240-244 Beecroft Road, Epping – Landcom Development

Integrated Water Management Plan and Drainage Concept

June 2018

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1 Introduction

Landcom and the Sydney Metro Delivery Office (SMDO), part of Transport for NSW (TfNSW), are collaborating to develop mixed use precincts around the Sydney Metro North West (SMNW) stations in consistency with the objectives of *A Plan for Growing Sydney* and *North-West Rail Link Corridor Strategy*.

The proposed development site is located at 240-244 Beecroft Road, Epping. The Stage 1 application is for the sub division of the site into two lots for the Epping Service Facility and the proposed residential flat building development and sub-stratum over the rail corridor.

The proposed concept for the site includes the following:

- Building envelope with a maximum height up to RL 48m
- Residential yield of approximately 442 dwellings (including a minimum of 5% affordable housing units)
- Maximum residential gross floor area (GFA) of around 39,000m²
- Car parking for approximately 356 spaces within the basement
- Loading, vehicular and pedestrian access arrangements

The site area is located on the northern edge of the Epping Town Centre with approximately 1.3 hectares (Lot 22 DP 1180959) and is proposed for a subdivision into three lots which would comprise of the Epping Service Facility building, a high density residential development and the SMNW rail corridor sub-stratum. The area is bordered by Beecroft Road and the existing heavy rail line (east), Ray Road and Devlins Creek (west), a locally significant bushland reserve (north) and a service station at Carlingford Road (south).

This Integrated Water Management Plan and Drainage Concept is part of the Environmental Impact Statement accompanying the Development Application (DA) in preparation of the residential flat building concept development on Lot 22.

The site is zoned R4 high density residential and is deemed a State Significant Development (SSD) due to its important capital value and locale within a rail corridor. It is approximately 1 hectare and the site's contours show drainage to the northwest corner of the proposed development at Devlins Creek. Figure 1 outlines the proposed site development area in relation to the Epping Railway Station.

Figure 1: Landcom's proposed high density residential development site area in Epping, NSW

This report presents the following information:

- Section 2: WSUD objectives for the site, taken from the Development Control Plan and other guidance documents
- Section 3: Existing conditions and background information on the site, relevant to WSUD
- Section 4: Water Quantity OSD requirements
- Section 5: Water Conservation requirements
- Section 6: Water quality modelling, to demonstrate the anticipated improvements to water quality from the WSUD strategy
- Section 7: Stormwater treatment elements and maintenance considerations
- Section 8: Conclusions

2 Relevant Water Management Requirements

The development is required to meet relevant water related provisions including:

- Department of Planning and Environment - Secretary's Environmental Assessment Requirements (Section 2.1)
- Landcom Sustainable Places Strategy (section 2.2)
- Sydney Water connections to Sydney Water Assets (Section 2.3)

2.1 Department of Planning SSD Secretary's Environmental Assessment Requirements

The Secretary's Environmental Assessment Requirements, Section 78A(8A) of the Environmental Planning and Assessment Act Schedule 2 of the Environmental Planning and Assessment Regulation 2000, states that the Environmental Impact Statement (EIS) must address the Environmental Planning and Assessment Act 1979 and meet the minimum form and content requirements in clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000.

Section 10 (Water, Drainage, Stormwater and Groundwater) of the Secretary's Environmental Assessment Requirements identifies four water related requirements for the development and include:

1. Identifies appropriate water quality management measures focusing on the management of the impacts from the proposed works on water courses, riparian corridors and groundwater dependent systems located in the vicinity of Devlins Creek.
2. Identifies any water licencing requirements or other approvals required under the Water Act 1912 or Water Management Act 2000.
3. Prepare an Integrated Water Management Plan / drainage concept. This should include stormwater and wastewater management, including any re- use and disposal requirements, demonstration of water sensitive urban design and any water conservation measures.
4. Provides details of water supply including consideration of alternative water supply arrangements, water sensitive urban design and water conservation measures.

2.2 Landcom

Landcom Sustainable Places Strategy (October 2017), requires Landcom developments:

> *To design our precincts based on best practice water sensitive urban design principles, and actively conserve potable water*

This objective is to be implemented by the following targets and measures:

- All projects to embed Water Sensitive Urban Design or other water sensitive strategies to reduce stormwater pollutant loads to minimise discharge from project sites. This is achieved stormwater from the site to meet the following targets:
  - 45% reduction in the average annual load of total nitrogen
  - 65% reduction in the average annual load of total phosphorus
  - 85% reduction in the average annual load of total suspended solids
  - 90% reduction in the average annual load of gross pollutants
- All new projects modelled to reduce mains potable water demand by 50% at the precinct scale, against a 2016 reference case.

2.3 Sydney Water

Sydney Water has a range of requirements for developments connecting if the development connects to Sydney Water infrastructure (Devlins Creek) including:

- Building over / adjacent to the stormwater channel
  - Flood impact assessment
  - Regardless of easements, minimum 1m offset from the outside face of our asset
  - Potential need to fence the channel, depending on existing fencing and changes to accessibility / adjacent land use
  - Pre- and post- dilapidation survey, including bond money
- Building works not occurring within Sydney Water easements
- Configuration of connections to our asset
  - Standard drawings are available for connections less than 300mm
  - Structural engineering design required for connections 300mm or greater
- On-site detention Policy
  - store the run-off caused by a storm event up to 100-year Average Recurrence Interval (ARI) for that site
  - discharge the run-off at a controlled rate which downstream stormwater assets can handle.
- Stormwater discharge quality –
  - 45% reduction in the average annual load of total nitrogen
  - 65% reduction in the average annual load of total phosphorus
  - 85% reduction in the average annual load of total suspended solids
  - 90% reduction in the average annual load of gross pollutants

2.4 Hornsby and Parramatta Councils

As the site is a Major Development being assessed by the Department of Planning and Environment, the development does not need to specifically need to address Council requirements. The following points identifies council requirements, all of which will be addressed by the development as it meets the other requirements stated above.

In May 2016 the NSW Government announced the formation of new councils that resulted in the amendment of Hornsby Council boundary area. The new City of Parramatta Council acquired part of the Hornsby LGA, including the proposed development site. The site is currently located within the Parramatta LGA and until there is a combined Development Control Plan (DCP) for the amalgamated Parramatta Council, both the and Parramatta Council and Hornsby Shire Council DCPs apply to the site.

Within both DCPs, water requirements for the development site have been adopted as per Section 3.36 and Appendix 7 of the Parramatta Council DCP and Section 1C.1.2 and 1C.1.3, which provide specific targets for the management responses above, namely:

- An on-site detention (OSD) system, designed in accordance with the Upper Parramatta River Catchment Trust On-Site Detention Handbook and Parramatta Council's Stormwater Disposal Policy and/or Hornsby Shire Council's Civil Works Specification. Hornsby Council's policy on OSD is being reviewed. The current OSD requirements for developments are that the Q20 post development outflow from the site is restricted to the Q5 predevelopment flow.
- Meet stormwater quality targets specifically:
  - 45% reduction in the average annual load of total nitrogen

- 60% reduction in the average annual load of total phosphorus
- 80% reduction in the average annual load of total suspended solids

2.5 Summary

Table 1 summarises the requirements for the water management plan set out by the relevant organisational bodies, and identifies where the requirements are discussed in the document.

Table 1: Relevant requirements for the site

Objective	Organisation	Comment and location in report where discussed
• Identifies appropriate water quality management measures focusing on the management of the impacts from the proposed works on water courses, riparian corridors and groundwater dependent systems located in the vicinity of Devlins Creek.	Department of Planning and Environment SEARs	Water quality requirements presented in Section 6 and 7, with status of the riparian zone discussed in Section 3.
• Identifies any water licencing requirements or other approvals required under the Water Act 1912 or Water Management Act 2000.	Department of Planning and Environment SEARs	Status of the riparian zone and licensing discussed in Section 3.
• Prepare an Integrated Water Management Plan / drainage concept. This should include stormwater and wastewater management, including any re- use and disposal requirements, demonstration of water sensitive urban design and any water conservation measures.	Department of Planning and Environment SEARs	This document presents an Integrated Water Management Plan / drainage concept for Development Application with further detail to be provided in the detailed design. OSD presented in Section 4, Water conservation in Section 5, WSUD and stormwater quality in Section 6.
• Provides details of water supply including consideration of alternative water supply arrangements, water sensitive urban design and water conservation measures.	Department of Planning and Environment SEARs	Outlined in Section 5 and Section 6
• WSUD Strategy	Landcom	This document is the WSUD strategy for the Development Application
• Stormwater quality targets • *45% reduction in the average annual load of total nitrogen* • *65% reduction in the average annual load of total phosphorus* • *85% reduction in the average annual load of total suspended solids*	Landcom, Sydney Water, Parramatta Council, Horsnby Council	WSUD principles have been incorporated throughout the development with a decentralised treatment approach primarily including vegetated systems that will be integrated into the landscape. Refer to Sections 6 and 7.
• On Site Detention • *store the run-off caused by a storm event up to 100 year Average Recurrence Interval (ARI) for that site*	Sydney Water, Parramatta Council, Hornsby Council	Sydney Water requirements outlined in Section 4

3 Existing Conditions

3.1 Stormwater infrastructure

There is minimal stormwater infrastructure within the site boundary. There is a pipe located through the centre of the site area and at a junction pit it moves flow west into a Sydney Water open channel asset and down into Devlins Creek. There are a few entry pits to the pipe which runs south to north as seen in the aerial image below (Figure 2). The site generally slopes to the northwest corner and into the stormwater channel with elevation from RL 85m AHD on the east to 75m AHD in the western corner.

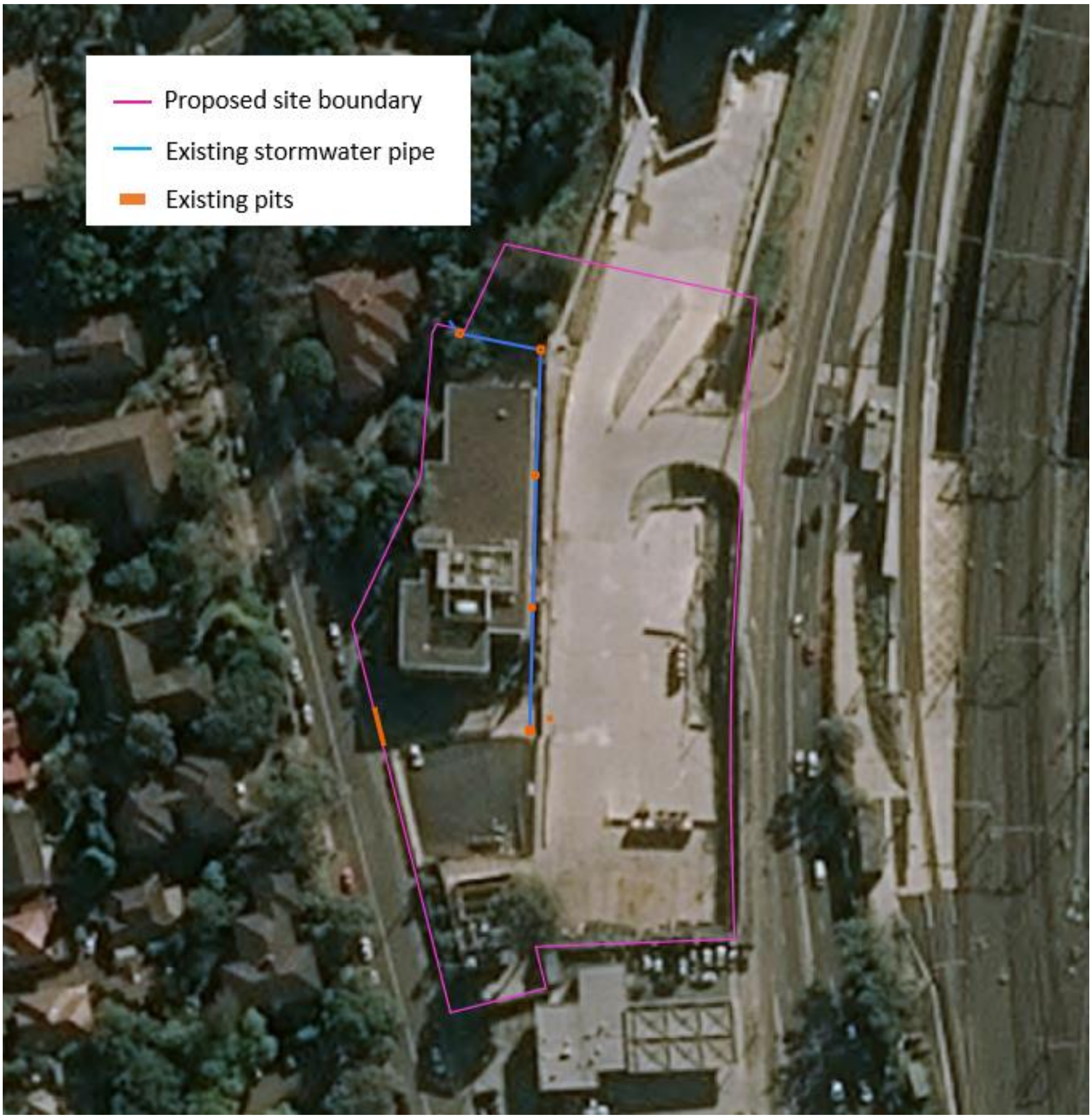

Figure 2: Proposed development with existing drainage (aerial image from Bing)

3.2 Receiving environment

The proposed development outfalls into a Sydney Water concrete open channel asset and flows into Devlins Creek. The Creek is receiving water for most flows from the site and is situated on the western border, running to the north and into the neighbouring bushland reserve.

3.2.1 Flora and Fauna

The site adjoins an existing watercourse connecting to Devlins Creek with existing dense vegetation. Previous investigations undertaken for this site's ecology show that the vegetation is not of any ecological value or providing any significant habitat.

3.2.2 Soils

The 1:100,000 geological map for the Sydney region indicates that the site is underlain by Ashfield Shale of the Wianamatta Group. The geotechnical investigation by *Pells Sullivan Meynink (PSM)* performed 8 test pits in September 2017. The summary table of the inferred subsurface conditions is below.

Table 2: Geotechnical investigation with inferred subsurface conditions.

INFERRED UNIT	INFERRED TOP OF UNIT DEPTH BELOW GROUND SURFACE (m)	DESCRIPTION
TOPSOIL	0.0	Sandy SILT with some gravel; brown, fine grained sand, sub-angular gravel up to 25 mm, loose consistency, dry, organics and bark observed.
FILL	0.0	Existing concrete slab. Sandy GRAVEL to gravelly sandy CLAY, sub-rounded to angular gravel up to 40 mm, fine to medium grained sand, low to high plasticity clay, medium dense to firm to stiff consistency, dry to moist.
NATURAL SOIL	0.1	Clayey SAND with some gravel; medium grained, yellow and orange, low plasticity clay, sub-angular gravel up to 30 mm, medium dense consistency, moist.
BEDROCK	0.8 to > 3.0	SANDSTONE: reddish brown to brown and grey, extremely weathered to highly weathered, extremely low to low strength.

3.2.3 Riparian Zones

An assessment of the topographic map for the site (Figure 3), shows that the site does not drain to a classified waterway as defined by a blue line on topographic maps of Sydney (see the NSW Office of Water *Controlled activities on waterfront land – Guidelines for Riparian Corridors on Waterfront Land* (July 2012). Devlins Creek in this location is a concrete channel owned and managed by Sydney Water (Figure 4). The site is not proposing to harvest any water.

As a result of both points there are not any water licencing requirements or other approvals required under the Water Act 1912 or Water Management Act 2000.

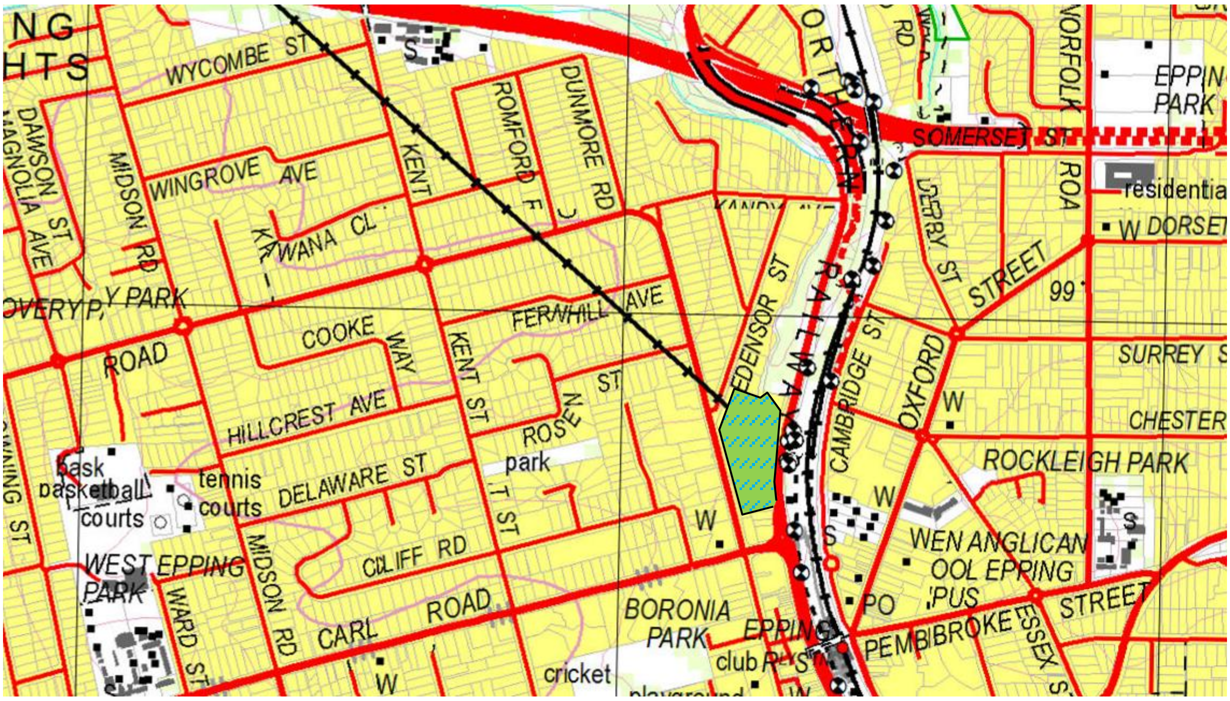

Figure 3: Topographic map of the area around the Epping Development (Sixviewer 2017).

Figure 4: Image of Devlins Creek in the vicinity of the site.

3.2.4 Flooding

Hornsby Shire Council has provided the “Hornsby Overland Flow Study” prepared by Cardno on 29 September 2010 (Cardno 2010). This preliminary study has investigated the entire urban area of the LGA and shows areas affected by the overland flow. In the flow map (Figure 5), the Epping development site is seen to be “affected by overland flow” but is not within the flood extent (blue lines).

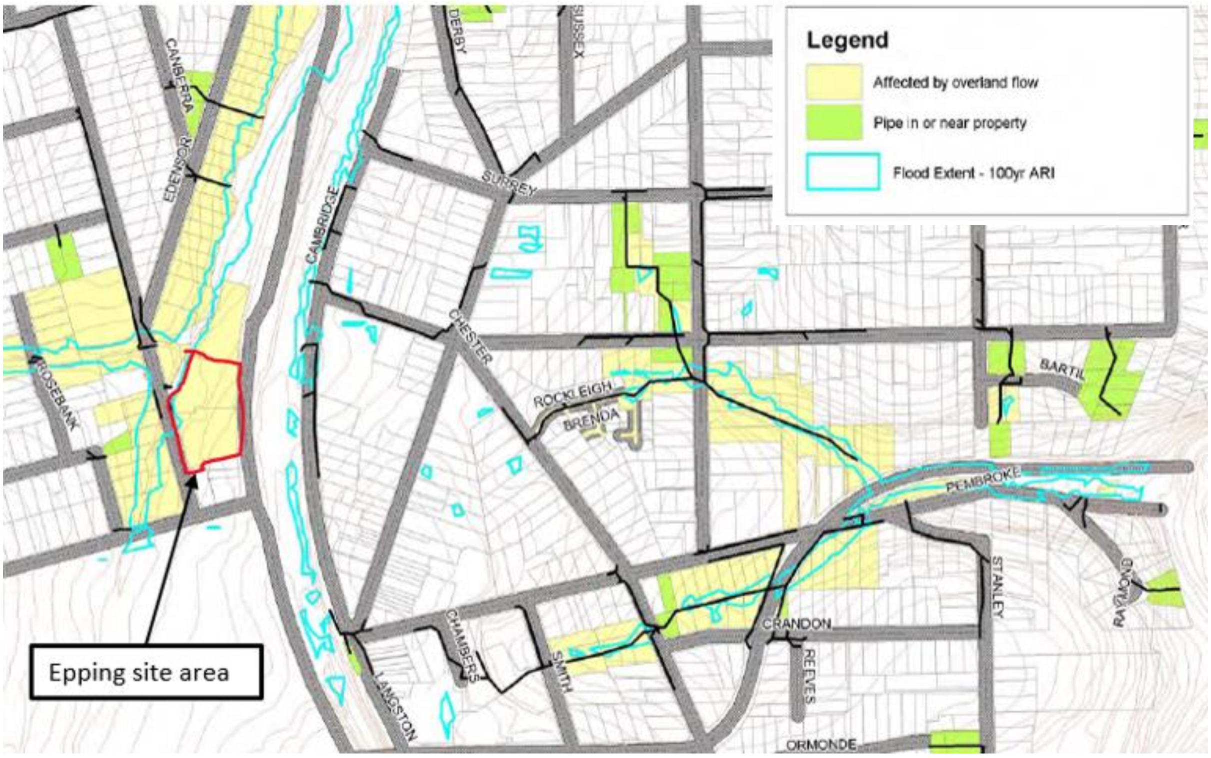

Figure 5: Map of properties affected by Overland Flow (100 year ARI) as detailed in the Hornsby Overland Flow Study (Cardno 2010).

The methodology for the overland flow study is to identify urban properties that may be affected by overland flooding during the 100 yr ARI. The following criteria adopted by HSC for the study is:

- Criterion 1 – the property is shown to have a piped or open drainage line through any part of the property as shown in the ‘pit and pipe GIS layer’ provided by Council
- Criterion 2 – the property is inundated by overland flow to a depth greater than 150 mm during a 100 year ARI design storm event
- Criterion 3 – any part of the property lies within 5 metres of a piped or open drainage line identified under Criterion 1, provided the drainage line is not located in a road reserve

The site is not located in the flood extent however the map does show affectation.

The detailed design will need to address flood affection which may impact on the site.

4 Stormwater Quantity

The development site is 10,142 m^2, with a pre-development impervious area of approximately 9400m2. The proposed development has an impervious area of 7,900m^2, as shown in Table 3.

Table 3: Development areas on the proposed masterplan.

Site	Area (m^2)	Area (%)
Impervious - roof	4,700	46%
Impervious - road/podium	3,193	31%
Pervious – landscape	2,249	22%
Total usable site area	10,142	100%

Sydney Water's On-site Detention Policy requires the any development site connecting to Sydney Water drainage system:

- store the run-off caused by a storm event up to 100-year Average Recurrence Interval (ARI) for that site
- discharge the run-off at a controlled rate which downstream stormwater assets can handle.

Sydney Water have advised that On-Site Detention requirement would only apply, if the development makes a direct stormwater connection to Sydney Water's stormwater system. The On-Site Detention requirements for the 10,142 square meters site at 242 – 244 Beecroft Road, Cheltenham, are:

- On Site Detention 109 cubic meters
- Permissible Site Discharge 310 L/s

The detailed design will need to include the following information in the connection drawing:

- Location of the On Site Detention in relation to the development
- Location of the On Site Detention in relation to overall stormwater network of the property
- Plan and Elevation of the On Site Detention tank with all dimensions
- Orifice plate calculation

Application for the direct stormwater connection is to be part of the Section 73 application for your development and need to mention in your application that you need a direct stormwater connection to Sydney Water's stormwater system.

The detailed design will need to confirm OSD requriements for the site.

5 Water Conservation

The Request for SEARs – 240-244 Beecroft Road, Epping, September 2017 (Keylan 2017), state that the site is adequately serviced with potable water, sewer, stormwater, electricity and telecommunications services. The detailed design should confirm with Sydney Water on requirements for potable water minimisation and wastewater minimisation due to any capacity constraints.

Water conservation requirements for the site are:

1. BASIX – a 50% reduction in potable water use

   (compared to 'pre-BASIX' benchmark)

2. Landcom's water conservation target - a 50% reduction in potable water use

   (compared to 2016 reference case or 'metro average')

To determine the 50% reduction in water consumption compared to the 2016 reference case, the CCAP precinct model (also known as Precinx) was used. The Precinx model is a strategic urban design software used to predict the environmental, economic and social impacts of residential, commercial and mixed-use developments. Water savings will be made through the use of water efficient fittings and appliances, a recycled water system (greywater from laundry use) and rainwater harvesting. Greywater and rainwater are used to meet irrigation and non-potable internal water demands (e.g. laundry and toilet flushing).

The Precinx model inputs from the mixed-use site with three 13-15-storey residential towers with a total of 442 apartments and 712m^2 of retail. The breakdown of apartments is shown in Table 4.

Table 4 Breakdown of apartment types.

Apartment Type	Number	Total GFA
3 bedroom	59	
2 bedroom	242	
1 bedroom	97	
studio	44	
TOTAL	**442**	**39,181**

The water consumption within the apartments was measured with the following efficient fittings and appliances:

- Dishwasher – 4.5 Star
- Washing Machine – 4 Star
- Toilet – 5 Star
- Shower head – 3+ star
- Tapheads – 4 Star

To determine how feasible the implementation of greater than 4-star dishwashers and washing machines is an analysis of WELS rating scheme was undertaken for all currently register products. The analysis shown in Figure 6, shows that there are 74 washing machines rated 4 stars of greater, representing 44% of the registered appliances. The same analysis shows that there are 163 dishwashers rated 4.5 stars of greater, representing 64% of the registered appliances. It is therefore considered that these appliances have been selected for the water analysis.

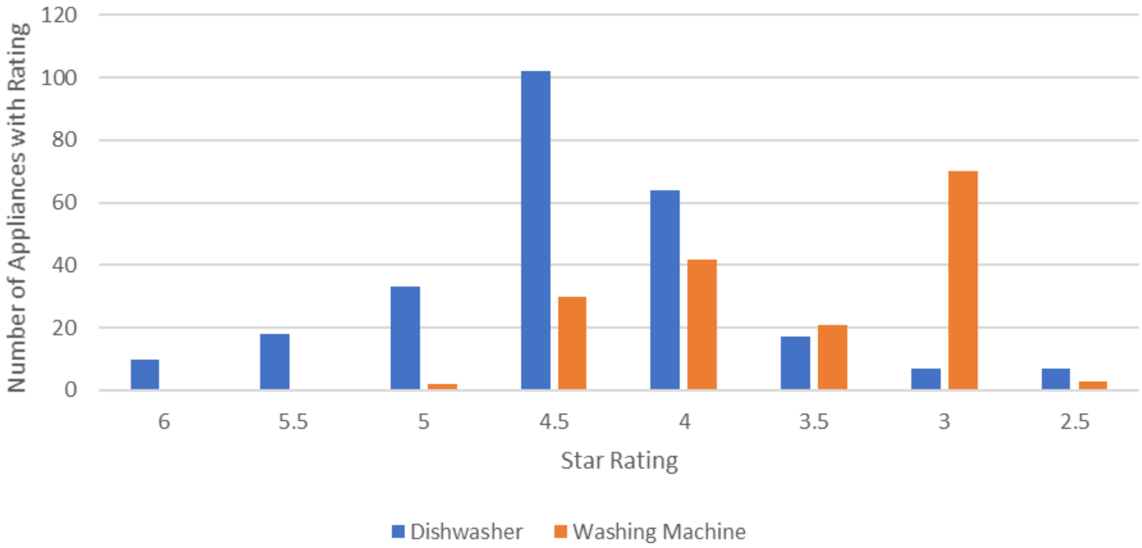

Figure 6 WELS rating of currently registers dishwashers and washing machines.

Rainwater harvesting modelling assumed harvesting rainwater from 90% of the 4,500m^2 roof area. The roof area will be composed of two surface types – typical roof surface and communal roof area (used by residents). Reuse of harvested rainwater is modelled to meet demands for laundry and toilet use in all of the apartments and retail areas, as well as irrigation demands for any landscaped areas of the site. The non-potable demands were estimated by the Precinx model at 12ML/year, of which 11ML/year was for internal use (laundry and toilets) and 1ML/year for irrigation. In addition to rainwater, greywater is also reused onsite to meet the demands for non-potable use (Precinx modelling has determined the volume of reuse supplied by greywater).

To determine an optimal tank storage volume a range of tank sizes were modelled with the 12ML/yr demand. The irrigation demand was modelled as an *annual* demand, and the internal non-potable use was modelled as a *daily* demand to account for typical residential use of laundry and toilet flushing. The modelling results show that the optimal size of a rainwater tank for the site is 100kL from which point there are diminishing returns from increasing the size of the tank (refer Figure 7). A 100kL storage volume would meet 19% of modelled irrigation and non-potable demands, which is a potable water saving of 2.3ML/yr.

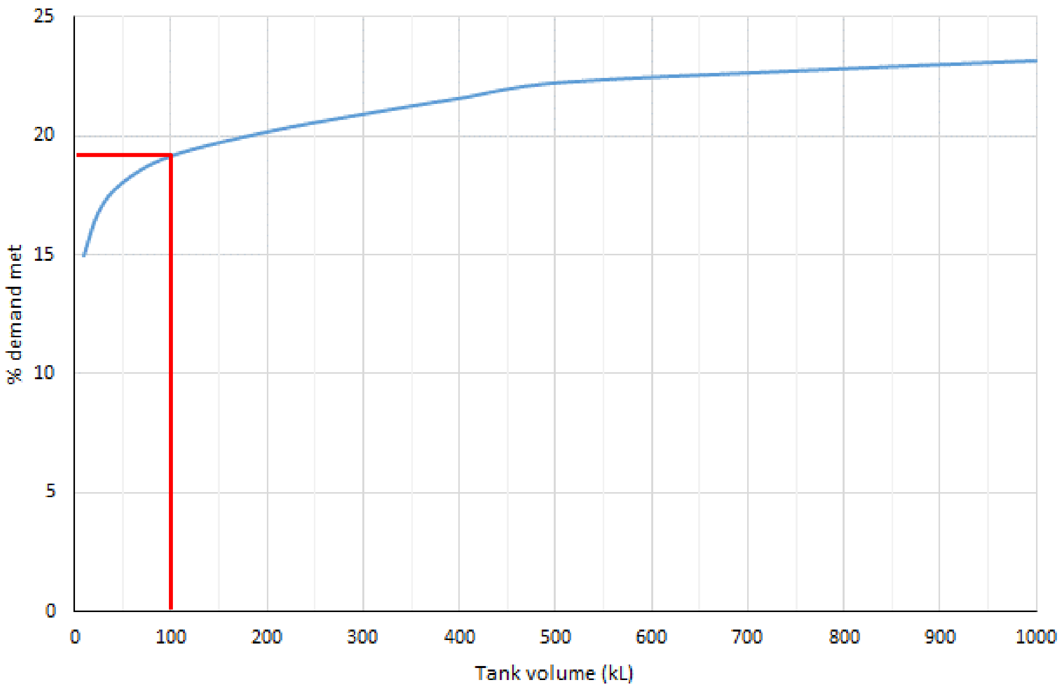

Figure 7. Rainwater tank sizing curve

6 Stormwater Quality and Water Sensitive Urban Design

Landcom requires a stormwater pollution reduction of:

- 45% average annual reduction in the load of total nitrogen
- 65% average annual reduction in the load of total Phosphorus
- 85% average annual reduction in the load of total suspended solids
- 90% average annual reduction in the load of gross pollutants

Water quality modelling has been carried out using MUSIC (Model for Urban Stormwater Improvement Conceptualisation) software (version 6.2) to determine the treatment areas required to achieve the water quality targets. The modelling parameters and results are described below.

6.1 Modelling parameters

In the absence of guidance from Landcom, Parramatta Council's DCP recommends using suitable modelling parameters for Parramatta/Western Sydney or by an equivalent widely accepted model or methodology. Parameters are not directly stated such as in the Hornsby Council's WSUD Reference Guideline and as such have been adopted for the Epping development site.

For stormwater quality modelling the recommended rainfall data is the 6-minute Sydney Observatory Hill (BOM station 066062) with a time period from 1/1/1981 to 31/12/1985. The average monthly evapotranspiration for Sydney Region is:

Month	J	F	M	A	M	J	J	A	S	O	N	D
PET (mm)	180	135	128	85	58	43	43	58	88	127	152	163

According to the geological map for the Sydney region, the Epping development site is underlain by Ashfield Shale and located in the Glenorie (gn) soil landscape which is described as high soil erosion hazard with localised impermeable highly plastic subsoils. The rainfall / runoff parameters for the soil landscape and pollutant concentration parameters are available in Hornsby Council's WSUD Reference Guidelines and are outlined in Table 5.

Table 5 Soil properties for MUSIC Source Nodes

Parameter	Unit	Adopted values
Impervious area parameters		
Rainfall Threshold (mm)	mm	1.5 (for roads/paths etc.) 0.3 (for roofs)
Pervious area parameters		
Soil Storage Capacity (mm)	mm	170
Initial Storage (%)	%	30
Field Capacity (mm)	mm	70
Infiltration Capacity Coefficient a		180
Infiltration Capacity Coefficient b		3.0
Groundwater Properties		
Initial Depth (mm)	mm	10
Daily Recharge Rate (%)	%	25
Daily Baseflow Rate (%)	%	25
Daily Deep Seepage (%)	%	0

The source (pollution generation) nodes were modelled with the parameters as shown in Table 6.

Table 6 Stormwater Quality Parameters for MUSIC Source Nodes

Land-use category	*Notes*		Log10 TSS (mg/L)		Log10 TP (mg/L)		Log10 TN (mg/L)	
			Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow
General urban (incl. public open space) **Residential** **Industrial** **Commercial**	*Adopted Residential for all non-building impervious areas within the site.* *Also adopted for designated rooftop communal areas.*	Mean Std Dev	2.15 0.32	1.20 0.17	-0.60 0.25	-0.85 0.19	0.30 0.19	0.11 0.12
Road Areas	*Not used in the MUSIC modelling as there are no roads within the site area*	Mean Std Dev	2.43 0.32	---* ---*	-0.30 0.25	---* ---*	0.34 0.19	---* ---*
Roof Areas	*Adopted for building areas proposed within the site, excluding designated rooftop communal areas.*	Mean Std Dev	1.30 0.32	---* ---*	-0.89 0.25	---* ---*	0.30 0.19	---* ---*

***** Base flows are only generated from pervious areas, therefore these parameters are not relevant to impervious areas

Designated rooftop communal areas have been modelled with 'Residential' lane use node (rather than 'Roof' land-use node) to reflect the activity in these areas.

The rainwater tank was modelled with parameters that incorporate Landcom's Precinx tool. With a 12 ML/yr demand expected from the development, the tank properties are shown in Table 7.

Table 7 Rainwater tank parameters for MUSIC model

Parameter	Adopted values
Number of Tanks	1
Volume below overflow pipe	100kL
Overflow pipe diameter	50 mm
Max Drawdown height	80 m
Demand	12 ML/yr
- Annual demand (irrigation)	1 ML/yr PET-Rain
- Daily demand (internal use)	30.1 kL/day

The bioretention system was modelled with the parameters as shown in Table 8.

Table 8 Properties for MUSIC bioretention system treatment node

Parameter	Adopted values
Extended detention depth	300 mm
Surface Area	Varied
Filter Area	Varied
Saturated Hydraulic Conductivity	120 mm/hr
Filter Depth	600 mm
TN Content of the filter media	600 mg/kg
Orthophosphate Content of the filter media	30 mg/kg
Exfiltration Rate	0 mm/hr
Lined Base	Yes
Vegetated with Effective Nutrient Removal Plants	Yes

The modelled site catchment areas are summarised in Table 9.

Table 9 MUSIC modelling catchment area for proposed development scenario

Scenario	Catchment type	MUSIC Node pollutant parameters	Total Area (ha)	Percentage of site
Proposed	Roofs	Residential - roof	0.45	45%
	Landscaping	Residential - landscape	0.25	25%
	Podium	Residential - pathways	0.32	31%

A schematic of the MUSIC model for the proposed development at the site is shown in Figure 8. The catchment, tank and bioretention nodes have been modelled to meet the required stormwater reduction targets.

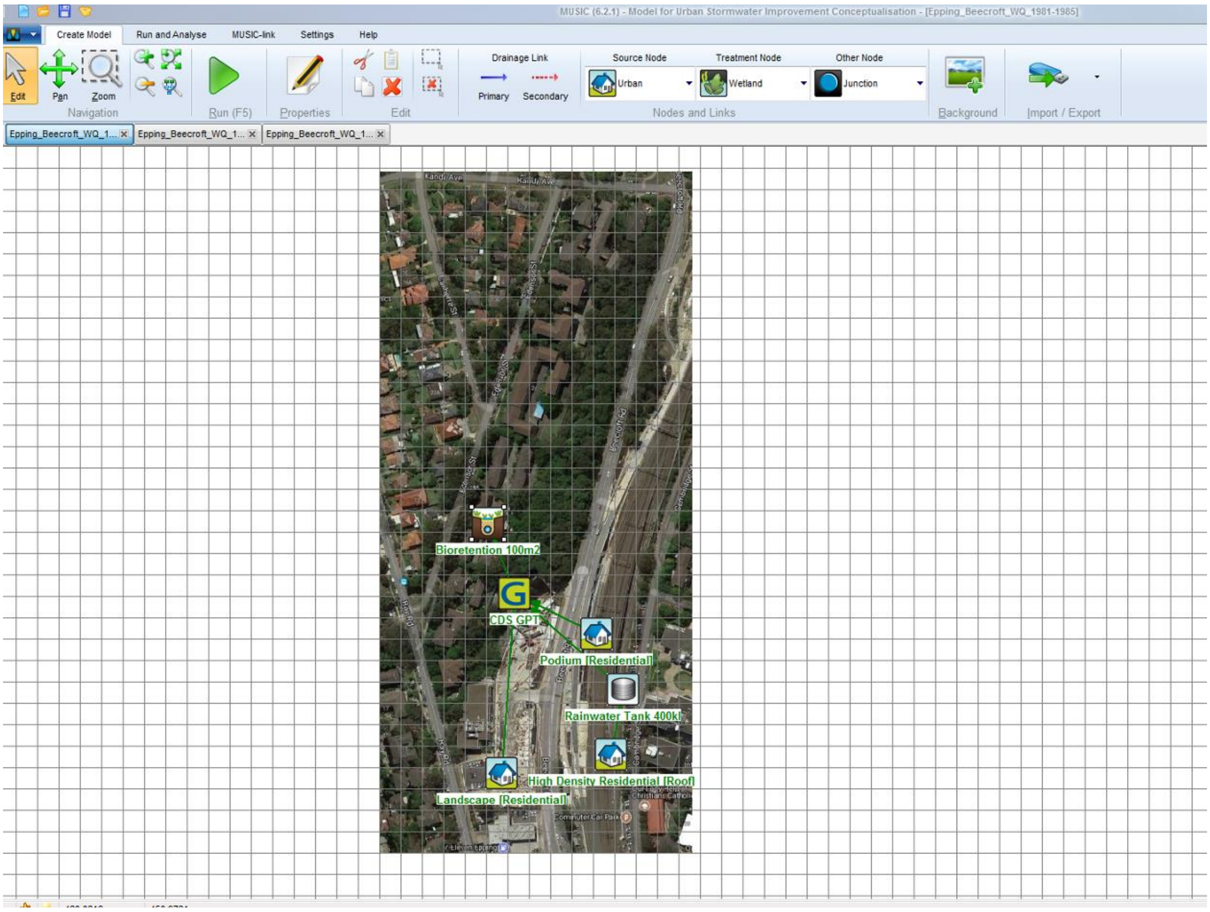

Figure 8: MUSIC model schematic of proposed site development at Epping

6.2 Modelling results

A range of bioretention system sizes were modelled to meet the stormwater quality targets based on the rainwater tank size outlined in Section 5 – 100kL, with the results shown in Table 10. The modelling showed a $60m^2$ bioretention system achieved the stormwater quality targets, in conjunction with 100 kL rainwater storage and reuse.

Table 10. Stormwater treatment MUSIC model results for 100kL tank and $60m^2$ bioretention system (inc. GPT upstream of the bioretention system)

Parameter	Inflow	Outflow	% reduction
Flow (ML/yr)	7.36	5.1	30.7
Total Suspended Solids (kg/yr)	814	107	86.9
Total Phosphorus (kg/yr)	1.69	0.407	76
Total Nitrogen (kg/yr)	14.6	5.43	62.8
Gross Pollutants (kg/yr)	127	0	100

A suitable location for the bioretention system is in the northwest corner near the outlet channel (Figure 9). Rainwater tanks are appropriate below ground level to meet a portion of annual residential reuse demands of 12 ML.

The detailed design will work with the masterplanner to identify the optimial location for stormwater quality treatment on site.

Figure 9: Possible Location of stormwater bioretention system in red in the north-western corner of the site.

7 Stormwater treatment elements

7.1 Bioretention system

Bioretention systems, also known as raingardens, are commonly constructed in Sydney to meet stormwater quality targets. They are suitable in a range of areas, and can be implemented at a range of scales in almost any size and shape.

Bioretention systems are vegetated soil filters. Stormwater runoff is treated by draining vertically through a vegetated filter media (typically a sandy loam). Treated stormwater is then collected by a perforated underdrain and directed to the downstream stormwater drainage system. A schematic of a typical bioretention system is shown in Figure 10.

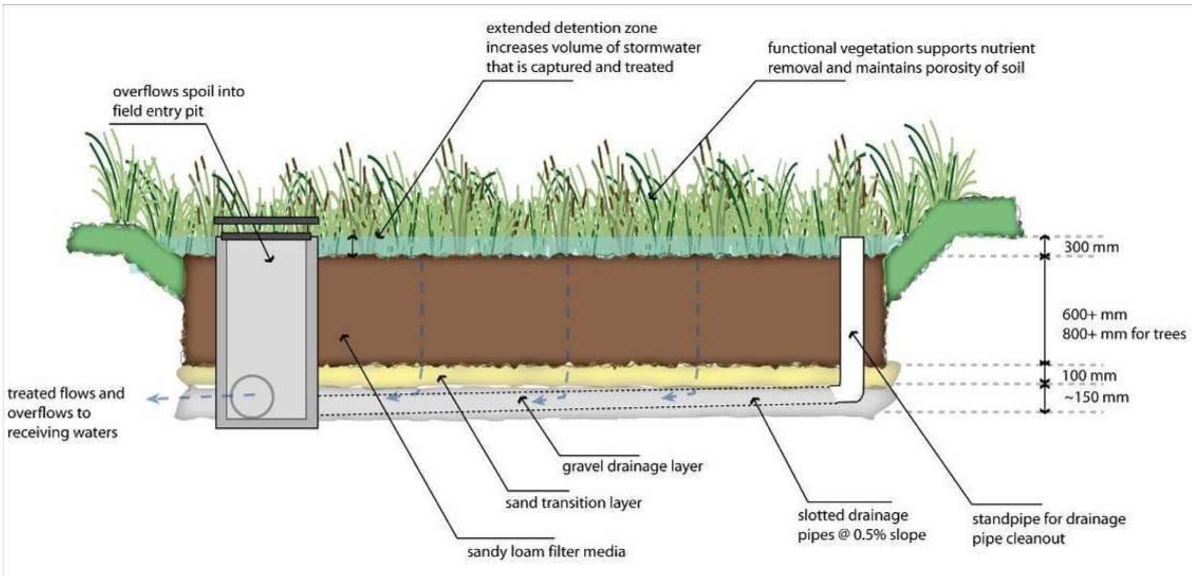

Figure 10: Schematic section through a typical bioretention system

Bioretention systems have a temporary ponding depth (extended detention) of between 100 - 300mm above the filter media surface to temporarily store stormwater thereby increasing the volume of runoff treated through the filter media.

Vegetation plays a key role in bioretention systems. The surface is densely planted with ground level grasses, sedges, and also some selected tree and shrub species. The agitation of the surface of the bioretention caused by movement of the vegetation and the growth and die-off of root systems help to prevent sediments from clogging the filtration media. Beneath the surface, vegetation provides a substrate for biofilm growth within the upper layer of the filter media. Vegetation facilitates the transport of oxygen to the soil and enhances soil microbial communities which enhance biological transformation of pollutants.

The bioretention system will be designed to include vegetation species that are appropriate for the location of the treatment system, particularly where the system is overshadowed. In addition to this the vegetation chosen will be drought tolerant species such as *lomandra longifolia*.

A bioretention system is proposed at the northwest corner of the site area. These bioretention raingardens will be offline, treating diverted 'low' flows (typically the 3-month ARI event) from the piped stormwater drainage system. Treated flows will be directed to the downstream drainage system and flow to the stormwater channel into Devlins Creek. Images for typical bioretention systems are provided in Figure 11.

Figure 11: Bioretention system (raingardens) at Pirrama Park, Pyrmont (left), Chippendale (right) (Photos: Alluvium).

7.2 Gross pollutant traps

Gross pollutant traps (GPTs) target gross pollutants including litter, coarse sediment, leaves and other vegetative matter. Many GPTs will also capture significant loads of coarse suspended solids. GPTs are often the first treatment measure in a treatment train and can be used upstream of wetlands and creeks to protect them from gross pollutants.

Pollutant capture efficiency of coarse material varies between different types of GPTs, however most GPTs cannot remove fine sediments, nutrients or other pollutants to any significant degree. As a result, GPTs are not recommended as the sole treatment system to meet the water quality targets identified by Council.

This system is proposed to be installed on the site, upstream of the proposed bioretention system. The GPT will provide pre-treatment for the bioretention system and aims to reduce the TSS pollutants significantly. A schematic image of the proposed CDS GPT is shown in Figure 12.

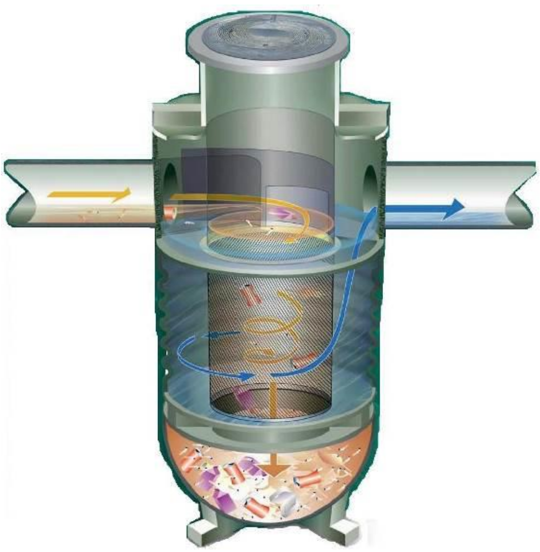

Figure 12: Illustrative section through a Rocla CDS 'Nipper'

7.3 Maintenance Considerations

WSUD infrastructure such as bioretention systems require ongoing inspection and maintenance to ensure they establish and operate in accordance with the design intent. Potential problems associated with WSUD as a result of poor maintenance include:

- Decreased aesthetic amenity;
- Reduced functional performance;

- Public health and safety risks; and
- Decreased habitat diversity (dominance of exotic weeds).

The following sections summarise the maintenance requirements of the proposed WSUD systems.

It is recommended that the personnel who are to undertake the operation and maintenance of the bioretention systems be briefed and trained on procedures and protocols. Keeping and maintaining records on the condition of the systems and all maintenance works required will be important to inform and schedule future maintenance works.

Importantly the most intensive period of maintenance in vegetated stormwater treatment systems is during the plant establishment period (initial one to two years) when weed removal and some replanting may be required. The WSUD designs developed for Macarthur Memorial Park will seek to minimise maintenance requirements during this period by incorporating a provision to isolate the majority of the 'vegetated' areas of the WSUD systems from inflows during the construction and establishment phase (i.e. by taking it offline). This greatly reduces the risk of plants becoming smothered by sediments resulting from construction activity (a common cause of early plant mortality and filter media clogging) and importantly also reduces the weed seed load being deposited in the basins during the period when the plants are establishing and least able to compete with (shade out) weed species. Therefore it is expected that the vegetation in the bioretention systems will become well established prior to bringing them online – which will occur at least 12 months after planting (i.e. at least one growing season such that root/rhizome establishment and foliage density are well developed).

7.3.1 Bioretention maintenance

Typical maintenance of bioretention systems during operation will involve:

- Routine inspection of the bioretention system to identify any areas of obvious increased sediment deposition, scouring from storm flows, erosion of the batters from lateral inflows, and clogging of the bioretention system (evident by a 'boggy' filter media surface).
- Routine inspection of inflow system, overflow pits and under-drains to identify and clean any areas of scour, litter build up and blockages.
- Removal of sediment where it is smothering the bioretention system vegetation.
- Where a sediment forebay is adopted, removal of accumulated sediment.
- Repairing any damage to the profile resulting from scour, rill erosion or vehicle damage by replacement of appropriate fill (to match onsite soils) and revegetating.
- Tilling of the bioretention system surface, or removal of the surface layer, if there is evidence of clogging.
- During the establishment phase, irrigation of vegetation until plants are established and actively growing.
- Removal and management of invasive weeds (herbicides should not be used).
- Removal of plants that have died and replacement with plants of equivalent size and species as detailed in the plant schedule.
- Pruning to remove dead or diseased vegetation material and to stimulate growth.
- Vegetation pest monitoring and control.

Maintenance should only occur after a reasonably rain free period when the soil in the bioretention system is dry. Inspections are also recommended following large storm events to check for scour and other damage.

7.3.2 GPT maintenance

Typical maintenance of the GPT's during operation will involve:

- Routine inspection and removal of pollutants by eductor (vacuum) truck.

8 Conclusion

The proposed stormwater treatment strategy for the Epping residential development is to adopt an integrated water management approach to water management through the development to meet the site water requirements. The proposed system includes:

- Water conservation measures including:
  - Dishwasher – 4.5 Star
  - Washing Machine – 4 Star
  - Toilet – 5 Star
  - Shower head – 3+ star
  - Tapheads – 4 Star
- Rainwater tank for non-potable uses in the residential and retail uses.
  - A 100kL tank provides rainwater storage for reuse that meets 19% of modelled non-potable demand (2.3ML/year potable water saving)
- Stormwater treatment was modelled to meet the stormwater quality targets based on the rainwater tank sizes of 100kL requiring:
  - 60m^2 bioretention system and GPT to meet the stormwater quality targets
- Sydney Water have advised that On-Site Detention requirement would only apply, if the development makes a direct stormwater connection to Sydney Water's stormwater system. The On-Site Detention requirements for the 10,142 square meters site at 242 – 244 Beecroft Road, Cheltenham, are:
  - On Site Detention 109 cubic meters
  - Permissible Site Discharge 310 L/s

Rainwater harvesting modelling undertaken for this strategy, combined with Landcom Precinx modelling (water efficiency savings and greywater reuse volumes – refer Landcom reporting), demonstrates the development meets both the BASIX and Landcom Precinx targets of a 50% reduction of potable water demand.

Water quality modelling results meet the Landcom target pollutant reductions of 45/65/85/90.

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