Cardno
Shaping the Future

Austral & Leppington North Precincts

Water Cycle Management
Responses to Exhibition Submissions

Project No: 600288

Prepared for: NSW Department of Planning & Infrastructure

6 December 2012

Cardno (NSW/ACT) Pty Ltd
ABN 95 001 145 035

Level 9, The Forum
203 Pacific Highway
St Leonards NSW 2065
Australia

Telephone: 02 9496 7700
Facsimile: 02 9439 5170
International: +61 2 9496 7700

sydney@cardno.com.au
www.cardno.com.au

Document Control

Version	Status	Date	Author		Reviewer	
1	Draft	2 July 2012	Nathan Evans Kieran Geraghty	NE KG	Dr Brett Phillips	BCP
2	Final	19 September 2012	Nathan Evans Kieran Geraghty	NE KG	Dr Brett Phillips	BCP
3	Revised	6th December 2012	Nathan Evans	NE	Dr Brett Phillips	BCP

File Reference:
N:\Water_Current Projects\600288 Austral & Leppington North\Report Addenda\600288 WCM Addendum DoPcomments.doc

Table of Contents

Appendices

List of Tables

List of Figures

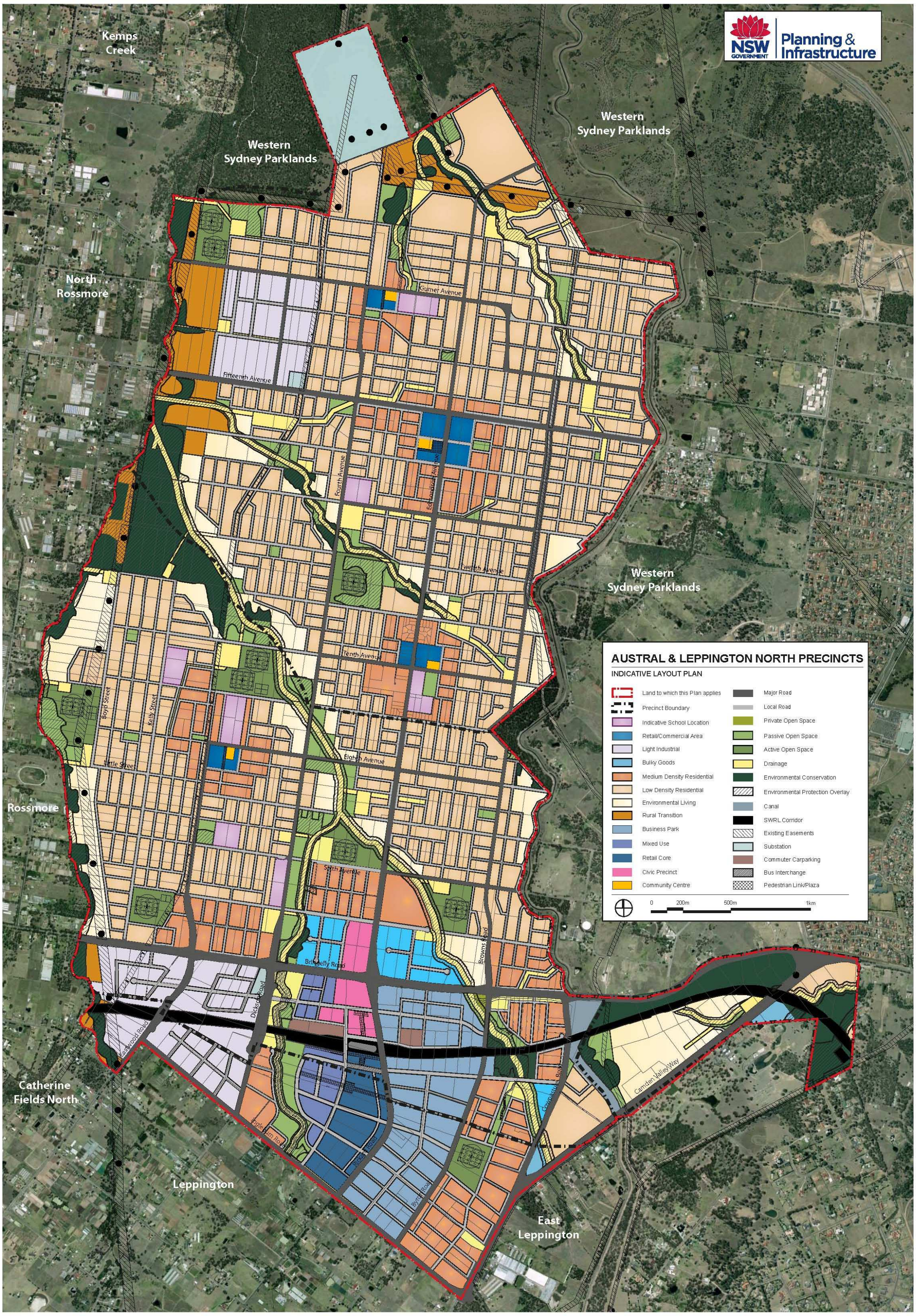
1 Introduction

This Report summarises additional assessments undertaken to date in response to submissions received during the Exhibition of the draft Precinct Plan for the Austral and Leppington North Precincts. These assessments will inform the finalisation of the Precinct Plan and the final Indicative Layout Plan (ILP) shown in Figure 1-1.

The following tasks have been completed as part of these assessments:

- Review of Stream Categorisation;
- Review of South Creek Flood Study and Bringelly Road concept design;
- Surveying of existing natural channels and additional road crossings;
- Comparison of the natural channel survey to ALS data and adjustment of ALS by lowering the surface level along the natural channels to reflect the findings of the ground survey;
- Review of detention basin locations in light of comments received during the public exhibition of the draft Precinct Plan and Water Cycle Management report;
- Assessment of basin overtopping implications during extreme storm events;
- Further modelling assessments of the Leppington Town Centre (LTC) that inform the requirements of lot based On-Site Detention (OSD), the configuration of an on-line basin located on Scalibrini Creek and the location of bioretention;
- Updating the TUFLOW model of existing conditions and the re-assessment of the 2yr, 20yr, 100yr, 500yr ARI and PMF events;
- Investigation of opportunities to increase the capacity of the trunk drainage system and to narrow and reduce the length of overland flow paths;
- Investigation of the impact of further filling of the floodplain under developed conditions on 100 year ARI flood levels;
- Updating the TUFLOW model of post-development conditions and re-assessing the 2yr, 20yr, 100yr, 500yr ARI and PMF events;
- Nomination of rain garden footprints for sub-catchments that do not drain to a combined detention basin / biofilter;
- Updating of Section 94 cost estimates;
- Updating of the flood emergency response strategy; and
- Formulation of provisions for a Leppington Town Centre DCP.

Figure 1-1: Austral Leppington North ILP



2 Review of Stream Categorisation

Discussions were undertaken both with NSW DP&I and NOW regarding stream categorisation within the Precincts. The outcome of these discussions was that several Category 3 streams were removed and the lengths of several streams were shortened. A summary of the main changes is described below:

- Stream ID 24 has been reduced in status to an overland flow path;
- Stream ID 25 is a Category 3 stream which has been shortened to extend only as far as the limit of medium category vegetation;
- Stream ID 27 remains a Category 3 stream ;
- Stream ID 31 is a Category 3 stream and which has been shortened while maintaining sufficient channel width for drainage purposes;
- Stream ID 29 is a Category 3 stream which has been shortened, realigned and re-sized to incorporate an additional existing channel adjacent to Fourteenth Avenue. Calculations were undertaken using Manning's equation to estimate the channel dimensions required to convey the 2 year ARI peak discharge from the tributary and Basin 17. Results indicate a total channel width of 15 m is sufficient to cater for the 2 yr ARI flow should the channel depth be approximately 1.2 m and the channel roughness value around 0.07.

Recently the approach to delineating riparian corridors has changed from the Riparian Corridor Management Strategy (RCMS, 2004) to the Strahler Stream Order and Waterway Classification System. This has been adopted by the NSW Office of Water in order to streamline the approach to riparian corridor management and eliminating the subjectivity in assigning the Category of a waterway using the RCMS.

The Strahler method is based on waterways being assigned an "order" according to the number of additional tributaries associated with each waterway. The Strahler method proposes core riparian zone widths depending on watercourse "order" and also allows the use of on-line detention basins for first and second order streams. The Strahler based approach also eliminates the requirement for a vegetated buffer on all first and second order streams. Otherwise the riparian corridor widths are similar to the previous approach where a first order stream is equal to a Category 3 , second order is equal to a Category 2 and third order and above is equal to a Category 1.

As RCMS guidelines were in place during initial assessment of stream categorisation they are referred to in this Report. However, the final ILP is based on the Strahler method.

Further details of the revised Riparian Corridor Management approach can be found at www.water.nsw.gov.au/controlledactivities

3 Data Review

3.1 Upper South Creek Flood Study

The South Creek Flood Study (SCFS) was prepared by WMAwater for Camden Council to predict flood behaviour under existing conditions. Kemps Creek and Bonds Creek are tributaries to South Creek and are therefore included in the flood study.

Calibration of the hydraulic model used for the Flood Study was made with rainfall data and flood marks of an event in 1988. The return period (likelihood of occurrence of a flood event) for the event is estimated to be approximately 30 years and it was found that the results of the model correlated reasonably well to the recorded flood marks. Frequency duration curves were plotted to gain an understanding of the event duration and return period.

The SCFS TUFLOW hydraulic model was built with a 1D/2D modelling approach using hydrological inflows from XP RAFTS. The hydraulic model uses a 1D natural channel link based on Mike-11 cross sections used in the 1990 Flood Study. The data of the 1990 study is based on ground survey that is more than 30 years old and may no longer represent the channel geometry today. It is likely that the channel would undergo change due to fluvial processes and physical disturbance due to channel diversion, filling and sedimentation.

A 50% blockage factor is applied to the 20 structures included in the model to predict flood levels in existing conditions. The application of the blockage is based on recent experiences in Wollongong (1998) and Newcastle (2007) where blockage was the main factor in reducing the ability for trunk drainage to alleviate flooding.

Results of the model at Bringelly Road are summarised in **Table 3.1**.

Table 3-1: Comparison of Flood Levels D/S of Bringelly road (m AHD)

	Kemps Creek			Bonds Creek		
Event	20 year ARI	100year ARI	PMF	20 year ARI	100year ARI	PMF
SCFS	74.1	74.2	74.8	73.6	73.7	74.4
Cardno	74.07	74.15	74.8	73.5	73.8	74.7

It is clear from a comparison of the results in **Table 3.1** that good agreement is achieved between the two flooding assessments. The main difference between the modelling approaches has been:

- The Cardno model used a 2D modelling approach for the natural channels where the ALS terrain is depressed to account for inaccuracy of the ground elevations in natural channels, (see Item 3 for details).
- The resolution of the terrain grid size is 10 m x 10 m in the SCFS while it is 5 m x 5 m in the Cardno model. Thus the terrain within the Precincts has been modelled in greater detail than in the SCFS.

It is concluded that the results of the Cardno model have been verified by the calibrated model results reported in the SCFS. Furthermore it is expected that the Precincts have been modelled in greater detail by Cardno.

3.2 Bringelly Road Concept Design

Bringelly Road acts as an important arterial road corridor within the South West Growth Centre and it has been advised that it is to be upgraded given the future developments within the Growth Centre.

Cardno have reviewed the Bringelly Road Upgrade REF, dated November 2011, which included a hydraulic assessment and design recommendations made by Lyall & Associates. The Kemps, Scalibrini and Bonds Creek crossings were all recommended for upgrade in order to make the road serviceable in the 100 year ARI flood. This generally involved raising the road crown and increasing culvert capacity to discharge the flows that would normally overtop the road. Different levels of culvert blockage were adopted depending on the perceived flood sensitivity of properties in the vicinity of the crossing. Hence a uniform 50% blockage factor was not applied.

The method of hydraulic assessment undertaken used a HEC-RAS model based on ground survey of the road corridor, with the model(s) only extending approximately 50-100m up and downstream of the corridor. Peak flows were estimated using the Probabilistic Ration Method detailed in Australian Rainfall & Runoff. It was reported that in general the discharge estimates were higher than those reported in previous studies (Perrens, 2003). Downstream boundary conditions were based on water levels reported in previous studies. This approach is suitable for a detailed assessment of a road crossing independent of proposed changes in the precincts. It is therefore concluded that the assessed afflux due to the proposed culverts would be accurate; however the assumed downstream boundary conditions are based on a previous flood study that has now been revised by the findings of the Upper South Creek Flood Study and the hydraulic modelling reported herein. It is therefore recommended that the road design be reviewed in light of the subsequent flood studies.

Preliminary assessment by Cardno has indicated that the upgraded Bringelly Road may have a significant effect on flood behaviour with localised increases in flood levels. However, these preliminary results are not considered a true representation of the design which may be due to differences in detailed survey data being adopted for the road design, by Lyall & Associates, and ALS data adopted for the Water Cycle Management strategy by Cardno.

The detailed survey accurately identifies the creek cross-section and culvert details while the ALS data can be less accurate as found in recent ground survey discussed in Section 6.1. ALS data is the topographic data used for broad-scale flooding assessment and has been used for the Austral and Leppington North Precincts. Ground survey of the Bonds, Kemps and Scalibrini Creeks was not available at the time of the Cardno flood modelling.

3.3 South West Rail Link

The South West Rail Link (SWRL) is currently under construction and will connect Leppington with the Main South railway line. A detailed hydraulic assessment was undertaken by John Holland using a 2D TUFLOW modelling approach. Hydrographs were estimated using RAFTS with parameters and assumptions that vary for each of the 50, 100, 200 year ARI and PMF events. This approach assumes that the rainfall losses associated with infiltration and surface irregularity reduce as the magnitude of the storm increases. Other model parameters including the BX factor and roughness values were informed by previous studies (Perrens 2003) and by hydrological modelling guidelines (Willing and Partners, 2003). It is concluded that the hydrology model approach is suitable for the design of the crossings and it would be expected that the design discharges are slightly higher than those predicted for the Precincts.

The hydraulic TUFLOW model was built using ALS data obtained from AAM Hatch in 2008 for the floodplain and from field survey of the creeks, where available. Detailed adjustments were made to the terrain in TUFLOW to accurately model ground irregularities, creek banks, artificial filling and farm dams. This represents a higher level of detail than that adopted for the hydraulic modelling of the Precincts. The modelling approach adopted for assessing the SWRL is of a suitable level of detail for design purposes. It is therefore expected that the results of the flood study are acceptable. However, it is reported that the SWRL results in increased flood levels at the crossings of Kemps and Bonds Creek located in the Precincts of up to 0.4m and an increase of up to 0.1 m at the Scalibrini Creek crossing. This afflux is expected to occur in the vicinity of the SWRL corridor and appropriate works are recommended to ensure that this does not adversely impact on existing properties. This is described as removal of a on-line property dam for Scalibrini Creek and in the form of creek training for Kemps and Bonds Creeks.

Cardno tested the hydraulic behaviour of the railway line in the TUFLOW model for the Precincts by including bridge openings over the existing model terrain. The results of these trials indicated a significant adverse impact on flood levels in the surrounding areas.

The results of the trial are preliminary only and differences in the assessed impacts may be attributed to differences between detailed survey used for the SWRL design and ALS data adopted for the Water Cycle Management strategy. In order to effectively assess the SWRL, a more detailed approach to modelling the waterway crossing would be required. This would be in the form of obtaining the ground survey used for the corridor design and characterising the bridge crossing design in greater detail. However, as this work is being undertaken as part of the detailed design for SWRL and in accordance with the Ministers Conditions of Approval for the project, it is not necessary to investigate impacts of the rail line in detail as part of the Precinct Planning process.

4 Review of Detention Basin Locations

A review of detention basin locations was undertaken. The main results of this review are outlined as follows.

4.1 Basin 29

It is proposed that Basin 29 be relocated from the upstream side of Seventeenth Avenue to the upstream side of Sixteenth Avenue.

The preliminary assessment found that the basin would receive flows from a reduced catchment area of approximately 97.31ha (a 12% reduction in contributing catchment) due to the relocation of the basin further upstream. This results in a smaller retarding basin with analysis indicating a basin area of 14,596 m^2 would be required. The outlet configuration remains the same as previously advised (2yr ARI outlet width = 3.28m and 100yr ARI outlet width = 6.03m) in order to attenuate the expected developed 2yr ARI and 100yr ARI peak flows to existing condition peak flows.

Basin 25 and Basin 27 are both located downstream of Basin 29. They are both offline basins and therefore not hydraulically linked. Hence any changes to Basin 29 does not affect these downstream basins.

However an additional 13.5ha of catchment will outflow un-retarded to the un-named Creek. In order to compensate for these uncontrolled flows, it is recommended that the relocated Basin 29 retain its original size of 16,614m^2 to further retard the local catchment runoff.

4.2 Other Basins

Basin 15 is located in the optimum location south of Fifth Avenue. Alternative locations have been considered but the location of the retirement village to the north of Fifth Avenue prevents its relocation.

Basin 17 has been relocated slightly further west in light of reduced flood extents resulting from the updated hydraulic modelling.

Offline Basins 1, 2, 3 and 7 have been removed due to the development of lot based on-site detention (OSD) for the Leppington Town Centre (LTC). Refer to Section 5.3 for further information.

A new online basin is proposed on Scalibrini Creek, south of Bringelly Road within the LTC. This is discussed further in Section 5.3.1.

Basin 35 is located in the southeast corner of the Precinct and will attenuate runoff from medium density residential areas within the LTC. It is not possible to relocate this basin east of Camden Valley Way as it would be located within the Liverpool LGA. Liverpool City Council has indicated they would not agree to a detention basin in their LGA to attenuate runoff generated in the Camden LGA.

5 Leppington Town Centre

A regional centre has been included in the Precinct Plan to provide a range of medium density residential, business, commercial and industrial land uses in proximity to public transport (SWRL) and arterial roads (Bringelly Road). The Leppington Town Centre (LTC) is located in the southern portion of the Precinct as shown in **Figure 5-1.** The approach to Water Cycle Management within the Town Centre would be refined in response to increased intensity of the land uses and to ensure water conservation objectives are met.

5.1 LTC WCM Strategy

The LTC is proposed to be an urban space characterised by an increased intensity of commercial/retail/business land uses with a higher lot utilisation and higher building heights. Therefore the impact on the existing water cycle regime would greater than in residential areas of the Precinct. As a result the WSUD strategy requires refinement within the LTC and is described by **Table 5-1**. Water conservation for residential development needs to comply with the BASIX requirements.

Table 5-1: LTC WCM Strategy

Element	WCM Measure	Description
Rainwater	Rainwater Tanks	Reduce potable water demand by supplying reclaimed water for toilet flushing, laundry use, garden irrigation around buildings and irrigation of dedicated passive recreational areas.
	Green Roofs	The use of gardens in the roof space is encouraged for commercial, business, industrial and multi storey residential buildings. This would reduce impervious surfaces, improve air quality, amenity, ambient air temperature, building insulation, bird habitat, and aesthetic quality of the urban environment.
Stormwater Quality	Gross Pollutant Trap (GPT)	Gross pollutant traps are to be provided to collect litter, debris and sediment prior to biofiltration. Propriety products are most appropriate for underground drainage systems and inlet controls are most appropriate for biofilters that receive surface runoff.
	End of Pipe Biofiltration (residential land use)	Bioretention basins located in within retarding basins or in open space outside of the core riparian zone have been proposed in the WCM strategy to control stormwater quality. These basins would incorporate a bio-filter at the low point to accept flows from the drainage system. The bio-filter would be sized to meet best practice targets for TSS, TP and TN.
	Private Domain Biofiltration for commercial and industrial land use	Opportunities to collect and treat stormwater could consist of street trees, rain gardens or bio-swales to treat stormwater either at source or in conveyance. The location of these measures could either be in association or external to lot OSD measures.

Element	WCM Measure	Description
	Public Domain Biofiltration for commercial and industrial land use	The roads and paved surfaces of the public domain are to be treated either at source or in conveyance with street trees and raingardens. The measures can be located either in the tree planting or parking bays of the road reserve.
Stormwater Quantity	Lot based OSD	For land uses other than residential the increase in stormwater discharge is to be managed by lot based on-site detention (OSD). The OSD device may be above and/or below ground and retarded flows would discharge to the drainage system.
	Retarding Basins	Offline retarding basins are proposed for residential areas where lot based OSD is not provided. On-line retardation may be included to allow for the management of post development discharges from the public domain that are not managed by lot based OSD. On-line configurations are only allowed in specific locations in accordance with the Riparian Corridor Strategy.
Reclaimed Water	Stormwater Harvesting	Stormwater is a resource that can be harvested and re-used for irrigation, wash down, fire control and/or car washing. Opportunities to harvest stormwater should be investigated to reduce potable water consumption. In future stages of the design process these opportunities should be explored further.
	Effluent Reuse	Reclaimed water is routinely used for irrigation purposes. However it may also contain chemical contaminants which may be detrimental to public health and the environment. Design criteria for effluent reuse are stricter than stormwater harvesting. Opportunities for effluent reuse could be investigated further at the design stage.
	Cooling Towers	Potential exists for reuse of harvested rainwater or stormwater in cooling towers to reduce the use of potable water. This may be applicable to proposed industrial development within the Precinct and should be investigated further at the design stage.

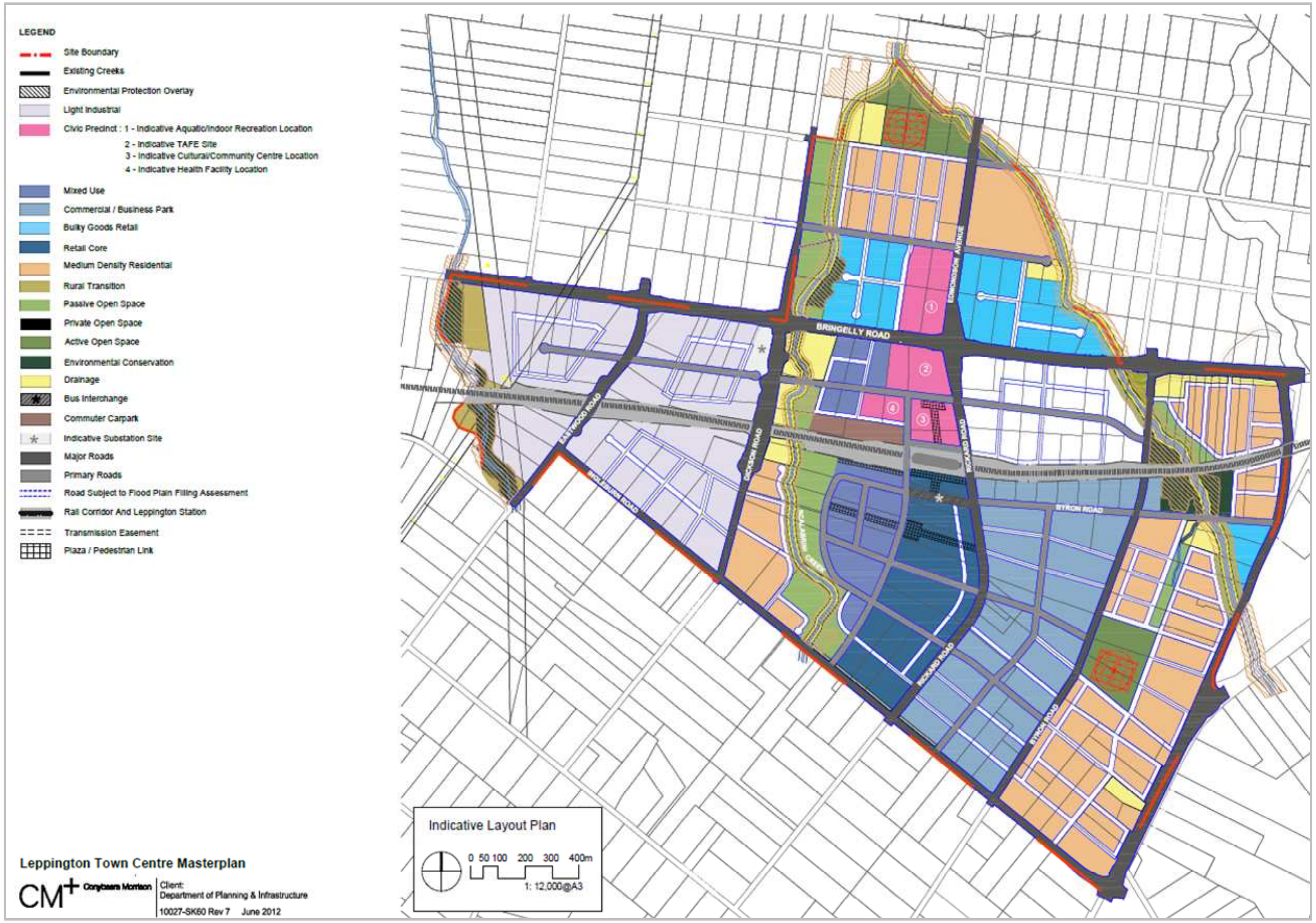


Figure 5-1: Leppington Town Centre ILP

5.2 Review of WSUD Measures

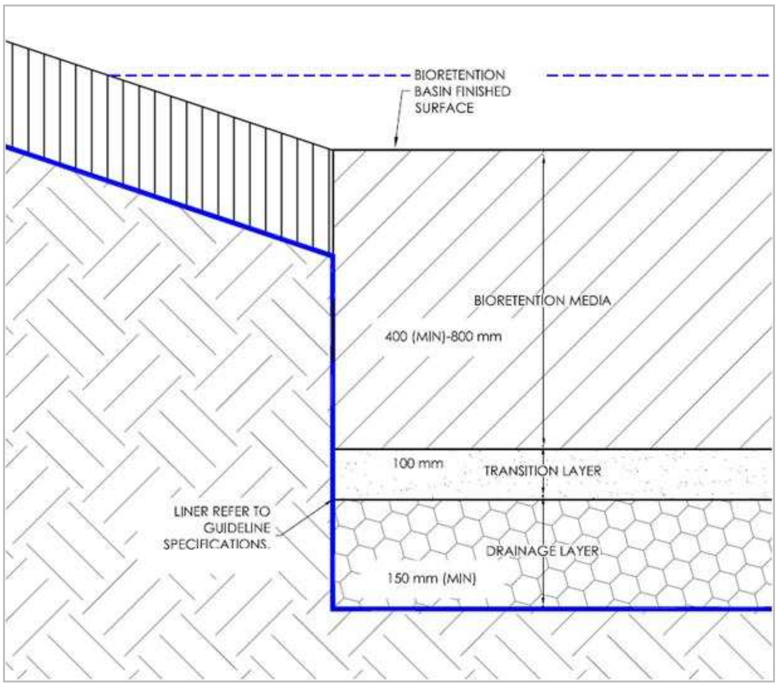
The selection of appropriate stormwater management devices is carried out according to a set of criteria that would rank a range of options. The approach taken in this instance is in the form of a qualitative matrix assessment as that shown in Table 5-2. Note that the assessment is limited to treatment measures to remove TSS, TP and TN. Devices that are suitable for Gross Pollutant removal are readily available as proprietary devices and were excluded from the assessment.

It was found from the qualitative assessment that biofiltration is the most suitable WSUD measure for the precincts as it is the best suited for use in the moderate-high saline soils of the area and should be economical to maintain.

5.2.1 Typical Bioretention Devices

Some examples of stormwater treatment measures that would be suitable for the LTC are provided herein. Each biofiltration/bioretention device has a common profile of filter, transition and drainage layer. A typical cross section through a bioretention system is shown in **Figure 5-2**.

Figure 5-2: Typical Bioretention Detail



Source: Sydney Metropolitan CMA, Typical Drawings for WSUD

A key criterion is the selection of the filter media to provide sufficient hydraulic conductivity while retaining sufficient water to support vegetation growth. A minimum 400mm filter depth is required for plant establishment. The transition layer separates the bioretention media from the drainage layer below. The drainage layer contains perforated pipes which convey treated stormwater to the drainage system.

Table 5-2: Stormwater Treatment Measure Assessment Matrix

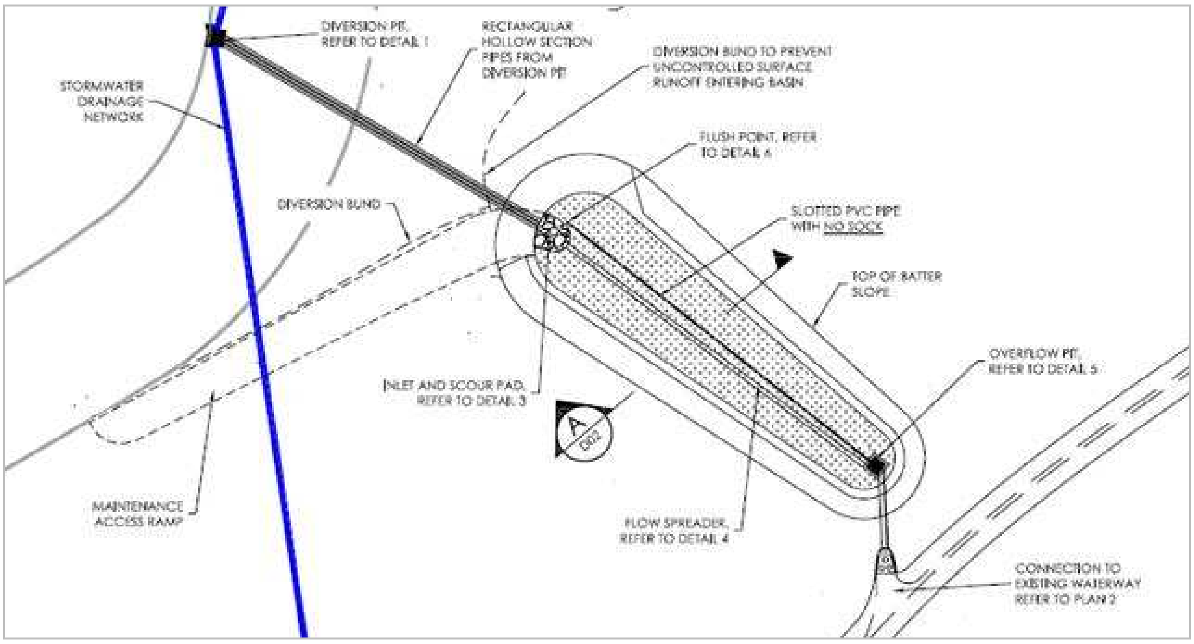
Criteria	Measure					
	End of Pipe Bioretention Basin	Small scale Biofiltration	Bio-Swales	Constructed Wetland	Sand filter with Hydrocon exfiltration pipe	Proprietary Filtration Devices (Stormwater 360, Stormfilter)
Description	• A basin with inset filter trench located at the low point of a sub-catchment accepting flows from the local drainage network. • A GPT would be located upstream of this device • Consists of a vegetated surface, extended detention overflow pit, filter media, sub-surface drainage and flushing points	• Raingardens and street trees located throughout the roads, footpaths and open spaces of the private and/or public domain • A GPT would not be located upstream of this device • Consists of a vegetated surface, filter media, sub-surface drainage and flushing points	• Open vegetated drains in the road reserve having a longitudinal biofiltration trench • Consists of a vegetated surface, edge strip, filter media, sub-surface drainage, overflow pits, check weirs and flushing points	• A series of basins including inlet pond and wetland zone to support macrohpyte plant species • Water is retained to assist with sediment and nutrient removal	• An underground trench comprising Hydrocon pipe and sand media with opportunity for extended detention in a basin above • Above surface is available for passive recreational use	• An underground pit comprising several filter cartridges and temporary storage chamber • Can be located under road/footpath pavement and carparks
Landtake	• Approx 0.5% of catchment area for most land uses	• Varies depending on catchment size, land use and constraints	• Requires a portion of the road reserve either within a median or on verge • Can interfere with traffic movements and cause ponding in the road reserve	• Approx 3% of catchment area for residential land use and 5% for commercial land use	• Footprint if Approx 0.5% of catchment area for most land uses	• Underground pit size dependant on design flow rate • Approximately 0.1% of catchment area
Topography	• Suits locations where the surface has a grade of 5% or less • Can be configured for steeper terrain with use of terracing	• Suits locations where the surface has a grade of 5% or less	• Suits locations where the road length has a grade of 0.5-5%	• Suits locations where the surface has a grade of 5% or less • Can be configured for steeper terrain with use of terracing	• Ideal for all types of topography	• Ideal for locations where constraints limit the opportunity to use other options such as dense urban applications

Criteria	Measure					
	End of Pipe Bioretention Basin	Small scale Biofiltration	Bio-Swales	Constructed Wetland	Sand filter with Hydrocon exfiltration pipe	Proprietary Filtration Devices (Stormwater 360, Stormfilter)
Soils	• Can be configured for a range of soil types • Infiltration can be included or excluded with the choice of appropriate lining • Impermeable lining recommended to suit locations having ASS or high salinity	• Can be configured for a range of soil types • Infiltration can be included or excluded with the choice of appropriate lining	• Can be configured for a range of soil types • Infiltration can be included or excluded with the choice of appropriate lining	• Not suited to ASS or moderate - high salinity • water retention not advised in saline soils • Plant species are sensitive to salinity & ASS	• Can be configured for a range of soil types • Infiltration can be included or excluded with the choice of appropriate lining	• Can be configured for a range of soil types • Impermeable lining recommended to suit locations having ASS or mod-high salinity
Maintenance Tasks	• Remove debris from surface • Irrigate vegetation • Weed removal • Sediment removal from surface • Inspect/clean of drainage system • Replacement of filter media required when stormwater ponding (without additional inflow) exceeds 24 hours duration	• Remove debris from surface • Irrigate vegetation • Weed removal • Sediment removal from surface • Inspect/clean of drainage system • Replacement of filter media required when stormwater ponding (without additional inflow) exceeds 24 hours duration	• Mow grass areas and prune vegetation • Remove debris from surface • Irrigate vegetation • Weed removal • Sediment removal from surface • Inspect/clean drainage system • Replacement of filter media required when stormwater ponding (without additional inflow) exceeds 24 hours duration	• Remove litter and debris from surface • Irrigate vegetation • Weed removal • Monthly water quality monitoring during 24 month establishment • Drain inlet pond and remove sediment • Inspect/clean of hydraulic controls • Drain wetland zone, remove sediment and replace dead vegetation	• An eduction vacuum system is used to clean out the pipes. • Filter media does not need to be replaced in this system as most solids are collected in the pipe.	• Backflushing for maintenance is not needed. • Determination of when cartridge needs replacement cannot be done visually. Frequency of cartridge replacement is determined by MUSIC Modeling, and by sampling the water quality regularly.
Maintenance Frequency	• Weekly inspections during 3 month establishment • Quarterly inspections • Annual monitoring of filter media • Media replacement 10-20	• Weekly inspections during 3 month establishment • Monthly inspections • Annual monitoring of filter media	• Weekly inspections during 3 month establishment • Quarterly inspections • Annual monitoring of filter media	• Monthly inspections and water quality monitoring during 2 year establishment period	• Eduction of hydrocon pipes once per year • Inspection of sand media once every three years	• One inspection and clean out per year. • Replacement of cartridges as required

Criteria	Measure					
	End of Pipe Bioretention Basin	Small scale Biofiltration	Bio-Swales	Constructed Wetland	Sand filter with Hydrocon exfiltration pipe	Proprietary Filtration Devices (Stormwater 360, Stormfilter)
	years	• Media replacement 5-10 years	• Media replacement 10-20 years	• Annual drainage of inlet pond • Drainage of wetland zone as required		
Design Life	• 20 to 30 years subject to routine maintenance	• 20 to 30 years subject to routine maintenance	• 30 years plus subject to routine maintenance	• 10 to 20 years subject to routine maintenance	• 50 + years	• 50 year design life
Summary	• Suitable for the LTC as the constraints of mod-high salinity can be managed and maintenance is less complex than other options • This option has been selected as the preferred approach and has been included in preliminary sizing calculations. Other suitable options can be explored in future stages of the design process.	• May be included as an option for stormwater treatment in the private domain • Filter media is likely to require replacement more frequently due to more intense loading directly from pavements with no GPT upstream	• Not suitable for the precinct due to complications with traffic movements, mowing requirements and ponding in the road reserve	• Not suitable for the precinct due to the high land take requirements and mod-high soil salinity	• May be included as an option where combined WSUD and passive open space use is preferred.	• May be included as an option where treatment in required within a densely urbanised space and biofiltration is not appropriate • The capital cost of this option is generally far greater.

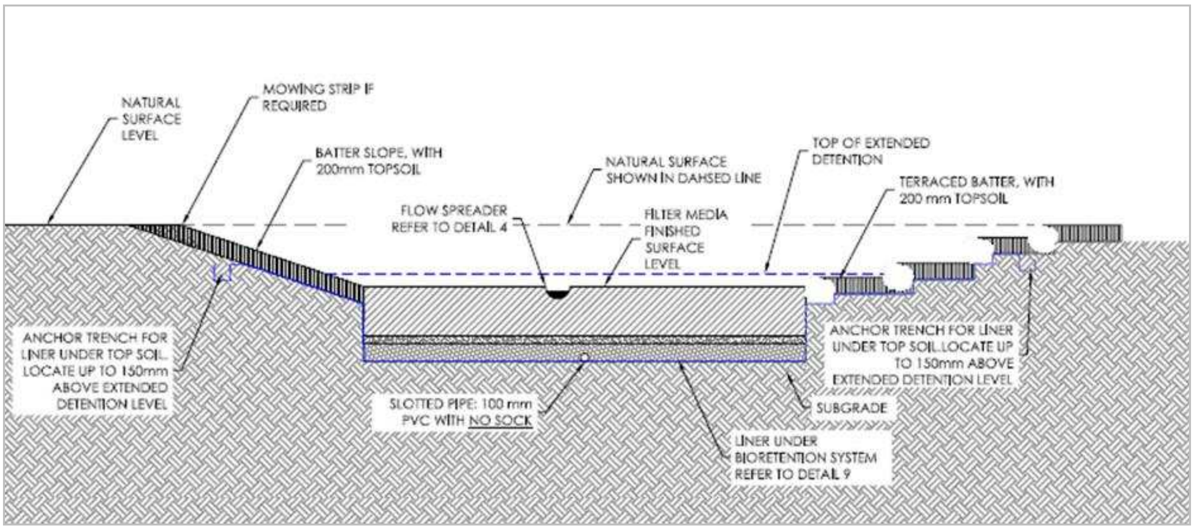
Bioretention measures may take the form of basins, swales and tree pits depending on contributing catchment size. Potential bioretention system locations are included in **Figure 5-8** and are indicative only at this stage. Typical details for bioretention measures are shown in the following **Figures 5.3** to **5.7**.

Figure 5-3: Typical Bioretention Layout – Flat Terrain (Slope <5%)



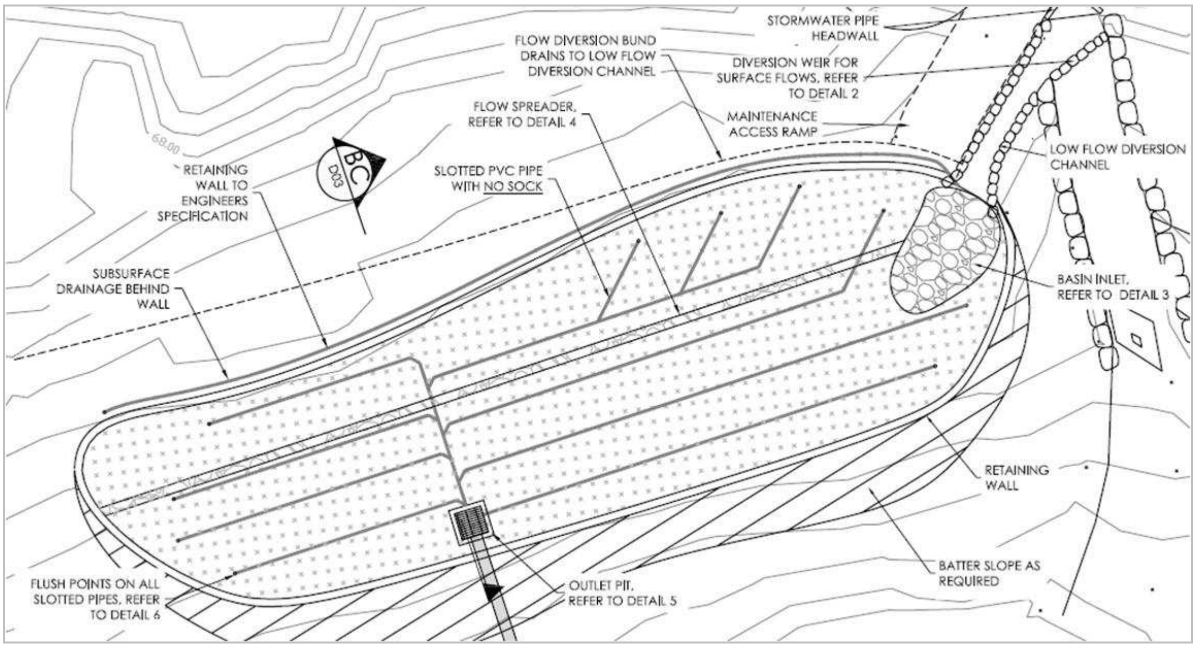
Source: Sydney Metropolitan CMA, Typical Drawings for WSUD

Figure 5-4: Typical Bioretention Detail - Flat Terrain (Slope <5%)



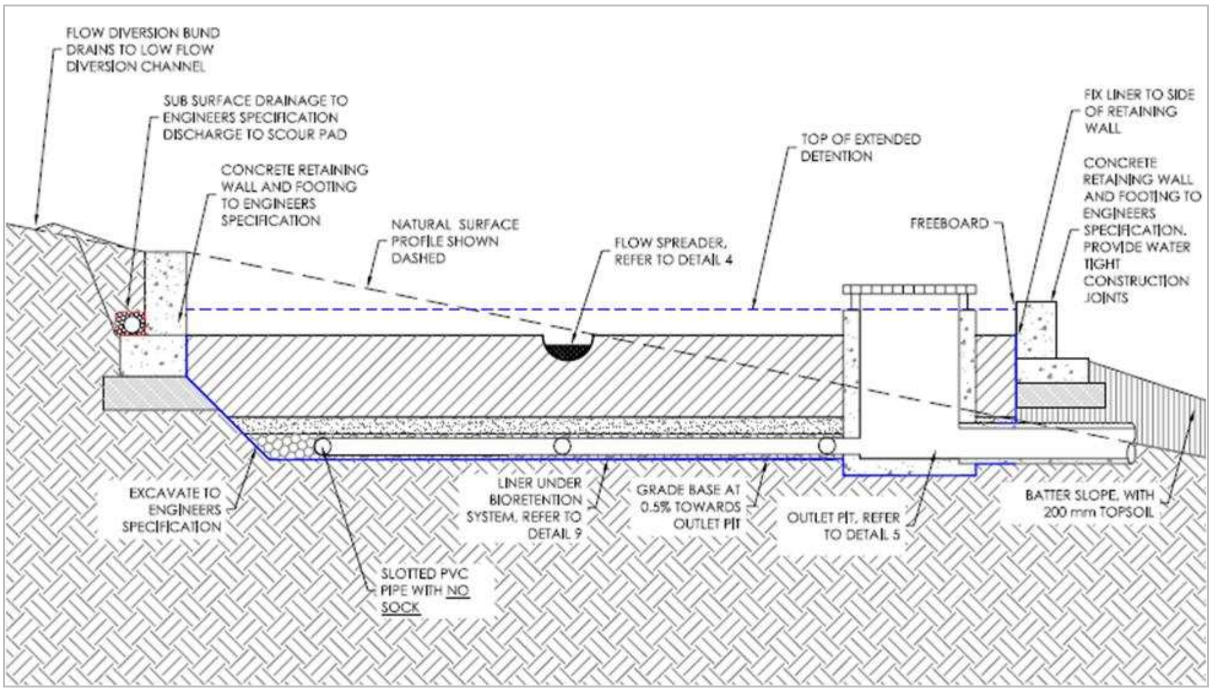
Source: Sydney Metropolitan CMA, Typical Drawings for WSUD

Figure 5-5: Typical Bioretention Layout – Steep Terrain (Slope >5%)



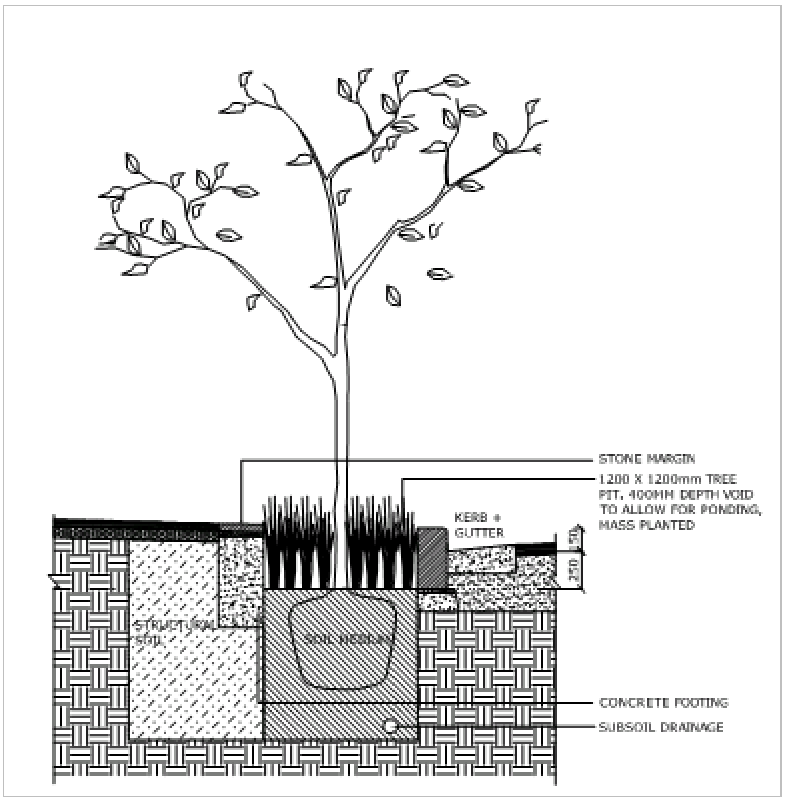
Source: Sydney Metropolitan CMA, Typical Drawings for WSUD

Figure 5-6:Typical Bioretention Detail - Steep Terrain (Slope >5%)



Source: Sydney Metropolitan CMA, Typical Drawings for WSUD

Figure 5-7: Typical Street Tree with bioretention



Source: City of Ryde, Public Domain Manual

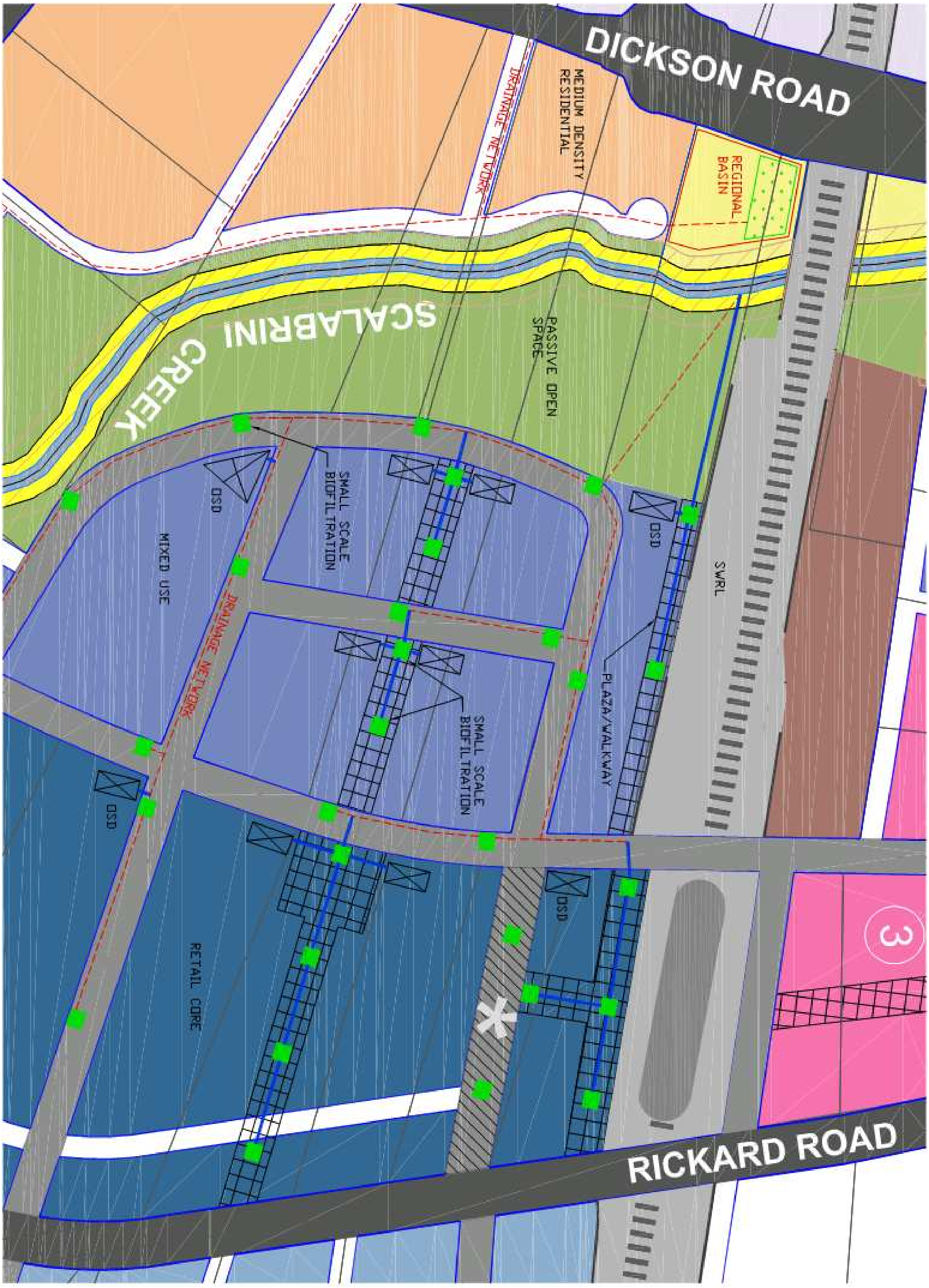
5.2.2 Typical Stormwater Treatment Train

The management of stormwater in the LTC would be separated in the private domain, with lot based OSD and stormwater treatment, and from the public domain with single or multiple biofiltration measures (street trees and raingardens). Some thought is then required to structure the treatment train so that the objectives of stormwater quality and quantity management are met without compromising local flooding or increasing the likelihood of stormwater system blockage.

Figure 5-8 is an example of how a part of the LTC could be structured so that the stormwater is managed appropriately with OSD in lots for commercial/industrial/business land uses and retarding basin for medium density residential use. Some suggestions are also made for inclusion of bioretention in the private domain that could be represented with street trees as per that displayed in **Figure 5-7**. The inclusion of biofiltration at source and in conveyance would sufficiently reduce pollutants to required levels.

The traditional approach to lot based OSD would be to install a tank or storage structure that only meets the stormwater quantity objective to reduce post development peak discharge. There are, however, opportunities to modify the OSD configuration for multiple uses. For example the provision of stormwater collection and detention presents an opportunity to provide additional treatment and retention for non-potable re-use.

Figure 5-8: Typical Stormwater Treatment Train in LTC



Note: GPTs are not shown above but would be normally located directly upstream of the inlet of a regional basin or at the inlet of a biofiltration measure

Figure 5-9: Typical lot OSD layout in LTC

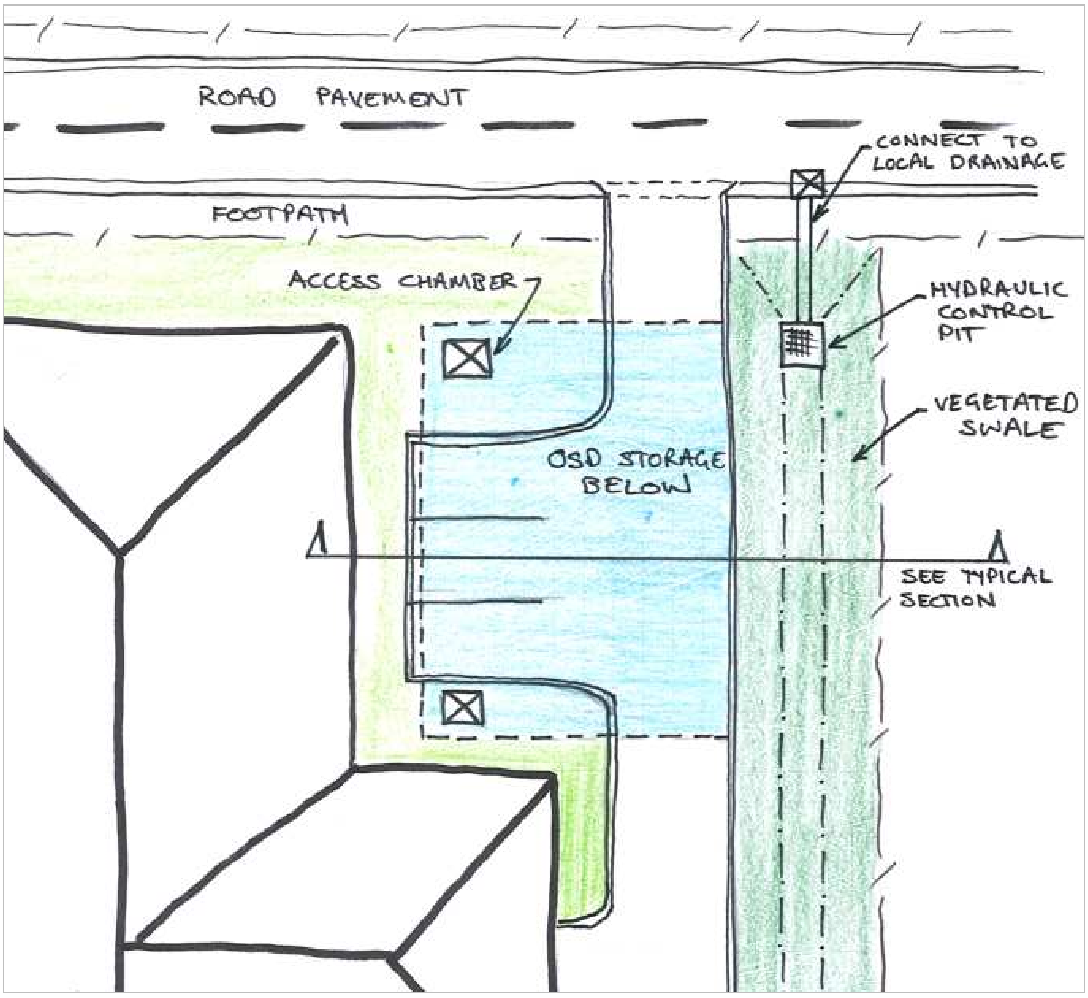
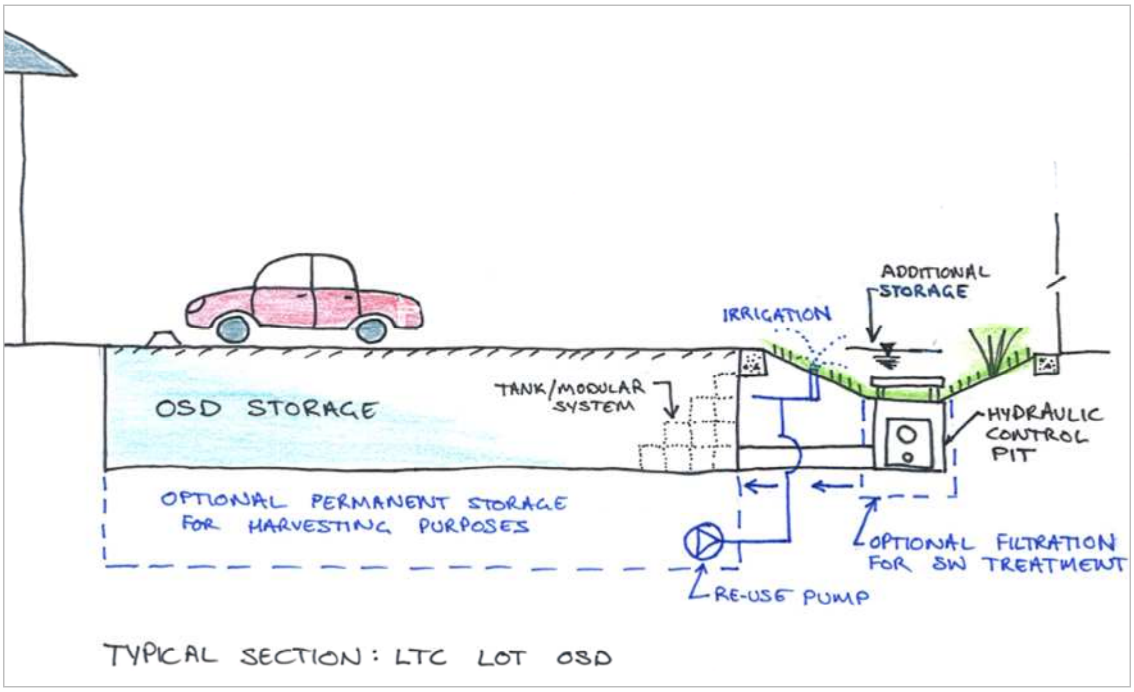


Figure 5-10: Lot OSD typical section in LTC



The DCP provisions that require lot based OSD could also promote stormwater harvesting and re-use, see Section 9.2 for details. An example of lot based OSD with provision for stormwater treatment and harvesting is shown in **Figure 5-9** and **Figure 5-10.**

5.3 On-site Detention in the Leppington Town Centre

During the development of the ILP it was identified that On-site Detention (OSD) would be included in commercial/industrial lots. This is a departure from the strategy elsewhere in the precincts where retarding basins which receive runoff from the whole subcatchment are strategically located on the floodplain adjacent to perennial streams. The lot based OSD approach would aim to retard post-development flows to pre-development levels within the private domain.

The approach to OSD was based on the following two guiding principles:

1. To ensure that future development has a negligible impact on existing flood behaviour; and
2. To conserve stream stability in perennial streams (Stream Categories 2 and 3).

Since the OSD would be located on individual lots within the commercial/industrial areas runoff from the public domain (road reserves, etc) would not be retarded. Therefore consideration was given also to the public domain runoff and how it may impact on the two guiding principles above. In general, the public domain represents a modest portion of the total catchment area and thus does not have much impact on flood behaviour during large storm events. While the conversion of existing undeveloped land into roads can significantly increase the local runoff it is typically exceeded by the runoff from the far greater area of lots. The installation of OSD on lots also separates the peaks of runoff from the public domain (roads) and the retarded outflows from the lots. As such the first guiding principle is in general satisfied in the case where OSD is implemented on lots alone.

However in smaller storm events such as the 2 year ARI the effect of land use change in the public domain is more pronounced. In this case, the second guiding principle requires consideration of measures to retard post-development runoff from the public domain in frequent storms in combination with lot based OSD. This was the basis of the preliminary investigation of an OSD strategy for the Leppington Town Centre where it is proposed to locate high density commercial, industrial and business related development.

5.3.1 Preliminary OSD Analysis

Study Area

A preliminary assessment of lot based OSD was undertaken for a number of sub-catchments draining to Scalibrini Creek. The findings of these investigations will inform a suitable approach for the remainder of the LTC. The study area is shown in **Figure 5-11**.

Table 5-3 summarises the land use breakdown for each local catchment.