Canada Bay Development Control Plan Burwood-Concord Precinct	85%	65%	45%	70%
Strathfield Development Control Plan	85%	60%	45%	90%
City of Sydney Development Control Plan	85%	65%	45%	90%
Sydney Water	85%	60%	45%	90%
Green Star Buildings Rating	85%	65%	45%	90%

3.4 Implementation

Treatment targets recommended below represent the most balanced approach between maintaining development feasibility and sustainability objectives, and are largely in line with Canada Bay Council's Burwood-Concord Precinct. The two regions share the same receiving waterway at St Luke's Canal, which will have further treatment from Sydney Water's facilities before discharging into Parramatta River. The proposed measures can achieve the treatment objectives and are relatively flexible in their integration into the public realm.

3.4.1 DCP Recommendation

The following treatment targets are recommended for new developments within the Burwood North Precinct:

- 85% reduction in post-development loads for Total Suspended Solids (TSS)
- 65% reduction in post-development loads for Total Phosphorus (TP)
- 45% reduction in post-development loads for Total Nitrogen (TN)
- 90% reduction in post-development loads for Gross Pollutants (GP)

3.4.2 Recommended Treatment Train

Water quality is assessed based only on the proposed future development and not relative to the previous use of the site. Based on this methodology the proposed masterplan can be categorised into the following development types with the associated water quality controls applying to the development

3.4.2.1 Lot Development

These areas will provide their own onsite water quality treatment devices to achieve the new recommended targets. These areas have been excluded from the modelling assessment as they will be assessed during their individual DA lodgement. The treatment train is anticipated to comprise either bioretention planting within landscaped areas or cartridge filter systems integrated into the lota based OSD system, dependent on the availability of appropriate landscaping space within each development proposal. These measures are located towards the end of the on-site stormwater reticulation system and after the capture of roof water in rainwater tanks.

3.4.2.2 Road and Public Domain

Road reserves are to incorporate water quality treatment devices to achieve Council's objectives before discharging into St Luke's Canal. Recommended treatments for various road typologies within the LGA are listed in the table below:

Table 3-2 Proposed Water Quality Treatment Devices

Road Name	Road Typology	Area (Ha)	Recommended Treatment Devices
Burwood Road	Transit Corridor	1.158	Bio-retention with a total filter area of 465 m^2
New Street	Shared Street	0.240	Bio-retention with a total filter area of 100 m^2
Shaftesbury Road	Primary Road	0.850	Bio-retention with a total filter area of 345 m^2
Neich Parade	Secondary Road	0.719	Bio-retention with a total filter area of 290 m^2
Webbs Lane N	Laneway	0.092	Bio-retention with a total filter area of 40 m^2

Generally, 4% of catchment area is needed for the water quality treatment train. These can come in the form of bio-swales or treebays with a width of 1.5 metres. It is noted that bio-retention devices should not be placed on steep slopes (>5%) which can become unstable when saturated.

Alternatively, OceanGuards can be installed upstream of existing stormwater pipes to capture suspended solids and gross pollutants, while Treebays can be used as bio-retention device within the road reserve areas afterwards to capture finer pollutants generated, such as Phosphorus and Nitrogen.

Each OceanGuard can treat around 1,400m^2 of road surface, which can potentially reduce the amount of bio-retention area needed to just 1% of the catchment area, however this introduces in-pit devices to the overall maintenance schedule, and introduce some risk of blockage. The alternative treatment recommendation setup is detailed in Appendix C, is generally implemented during the detailed masterplanning stage and will need to be investigated on a street-by-street basis in consultation with the stormwater asset maintenance group within Council.

Table 3-3 Typical Design Parameters of Proposed Treatment Devices

Treatment Devices	Design Parameters	Compliance
Bio-retention (Treebay)	Extended Detention Depth = 0.3 m Filter Depth = 0.4 m Saturated Hydraulic Conductivity = 120 mm/hr TN Content of Filter Media = 800 mg/kg Orthophosphate Content of Filter Media = 35 mg/kg	The design parameters are in compliance with the NSW MUSIC Modelling Guideline
OceanGuards	High Flow Bypass = 0.02 m^3/s	The MUSIC node is provided by Ocean Protect and in compliance with the NSW MUSIC Modelling Guideline
GPTs	High Flow Bypass = 0.022 m^3/s	The MUSIC node is designed as per Rocla's GPT CDS0506

3.4.2.3 Open Space

Bio-retention is the recommended treatment device for local runoffs within new open spaces of the proposed masterplan, as these features can be shaped to suit the desired landscaped character of the parks. The planted bed composition of the bio-retention can be disguised within the wider planting design for the open space, with the scale of filter area listed in the table below for the nominated open spaces through the masterplan.

Typical bioretention area is listed in Table 3-4 below, again taking the methodology of 4% of catchment area for treatment.

Table 3-4 Proposed Water Quality Treatment Device

Open Space	Area (Ha)	Recommended Treatment Device
F1/F2/F6	0.226	Bio-retention with a total filter area of 95 m^2
G3	0.364	Bio-retention with a total filter area of 150 m^2
H1/H2	0.387	Bio-retention with a total filter area of 155 m^2
E7	0.114	Bio-retention with a total filter area of 50 m^2
I3	0.120	Bio-retention with a total filter area of 50 m^2
B6	0.155	Bio-retention with a total filter area of 65 m^2
E3	0.121	Bio-retention with a total filter area of 50 m^2
D2	0.134	Bio-retention with a total filter area of 55 m^2
D3	0.115	Bio-retention with a total filter area of 45 m^2

Figure 3-2 Precinct Location Identifiers

Alternatively, GPTs can be installed upstream of existing stormwater pipes to capture suspended solids and gross pollutants to greatly reduce the amount of bioretention needed. This setup is detailed in Appendix C and recommended within the Green Corridor, which can be easily accessed for regular clean-up. The benefit of GPTs over the in-pit Oceanguard filters is the storage potential for pollutants. GPTs are customisable and can be sized to store large volumes of pollutant without causing system blockage.

As per Section 3.13 of Burwood Council Stormwater Management Code, all drainage and water quality products are to be designed to be visually unobtrusive and sympathetic with the development. This requirement is necessary to ensure future residents do not adjust or remove devices for aesthetic reasons without understanding the functional impact of such actions.

3.4.2.4 Life Cycle of Water Quality Products

The *Water Sensitive Urban Design Guidelines* by Melbourne Water provides a comprehensive breakdown of requirements throughout the lifecycle of typical water quality devices and covers the type proposed in the treatment train. The table below summarises the relevant requirements for the recommended devices.

Table 3-5 Lifecycle – Water Sensitive Urban Design

Product	Construction	Operation	Maintenance
Bioretention	Throughout the construction phase there are several hold points at which the constructed elements need to be cross checked with the design these include: • Liner – installation of the liner is as per standards. • Pipes – Check perforated pipes are installed as per design plans. • Filter Media – check hydraulic conductivity meets design requirements • Inlet & Outlet structures – Check construction of structures in accordance with design plans	Operational plans generally include the following information: • Site visit and relevant photos of surrounding infrastructure • Expected frequency of operation (can be based on design storms)	Vegetation on the batters and basin surface typically needs maintenance once a quarter, the labour varies depending on bioretention sizing. Visual inspection of drainage assets is required on a bi-annual basis, it is expected that the basin surface will be assessed during this inspection. Replacement of bioretention media is expected every 10-15 years with the frequency to be adapted based on the rain events. The labour costs are based on contractor rates.
OceanGuard /GPT	Throughout the construction phase there are several hold points at which the constructed elements need to be cross checked with the design these include: • Installation – as per manufacturers specifications • Backfill – as per design.	Operational plans generally include the following information: • Site visit and • Relevant photos of surrounding infrastructure Expected frequency of operation (can be based on design storms)	The recommended “Vortex” style GPT has a fairly simple maintenance procedure where cleaning can be accomplished using a vacuum truck, with no requirements to enter the unit. Debris removal works are generally required on a bi-annual basis with 2 personnel required for 4 hours depending on the size of the GPT.

3.5 Conclusion

WSUD can include a variety of methods such as stormwater detention or retention, water re-use, water efficiency, reduction in nuisance flooding, minimising stormwater pollution, enhancing groundwater infiltration and overall improve the visual amenity of the area.

However, the implementation of effective and durable WSUD systems in a dense urban environment can be challenging due to spatial limitations, particularly for small scale redevelopments. Redevelopment on a precinct scale provides an excellent opportunity for WSUD to be implemented in a rigorous and effective manner which will enhance the quality of the environment within Burwood North.

WSUD can be applied in a multitude of ways, there is no single approach that can be costed and utilised for adoption as it will depend on the designer and the building, site and other components available. The DCP recommendation outlines the target that should be considered and modelled, ensuring compliance with water quality requirements and best practice.

4 Flooding

4.1 Flood Hazard in Burwood

With the historical urbanisation of the catchment, there is no floodplain provision for the conveyance of runoff that occurs as a result of intense storms over the Burwood Precinct. Once the drainage system becomes full, excess runoff occurs through the precinct road reserves and through private land, with relatively widespread inundation occurring in major and extreme flooding scenarios.

4.1.1 Existing Flooding Conditions

Peak flood depth and water surface levels can vary significantly across the whole study area due to local level changes around buildings and structures, and the relatively steep slopes in parts of the catchment. Shallow depths of inundation are a defining feature of the public domain in many places, as a result of some wide road reserves within Burwood.

The most significant concentration of overland flow originates around Burwood Park and Burwood Westfield, which travels in a North East direction and often through private properties. Where buildings or fences intersect the flow path, flood water accumulates on the upstream side. It's evident that most of the stormwater pipes in the street system are operating at full capacity during minor storm events and surcharge in heavier storm events.

The intersection between Shaftesbury Road and Parramatta Road act as the topographic low point of the entire flow path. Most of the local flow paths converge at this location which is then conveyed north via the open channel of St Luke's Canal. Concord Oval to the west of the canal acts as a flood detention system during extreme flood events. The lower parts of the canal are also low lying and thus affected by high tailwater levels in the Parramatta River which constrains the free outflow of floodwaters.

Two Sydney Water trunk drainage pipes traverse Burwood (Figure 2-1) to convey flow across Parramatta Road, most of the masterplan area are served by this system. The pipe adjacent to Luke Avenue has a height of 1.37m and width of 2.67m. The pipe located between Shaftesbury Road and Loftus Avenue has a height of 1.37m and width of 3.35m.

The classification of flood hazard is based on the ARR19 hazard categories. These categories range from H1 to H6 and are based on a combination of flow velocity and depth.

A chart showing how the categories are defined is shown in Figure 4-1. The NSW Floodplain Manual describes High Hazard as areas where there 'possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty in wading safety potential for significant structural damage to buildings'. This generally relates to H4 to H6 for the ARR19 hazard categories. However H3 is considered to be the hazard class from which it is no longer safe.

Refer to the mapped results from the flood study, presented in section 4.3 and Appendices A and B.

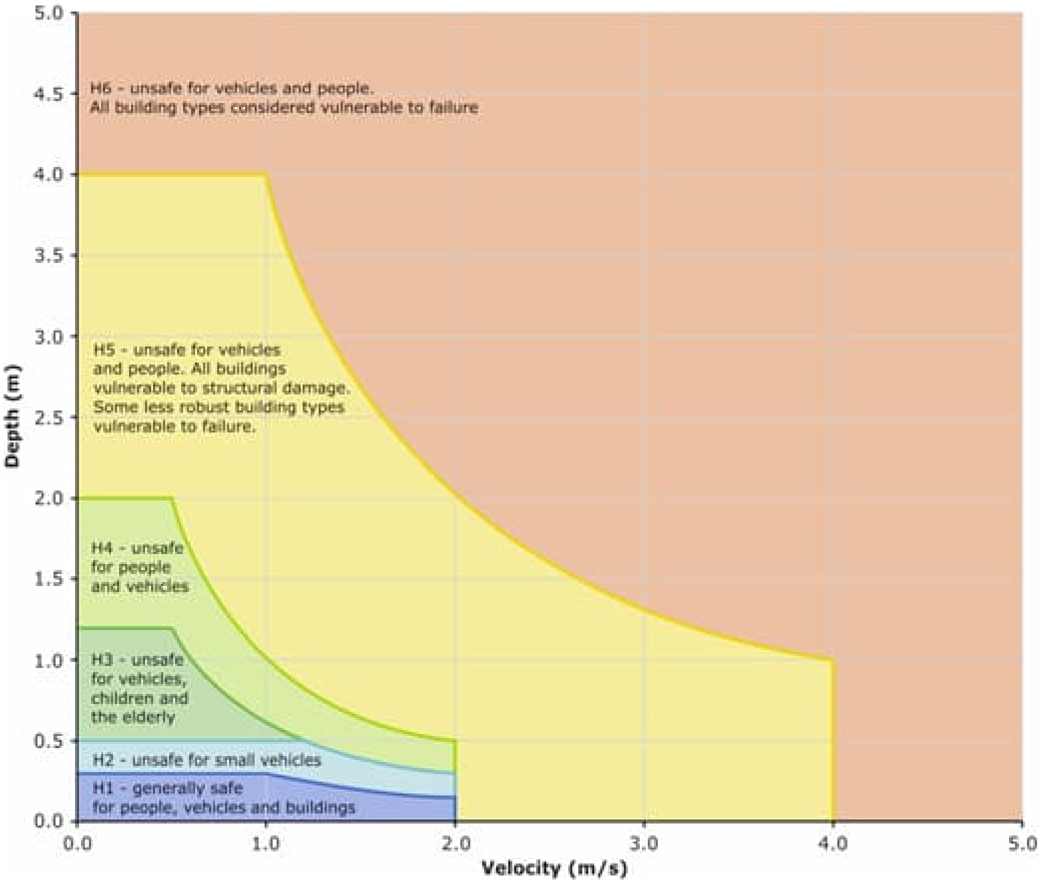

Figure 4-1 Australian Rainfall and Runoff 2019 Flood Hazard Categories

4.2 Flood Mitigation Options

Flood mitigation options can be categorised into the following general classification, whereby the measures target specific flood behaviour in reducing the velocity, depth or a combination of both.

4.2.1 Flood Storage

In larger storm events local depressions in the road reserves and general topography become filled runoff water, with excess runoff water forming overland flow. The quantity of runoff that can be stored temporarily in these depressions can mitigate against the effects of overland flows, with a greater storage of runoff associated with reduced impact of the overland flows.

By lowering ground levels around road reserves and lower areas of the topography, an increase in temporary storage potential for runoff can be achieved. Through coordinated civil design of open spaces, significant storage volumes can be achieved through lowering ground levels within landscaped areas and recreational areas that are not required to function as a flood evacuation route.

Additional flood storage is also created through integrating soft WSUD features which typically sit below the adjacent ground level such that these features are fed runoff water from the precinct ground level via gravity. This serves to create flood storage volumes in addition to their primary function in treating runoff water quality.

4.2.2 Overland flow conveyance

Set backs of the buildings and streetscape obstructions to overland flow adjacent to the road reserves, where overland flow occurs, can serve to calm the flood behaviour by widening the flow path available. For an existing road reserve that experiences overland flow, by widening the flow path the depth of flow is generally reduced which contributes to a safer resulting condition for people and vehicles. Conversely a larger flow capacity of the road reserve is afforded when a wider cross section adopted.

4.2.3 Piped System Capacity

Currently the site has a combination of Burwood City Council and Sydney Water networks that help convey flows within underground piped systems which eventually discharge to Parramatta River. Having a series of pits and pipes has allowed surface catchments to drain to these networks reducing overland flows within crucial areas of vehicular and pedestrian movement ie footpaths, pedestrian crossings.

There are a number of ways flood mitigation by increasing the capacity of the stormwater network can be achieved some of which are outlined below:

- Multiplying number of pipes concurrently running through the site;
- Providing additional inlet capacity within the pits by increasing lintel capacity; and
- Upsizing the existing stormwater pipes.

As the Council stormwater network is typically designed for minor storms (5% AEP), the reduction in overland flows may be most evident in these frequent storms. As the network seems to have downstream capacity constraint, a reduction in overland flows for rare storms up to and including 1% AEP diminishes with increased storm severity.

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4.3 Assessment

The methodology adopted to assess the impact of the proposed masterplan is outlined below, which focused on:

- Potential increases in flood risk and flood affectation on properties within the precinct and assets as well as potential impacts to any emergency management arrangements
- Land use compatibility in relation to flood hazard
- Compatibility with council floodplain risk management in terms of safe velocities and depths for pedestrians and vehicles
- Where required mitigation and management measures have been identified.

Modelling for this proposal has been largely based on existing hydraulic models as provided by Burwood Council for the catchment. The hydrological modelling approach that has been adopted in this study includes extracting inflow hydrographs from a catchment and node-based DRAINS hydrological model and applying them at low points within digitised catchment polygons in the TUFLOW hydraulic flood model.

A TUFLOW one-dimensional/two-dimensional hydraulic model has been adopted for this proposal to simulate flooding behaviour for both the baseline (existing environment) scenario and the post development scenario. The post development scenario was run in an iterative approach, to test the effectiveness of the potential flood mitigation options.

The model has been prepared to assess the full range of infrequent flood events along with the extreme flood event. The flood events which will be presented for each assessment include the 1% AEP and PMF events. Climate change has been directly incorporated into each assessment.

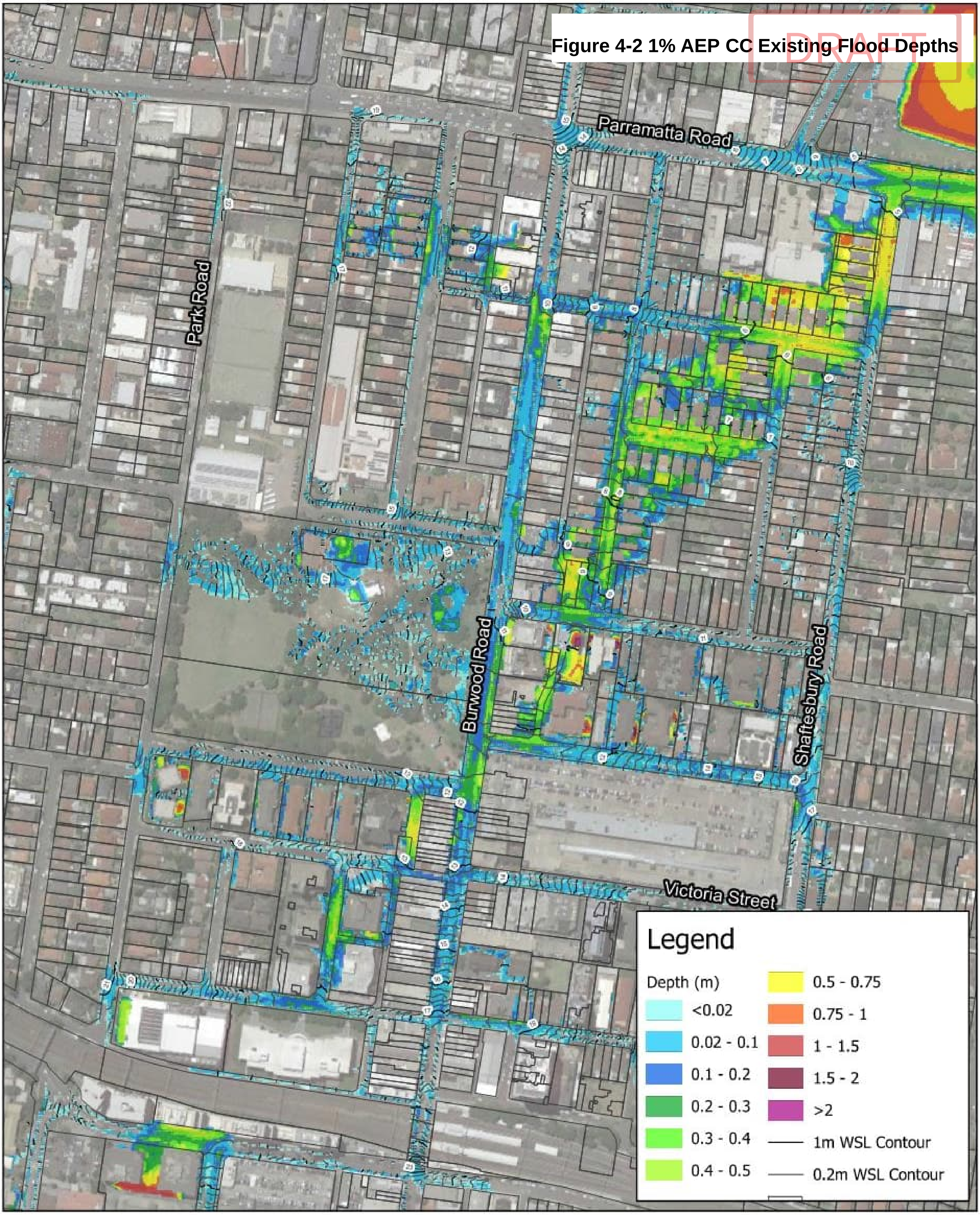
A key phase of building a suitable hydraulic model is the process of model calibration and validation. Calibration involves utilising historic flood event data (referred to as observed data) to change model inputs to get the model to replicate the historic flood event. Validation then involves checking the model inputs against another historic flood event. This is preferred so that the adopted model adequately predicts flood behaviour, where historic data is available. In the absence of historical data, models have been developed based on standard parameters from ARR2019.

4.3.1 Climate Change Modelling

The Floodplain Risk Management Guideline: Practical Consideration of Climate Change – Department of Environment and Climate Change (2007) is designed to be used in addition to the Floodplain Development Manual (2005) and provides recommendations and methodologies for examining flood risk to developments in light of the projected impacts of climate change on sea levels and design rainfall events.

The one per cent Annual Exceedance Probability flood event (1% AEP flood event) incorporates allowances for climate change impacts, which includes sea level rise of 0.9m over a period to 2100, and rainfall intensity uplift 21.3% in accordance with ARR19.

4.3.2 Modelling Results



TITLE

1% AEP Climate Change Flood Depth and Water Surface Levels

PROJECT

Burwood North Masterplan

0 50 100 m

MOTT MACDONALD

Date	Drawn	Check	Approved	Scale	Rev
09/11/2022	SC	SC	JM	1 : 4500	1

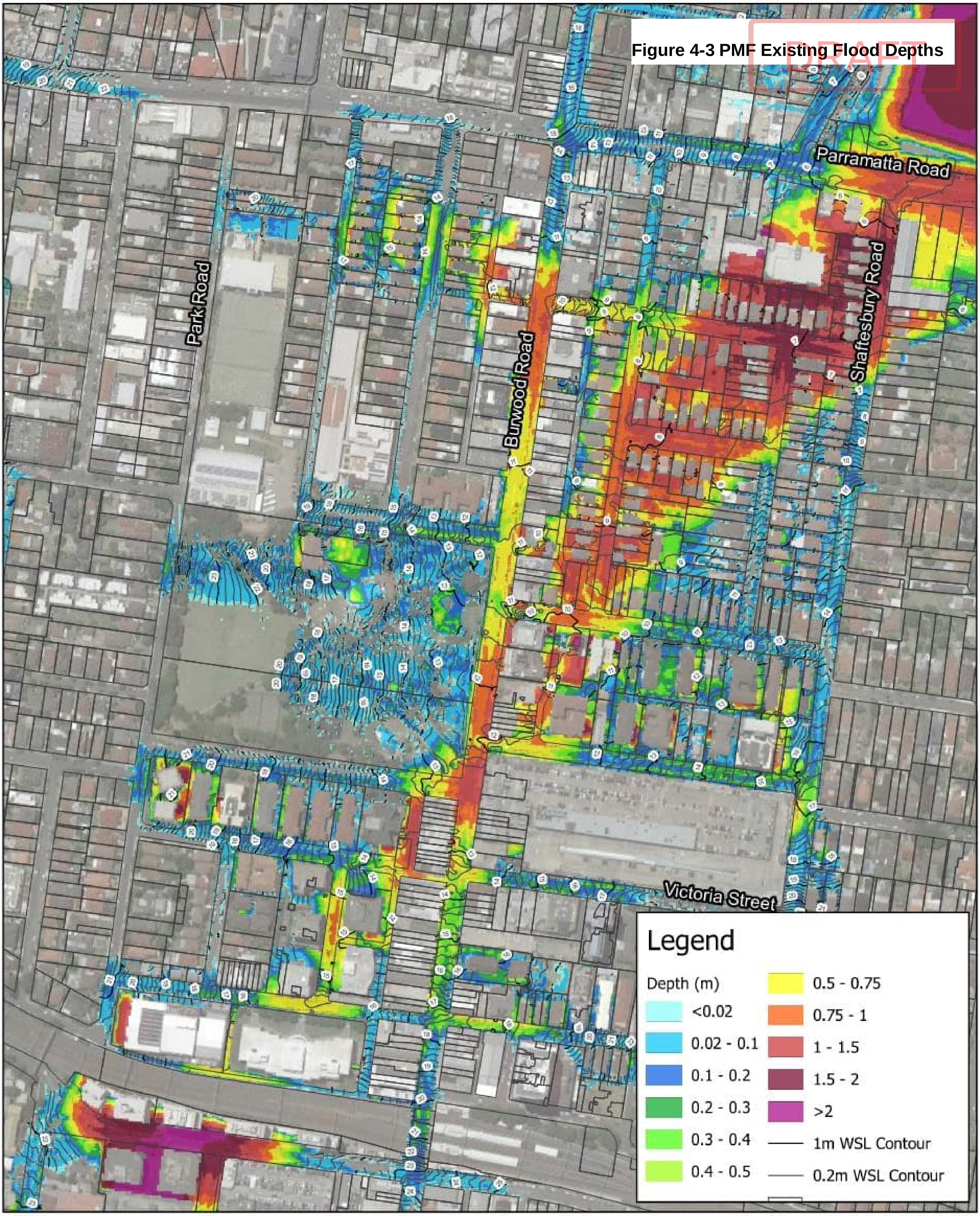


Figure 4-3 PMF Existing Flood Depths

TITLE
PMF Flood Depth and Water Surface Levels

PROJECT
Burwood North Masterplan

0 50 100 m

MOTT MACDONALD

Date	Drawn	Check	Approved	Scale	Rev
09/11/2022	SC	SC	JM	1 : 4500	1

4.3.3 Post Development Flooding Conditions

The assessment of potential flooding impacts on existing flood regimes has been conducted in accordance with the requirements of the Floodplain Development Manual (NSW Government, 2005), which incorporates the NSW Government's Flood Prone Land Policy. The key objectives of this policy are to identify potential hazards and risks, reduce the impact of flooding and flood liability on owners and occupiers of flood prone property, and to reduce public and private losses resulting from floods. This policy also recognises the benefits of the use, occupation and development of flood prone land.

The development of the post development flood model incorporated flood storage in the form of wide, shallow swales to provide storage prior to discharging to the existing Council network. The intent with wide shallow swales is to retain the recreational function of the land although only floodwater resilient street furniture would be present within the flood storage areas.

Once full, the flood storage swales deliver excess flows to the north into the adjacent road reserve, with the location of swales having been determined using The Draft Burwood North Precinct Masterplan: Masterplan Report by Cox, see Figure 4-4: Indicative below. The initial conservative approach to flood mitigation was to adopt swale depths up to a maximum of 1m, to be considered in the flood model. In addition to this, the post development modelling includes building footprint updates inline with the Masterplan. This revised footprint serves to ease some constraints on overland flow by improving overland flow conveyance.

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Figure 4-4: Indicative flood storage swale locations

Results from the 1% AEP post-development modelling indicate an overall improvement in flooding within roads conveying major flowpaths ie Burwood Road, Esher and New Street see Figure 4-5. Flood level change, or afflux, up to 0.1m can be seen within paths of proposed buildings, this is expected as flow paths have been altered from the existing scenario, allowing ponding within open spaces/paths. Mitigation measures such as additional stormwater capacity (as discussed in section 4.2.3), can be provided during detailed design stages of developments to alleviate some of these local ponding issues.

Ongoing coordination will take place with Burwood City Council to determine appropriate swale extents and depths.

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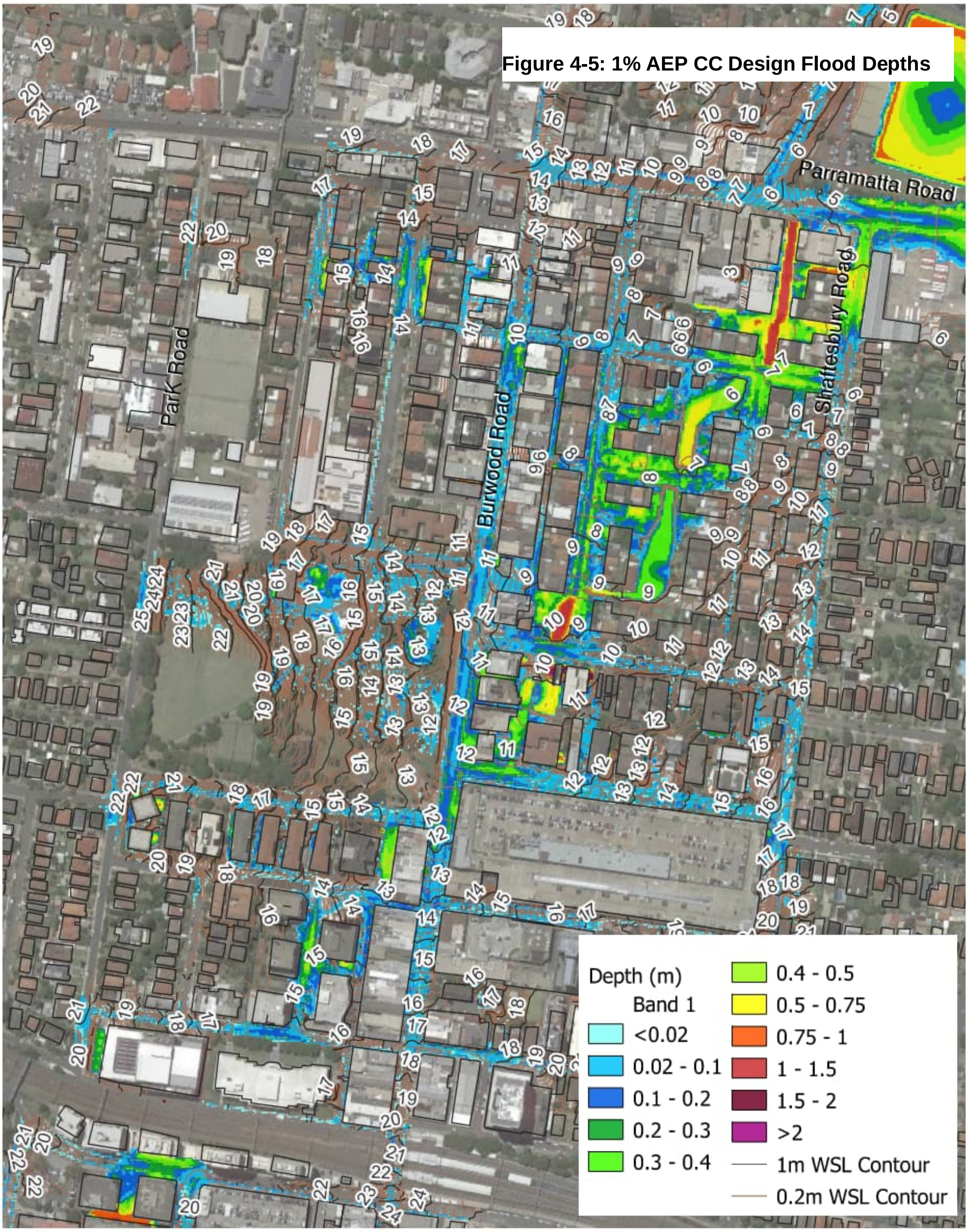
Figure 4-5: 1% AEP CC Design Flood Depths



TITLE 1% AEP Climate Change Flood Depth and Water Surface Levels PROJECT Burwood North Masterplan	0 50 100 m MOTT MACDONALD				
	Date 14/03/2023	Drawn FH	Check SC	Approved JM	Scale	Rev 1

4.4 Implementation

The creation of flood storage through the new open spaces serves to reduce flood hazard significantly through local street road reserves. In minor storms a stormwater inlet at the northern end of each flood storage swale will capture the runoff, with a capacity up to the 5% AEP event. In larger storms the flood storage will begin to fill as the stormwater system no longer accepts additional flow. Any surcharge from the flood storage areas must be design to occur back into the adjacent northern road reserve, providing a logical relief point for large flood flows towards St Lukes Canal downstream.

Adopting building setbacks and clear road reserve environments improves and calms the way overland flow is handled in the road reserves themselves.

The OSD policy which requires developments to provide detention on-lot will also provide a very significant reduction in flood risks during the worst case short duration storms. As this is developer led and potentially implemented incrementally this is not shown in the post-development scenario, but will yield an improvement on the documented overland flow regime over time.

4.4.1 Flood Planning Levels

In accordance with the NSW *Flood Prone Land Policy* and associated guidance the flood planning levels for development in the precinct are recommended to be the 1% AEP, with additional 500mm freeboard for habitable floors. Adoption of flood planning levels should consider the likely life of the structure meaning that climate change uplift on flood levels is to be adopted.

Sustainable Burwood published in 2022 sets a proactive goal to manage flood risk for the community into the future, specifically by committing to *Minimise the impact of flooding to the Burwood community*. Unless Council develops a specific climate change impact mitigation strategy including guidance on the use of climate change uplift on floor levels, the default position is recommended as the Australian Rainfall and Runoff advice on adopting representative concentration pathway (RCP) 8.5 projections.

Accordingly, increased flood planning levels are recommended to account for future rises in rainfall intensities. This can be achieved through requirements for habitable floor levels to consider future flood levels to be experienced through the design life of the structure.

4.4.2 Emergency Response Plan

The local catchments that cause flooding within properties and road reserves around the precinct are generally small urban catchments, with the resulting flood risk typically flash flooding type inundation that occurs in shorter intense storm events. The critical duration in a 30 minute PMF flood, which discharges through the precinct to the northeast, is 15-minutes.

There is no specific warning system for small catchments such as St Lukes as the time from rain falling to flooding occurring is too short a time to issue warnings. The SES is the legislated combat agency for floods in NSW and is responsible for the control of flood response operations. It maintains a flood intelligence system for key flood warning gauges in NSW on major river systems and develops specific flood emergency plans for LGAs which are subject to flooding.

Adequate warnings give residents time to move above the reach of floodwaters and to evacuate from the immediate area to high ground. The rate of rise and duration of inundation have been extracted on the likely evacuation routes through the precinct. General evacuation routes to the east and west along local roads is appropriate, however key connections in the north-south direction experience inundation.

The critical points on these north-south connections includes two locations along Burwood Road, and Shaftesbury Road nearer Parramatta Road. A map showing where the water levels were extracted are shown in Figure 4-6. A chart showing the PMF rainfall and flood depth at the three locations shown are presented in Figure 4-7. The response time from the local catchment is relatively fast with the PMF flood levels on the adjacent roads rising to a point that they would not be trafficable is less than 10-minutes.

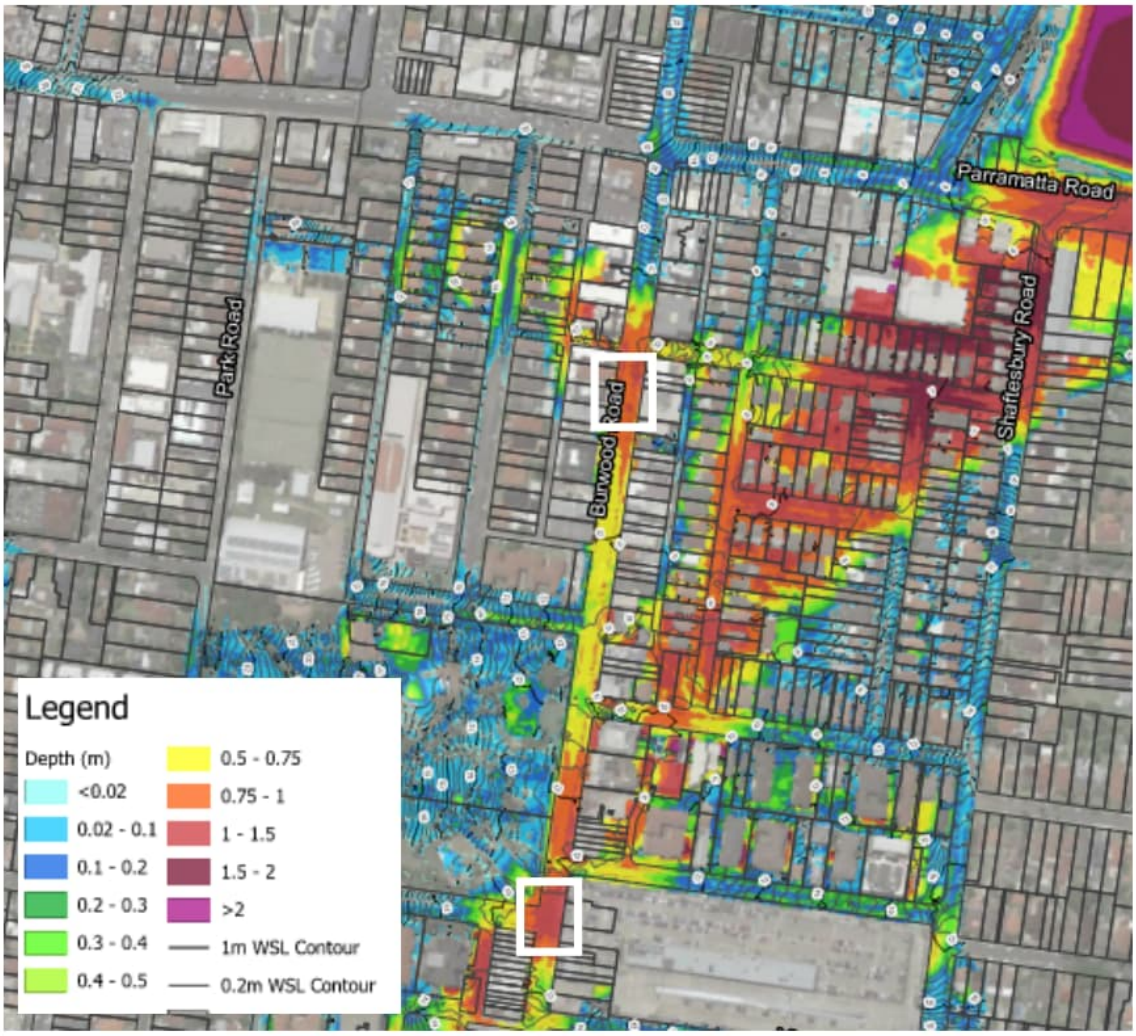


Figure 4-6 PMF Flood Inundation Check Locations

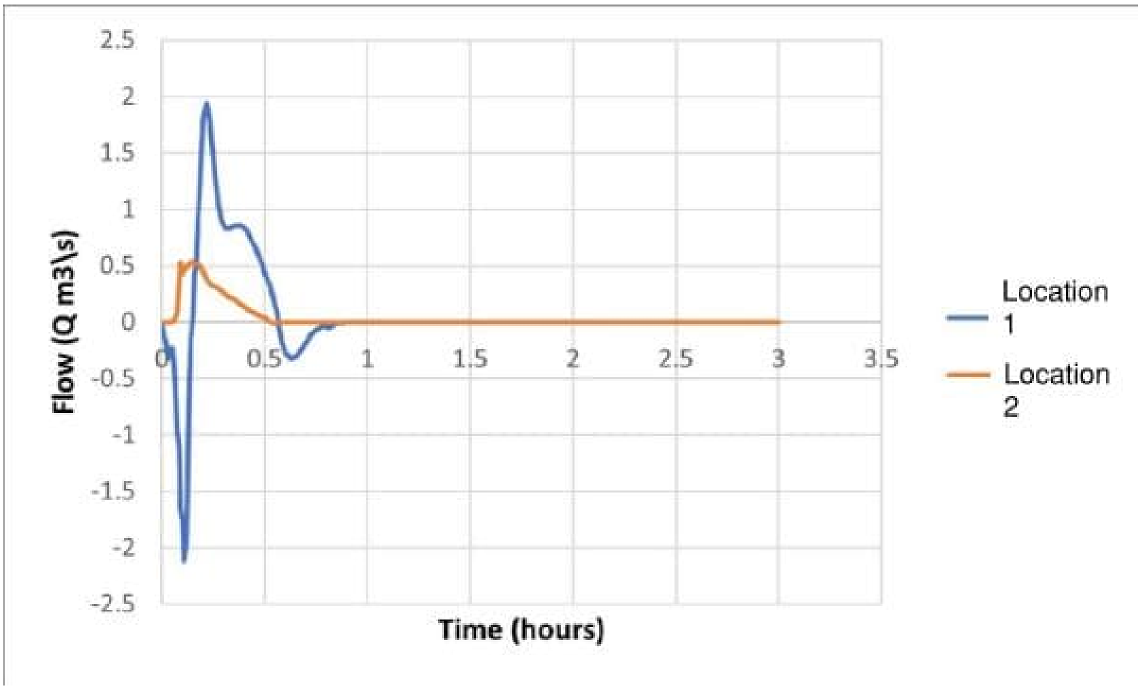


Figure 4-7: PMF Inundation time

Opportunities for improved evacuation access routes to the west are indicated in Figure 4-8 below, including;

- Formalised connectivity from Burwood Road through to Neich Parade via private carpark and Riley Lane;
- New connection to Burwood Road from New Street, and;
- Direct connectivity from Burwood Road through to Neich Parade via Nicoll Lane.

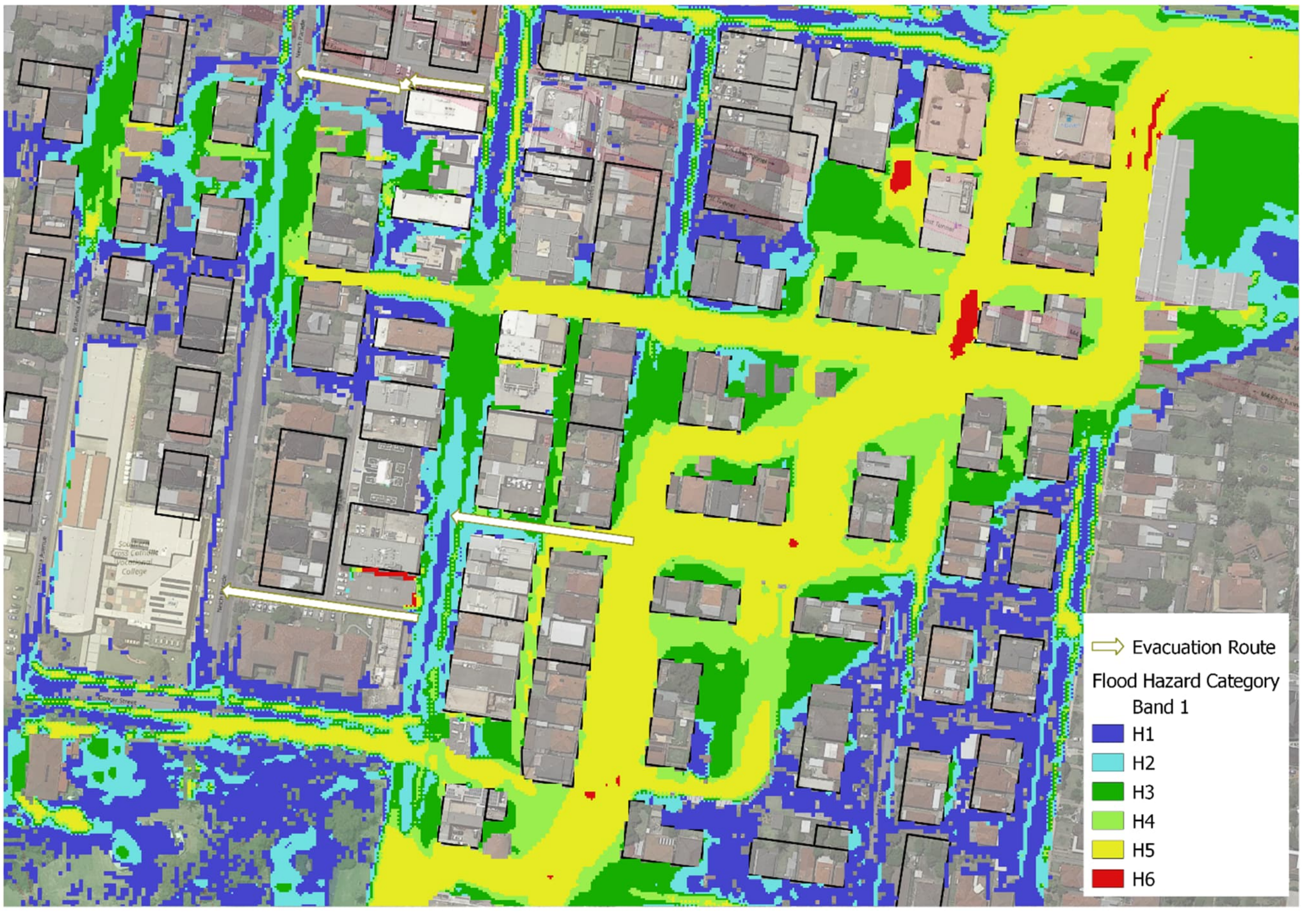


Figure 4-8 Opportunities for improved emergency evacuation routes

5 Conclusion

Detailed reviews of drainage, water quality and flood modelling for the precinct has been undertaken, adopting and updating the previous flood modelling and developing new water quality models. The results of these initial assessments have been presented along with a proposed masterplan level stormwater and flood management scheme and opportunities for Water Sensitive Urban Design (WSUD) enhancement.

Under current flood conditions, there is significant flooding through the precinct from south of Burwood Park through the urban environment to the east of Concord Oval. A combination of flood mitigation and stormwater infrastructure works are proposed to mitigate these issues:

- Increased flood planning levels to account for future rises in rainfall intensities;
- Establishment of a green corridor along the original riverbed to increase the amount of open space and assist in flood mitigation through the provision of flood storage swales; These flood storage swales will reduce development potential but can have increased massing shifted onto adjacent sites to meet feasibility requirements.
- It is noted that bio-retention system will increase maintenance cost especially within public open space. This will mainly be collected through council rates but have opportunities to shift the cost onto adjacent development lots via strata payment.
- Establishment of a minor and major drainage system to adequately drain the precinct with a view to integrate this to the green corridor including;
    - wider overland flow paths in key precinct areas previously constrained
- Introduction of Water Sensitive Design (WSUD) measures to
    - improve existing water quality of the precinct runoff, and;
    - increase local infiltration of runoff to reduce peak discharge flows to receiving watercourses.

Based on the investigations undertaken, solutions exist to reduce flooding risks on a precinct scale, with residual risk to be mitigated using appropriate FPLs, setbacks and emergency response frameworks. WSUD measures can be readily implemented for water quality enhancement, and will also serve to improve bio-diversity and align with the precinct's sustainability objectives.

5.1 LEP and DCP recommendations

Amendments to the Burwood Local Environmental Plan (BLEP) 2012 and Burwood Development Control Plan (BDCP) 2021 have been recommended to achieve the masterplan objectives. Some are minor updates to ensure relevant aspects of the current design standards are implemented across future development.

Other recommendations including controls relevant in achieving the water quality outcomes discussed in this report are summarised below. The following water quality targets are recommended for new developments within the Burwood North Precinct:

- 85% reduction in post-development loads for Total Suspended Solids (TSS)
- 65% reduction in post-development loads for Total Phosphorus (TP)
- 45% reduction in post-development loads for Total Nitrogen (TN)
- 90% reduction in post-development loads for Gross Pollutants (GP)

6 References

Australian Institute of Disaster Resilience (2017a) Australian Disaster Resilience Handbook 7. Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia

Australian Institute of Disaster Resilience (2017b) Guideline 7-3. Flood Hazard

Babister, M., Trim, A., Testoni, I. and Retallick, M. 2016. The Australian Rainfall & Runoff Datahub, 37th Hydrology and Water Resources Symposium Queenstown NZ

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) (2019) Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia

Burwood Council (2022) *Sustainable Burwood* (Version 1)

Department of Planning and Environment (previously Department of Planning, Industry and Environment) (2021) Considering flooding in land use planning Guideline July 2021

FAWB (2009). Adoption Guidelines for Stormwater Biofiltration Systems, Facility for Advancing Water Biofiltration, Monash University, June 2009.

Melbourne Water, *Water Sensitive Urban Design Guidelines*

NSW Department of Infrastructure, Planning and Natural Resources (2005) *Floodplain Development Manual – the management of flood liable land*

NSW Department of Planning and Environment (2022) *Flood Risk Management Manual – The management of flood liable land*

Sydney Water, *Western Parkland City: Urban Typologies and Stormwater Solutions* report (2020)

WMAwater (2019) Exile Bay, St Lukes and William Street Flood Study – Report

A. Flood Mapping Existing Conditions

B. Flood Mapping Future Development

C. Alternative Water Quality Treatment

An alternative approach to that nominated in Table 3-2 includes a treatment train of treebays and in-pit filter baskets or "OceanGuards" at discrete spacing along the road reserve, and reduced bioretention areas. This is another approach where street trees can be implemented into the WSUD treatment to make use of their footprint.

Table 6-1 Road Water Quality Treatment

Road Name	Road Typology	Area (Ha)	Recommended Treatment Devices	Description
Burwood Road	Transit Corridor	1.158	Bio-retention with a total filter area of 90 m^2	18 x Treebays with a dimension of 3.3 x 1.5
			OceanGuard	8 x OceanGuards to be placed within stormwater pits
New Street	Shared Street	0.240	Bio-retention with a total filter area of 25 m^2	5 x Treebays with a dimension of 3.3 x 1.5
			OceanGuard	2 x OceanGuards to be placed within stormwater pits
Shaftesbury Road	Primary Road	0.850	Bio-retention with a total filter area of 70 m^2	14 x Treebays with a dimension of 3.3 x 1.5
			OceanGuard	6 x OceanGuards to be placed within stormwater pits
Neich Parade	Secondary Road	0.719	Bio-retention with a total filter area of 65 m^2	13 x Treebays with a dimension of 3.3 x 1.5
			OceanGuard	5 x OceanGuards to be placed within stormwater pits
Webbs Lane N	Laneway	0.092	Bio-retention with a total filter area of 10 m^2	2 x Treebays with a dimension of 3.3 x 1.5
			OceanGuard	1 x OceanGuards to be placed within stormwater pits

Similarly for new open spaces proposed by the masterplan, Gross Pollutant Traps can be placed at the downstream location, prior to discharging into the local drainage system. This will greatly reduce the amount of bioretention required, which can come in the form of treebays, raingardens or even WSUD basins. Examples for treatment within the green corridor can be found in the table below.

Table 6-2 Green Corridor Water Treatment Strategy

Open Space	Area (Ha)	Recommended Treatment Devices	Description
F1/F2/F6	0.226	Bio-retention with a total filter area of 30 m^2	6 x Treebays with a dimension of 3.3 x 1.5
		GPT	1 x CDS0506 to be placed at the end of the treatment train before runoff entering the existing drainage network
G3	0.364	Bio-retention with a total filter area of 50 m^2	10 x Treebays with a dimension of 3.3 x 1.5
		GPT	1 x CDS0506 to be placed at the end of the treatment train before runoff entering the existing drainage network
H1/H2	0.387	Bio-retention with a total filter area of 60 m^2	12 x Treebays with a dimension of 3.3 x 1.5
		GPT	1 x CDS0506 to be placed at the end of the treatment train before runoff entering the existing drainage network
E7	0.114	Bio-retention with a total filter area of 15 m^2	3 x Treebays with a dimension of 3.3 x 1.5
		GPT	1 x CDS0506 to be placed at the end of the treatment train before runoff entering the existing drainage network
I3	0.120	Bio-retention with a total filter area of 15 m^2	3 x Treebays with a dimension of 3.3 x 1.5
		GPT	1 x CDS0506 to be placed at the end of the treatment train before runoff entering the existing drainage network

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