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Executive Summary

This LWMS provides the framework to manage the broader water related issues for the re-development of the Central Maddington Outline Development Plan (ODP). Primarily, the ODP proposes to increase densities within the ODP area which will result in an increase in stormwater runoff generated from new streets and additional roof and paved surfaces from new residential dwellings.

The ODP represents infill development of an established urban area which presents challenges for local water management that are more complex, and vary significantly to those for greenfield development. As a result this LWMS provides a practical approach to addressing water management and implementing water sensitive design principles (WSUD). This approach has meant that the LWMS provides far more detail than would normally be required and has had to consider water management strategies at the broader catchment level, street level and the individual lot level.

This LWMS provides strategies to address additional quantities of stormwater, and also focuses on managing water quality and water conservation for the ODP area. Water management is to be addressed in a manner that is consistent with state and local policy advocating sustainable use of water resources.

Quantities of stormwater are to be managed to ensure flooding does not occur. Flooding can cause property damage and impact people's safety, create health problems from vector borne disease, and alter ecological processes. To address this, additional stormwater runoff generated from newly created individual lots, and new roads, is to be managed so that post development flows for the 100 year ARI rainfall event do not exceed pre-development flows for the 5 year ARI rainfall event.

Stormwater quantities will be managed by:

- Ensuring additional storage is provided for in the new piped network of various sections of new road, so that stormwater road runoff is retained for larger rainfall events and then released into the existing piped network at predevelopment rates.

- Ensuring additional storage is provided for on individual dwelling/lots within underground storage tanks (and rainwater tanks where necessary), so that post development flows for the larger rainfall event will be retained on-site and then released into the existing piped network at predevelopment rates.

Quality of stormwater is to be managed by treating the water as close to the source as possible for the smaller more frequent rainfall events. Stormwater runoff can be contaminated from the first winter rains and the pollutants it collects, such and phosphate, nitrates and hydrocarbons that accumulate roof surfaces and new roads.

Due to the clay nature of the soil which is characterised by poor permeability it is unlikely that contamination of groundwater will occur through infiltration of surface runoff. Therefore the opportunity to improve water quality is best addressed through the treatment of surface runoff prior to entering the receiving waters of the Canning River.

Stormwater quality will be managed by:

- Providing bioretention facilities in road reserves to that will treat stormwater runoff with a suitable filter medium for a 1 year ARI rainfall event and then release it gradually into the existing piped network.

- Providing bioretention facilities on newly created dwelling/lots to treat stormwater roof runoff with a suitable filter medium then release it gradually into the existing piped network.

Water conservation presents a challenge for the irrigation of proposed parkland due to the potential lack of availability of ground water for bore irrigation and its potential to be saline. The solution requires a practical approach and one that may require "best fit" rather than ideal water sensitive urban design techniques

Water conservation for individual lots is expected to be achieved through a range of water saving measures which involves reducing the use of scheme water in the following ways.

- implementing new water saving technology in new homes in bathrooms, toilets, laundries and tap outlets generally.
- installing rainwater tanks on individual properties with a connection to the house and using stored rainwater in place of scheme water applications such as washing machines and toilets.
- using stored rainwater for outside the home applications such as garden irrigation and car washing.
- promotion of water efficient gardens and public spaces.

Whilst some of these conservation measures are voluntary others are mandatory and are enforced through the Building Code. It is expected that mandatory requirements alone will be sufficient in achieving the state water consumption target of 100kL/person/year. Nevertheless, the implementation of water conservation measures, both mandatory and voluntary has increased overtime for the broader metropolitan area and this trend is expected to continue in the future development of the ODP area.

To facilitate the implementation of stormwater management strategies the following measures will be required:

- Applications for subdivision and development for individual lots which require access to an existing road will need to be accompanied by a detailed drainage plan detailing how runoff for individual lots will be contained entirely on-site.
- Applications for subdivision and development which requires the construction of new roads must be accompanied by an Urban Water Management Plan (UWMP) for sections of road identified in this report, detailing how additional runoff generated by proposed new roads will be retained in bioretention pockets within road verges.

The implementation of strategies will be further facilitated to a large extent by the preparation of a developer contribution arrangement which is to be undertaken by the City of Gosnells. This will encourage staged development of the ODP area and provide a means to equitably fund new road construction and the inclusion of bioretention facilities within the design. It is also expected that pre and post development monitoring will be undertaken to monitor surface waters, which will determine the effectiveness of strategies and guide contingency actions if necessary.

1. Introduction

1.1 Background

This report intends to satisfy the requirement for a Local Water Management Strategy (LWMS) and is to be prepared in accordance with State Planning Policy 2.9 – *Water Resources* and the Western Australian Planning Commission's *Better Urban Water Management* document. The primary function of this LWMS is to address the management and sustainability of the total water cycle associated with the planning and development of the Central Maddington Outline Development Plan (ODP) area.

The ODP area covers approximately 150ha of land. The area equates to approximately 30 percent of the residential land in Maddington and 15 percent of the total Maddington suburban area, which also accommodates industrial and rural activities. The natural feature of the Canning River defines the northern extent of the ODP boundary with Kelvin Road defining the western boundary. The eastern border of the ODP area is partly defined by the Maddington railway line and the residential suburb of Maddington. Other significant features of the ODP include Albany Highway and its abutting commercial area and the Maddington railway line, which seemingly divides the ODP area into two distinct northern and southern precincts. The ODP area also has an assortment of smaller parks and the Maddington Primary school.

The primary purpose of the ODP is to facilitate infill development of the residential area at much higher densities, to encourage a greater proportion of population within convenient walking distance of the nearby Centro Maddington Shopping Centre and the Maddington railway station.

The preparation of the Central Maddington ODP involved:

- Amending the City's Town Planning Scheme No.6 (TPS 6) to change the zoning of ODP area to a 'Residential Development' zone.
- Preparation of the ODP to introduce higher residential density codes and identify the location of new roads and areas of public open space, which is intended to overly the Residential Development zone.

The Central Maddington ODP provides the framework to guide future subdivision and development. To ensure water issues associated with subdivision and development will be adequately considered, the ODP is accompanied by this LWMS.

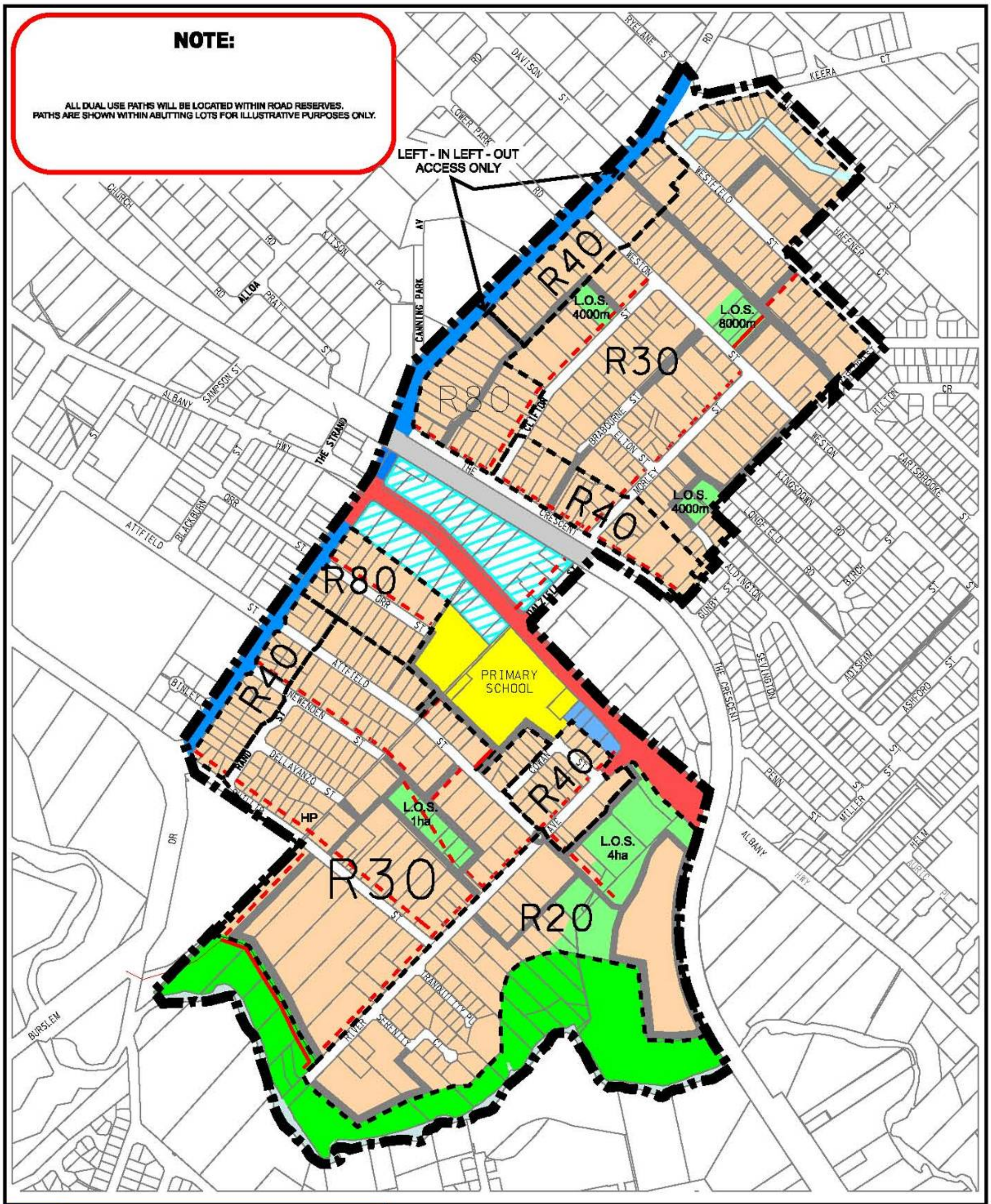
Figure 1 shows the Central Maddington ODP.

1.2 A Local Water Management Strategy for Infill Development

The Central Maddington ODP area is well established low density urban environment. The ODP is intended to facilitate an increase in residential densities, provide additional road connections and areas of public open space. This type of development is typically referred to as "urban infill" and the provision of additional infrastructure and/or upgrades of infrastructure within an established urban environment is commonly referred to as "retrofitting".

The infill nature of the ODP is significant in that the requirements for local water management are very different from that of Greenfield development. In many instances, there are considerable constraints to implementing water sensitive urban design (WSUD) infrastructure, with the two most common being availability of land to retrofit the existing situation and the cost associated of doing so. In this regard, preparation of an LWMS for infill requires a flexible and practical approach to implementing WSUD principles which, in some cases, might not be ideal but represents the "best fit" scenario.

The WAPC's *Better Urban Water Management* document provides a process for achieving better management of urban water, through the application of integrated water cycle management via the planning system of Western Australia. Whilst it is does not specifically address some of the complexities with urban infill development, its principles regarding local water management are sound and have been adhered to and/or adapted where necessary in the preparation of this LWMS.



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	Copyright City of Gosnells 2009
Figure 1	DRAFT CENTRAL MADDINGTON OUTLINE DEVELOPMENT PLAN

DATE:	1/7/2009	CURRENCY:
SCALE:	1:7,500@A3	REVISED:
PREPARED BY:	JOHN HICKEY	ADOPTED BY COUNCIL:
GRID:	MGA94 (ZONE 50)	ADOPTED BY WAPC:
FILE No:	P:\OD\CM\CMODP_V3.DGN	

The City of Gosnells provides the information contained herein. The Council of the City of Gosnells shall not be liable for any loss or damages howsoever caused as a result of reliance upon information contained in this document.

LEGEND

- RESIDENTIAL
- RESIDENTIAL DENSITY CODES
- HIGHWAY COMMERCIAL
- MIXED BUSINESS
- LOCAL OPEN SPACE
- PUBLIC PURPOSES
- WATER COURSES
- PRIMARY REGIONAL ROADS
- OTHER REGIONAL ROADS
- RAILWAYS
- PARKS AND RECREATION
- WATERWAYS
- ODP BOUNDARY
- PROPOSED ROADS
- ROUNDABOUTS
- DUAL USE PATHS
- HP HERITAGE PLACE (see Part 1 of ODP Text)

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2. Integrated Total Water Cycle Management

2.1 State Planning Policy 2.9 Water Resources

The total water cycle is made up of a number of water elements, namely reticulated scheme water, groundwater, stormwater, wastewater, flooding, water quality, wetlands and watercourses. These elements should be viewed as a single interconnected system and considered as an integral part of the planning and development of an area. The key principles of the integrated water cycle management system are outlined in State Planning Policy 2.9 Water Resources (Government of WA 2006). These are:

1. Consideration of all water resources including wastewater, in water planning;
2. Integration of water and land use planning;
3. The sustainable and equitable use of all water sources, having consideration of the needs of all water users, including the community, industry and the environment;
4. Integration of human water use and natural water processes; and
5. A whole-of-catchment integration of natural resource use and management.

Incorporating the above principles into the planning for the Central Maddington ODP is to be achieved, in part, through the application of water sensitive urban design techniques detailed in the Stormwater Management Manual for WA, 2004-2007.

2.2 Better Urban Water Management Guidelines 2008 – Water Sensitive Design

The general objectives of water sensitive design have been summarised in *Better Urban Water Management, 2008* and were adapted from the *Stormwater Management Manual 2008*. The objectives outlined below are focused toward minimising the impacts of urbanisation on the natural water cycles and addressing issues of water conservation, water quality and water quantity in connection with other social and environmental objectives. These principles are:

1. To manage a water regime
2. To maintain and, where possible, enhance water quality
3. To encourage water conservation
4. To maintain and, where possible, enhance water-related environmental values; and
5. To enhance water-related recreational cultural values.

The principles of appropriate stormwater management, premised on water sensitive design, have been summarised in Better Urban Water Management, and adapted from the Stormwater Management Manual 2008. These are:

- Protect natural systems – protect and enhance natural water systems and their hydrological regimes in urban developments;
- Integrate stormwater treatment into the landscape – use stormwater in the landscape by incorporating multi-use corridors that maximise the visual and recreational amenity of developments;
- Protect water quality – protect waterways and other water bodies from drainage from urban development and minimise outputs of phosphorous, nitrogen and other pollutants;
- Manage run-off and peak flows – reduce peak flows from urban developments by using local detention measures and minimising impervious areas; and

- Add value while minimising development costs – minimise the drainage infrastructure cost of development.

This LWMS is intended to provide the framework for sustainable management of the total water cycle associated with subdivision and development of the Central Maddington ODP area. It is based on the approach, and the principles and objectives outlined above.

3. Proposed Development

3.1 Central Maddington Outline Development Plan

3.1.1 Purpose of the Central Maddington ODP

The ODP is the planning framework intended to guide subdivision and development of the ODP area. The planning for this area is premised on state and local planning strategic objectives which propose to make more efficient use of established urban land that is in close proximity to public transport and commercial centres. This is expected to achieve a more compact and sustainable form of urban development and assist in meeting the state's proposed future growth and population targets outlined in its regional strategy Direction 2031 and Beyond.

The ODP will facilitate low, medium and high density residential development, ranging from R20 to R80. It is estimated that the proposed increase in residential density has the potential to yield a further 2,300 dwellings across approximately 150 hectares. To support the proposed increase in population to the area, the ODP provides new areas of public open space, additional roads, and cycle and pedestrian paths. The ODP is expected to improve the connection and accessibility to the nearby Centro Maddington shopping centre and Maddington railway station.

The ODP is shown at **Figure 1.**

3.1.2 Relevance of Water Management in the ODP Area

Residential lots within the ODP area were previously zoned Residential R17.5 under TPS 6, with the ODP primarily proposing to intensify the extent of residential development. With respect to this LWMS, this is significant, in that it represents an increase in stormwater runoff from additional dwelling roofs and paved areas, as well as additional stormwater runoff from proposed new roads. The catchment is made up of predominantly heavy soils, which limits opportunities for infiltration and biological water quality treatment. Whilst this strategy addresses all elements of water cycle management, a key focus is the imperative to manage the quantity and quality of additional stormwater so that existing hydrological processes are maintained, environmental assets are protected and flood risk is mitigated.

Helm Street Main Drain enters the Canning River in the ODP area, although only 1.45% of the drain's catchment lies within the ODP area. This tributary of the Canning River has been identified by the Swan River Trust as a high priority for water quality amelioration. The potential impact on water quantity and quality in this water course for the ODP area, though, is not considered high.

3.1.3 Overview of ODP Implementation

The implementation of the water management strategies in this report will, to a large extent depend on how the ODP area is developed. With the high level of fragmented landownership it is expected that the majority of the ODP area will involve landowners submitting planning and building applications for individual properties. Those smaller lots involving proposals for several dwellings with access to an existing road can be dealt with via individual applications, with water management able to be addressed on a lot by lot basis.

Development of properties requiring the construction of new roads will have to be staged to allow time for those roads and associated drainage facilities to be constructed. This is to be achieved through the preparation and approval of an Urban Water Management Plan (UWMP). The UWMP will provide specific details on the management and location of verge water treatments for the length of a new road, and subsequently allow individual properties along this road to be developed on a lot by lot basis.

The construction of new roads and preparation of UWMPs will be prioritised on the willingness of landowners to subdivide and develop and the extent to which each road will facilitate such development. A number of UWMPs will be required for the various sections of new road proposed on the ODP, and these will need to be prepared and approved prior to approval for subdivision and development. Responsibility for the preparation of an UWMP and associated costs will be a matter that needs to be addressed through the drafting of plans for the operation of a developer contribution arrangement for the ODP area.

Notwithstanding the above, this report details a range of strategies designed to guide the development of the ODP area and the management of the various water components of the urban environment.

4. Pre-development Environment and Implications for Local Water Management

4.1 Built Form

The ODP area is part of a well established urban environment which provides opportunities for strategically located residential infill development. It is well serviced by existing retail, commercial and community facilities, and the adjacent Centro Shopping Centre and the Maddington Railway Station.

The ODP area, shown in **Figure 1**, is divided by the railway line, Albany Highway and a number of commercial properties in between. This separation represents two distinct sub-precincts which, for the purposes of this report will be referred to as Central Maddington Precinct North (CMPN) and Central Maddington Precinct South (CMPS), where relevant.

The predominant land use in CMPN, accounting for approximately 70 percent of all lots and 90 percent of the land area, is low density residential development. Relatively large underdeveloped single residential lots characterise the area. Approximately 70 percent of the total numbers of lots exceed 1000m^2 in area with around one third exceeding 2000m^2. Of those lots less than 1000m^2 the majority are in the 700m^2 to 1000m^2 range.

Land adjacent to the railway reservation and fronting Albany Highway forms part of a commercial precinct with a land area totalling 59ha and lots averaging 3000m^2. Lots in the commercial precinct are occupied by car/caravan sales yards, an office complex and a small amount of retail development, and some of the lots are vacant.

Land uses in CMPS are more varied, with low density residential lots accounting for approximately 50 percent of the land area. This land, like CMPN, is characterised by large underdeveloped lots, however there is a greater proportion of lots below 1000m^2 in area compared to CMPS. These lots are generally situated within 150 metres of Olga Road.

The residential component of the overall ODP is generally developed with single dwellings and associated outbuildings and is serviced to a large extent by existing infrastructure such as roads, drainage, scheme water and power etc.

An aerial photo in **Figure 2** shows the ODP area and adjacent Centro Maddington shopping centre and Maddington Railway.

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Central Maddington ODP Area

Figure 2 CENTRAL MADDINGTON AERO PHOTO

Scale: 1:7500

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4.2 Existing Drainage Network & Surface Waters

4.2.1 Drainage Catchment Overview

The majority of the ODP area is situated within the Canning/Helm Street catchments of the Swan Canning River systems. Surface runoff flows through natural drainage contours and the Water Corporations Helm Street Main Drain. A part of the Helm Street Drain within the ODP area is a Conservation Category Westland referred to as Stokely Creek. Flows are generally westward and outfall to the Canning River.

The ODP area is also served by an existing piped drainage network intended to cater for a low density urban environment. The existing piped and open drain network can be separated into individual catchments which have been determined based on the topography and direction of flow of the piped network and the open drains they feed into. The catchments are illustrated in **Figure 3** which shows surface drainage channels and the piped network and includes inlets and outlets of the various catchments.

The **AS** catchments flow into the Alcock Street Drain which flows into the Graze Place Drain. The **GP** catchment feeds into the Graze Place Drain which delivers flow to Bickley Brook and, thereafter, the Canning River. The **RR** catchment flows into the Railway Reserve Drain which eventually flows into the Canning River. The **C1** and **C2** catchments also flow into the Canning River. The **RRC** catchment represents the only commercially zoned catchment and flows in the Railway Reserve Drain.

Whilst the piped networks play a role in stormwater conveyance and flood avoidance, they present limited opportunities for improving storm water quality before discharge to the receiving environment.

4.2.2 Implications for Local Surface Water Quantity

Implementation of the ODP will see the construction of new dwellings and new local roads within the existing urban form, which will generate additional stormwater runoff from new roof and paved surfaces. As a result, the cumulative effects of discharging additional stormwater into the existing drainage system are likely to exceed system capacity and have an adverse impact on the existing hydrological processes within the ODP area.

One option to address additional stormwater volume is to upgrade the capacity of existing drainage network to cater for increase volumes. However this is considered a costly exercise and is likely to be cost prohibitive to the developers and does not offer opportunities to address water quality issues.

The preferred option is to manage stormwater runoff from both new dwellings and new roads by ensuring that post development flows do not exceed predevelopment flows, thus maintaining the status quo. This is to be achieved in part, through on-site detention of stormwater for all new dwellings on individual lots, which is usually achieved through the use of conventional soakwells. However, due to poor infiltration qualities of the study area's generally heavy soil it is expected that more unconventional methods will be required. To address stormwater generated from new roads, stormwater is to be detained and treated within new road verges so that pre-development flow levels will be maintained. Further details are provided in section 7 of this report.

Figure 3 shows the various drainage catchments within the ODP area. The pre-development discharge flow rates for the piped drainage system for the various catchments are examined in the relevant strategy section of the report. Catchments and discharge rates are based on existing densities and impervious surfaces.

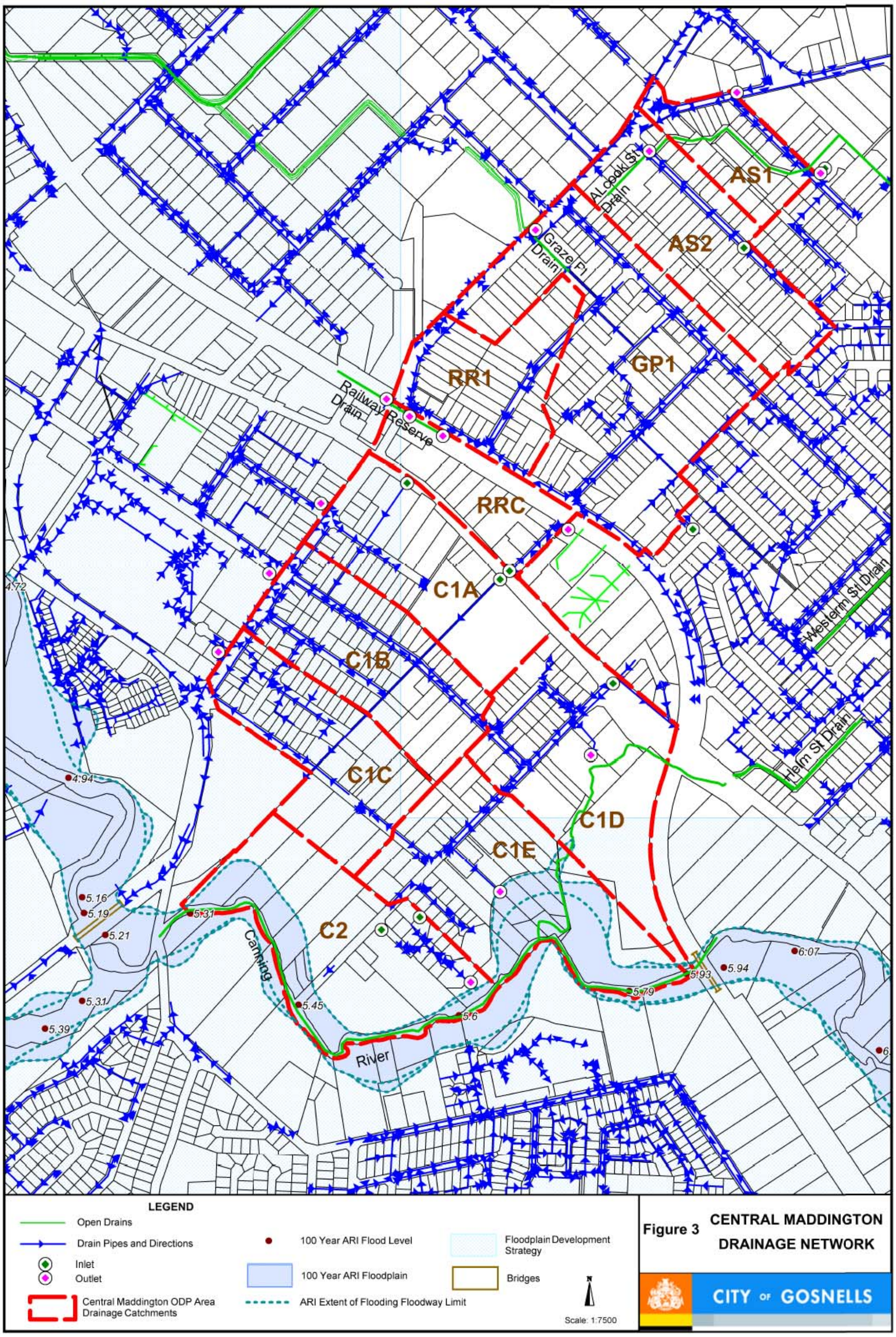

Figure 3 CENTRAL MADDINGTON DRAINAGE NETWORK

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4.2.3 Implications for Local Surface Water Quality

To ensure issues of water quality are addressed, runoff is to be treated prior to discharge to receiving waters. Apart from the first rainfall after the summer months, which typically collects the accumulation of nutrients, stormwater runoff from subsequent rainfall from individual residential and commercial properties is relatively clean. However, treatment is still to be provided for all newly created dwellings through on-site biorention facililties with suitable filter medium. This will provide adequate stormwater treatment prior to discharge into the existing piped network. The treatment of new road runoff and runoff from other paved areas, which are potentially contaminated with hydrocarbons, phosphates and nitrates, will need some form of treatment to reduce pollutant load. This treatment will occur within new road verges via some means of biofiltration.

The Swan River Trust (SRT) Non-Nutrient Contaminants in the Swan Canning River System Program was a three year program which involved water sampling and assessment of potential contaminants delivered to and contained within the Swan Canning River. Samples were taken from a number of locations, including the Helm Street drain, which is one of the tributaries of the Canning River within the ODP area. The findings of the program are contained in the SRT's *Non-Nutrient Contaminants in the Swan Canning River System - Summary Paper 2009*.

Contaminants considered were those known to be associated with stormwater and included hydrocarbons, pesticides, herbicides, metals and organochlorins, to name a few. The Helm Street drain has been identified to contain contaminants such as metals and herbicides but not at considerably high levels compared to other sample sites.

The Swan Canning River Water Quality Improvement Programs (SRWQIP) aims to reduce nitrogen and phosphorus input from catchments into the Swan Canning River. With respect to the Helm Street Drain the SRWQIP advises that:

- For nitrogen, the Helm Street drain has unacceptable water quality (annual average TN load of 1.7 tonnes) and requires a load reduction of more than 45%.

- For phosphorous, the objective for the Helm Street drain (annual average TP load 0.07 tonnes) is to maintain and improve water quality requiring a load reduction of 10-45%.

The targets for total nitrogen and phosphorus concentrations for the Swan Canning River Catchments tributaries outlined in the (SRWQIP, 2009) are tabled below.

HRAP interim targets for median TN and TP in Swan Canning Catchment tributaries		
Target	**TN mg/L**	**TP mg/L**
Short-term	2.0	0.1
Long-term	1.0	0.1

The information in the table above is based on a natural river system representing a pervious catchment with low levels of water runoff. The aim is for the sub-catchments of the Swan River Canning System to meet these long and short term concentration targets for nitrogen and phosphorus.

The SCWQIP is intended to deliver nutrient load reduction actions for the HRAP by establishing load reductions targets based on annual water yield (runoff to the river) from urbanised catchments. For example, catchments generating greater than 200mm of runoff represent the highest density of development, the greatest area of impervious catchment, and therefore the greatest amount of runoff and subsequent water yield. The load reduction targets for phosphorus and nitrogen are table below.

Target for median TN and TP concentration in tributaries of the Swan Canning river system		
Annual Water Yield (mm)	**TN Concentration mg/L**	**TP Concentration mg/L**
< 100	1.0	0.1
100 to < 200	0.75	0.075
>= 200	0.5	0.05

Department of Water (DOW) mapping advises that the Helm Street catchment is 6km^2. The only portion that lies within the ODP area is approximately 8.7ha which represents 1.45% of the Helm Street catchment. The balance of the ODP area lies within the 73.7km^2 Munday/Bickley Brook catchment.

The Helm Street catchment represents a relatively small proportion of runoff that may be potentially delivering contaminants to the drain. Therefore there is very little opportunity to improve quality of the water as it requires consideration of the broader catchment which is not contained within the ODP area.

Nevertheless, it is intended that some water quality improvements will be attained through the preparation and implementation of an Environmental/Wetland Management Plan for the Conservation/Openspace area proposed for the Stokely Creek section of the Helm Street Drain. The Environmental/Wetland Management Plan for the Conservation/Open Space will be open to consideration for inclusion in the Developer Contribution Arrangement for the Central Maddington ODP.

4.3 Soil Type & Groundwater

4.3.1 Overview

The soil profile of the ODP area is part of the Guildford Formation with the predominant type being sandy clay, which is prone to seasonal flooding (Geological Survey 1986 in Brown & Root 2001).

The soil mapping for the study area is shown in **Figure 4**.

The City, in partnership with Curtin University has been investigating soil permeability and groundwater levels at selected sites across the City of Gosnells. The sample sites have been targeted in infill areas proposed to be redeveloped at higher densities, where the management of increased stormwater runoff from more highly impervious catchments is more critical.

The investigation, which has not yet been completed, will be used to develop stormwater management strategies for these infill areas. The investigation so far shows that:

- Approximately 90% of the ODP area is comprised of soils with very slow permeability.
- Ground water levels are, on average approximately 4m.

The results of the study confirm that soils within the ODP area have poor infiltration qualities and will not be suitable for infiltration in the management of additional stormwater expected from the redevelopment of the area.

The Department of Water's Groundwater Atlas shows a maximum groundwater depth between 6mAHD and 8mAHD and a minimum depth of 6mAHD to 3mAHD. Groundwater levels are on average one metre below the surface and represent the upper level of the superficial (unconfined) aquifer beneath the Swan Coastal Plain (Water & Rivers Commission 1997 in Brown and Root 2001).

The hydrological contours of the ODP area are illustrated in **Figure 5**.

4.3.2 Implications for Local Groundwater

Due to the poor infiltration characteristics of the soils, groundwater levels are unlikely to rise from direct infiltration from larger rainfall events. Any existing localised flooding is predominantly caused by surface runoff rather than rising groundwater, however a shallow water table could contribute to increased flooding to some extent. Poor infiltration provides a disconnection between groundwater and infiltrated stormwater which means that the potential for groundwater contamination from stormwater runoff is negligible. In this regard, addressing issues of water quality is best targeted towards improving the quality of stormwater.

The management of stormwater quality is addressed in section 7 of this report.

4.3.3 Implications of Soil Type - Acid Sulfate Soils

The acid sulfate soil mapping (WAPC Bulletin 64, 2009) for the ODP area identifies a moderate to low disturbance risk rating to a depth of three metres, in accordance with the Western Australian Planning Commissions Bulletin 64 (2009). It is unlikely that earthworks will occur below 3m and therefore an acid sulphate management plan is unlikely to be required during the development of the ODP area.

The acid sulfate soil mapping is shown in **Figure 6**.

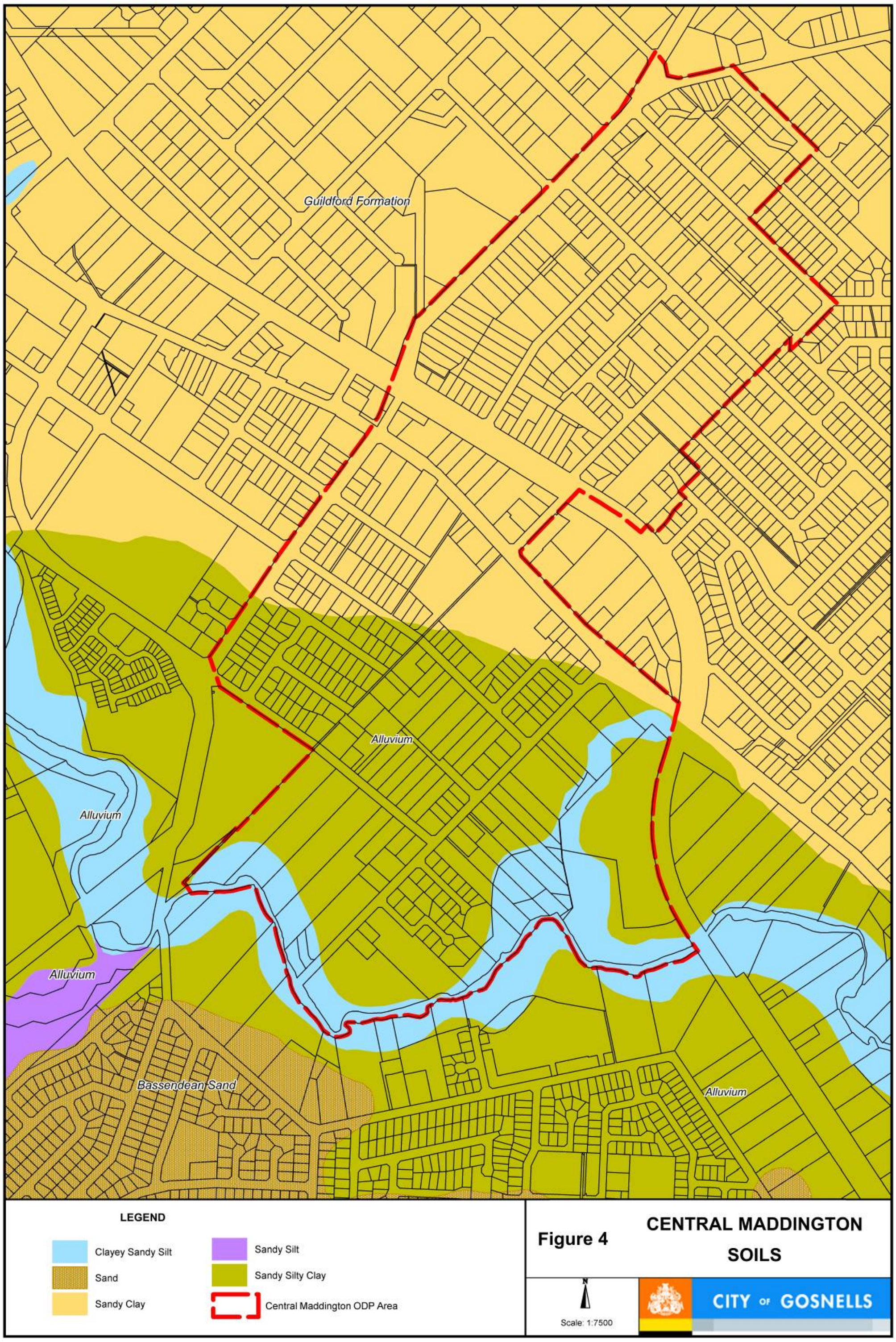
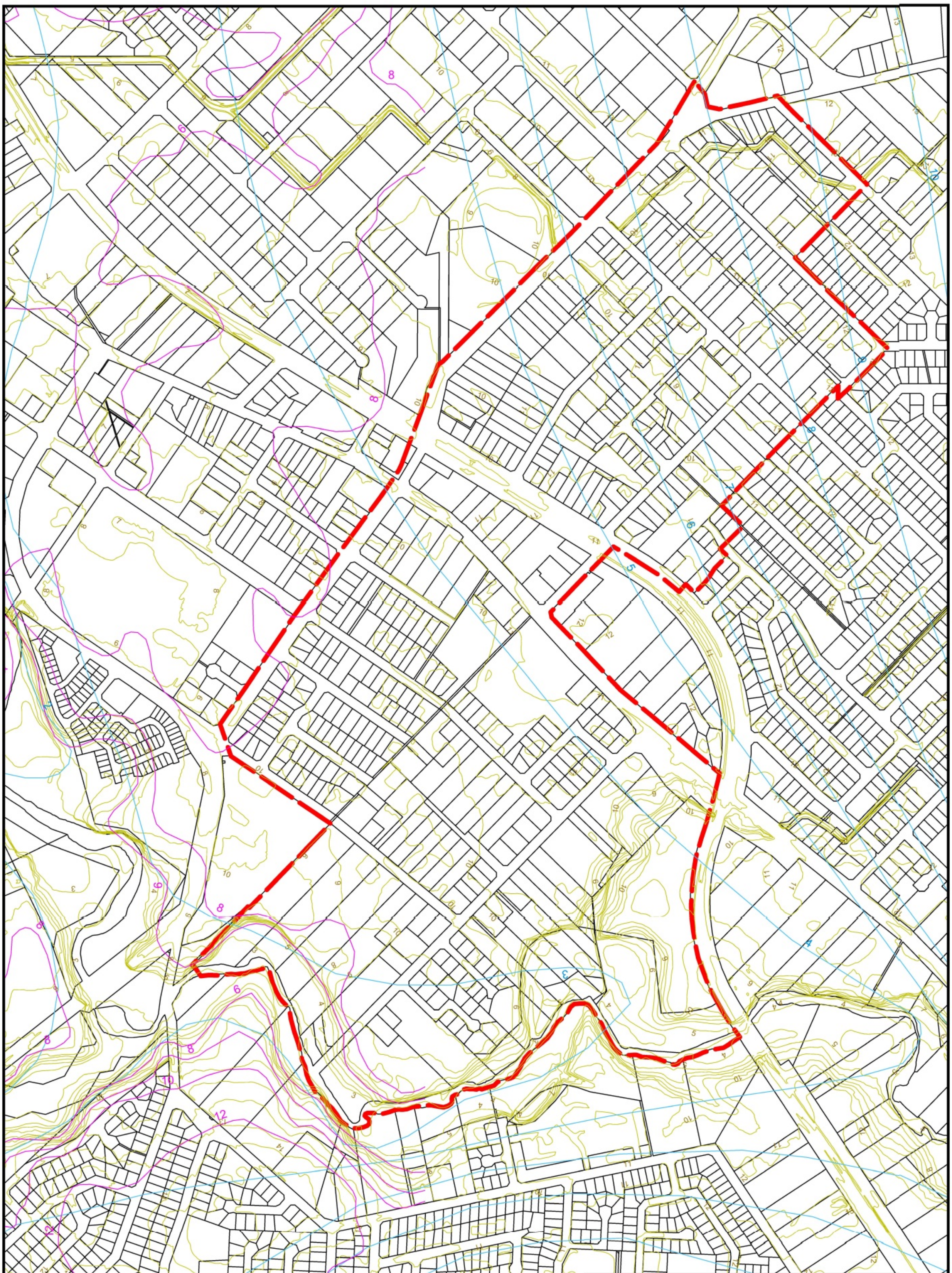


Figure 4 CENTRAL MADDINGTON SOILS



LEGEND

- Groundwater Contours Historical Maximum
- Groundwater Contours Minimum
- Ground Contours
- Central Maddington ODP Area

Figure 5 GROUNDWATER HYDROLOGICAL CONTOURS

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Scale: 1:7500

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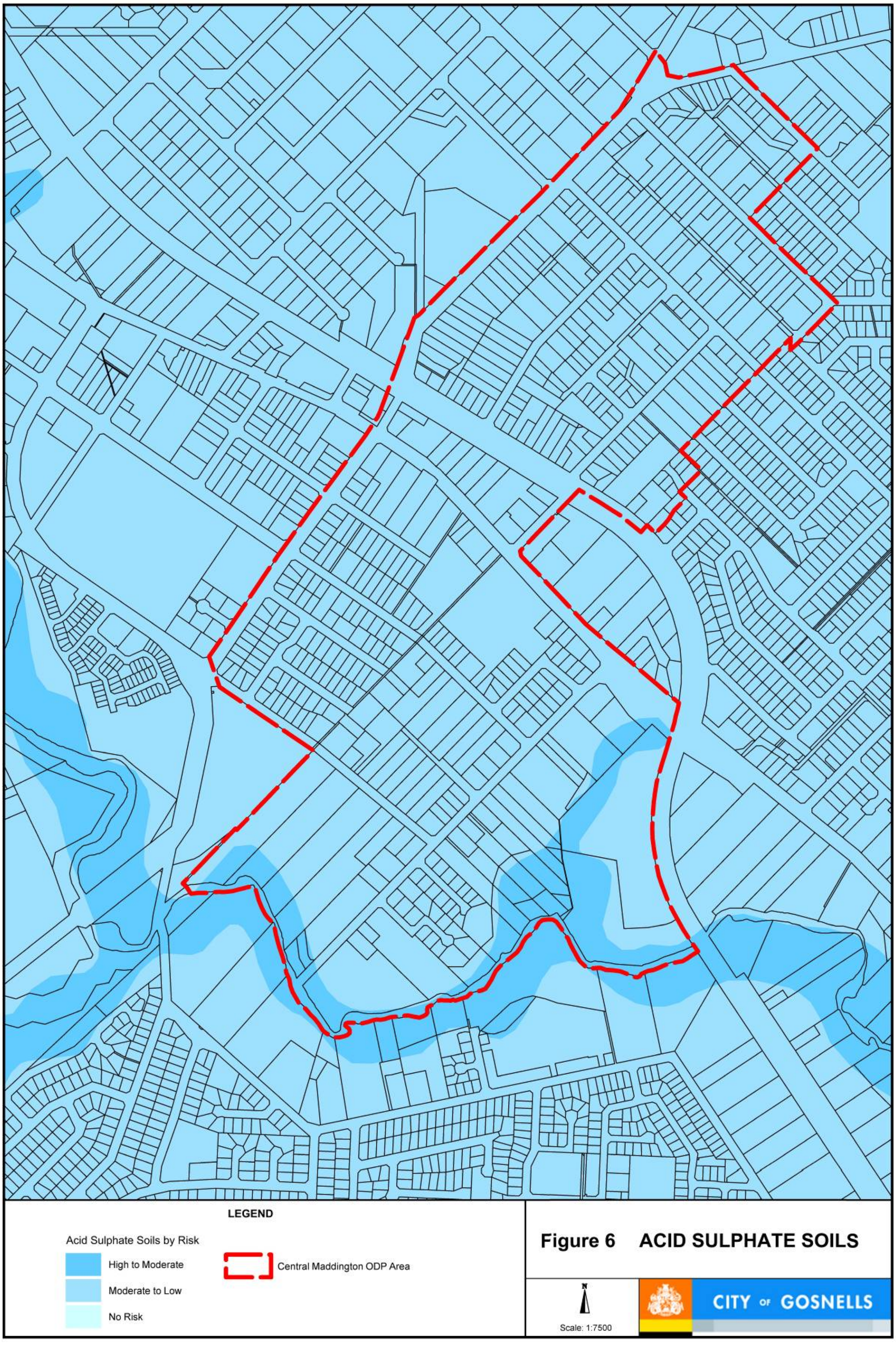


Figure 6 ACID SULPHATE SOILS

4.4 Environment Attributes

4.4.1 Overview

The ODP area is bordered by the Canning River along the southern boundary and is closely linked with the areas of remnant vegetation associated with Bush Forever site 246 (also partly mapped as Conservation Category Wetland (CCW)) and Stokely Creek (that part of the Helm Street drain between Albany Highway and the Canning River, which is also mapped as CCW) that outfall to the Canning River.

In the past, parts of the Helm Street drain upstream of Albany Highway have been modified and either 'trained' or piped beyond the ODP area. The portion of drain within the ODP area, close to the river (Stokely Creek wetland) is relatively intact (Brown and Root 2001).

4.4.2 Implications for Stokely Creek, Bush Forever Site 246 and CCW's

To protect the environmental values of the wetland, the Stokely Creek CCW is to be integrated with additional areas of adjacent open space and is to be retained as a conservation/open space reserve. This area is shown on the ODP as local open space and is located in the south east corner of the ODP adjoining the Canning River foreshore.

The integration of public open space with the wetland will be supported by an Environmental/Wetland Management Plan. This will detail opportunities for revegetation and rehabilitation of the wetland, water quality improvement as well as passive recreation and continued stormwater management function. The plan will seek to protect and enhance the ecological value and function of the wetland in the following ways:

- Specifically defining the wetland boundary and buffer (where applicable).
- Setting methods to protect ecological values and functions.
- Identifying revegetation and rehabilitation requirements.
- Identifying compatible and non-compatible recreation activities and facilities.
- Defining access points.
- Identifying methods to maintain hydrological regime and water quality.
- Developing a monitoring program, implementation program and contingency.

It is important to note that the ODP shows a proposed crossing over Stokely Creek which is the sole means of access to Lot 808. The construction of this road needs to be carefully considered with respect to wetland values, and expressed in the Environmental/Wetland Management plan in a manner that delivers appropriate offsets and an overall net benefit to the wetland generally.

Consideration of any such work within Stokely Creek requires the approval from Department of Environment and Conservation (DEC), the Water Corporation and the Swan River Trust. Development of Lot 808 which abuts a Parks and Recreation Reserve (P&R) and the Canning River will require approval from the Department of Planning and the Swan River Trust (SRT). In some cases it may be possible to use the P&R reserve for water quality treatment through a negotiated outcome with the relevant authorities.

4.4.3 Implications for the Canning River

The Canning River foreshore part of the ODP area is reserved for Parks and Recreation under the Metropolitan Region Scheme (MRS). As the zoning suggests, this area is intended for public recreation and not for subdivision and development. Therefore a sufficient level of protection is afforded to Bush Forever sites along the Canning River and the river environment generally.

With respect to water management, any additional stormwater runoff generated from development of the ODP area, is not to discharge to the Canning River directly, either from new roads or newly developed private property, unless it is has been treated to improve water quality. It is also important to maintain pre-development stormwater quantities as additional stormwater discharge to the river has the potential to erode river banks and alter hydrological processes. Structural controls will need to be introduced, where possible, to improve quality of stormwater runoff prior to discharge to the Canning River.

Figure 7 shows Stokely Creek CCW and Bush Forever Sites 246 along Canning River**.**

4.5 Public Open Space and Recreation

The importance of public parkland with respect to local water management is twofold. Firstly, it depends on whether parkland is required to serve a drainage function, where it is used to detain stormwater runoff in larger rainfall events. The second relates to the method of parkland irrigation, which needs to consider, the availability water and its source, the volume of water required for suitable irrigation and its relationship to the principle of water conservation.

The ODP area currently comprises the following parks:

- Weston Street Reserve (4646m^2)
- Clifton Street Reserve (3614m^2)
- Brabourne Street Reserve (994m^2)
- Orr Street Reserve (1672m^2)
- Gordon Graham Park (2876m^2)
- Dellavanzo Street Reserve (2639m^2)

Currently none of the existing parks in the ODP area are required for drainage purposes. With respect to irrigation, the Weston Street Reserve is the only park which is irrigated and currently uses scheme water for irrigation.

Figure 8 shows the existing parks and those that are proposed to remain or expanded.

4.5.1 Implications for Water Conservation

The majority of existing parks are proposed to be disposed of with the exception of Weston Street Reserve which is to be expanded to 8000m2, and Clifton Street Reserve which is to be expanded to 4000m2. Additional parkland is proposed under the ODP to introduce a 4000m2 park near Aldington Street, a 1ha park along Newenden Street and a 4ha open space/conservation reserve encompassing Stokely Creek CCW.

The location of parkland proposed for the ODP area is shown in **Figure 1**.

As evidenced from existing parkland within the area, irrigation of new parkland and/or upgrade of existing parkland in the ODP will be challenging. In the City's experience, it has been difficult to use bores to irrigate parkland in Maddington due to the lack of availability of groundwater and the tendency for the water to be saline. In the absence of bore water, parkland can be irrigated using scheme water however, scheme water is considered a scarce resource and therefore is not ideal in terms of water conservation   The other option would be to not irrigate parkland at all which addresses the issue of water management, that is, there is none, but may create negative feeling within the community who have an expectation that parks should be the traditional green grassed variety.

In light of current challenges, innovative approaches to parkland irrigation are required. For example a combination of bore water (if it's not saline) and scheme water could be used for irrigation, with the possibility of reducing the amount of area requiring irrigation by reducing turfed areas and introducing mulch, native plants, softfall around playground equipment and additional parkland treatments such paths, seating areas and hardstanding play areas.

The options of using scheme water, bore water, or a combination of both, coupled with reducing areas requiring irrigation, are currently the most cost effective measures for parkland irrigation. There are other more effective alternatives that can be considered in terms of achieving urban water sensitive design. The City encourages innovative water harvesting solutions to support the development of quality POS, and encourages stakeholder involvement and a collaborative approach to seeking funding mechanisms, so this can be achieved. (E.g. State Government funding).

These other alternatives involve using harvested stormwater for irrigation which is stored in parkland. It is also possible to combine stormwater with bore water which reduces salinity and provides a suitable irrigation water source.

The exact details of how parkland is to be irrigated will be addressed through the preparation of a Development Plan for each park shown on the ODP. Preparation of Development Plans typically are the responsibility of individual landowners however further consideration is to be given to their inclusion in a developer contribution arrangement (DCA).

4.5.2 Implications for Drainage

It is considered that the proposed parkland in the ODP will not be required for drainage in larger rainfall events, as it is expected that the increase in post development stormwater runoff will be contained on individual lots during these larger rainfall events, and stored in larger pipes proposed in new roads. Nevertheless, if in future it is proposed to use parkland for drainage, this will need to be accompanied by an UWMP.

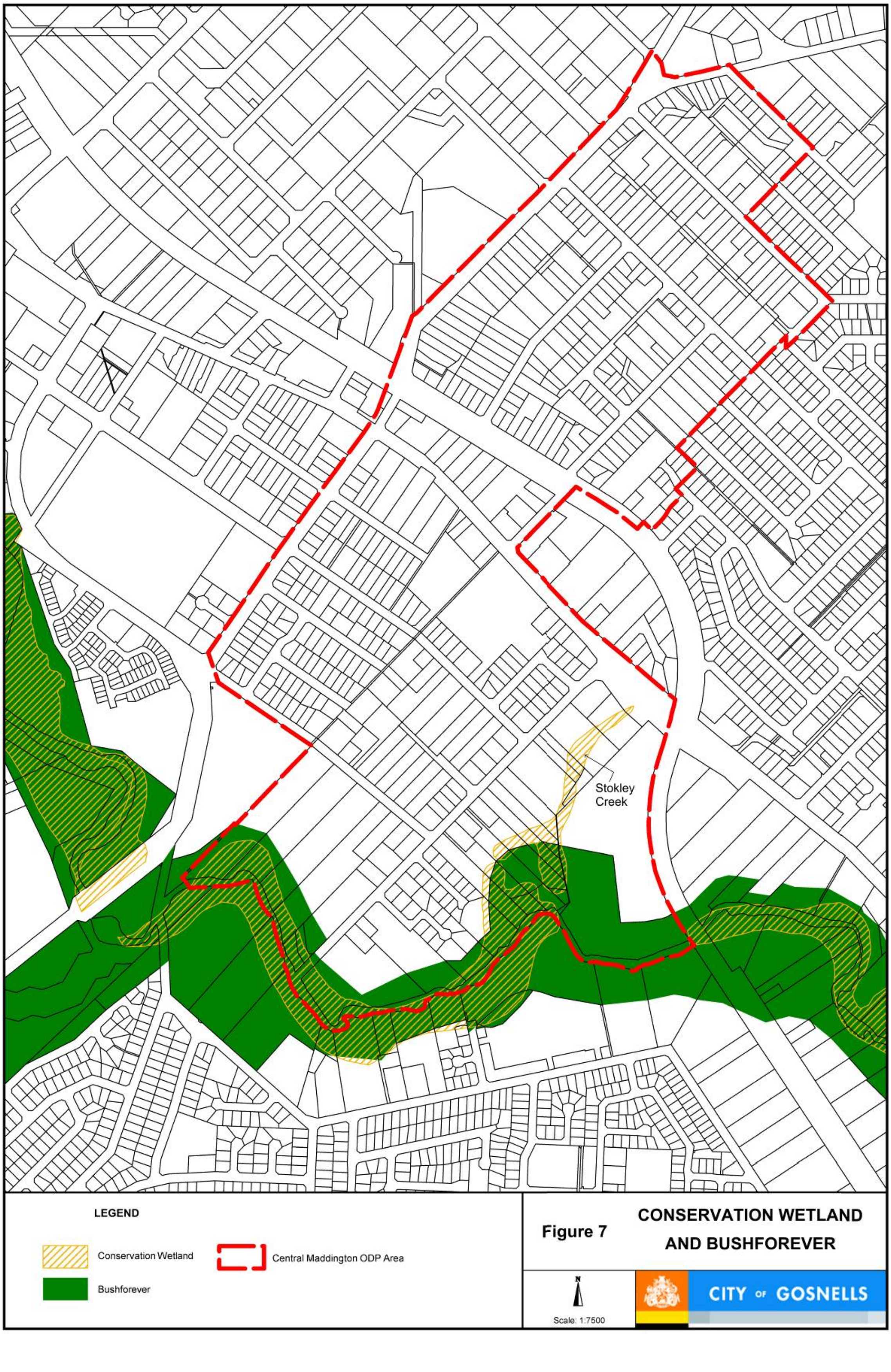
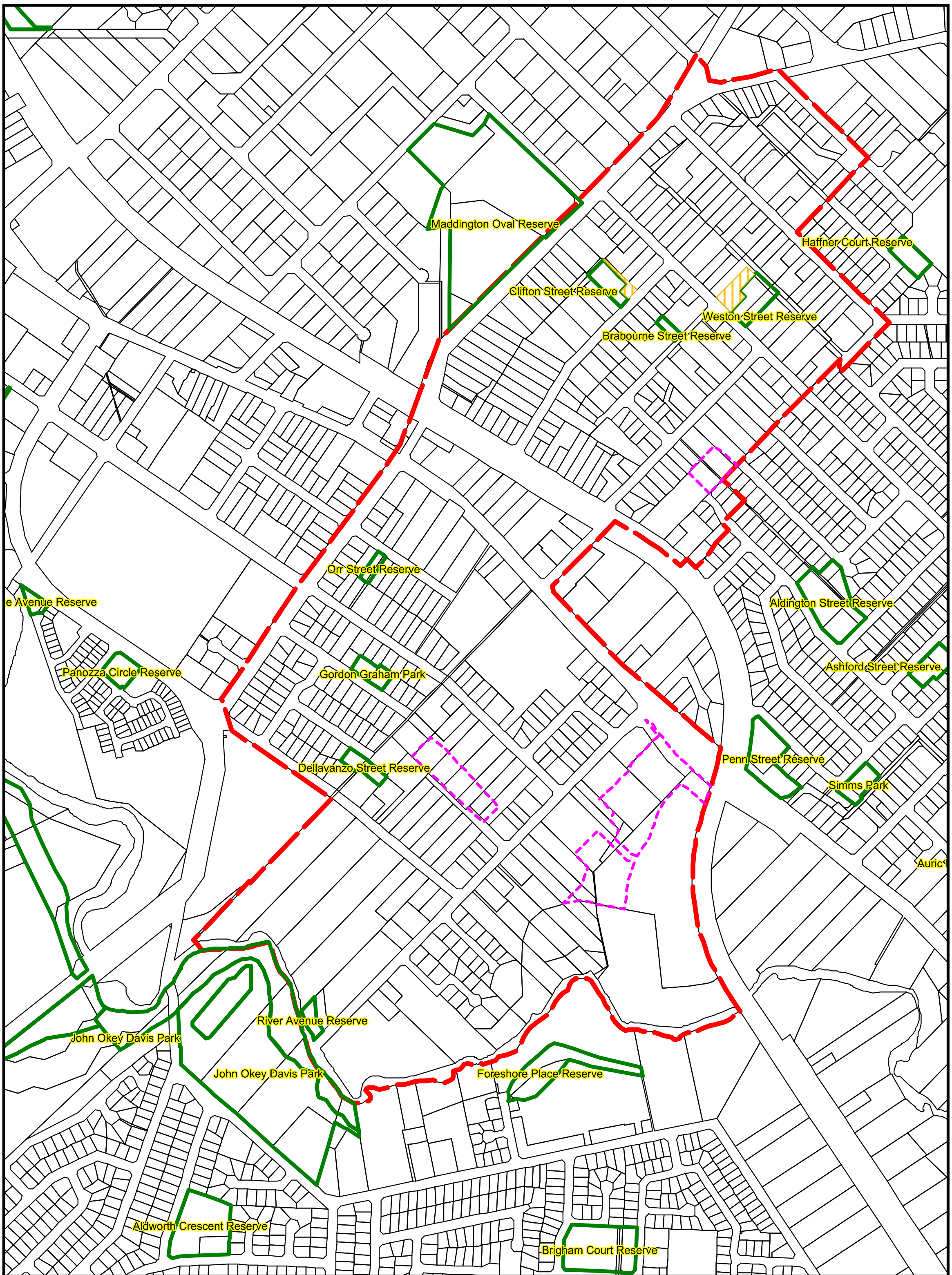


Figure 7 CONSERVATION WETLAND AND BUSHFOREVER



LEGEND

Areas of Expanded Parkland

Existing Parks

Areas of New Parkland

Central Maddington ODP Area

Figure 8

PUBLIC OPEN SPACE PROFILE MAP

Scale: 1:7500

CITY OF GOSNELLS

5. Design Objectives

Design objectives appropriate for the ODP are outlined in *Better Urban Water Management (WAPC 2008)*. These objectives and associated urban water management criteria are intended to guide the preparation of *Local Water Management Strategies* which will facilitate sustainable urban water management for the ODP area. These objectives are described in more detail below and the subsequent strategies proposed are detailed further in the report.

5.1 Water Conservation and Efficiency

Objective	Criteria
Minimise the use of potable water used outside of homes and buildings	Water consumption benchmark of 100 kL/person/yr of scheme water.

5.2 Water Quantity Management

Objective	Criteria
Post-development annual stormwater discharge volume and peak flow is to be maintained relative to predevelopment conditions	*Ecological Protection* Critical one year (ARI) event, the post-development discharge volume and peak flow maintained to pre-development conditions, to maintain environmental flows and/or hydrological cycles. *Flood Management* Manage the catchment run-off for up to the 1 in 100 year ARI event in the development area to pre-development conditions.

5.3 Water Quality Management

Objective	Criteria
Maintain surface water quality at pre-development levels (winter concentrations) and, if possible, improve the quality of water leaving the development area to maintain and restore ecological systems in the sub-catchment in which the development is located.	*Drainage* All post-development stormwater run-off entering the drainage network is to receive treatment prior to discharge to a receiving environment. *Pollutant controls* - Pollutant outputs of the post-development stormwater run-off should not exceed pre-existing catchment conditions and where possible, improve water quality in accordance with National Water Quality Management Strategy (ANZECC and ARMCANZ, 2000).

5.4 Disease Vector and Nuisance Insect Management

To reduce health risks from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated in a time period not exceeding 96 hours.

Permanent water bodies are discouraged, but where accepted by DoW, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice of the Departments of Water and Health. A proposal for the construction of permanent water body will need to consider the requirements of Councils *Artificial Waterbodies Policy No. 2.3.1.4.*

6. Water Conservation Strategies

The two significant components of water conservation involve stormwater (non potable) and mains scheme water (potable). Implementation of conservation measures relies upon reducing consumption of potable water by, using it more wisely, and using potable and non-potable water in a more efficient manner.

There are a number ways to conserve potable water sources. Whilst these methods are not always enforceable, their use is likely to increase based on increased awareness of the issue of water scarcity and associated water restrictions for domestic irrigation.

6.1 Conservation of Scheme Water

The concept of water conservation is premised on water reducing technology and also retaining roof rain water (non-potable) so that it can replace other household water uses that other wise require scheme water (potable).

The objectives and strategies for potable water conservation for the ODP area are tabled below.

Objective	Criteria	Strategy
Minimise Total Water Use	Reduce average water consumption to 100kL/year	‣ Reduce water consumption by using water saving technology with: - household tap fixtures, - shower fixtures - low volume dual flush toilets
Use water more efficiently		‣ Use rainwater storage tanks as a means of storing roof stormwater and use it as an alternatives to potable scheme water in the following instances: - garden reticulation - toilet flushing - car washing - washing machine water. ‣ Use other stormwater retention methods: - below-ground rainwater/stormwater storage units and media filled storage tanks - rain gardens - roof gardens - stormwater sculptures and water features ‣ Limit garden irrigation by reducing number of watering days per week

Application of the above strategies to conserve water will help achieve the benchmark water consumption target of 100k/Lyear, outlined in the State Water Plan. Additional information on water conservation can be found on the Department of Water's website.

6.1.1 Building Code of Australia

Water efficiency controls for new dwellings were introduced in 2007 through the Five Star Plus Building standards, which were based on two new building codes, the Energy Use in Houses Code and the Water Use in Houses Code. These standards, which are now part of the Building Code of Australia, require the following water efficiency technologies to be implemented for all new dwellings:

- All tap fittings, except bath outlets and garden taps, and sanitary flushing systems (toilets) must be a minimum of 4 star WELS rated
- All showerheads must be a minimum of 3 star WELS rated

In addition to the above water efficiency measures, the Water Cooperation's Waterwise Display Village program has seen the development of Waterwise Criteria to further improve water efficiency design for new developments, both in the home and outside of the home. Whilst these criteria are not enforceable, it guides the design and construction of water efficient homes with the aim of achieving water conservation targets, outlined in the State Water Plan.

6.1.2 Water Reducing Technology

Information on annual scheme water usage is contained within the Perth Residential Water Use Study 2008/2009 and the Domestic Water Study 1998/2001 from the Water Corporation. It is intended to illustrate how much scheme water the average household in the Perth Metropolitan area uses in a year, and the various uses it's required for, both in the home and outside of the home. It makes a comparison between those that use water wise technology and those that don't, and outlines the potential for further scheme water reductions where conventional measures are replaced with water wise measures.

The Domestic Water Study determined the annual water usage to be 128kL per person annually. The Perth Residential Water Study which was intended to update the previous study determined the annual water usage to be 106kL/yr. This is very close to the State Water Plan's consumption target of 100kL/yr. The reduction in water consumption is attributed to increased education concerning the current issue of water shortages and the implementation of water saving technology inside and outside of the home.

Potential reductions in scheme water usage through the implementation of water wise technology are outlined in the Perth Residential Water Use Study 2008/2009 and the Domestic Water Study 1998/2001. If the percentage of those dwellings in the metropolitan area using conventional water use practices implemented water wise technology, then the average water use per person/year would potentially reduce water consumption to 84kL/person/yr, which would be below the State Water Plan consumption target of 100kL/person/yr. If only the enforceable water saving measure were introduced (taps, toilet, bath and shower) then water consumption would equate to 93KL/person/yre which is still below target.

It is considered that all new dwellings within the ODP area will incorporate a substantial amount of water saving technology which will be enforced through the Building Code, and be applied voluntarily to reduce water usage. With continued education and development of awareness programs by the government, new dwellings in the ODP area will be able to achieve the State Water Plans consumption target.

6.1.3 Rain Water Tanks

Rain water tanks can be used as a means of storing stormwater runoff and using it for specific activities where potable water can be displaced. Rain water tanks, if plumbed to the house and used to supply water for toilet flushing and laundry purposes can provide significant water efficiency. Using rainwater tanks for garden irrigation provides little scheme water displacement but can have an impact on water quality by trapping the first flush from the roof.

Rain water tanks also have the potential to provide an important drainage function. In some instances, new dwellings may require rainwater tanks to store some of the rainwater generated during a 100 yr ARI rainfall event. This allows predevelopment flows to be maintained which is addressed further in section 7 of the report.

A suitable size rainwater tank for a domestic dwelling is 1kL to 5kL. (Stormwater Manual WA). The actual size of the tank required for domestic purposes is ultimately dependent on seasonal rainfall, the surface area of roof catchment and volume of water required for specific activities. The following table and formula can be used to calculate the size of the rainwater tank.

Runoff (litres) = A (efficiency of collection) * (rainfall - B) * roof area;

Where A = 0.8 to 0.85 (that is 80 to 85% efficiency determined by enHealth Council 2004); and

B = 2mm per month (24mm/yr) for losses to absorption and wetting of surfaces (enHealth Council 2004).

Annual Rainfall (mm)	**Maximum Volumes of Rainwater per Year (kL)**						
	Roof area (m^2)						
	100	***150***	***200***	***250***	***300***	***400***	***500***
150	10	15	20	25	30	40	50
200	13	21	27	35	42	53	70
250	18	27	36	45	54	72	90
300	22	33	44	55	66	88	110
400	30	45	60	75	90	120	150
500	38	57	76	95	114	152	191
600	46	69	92	115	138	184	230
800	62	93	124	155	186	248	310
1000	78	117	156	195	234	312	390
1200	94	141	188	235	282	377	470

Note: *The above table and formula are contained within the Stormwater Manual WA.*

The size of the rainwater tank is determined from the following formula:

Vt = Vt-1 + (Runoff - Demand);

Where t = number of months

Vt = volume of water remaining in the tank at the end of the month

Vt-1 = volume of water left in the tank from the previous month.

To ensure that the size of the tank is sufficient to cater for water supply, Vt is to be equal to or greater than 0. Under 0 means the tank is empty and cannot meet the supply demand. Over zero represents additional water which will be discharged via an overflow outlet.

The use of stormwater tanks is not enforceable however studies have shown that their use has the potential to save 18 to 55kL per year (this is only an estimate as annual rainfall will vary from year to year). The reduction in scheme water use represents a potential cost saving, and it is considered that due to ever increasing water shortages many people will install rainwater tanks in future development of the ODP area.

Whilst mandatory water saving measures, applied under the BCA, are likely to achieve the State Water Plan consumption target of 100kL/yr (as detailed above), the use of rainwater tanks with a potential scheme water saving of 18 to 55kL would represent a further significant reduction in scheme water usage for the ODP area.

7. Stormwater Management Strategy

Management of stormwater requires controls on additional quantities and quality of stormwater generated by increased roof and road runoff and other impervious areas from future development.

7.1 Stormwater Quantity Control Measures

Due to the prohibitive cost of retrofitting the existing piped drainage network, the poor infiltration quality of the soil, and the lack of availability of space to accommodate additional drainage facilities, the considered option is for individual properties to accommodate larger rainfall events on-site individual properties, and for new roads to detain larger rainfall events as close to the source as possible within road reserves.

The objectives and strategies for the management of stormwater quantities for the ODP area are tabled below and address runoff for newly constructed dwellings on private lots and also runoff from newly constructed roads.

Objective	Criteria	Strategy	Implementation
Post-development annual stormwater discharge volume and peak flow is to be maintained relative to predevelopment conditions	▸ *Ecological Protection* Critical one year (ARI) event, the post-development discharge volume and peak flow maintained to pre-development conditions, to maintain environmental flows and/or hydrological cycles.	▸ Bioretention pockets are to be introduced into verges of new roads and engineered to accommodate additional stormwater run off for a 1yr ARI rainfall event.	▸ Proposed new dwellings or lots requiring new road frontage must prepare and submit a UWMP for approval by the City prior to approval for subdivision or development. ▸ Stormwater bioretention systems for new roads designed for a 1 yr ARI rainfall event in accordance with calculations in section 7.1.2
	▸ *Flood Management* Manage the catchment run-off for up to the 1 in 100 year ARI event in the development area to pre-development conditions.	▸ Stormwater detention for newly created dwellings or lots to be engineered to accommodate the 1 in 100yr ARI rainfall event. ▸ New roads are to be engineered to detain post development stormwater volumes for a 100yr ARI rainfall event within the piped drainage system, and release stormwater at predevelopment levels into the existing drainage system. ▸ All new building pads to be raised 300mm above the 1 in 100yr ARI event except for dwellings south west of Philip Street and south east of River Avenue which requires the minimum standard of 500mm. ▸ Monitoring stations will be set up throughout the	▸ Proposed new dwellings or lots accessed from an existing road, require a detailed drainage strategy to be submitted and approved by the city prior to approval for development and/or subdivision. ▸ On-site stormwater systems for new dwellings or lots to be designed in accordance with Drainage Strategy calculations in Appendix C. ▸ Stormwater retention systems for new roads designed for a 100yr ARI rainfall event in accordance with calculations in section 7.1.2 ▸ A surface water monitoring program will be undertaken by a qualified consultant.

		ODP area to monitor water quantities to ensure predevelopment flows are being maintained.	

7.1.1 Drainage Catchments - Maintenance of Predevelopment Flows

The various catchments on the plan at **Figure 3** represent drainage catchments. These have been determined by topography and the flow of the piped network and the larger open drains they connect with.

Tabled below are the pre-existing stormwater discharge levels for individual catchments for the 1 in 5yr ARI rainfall event. To ensure these flows are maintained consideration is to be given to the 1 in 100yr ARI rainfall event, with any additional runoff to be stored on-site within individual lots in the catchment.

This is to be achieved by providing additional capacity within underground storage units and in some cases may require further storage capacity within rainwater tanks. It is considered that retention of the 100 yr event can be achieved with a three cubic metre underground storage unit, and if additional storage capacity is required, then a two cubic metre rainwater tank will suffice. A visual concept of this approach is provided in the Drainage Strategy contained at **Appendix C**.

It's important to note that post development flows have factored in the proposed new residential density codes shown on the ODP which will increase the amount of impervious area within the ODP area and generate more runoff than the existing situation.

7.1.2 On-site Stormwater Retention - Individual Lots

The information below shows the volume of post-development stormwater generated from each catchment in the ODP. It is the developers' responsibility to ensure that the additional quantities of stormwater can be adequately detained on-site for individual lots during a larger rainfall event.

The volumes of stormwater expected to be generated from proposed new individual lots for the 100 year ARI rainfall event will be detained on-site through the implementation of drainage technology detailed in the Drainage Strategy contained at **Appendix C**. This means that storage of stormwater will not be required in parkland proposed on the ODP.

The following calculation provides detail on how the post development stormwater volume is determined for Catchment C1, Sub-catchment C1A (R80). Further to this, stormwater volumes have been tabulated for convenience with all other relevant information specific to each catchment provided underneath next to an asterisk.

Please note that all values and calculations shown below are indicative only and will need to be confirmed by individual drainage strategies submitted for development and or subdivision of individual lots.

Catchment C1

Sub-catchment C1A (R80)
Area of R80 catchment = 33056m^2
Proposed R80 - density = 180m^2 average lot size

Predevelopment coefficient = 0.4
1 in 5 year flow rate = 93.4L/s = 0.0934m^3/s

Number of existing lots in catchment = 21

Number of existing dwellings = 16

16 dwellings on 500m^2 lots = 8000m^2 total lot area
Post developed area of R80 catchment - pre existing area of existing dwellings
33056m^2 - 8000m^2 = 25056m^2

Post development coefficient 0.65
1 in 100 year flow rate = 209.4 L/s
Catchment volume allowing for predevelopment flows = 455 m^3

25053/180 (average lot size) = 139 lots to accommodate 455m^3 runoff

= 3.27m^3 per lot for a 1 in 100 year event.

Catchment C1								
Sub catchment	Land use	Area m^2	Pre Flow m^3/s 5yr ARI	Post Development Coefficient.	Post Flow L/s 100 yr ARI	Volume m^3	No. of lots	Volume per lot m^3
C1A	R80	33,056	0.0934	0.65	209.4	455	139	3.27
	HC	24,172	0.128	0.8	155	248	0.0185 m^3/m^2	
	PS	45,857	0.129	0.75	234.1	463	0.0215 m^3/m^2	
C1B	R40	15,676	0.0443	0.55	50.7	79	32	2.47
	R30	67,299	0.190	0.5	288	521	149	3.50
C1C	R40	11,857	0.0335	0.55	30.8	41	19	2.16
	R30	72,808	0.206	0.5	355.5	686	184	3.73
C1D	R40	30,332	0.0857	0.55	112	187	71	2.37
	R30	7,072	0.0200	0.5	35.8	70	18	3.9
	R20	28,090	0.0793	0.45	156.7	332	54	6.1
	MB	4,717	0.0250	0.8	17.1	18	0.0108 m^3/m^3	
C1E	R30	28,895	0.0816	0.5	140.8	271	72	3.76
	R20	47,543	0.134	0.45	211.4	390	73	5.34

* Predevelopment coefficient for Highway Commercial (C1A HC) = 0.75
* Existing impervious C1A HC area = 13,392m^2.
* Existing undeveloped C1A HC area = 10,780m^2.
* Volume output based on square metres of development

* Predevelopment coefficient for Primary School (C1A PS) = 0.6
* Existing impervious C1A PS area = 21,577m^2.
* Existing undeveloped C1A PS area = 24,280m^2.
* Volume output based on square metres of development

* No. existing lots (C1B R40) = 18
* No. existing dwellings (1CB R40) = 17
* Predevelopment coefficient = 0.4
* Existing developed (C1B R40) area = 17 dwellings @ 500m^2 = 8,500m^2
* Post developed (C1B R40) area = 7,176m^2
* Volume output based on square metres of development = 0.01101m^3/m^2

* No. existing lots (C1B R30) = 51
* No. existing dwellings (C1B R30) = 45 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (C1B R30) area = 45 dwellings @ 500m^2 = 22,500m^2
* Post developed (C1B R30) area = 44,799m^2
* Volume output based on square metres of development = 0.01163m^3/m^2

* No. existing lots (C1C R40) = 16
* No. existing dwellings (C1C R40) = 15 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (C1C R40) area = 15 dwellings @ 500m^2 = 7,500m^2

* Post developed (C1C R40) area = 4,357m^2
* Volume output based on square metres of development = 0.0101m^3/m^2

* No. existing lots (C1C R30) = 40
* No. existing dwellings (C1C R30) = 35 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (C1C R30) area = 35 dwellings @ 500m^2 = 17,500m^2
* Post developed (C1C R30) area = 55,308m^2
* Volume output based on square metres of development = 0.01240m^3/m^2

* No. existing lots (C1D R40) = 29
* No. existing dwellings (C1D R40) =29 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (C1D R40) area = 29 dwellings @ 500m^2 = 14,500m^2
* Post developed (C1D R40) area = 15,832m^2
* Volume output based on square metres of development = 0.01181m^3/m^2

* No. existing lots (C1D R30) = 4
* No. existing dwellings (C1D R30) = 3 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (C1D R30) area = 3 dwellings @ 500m^2 = 1,500m^2
* Post developed (C1D R30) area = 5,572m^2
* Volume output based on square metres of development = 0.01256m^3/m^2

* No. existing lots (C1D R20) = 2
* No. existing dwellings (C1D R20) = 2 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (C1D R20) area = 2 dwellings @ 500m^2 = 1,000m^2
* Post developed (C1D R20) area = 27,090m^2
* Volume output based on square metres of development = 0.01225m^3/m^2

* Predevelopment coefficient for Mixed Business (C1D MB) = 0.75
* Existing impervious C1D MB area = 3055m^2.
* Existing undeveloped C1D MB area = 1662m^2.
* Volume output based on square metres of development

* No. existing lots (C1E R30) = 14
* No. existing dwellings (C1E R30) = 14 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (C1E R30) area = 14 dwellings @ 500m^2 = 7000m^2
* Post developed (C1E R30) area = 21,895m^2
* Volume output based on square metres of development = 0.00329m^3/m^2

* No. existing lots (C1E R20) = 24
* No. existing dwellings (C1E R20) = 22 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (C1E R20) area = 22 dwellings @ 500m^2 = 11000m^2
* Post developed (C1E R20) area = 36543m^2
* Volume output based on square metres of development = 0.00200m^3/m^2

Catchment C2								
Sub catchment	Land use	Area m^2	Pre Flow m^3/s 5yr ARI	Post Development Coefficient.	Post Flow L/s 100 yr ARI	Volume m^3	No. of lots	Volume per lot m^3
C2	R30	34,702	0.098	0.5	216.7	468	112	4.18
	R20	38,711	0.109	0.45	186.4	358	64	5.59

* No. existing lots (C2 R30) = 6
* No. existing dwellings (C2 R30) = 2 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (C2 R30) area = 2 dwellings @ 500m^2 = 1000m^2
* Post developed (C2 R30) area = 33702m^2
* Volume output based on square metres of development = 0.01389m^3/m^2

* No. existing lots (C2 R20) = 16
* No. existing dwellings (C2 R20) = 13 dwellings
* Predevelopment coefficient = 0.4

* Existing developed (C2 R20) area = 13 dwellings @ 500m^2 = 6500m^2
* Post developed (C2 R20) area = 32211m^2
* Volume output based on square metres of development = 0.00199m^3/m^2

Catchment RR1								
Sub catchment	Land use	Area m^2	Pre Flow m^3/s 5yr ARI	Post Development Coefficient.	Post Flow L/s 100 yr ARI	Volume m^3	No. of lots	Volume per lot m^3
RR1	R80	35,745	0.101	0.65	206.8	432	137	3.15
	R40	9,867	0.0279	0.55	16.7	16	10	1.6
	R30	22,254	0.0629	0.5	110.9	216	57	3.79

* No. existing lots (RR1 R80) = 22
* No. existing dwellings (RR1 R80) = 22 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (RR1 R80) area = 22 dwellings @ 500m^2 = 11,000m^2
* Post developed (RR1 R80) area = 24,745m^2
* Volume output based on square metres of development = 0.01746m^3/m^2

* No. existing lots (RR1 R40) = 8
* No. existing dwellings (RR1 R40) = 15 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (RR1 R40) area = 15 dwellings @ 500m^2 = 7,500m^2
* Post developed (RR1 R40) area = 2,367m^2
* Volume output based on square metres of development = 0.00676m^3/m^2

* No. existing lots (RR1 R30) = 10
* No. existing dwellings (RR1 R30) = 10 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (RR1 R30) area = 10 dwellings @ 500m^2 = 5,000m^2
* Post developed (RR1 R30) area = 17,254m^2
* Volume output based on square metres of development = 0.01252m^3/m^2

Catchment RRC							
Sub catchment	Land use	Area m^2	Pre Flow m^3/s 5yr ARI	Post Development Coefficient.	Post Flow L/s 100 yr ARI	Volume m^3	Volume per m^2
RRC	HC	38,216	0.2024	0.8	57.7	15	0.00267

* Predevelopment coefficient for Highway Commercial (RRC HC) = 0.75
* Existing impervious RRC HC area = 32,608m^2.
* Existing undeveloped RRC HC area = 5,608m^2.
* Volume output based on square metres of development

Catchment GP1								
Sub catchment	Land use	Area m^2	Pre Flow m^3/s 5yr ARI	Post Development Coefficient.	Post Flow L/s 100 yr ARI	Volume m^3	No. of lots	Volume per lot m^3
GP1	R80	4,188	0.0118	0.65	26.6	58	17	3.41
	R40	53,163	0.1502	0.55	234.5	431	150	2.87
	R30	121,674	0.3437	0.5	537.9	989	278	3.56

* No. existing lots (GP1 R80) = 2
* No. existing dwellings (GP1 R80) = 2 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (GP1 R80) area = 2 dwellings @ 500m^2 = 1000m^2
* Post developed (GP1 R80) area = 3188m^2
* Volume output based on square metres of development = 0.01819m^3/m^2

* No. existing lots (GP1 R40) = 33
* No. existing dwellings (GP1 R40) = 40 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (GP1 R40) area = 40 dwellings @ 500m^2 = 20,000m^2
* Post developed (GP1 R40) area = 33,163m^2
* Volume output based on square metres of development = 0.01299m^3/m^2

* No. existing lots (GP1 R30) = 90
* No. existing dwellings (GP1 R30) = 76 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (GP1 R30) area = 76 dwellings @ 500m^2 = 38,000m^2
* Post developed (GP1 R30) area = 83,677m^2
* Volume output based on square metres of development = 0.01182m^3/m^2

Catchment AS1								
Sub catchment	Land use	Area m^2	Pre Flow m^3/s 5yr ARI	Post Development Coefficient.	Post Flow L/s 100 yr ARI	Volume m^3	No. lots	Volume per lot m^3
AS1	R30	35,056	0.099	0.5	135.4	232	70	3.31

* No. existing lots (AS1 R30) = 25
* No. existing dwellings (AS1 R30) = 28 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (AS1 R30) area = 28 dwellings @ 500m^2 = 14000m^2
* Post developed (AS1 R30) area = 21056m^2
* Volume output based on square metres of development = 0.01102m^3/m^2

Catchment AS2								
Sub catchment	Land use	Area m^2	Pre Flow m^3/s 5yr ARI	Post Development Coefficient.	Post Flow L/s 100 yr ARI	Volume m^3	No. lots	Volume per lot m^3
AS2	R40	12,973	0.0366	0.55	67.0	133	43	3.09
	R30	41,800	0.1181	0.50	159.4	271	82	3.3

* No. existing lots (AS2 R40) = 9
* No. existing dwellings (AS2 R40) = 7 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (AS2 R40) area = 7 dwellings @ 500m^2 = 3,500m^2
* Post developed (AS2 R40) area = 9,473m^2
* Volume output based on square metres of development = 0.01404m^3/m^2

* No. existing lots (AS2 R30) = 47
* No. existing dwellings (AS2 R30) = 34 dwellings
* Predevelopment coefficient = 0.4
* Existing developed (AS2 R30) area = 34 dwellings @ 500m^2 = 17,000m^2
* Post developed (AS2 R30) area = 24,800m^2
* Volume output based on square metres of development = 0.01093m^3/m^2

7.1.3 Additional Runoff for New Roads

New roads will need to retain additional stormwater they generate for a 1yr ARI rainfall event and a 100yr ARI rainfall event. The 1yr rainfall event can be accommodated within bio-retention pockets in the road reserve to address stormwater quality and quantity in more frequent rainfall. The much larger 100yr rainfall event is to be retained within the larger piped network for new roads and gradually released into the existing piped network at predevelopment rates.

There are approximately 5,896 linear metres of new road proposed with an average reserve width of 17.9m, which is a total road reserve surface area of 105538m^2. For a 1 year ARI rainfall event, assume a runoff coefficient of 0.9 for new roads, a stormwater treatment area of 2% of the impervious area, and an average bio-retention area of 3 metres by 10 metres. The number of bioretention pockets can be calculated using the following equation.

$105538m^2 \times 0.9 = 81718m^2 \times 0.02 = 1900m^2$ of area required for bioretention.

This means 63 bioretention pockets will be required at 1 for every 93 metres of road for a 1 year ARI rainfall event.

To detain runoff in the larger 100 year ARI rainfall event the following equation applies.

New road length = 5896m at 17.9m width
New road area = $105538m^2$
Predevelopment runoff coefficient = 0.4
Predevelopment flow rate (5yr ARI) = $0.2981m^3/s$

Post development runoff coefficient = 0.9
Post development flow rate (100yr ARI) =1221.2 L/s
Volume of runoff generated = $3{,}355m^3$

Volume generated per square metre of new road = $0.03179m^3m^2$

It is intended that additional stormwater generated in a 100 year ARI event will be detained within the larger pipe system in proposed new roads, and gradually released into the existing pipe system in existing roads at the predevelopment flow rate. This means pipes in new roads must be sized accordingly to detain the 100 year ARI rainfall event. Based on the additional volume of $3{,}335m^3$ the pipe size can be determined in the following manner:

Length of pipe required (LP) = volume required to be stored (VS) / π multiply (radius (R) of pipe)^2 .

Therefore:

$LP = 3{,}355m^3 / \pi \times (0.2025)^2$
*= 5274 metres of 900 **Ǿ** pipe for 5896 metres of new road*

The calculations and figures above consider the proposed new road network in its entirety. In reality drainage will be addressed for sections of road (shown in **Figure 9**) though the submission of UWMP's by developers. As such the calculations and figures are indicative only and will need to be confirmed through UWMP's.This is discussed in the implementation section of the report.

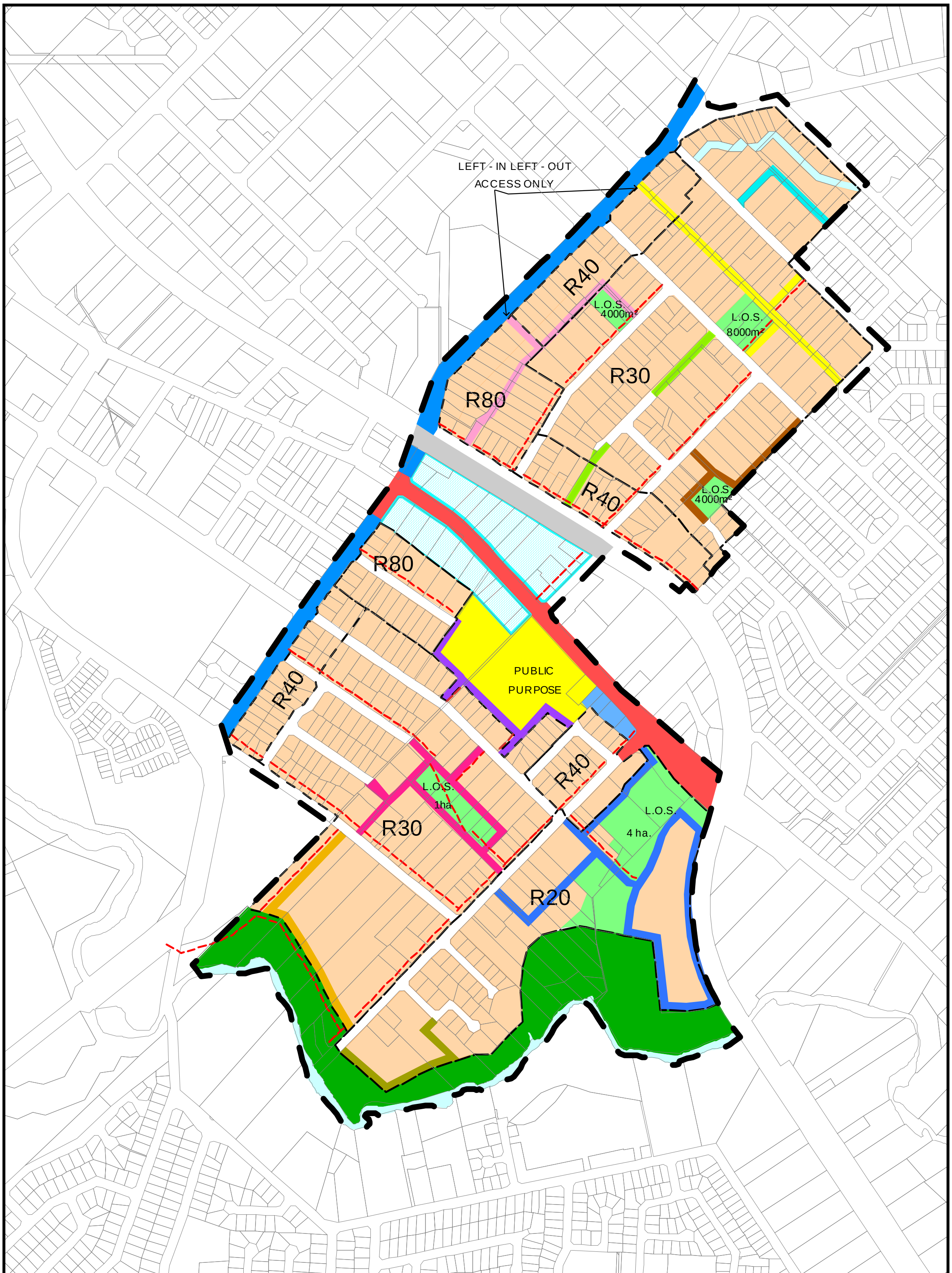


Figure 9 **URBAN WATER MANAGEMENT PLANS FOR PROPOSED NEW ROADS**

LEGEND

UW1 UW3 UW5 UW7 UW9

UW2 UW4 UW6 UW8 UW10

Scale: 1:7500

DRAFT CENTRAL MADDINGTON
OUTLINE DEVELOPMENT PLAN

CITY OF GOSNELLS

7.2 Stormwater Quality Control Measures

Existing district drainage infrastructure was designed to address stormwater disposal requirements without any specific emphasis on water quality aspects. Contemporary drainage quality control technology involves retention and the use of vegetation and soil media to remove sediments and particulates, and to attenuate nutrients. They can reduce pollutants in stormwater such as nitrates and phosphates which are typically found in garden fertilizers, as well as hydrocarbons from road surfaces in the form of oils generated by motor vehicles.

The following objectives and strategies for improving the quality of stormwater from new residential construction and new roads are aimed at detaining and treating potentially polluted stormwater as close to the source as possible and prior to being conveyed to the receiving waters of the Canning River.

Objective	Criteria	Strategy	Implementation
Maintain surface water quality at pre-development levels (winter concentrations) and, if possible, improve the quality of water leaving the development area to maintain and restore ecological systems in the sub-catchment in which the development is located.	▸ *Drainage* All post-development stormwater run-off entering the drainage network is to receive treatment prior to discharge to a receiving environment. ▸ *Pollutant] controls* - Pollutant outputs of the post-development stormwater run-off should not exceed pre-existing catchment conditions and where possible, improve water quality in accordance with National Water Quality Management Strategy (ANZECC and ARMCANZ, 2000).	▸ Bioretention pockets are to be introduced into verges of new roads and engineered to accommodate additional stormwater run off for a 1yr ARI rainfall event. ▸ Bioretention areas are to be provided on individual lots and engineered to accommodate additional stormwater run off for a 1yr ARI rainfall event. ▸ Bioretention pockets to be engineered with suitable filter media to reduce hydrocarbon road runoff pollutants. ▸ Other possible quality control measures that could be included in new roads are: - buffer strips - bio-retention swales - rain gardens - bio-filtration pockets - median swales - gross pollutant traps ▸ Monitoring stations will be set up throughout the ODP area to monitor nitrate and phosphate loadings.	▸ Proposed new dwellings or lots requiring new road frontage must prepare and submit a UWMP for approval by the City prior to approval for subdivision or development. ▸ Stormwater retention system for new roads designed in accordance calculations in the implementation section 7.2 ▸ Stormwater bioretention systems for new roads designed for a 1 yr ARI rainfall event in accordance with calculations in section 7.1.2 ▸ A monitoring program will be undertaken by a qualified consultant

The most significant reductions in total phosphorus and total nitrogen can be achieved through bioretention pockets and filter medium located in road reserves of new roads. However, reductions are also expected to be achieved through bioretention on individual lots, particularly during the first flush from winter rain which collects the accumulation of pollutants from roof surfaces.

Monitoring will be required to examine phosphorus and nitrogen levels. This is discussed further in section 9.4 of this report.

The targets for total nitrogen and phosphorus concentrations for the Swan Canning River Catchments tributaries outlined in the (SRWQIP, 2009) are tabled below.

HRAP interim targets for median TN and TP in Swan Canning Catchment tributaries		
Target	**TN mg/L**	**TP mg/L**
Short-term	2.0	0.1
Long-term	1.0	0.1

The SCWQIP is intended to deliver nutrient load reduction actions for the HRAP by establishing load reductions targets based on annual water yield (runoff to the river) from urbanised catchments. The load reduction targets for phosphorus and nitrogen are table below.

Target for median TN and TP concentration in tributaries of the Swan Canning river system		
Annual Water Yield (mm)	**TN Concentration mg/L**	**TP Concentration mg/L**
< 100	1.0	0.1
100 to < 200	0.75	0.075
>= 200	0.5	0.05

Pollutants can be reduced and/or removed from stormwater via vegetation filters and physical containment filters introduced as part of stormwater structural controls.

A combination of the following structural controls could be implemented to improve stormwater quality. Examples of these are included at **Appendix A.**

- Buffer strips
- Bioretention swales
- Rain gardens
- Biofiltration pockets
- Median swales
- Gross pollutant traps

Retrofitting the entire ODP area with the above structural controls will not be feasible however any new development including new roads may have to incorporate such controls to ensure that stormwater quality is improved. At the very least, new roads will require bio-retention pockets in new road reserves and if other structural controls are required these will be determined through the preparation and submission of UWMP's for various sections of new roads.

These various sections of road are shown at **Figure 9**.

To ensure stormwater quality is improved, monitoring will be undertaken to examine phosphorus and nitrogen levels. This is discussed further in **section 9.**4 of this report.

8. Ground Water Management Strategy

The quality of groundwater would usually be controlled through water sensitive design and best management practices. However, due to the poor infiltration properties of the soil, the potential for contaminated stormwater to infiltrate to groundwater is negligible.

The focus of water quality in this report is tailored toward managing stormwater, where the implementation of structural controls will be most effective. The management of stormwater quality is addressed in section 7 of this report.

9. Implementation Strategy

9.1 Proposals for Individual lots with Access to Existing Road Frontage

Implementation of the LWMS principles will occur in stages as the ODP area is developed over time. Many of the conservation, quantity and quality stormwater controls will be addressed and implemented through applications for subdivision, development and building licences for individual lots.

Given the potential poor infiltration characteristics of soils in the ODP area, it is considered necessary to prepare detailed drainage plans earlier in the planning process as part of an application submitted for subdivision and development. Proposals will be able to be assessed against the drainage criteria in this LWMS well in advance of the construction of dwellings and provide confidence that on-site stormwater detention can be achieved despite potential soil constraints.

To facilitate the application approval process, the City has prepared on-site stormwater drainage guidelines which will provide guidance on what the City expects with respect to how drainage is to be managed for new developments, and the process that needs to be followed to obtain approval.

The drainage guidelines are attached at **Appendix B**. These guidelines will be reviewed and updated over time.

In addition to the drainage guidelines a lot development drainage strategy is contained in **Appendix C**, which details how on-site stormwater detention for an individual lot can be achieved using contemporary drainage design.

9.2 Proposals for Individual lots with New Road Frontage

Proposals for development of larger civil works such as new roads will need to be accompanied by an UWMP, to pre-determine how stormwater road runoff quantities and quality will be managed prior to consideration of development applications for individual properties that front and require access from the new roads.

The preparation of a number of UWMP's is required for the various sections of proposed new roads in the ODP area. Road construction works will be staged and prioritised based on individual landowners' willingness to subdivide or develop and the extent to which each road will facilitate such development. Responsibility for the preparation of an UWMP and associated costs will be the responsibility of individual landowners. However the inclusion of UWMPs in a developer contribution arrangement (DCA) is to be given further consideration.

9.3 Conservation Technology

Other design objectives are expected to be implemented on a voluntary basis as people’s awareness and enthusiasm for water saving technology, and recognition of the financial benefits is becoming more prevalent. Additional information on water conservation technology can be found on the Department of Water's website.

9.4 Monitoring Program

An important part of implementing the strategies in this LWMS will be to monitor actual effects of ODP development. It is intended that monitoring stations will be set up throughout the ODP area to monitor the quality of water in terms of nitrate and phosphate loadings, and also to measure water quantities to ensure predevelopment flows are being maintained. A monitoring program will be undertaken by a qualified consultant who will be appointed once the ODP has been approved. Monitoring will attain baseline data for the current urban environment and will continue for a number of years through to post-development of the ODP area. Part of the monitoring program will be to recommend contingency actions should quantity and quality of water exceed predevelopment levels. The cost of this undertaking is likely to be incorporated into the DCA as a shared cost and consideration will need to be given to factoring in a allowance for remedial works and contingency actions.

9.5 Summary of Responsibilities

The following table summarises responsibilities for the implementation of the various objectives which have been detailed in the various sections of this LWMS.

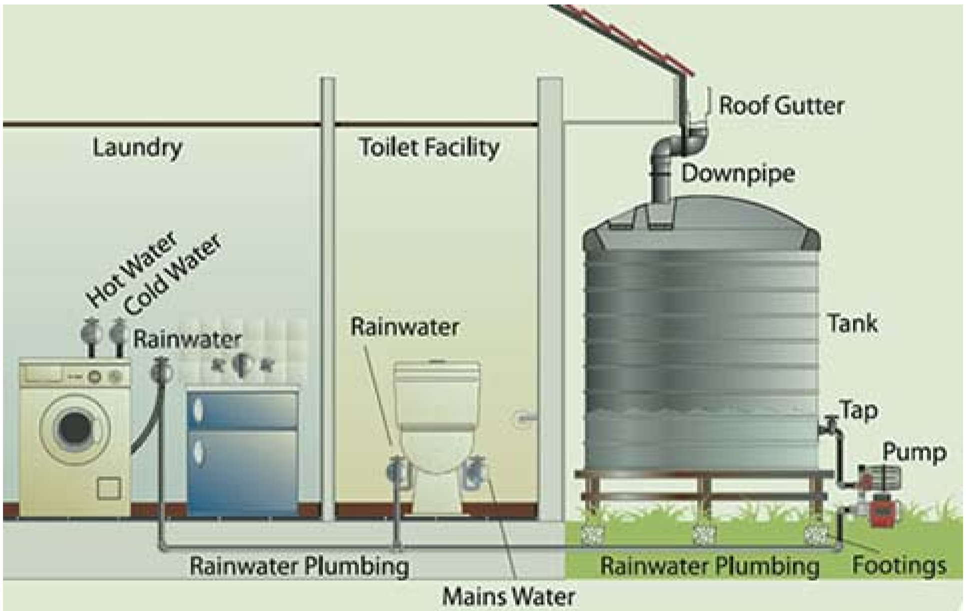
Water Conservation Measures				
Objective	**Criteria**	**Strategy**	**Implementation**	**Responsible**
Minimise Total Water Use and use water more efficiently	Reduce average water consumption to 100kL/year	▸ Reduce water consumption by using water saving technology with: - household tap fixtures, - shower fixtures - low volume dual flush toilets	WELS rated water efficiency technologies provided in new dwellings and considered as part of a Building Application.	Developer
		▸ Use rainwater storage tanks as a means of storing roof stormwater and use it as an alternatives to potable scheme water in the following instances: - garden reticulation - toilet flushing - car washing - washing machine water.		Developer
		▸ Use other stormwater retention methods: - below-ground rainwater/stormwater storage units and media filled storage tanks - rain gardens - roof gardens - stormwater sculptures and water features		Developer
		▸ Limit garden irrigation by reducing number of watering days per week		Landowner

Water Quantity Management				
Objective	**Criteria**	**Strategy**	**Implementation**	**Responsible**
Post-development annual stormwater discharge volume and peak flow is to be maintained relative to predevelopment conditions	▸ ***Ecological Protection*** Critical one year (ARI) event, the post-development discharge volume and peak flow maintained to predevelopment conditions, to maintain environmental flows and/or hydrological cycles.	▸ Bioretention pockets are to be introduced into verges of new roads and engineered to accommodate additional stormwater run off for a 1yr ARI rainfall event.	▸ Proposed new dwellings or lots requiring new road frontage must prepare and submit a UWMP for approval by the City prior to approval for subdivision or development.	Developer
			▸ Stormwater bioretention systems for new roads designed for a 1 yr ARI rainfall event in accordance with calculations in section 7.1.2	Developer
	▸ ***Flood Management*** Manage the catchment run-off for up to the 1 in 100 year ARI event in the development area to pre-development conditions.	▸ Stormwater detention for newly created dwellings or lots to be engineered to accommodate the 1 in 100yr ARI rainfall event.		
		▸ New roads are to be engineered to detain post development stormwater volumes for a 100yr ARI rainfall event within the piped drainage system, and release stormwater at predevelopment levels into the existing drainage system.	▸ Proposed new dwellings or lots accessed from an existing road, require a detailed drainage strategy to be submitted and approved by the city prior to approval for development and/or subdivision.	Developer
		▸ All new building pads to be raised 300mm above the 1 in 100yr ARI event except for dwellings south west of Philip Street and south east of River Avenue which requires the minimum standard of 500mm.	▸ On-site stormwater systems for new dwellings or lots to be designed in accordance with Drainage Strategy calculations in Appendix C.	Developer
		▸ Monitoring stations will be set up throughout the ODP area to monitor water quantities to ensure predevelopment flows are being maintained.	▸ Stormwater retention systems for new roads designed for a 100yr ARI rainfall event in accordance with calculations in section 7.1.2	Developer
			▸ A surface water monitoring program will be undertaken by a qualified consultant.	Developer

Water Quality Management				
Objective	**Criteria**	**Strategy**	**Implementation**	**Responsible**
Maintain surface water quality at pre-development levels (winter concentrations) and, if possible, improve the quality of water leaving the development area to maintain and restore ecological systems in the sub-catchment in which the development is located.	▸ *Drainage* All post-development stormwater run-off entering the drainage network is to receive treatment prior to discharge to a receiving environment. ▸ *Pollutant] controls* - Pollutant outputs of the post-development stormwater run-off should not exceed pre-existing catchment conditions and where possible, improve water quality in accordance with National Water Quality Management Strategy (ANZECC and ARMCANZ, 2000).	▸ Bioretention pockets are to be introduced into verges of new roads and engineered to accommodate additional stormwater run off for a 1yr ARI rainfall event. ▸ Bio retention pockets to be engineered with suitable filter media to reduce hydrocarbon road runoff pollutants ▸ Other possible quality control measures that could be included in new roads are: - buffer strips - bio-retention swales - rain gardens - bio-filtration pockets - median swales - gross pollutant traps ▸ Monitoring stations will be set up throughout the ODP area to monitor nitrate and phosphate loadings.	▸ Proposed new dwellings or lots requiring new road frontage must prepare and submit a UWMP for approval by the City prior to approval for subdivision or development. ▸ Stormwater detention system for new roads designed in accordance calculations in the implementation section 7.2 ▸ Stormwater bioretention systems for new roads designed for a 1 yr ARI rainfall event in accordance with calculations in section 7.1.2 ▸ A monitoring program will be undertaken by a qualified consultant.	Developer Developer Developer Developer

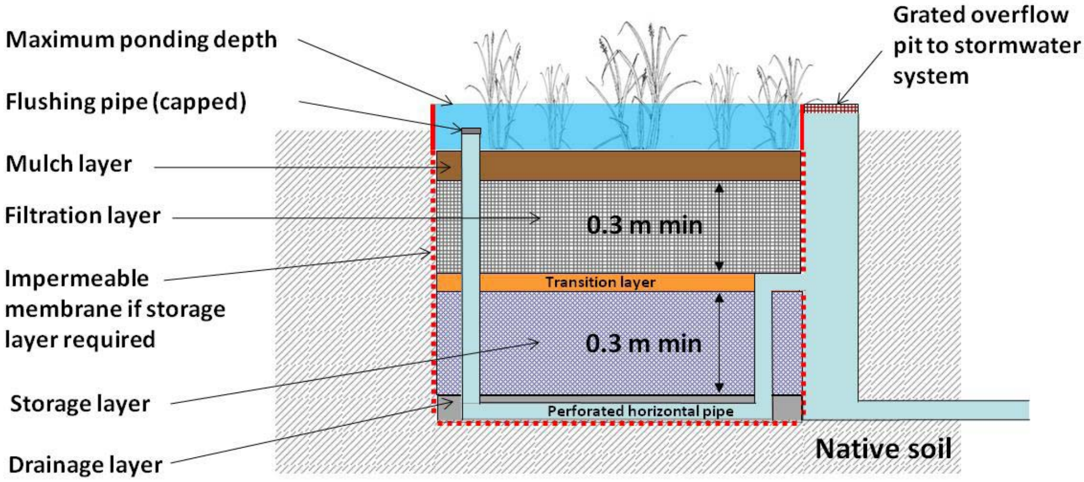
Appendix A Examples of Stormwater Management

Domestic Rainwater Tanks
Stormwater Manual Western Australia



Rainwater Tank Connected to In-house Appliances
Actew Corporation

Roadside Bio-Retention and Filtration Pocket
Picture from Review of Street Scale WSUD in Melbourne - Study and Findings



Water Sensitive Urban Design – Greater Adelaide Region
Technical Manual – December 2010

Roadside Bioretention Pocket

Water Sensitive Urban Design – Greater Adelaide Region
Technical Manual – December 2010

Median Swale
Stormwater Manual Western Australia

Vegetated Buffer Strip
Stormwater Manual Western Australia

Appendix B Drainage Guidelines

Introduction

This Guidance Note relates to all properties within the Central Maddington Outline Development Plan (ODP) area. It outlines what the residential density codings mean, how they impact on the potential for subdivision and development and the requirements that need to be met in applying for and obtaining approval.

Residential Density Codes Explained

Most residential properties have a single density coding, often called an 'R-Code', which guides how they can be developed.

The residential density coding on the ODP provides density codes ranging from ranging from R20 to R60.

You can find out the density coding of any property in the City by clicking on the On-line Mapping tab on the City's website at www.gosnells.wa.gov.au

The introduction of densities ODP is intended to provide opportunities for the redevelopment of land in an area which is well serviced by public transport and is close to the Centro Maddington commercial centre with the aim of:

- Making more efficient use of land near commercial, community and public transport facilities;
- Increasing patronage of public transport and the use of other more sustainable travel modes, like cycling and walking;
- Improving the viability and vitality of local shops and other businesses; and
- Provide a range of housing types and size to meet the current and future needs of growing and diverse population.

Landowners are entitled to apply for subdivision and development if their properties are coded R20 in accordance with the R20 requirements and any relevant planning policies. Landowners who have properties coded above R20 and wish to develop at densities greater than R20 are also entitled to apply for subdivision and development if special requirements can be met.

These special requirements relate to the following matters:

- Whether an Outline Development Plan (ODP) is needed to coordinate redevelopment and, if so, whether an ODP is in place at the time of making the application for subdivision and development;
- The availability and capacity of the range of infrastructure services to cater for the proposed development;
- The management of stormwater and measures aimed at water conservation; and

- The need, where necessary, to put measures in place to mitigate the impacts of transport-related noise, such as aircraft, rail or road noise.

Details on the requirements for subdivision and development, particularly those that need to be addressed to obtain the City's support for an application for subdivision or the City's approval to develop land at densities greater than R20 are provided later in this Guidance Note.

Calculating Subdivision and Development Potential

With the introduction of the new density codes in the ODP area, owners of land a may have the potential to subdivide and/or develop.

Subdivision and development are subject to separate application approval processes, with varying requirements, however the steps involved in calculating subdivision and development potential are similar.

The State Government Planning Policy, known as the Residential Design Codes (or R-Codes), is used to determine the number of dwellings that may be constructed on a residential zoned lot and to set requirements for development of those dwellings. The R-Codes are also used to determine the number of new lots that can be created from the subdivision of residential property.

The potential maximum number of dwellings that can be developed on a lot can be calculated by dividing the area of the property by the average lot size of the applicable density code in Table 1:

TABLE 1

Residential Density Code	Minimum Lot Size (m^2)	Average Lot Size (m^2)
R17.5	500	571
R20	440	500
R25	320	350
R30	270	300
R35	235	260
R40	200	220
R50	160	180
R60	160	180

Note: Assumes single or grouped dwellings only. Multiple dwellings have different area requirements. Refer to R-Codes.

Subdivision and Development Potential - Calculation Example

A 1000m^2 lot is coded R30.

The R30 code has an average lot size requirement of 300m^2.

1000m^2/300 = 3.3

Therefore, the total number of dwellings permitted = 3

Note – the calculation is always rounded down to nearest whole number.

If the property in this example already contained an existing dwelling, then it would be possible, subject to meeting applicable requirements, to obtain approval to:

- construct two additional dwellings; or

- demolish the existing dwelling and construct three new dwellings.

If the applicable requirements can not be met, then subdivision and development at the lower residential density code of R20 may be more easily achieved. In this example a property developed at R20, must have an average lot size requirement of $500m^2$. Using the same calculation method, a $1000m^2$ lot could contain only two dwellings or a single additional dwelling if the existing dwelling is to be retained.

Subdivision potential is calculated on a similar basis.

Constraints on Calculating Development and Subdivision Potential

Table 1 indicates the maximum subdivision and development potential that may be achievable. A range of factors may constrain the actual number or lots or dwellings that are able to be permitted or practical or feasible to achieve, such as:

- R-Codes provisions – such as requirements for vehicular access, car parking, private open space, boundary setbacks, overshadowing and privacy.
- Building Code of Australia provisions – such as structural requirements.
- Service requirements and easements – such as for water, sewer, power and gas supply.
- Drainage requirements – need for soakwells, raingardens or drainage connections.
- Lot shape and dimensions.
- Whether existing buildings are proposed or required to be retained.
- Financial considerations.

As there are many variables that can influence the development or subdivision potential of a property, it may not be possible to determine the actual potential until a detailed project feasibility analysis and development design is completed. The City is unable to provide advice on project feasibility or offer a design service and suggests landowners seek professional advice.

Density Bonuses and Other Housing Options

The potential entitlement to a density bonus exists for the construction of certain types of dwellings, such as housing for the elderly or single bedroom units. The potential also exists to obtain approval for construction of ancillary accommodation (often referred to as a ‘granny flat’). Refer to the R-Codes for details.

The City is also looking at amending TPS 6 to provide for other density bonuses, such as for corner lots or properties that abut public open space or pedestrian accessways. Visit the City’s website for details on these future planning initiatives.

Responsible Authority for Subdivision Applications

Applications for approval of the subdivision or amalgamation of land – whether for the creation of freehold (sometimes referred to as a green title) or strata titled lots – must be submitted to the WA Planning Commission.

The Commission is responsible for determining these applications.

The Commission will refer submitted applications to various public and servicing agencies, including the City, for assessment who in turn provide a recommendation back to the Commission.

The following section of this Guidance Note outlines the matters relevant to the City's involvement with the subdivision application process. Applicants should be aware that the Commission and other public and servicing agencies involved in the process will have their own requirements to be met.

Subdivision Application – Information Requirements

The WA Planning Commission has published a guide that sets out what information must accompany applications for approval of the subdivision of land. This can be obtained at www.wapc.wa.gov.au.

In assessing an application for subdivision of residential land within the ODP area, regardless of whether approval of the lower R20 density or densities greater than R20 is sought, the City's two main considerations will be:

- Whether an ODP is in place at the time of making the application for subdivision and development;

- Whether the proposed subdivision will lead to the creation of new lots that are capable of being developed to an appropriate standard and in compliance with all relevant requirements.

Outline Development Plan Requirements

ODPs are a type of structure plan used to coordinate an area's redevelopment and often establish a framework for the provision of new roads, public open space and other community infrastructure and in some cases to provide for a change in land use.

Council has adopted a stance that subdivision in ODP areas generally should not occur until an ODP has been prepared and approved.

The City will generally recommend that the Commission refuse applications made in advance of an ODP being approved as subdivision without an overall plan to coordinate development within the broader precinct will likely make that task even more difficult and potentially lead to complications and inequities.

Please note that a review of Council's ODP Requirements Policy is currently underway. The review is examining the need for ODPs and is exploring if there is the potential to achieve an appropriate standard of redevelopment without ODPs. This will be the subject of a report to Council in the near future. Landowners will be consulted on any draft changes to the Policy.

Development Capability of New Lots

It can be difficult to assess whether the lots to be created from a proposed subdivision are capable of being appropriately developed to applicable requirements and standards without plans indicating the intended development. Small lot subdivisions with limited amount of space available can present design challenges.

The City will prefer that subdivision applications seeking approval at densities greater than the R20 code only be approved where there is already a development application approved that accords with the proposed subdivision.

Subdivision applications that seek to create lots less than 350m^2 where no development application has been approved will need to be accompanied by plans and other information as set out in the Development Application – Information Requirements section of this Guidance Note, so the proposals can be assessed in parallel.

Subdivision Approval Conditions

In the event that the City recommends to the Commission that it approve a subdivision application for land at residential densities greater than R20, the City may request the imposition of conditions, including but not limited to the following requirements:

- Certification that the site has been adequately filled and compacted for building on.
- Satisfactory arrangements for the construction of driveways, particularly when for communal use.
- Satisfactory arrangements being made to appropriately manage stormwater drainage.
- Public Open Space contributions consistent with Commission Policy (Generally for more than five lots).
- Satisfactory arrangements being made to ensure prospective purchasers are aware of any factor that may limit or impact on the use or enjoyment of the land or of any special building requirements that may apply, such as drainage, upgrading of any existing dwelling or noise insulation.

Responsible Authority for Development Applications

Applications for the development of land must be made to the City. In most cases, the City is responsible for determining development applications, but there are some exceptions such as where the application involves land reserved under the Metropolitan Region Scheme (in which the Commission is usually responsible for determination) or where the value of the development exceeds $3 million (in which case the application may be referred to the regional development assessment panel for determination, once established).

For residential zoned land, development approval is required when it is proposed to:

- Construct a dwelling or dwellings on a freehold titled lot which already contains an existing dwelling or dwellings.
- Construct two or more dwellings on a vacant freehold or strata titled lot.
- Extend an existing dwelling or construct a new dwelling on a strata title lot.
- Extend an existing dwelling or construct a new dwelling on any lot that involves assessment of the proposal against the Performance Criteria of the R-Codes.

- Construct a new dwelling or outbuilding on the same lot as an existing heritage building or place, or any extension or external modifications to a heritage building.

- Establish a home-based business or other commercial activity

- Park a commercial vehicle.

A building licence is also required for most new or extended residential structures. An application for a building licence is usually submitted by a builder or building company to the City. The City is required to determine licence applications. Refer to the City's website for details.

Development Application – Information Requirements

As detailed previously, the carrying out of subdivision and development will be subject to a range of standard requirements, in addition to some special requirements that need in order to obtain approval at residential densities greater than R20. The background and rationale supporting the special requirements are explained in the following section.

The following information needs to be provided in support of applications for approval for the development of land within the Central Maddington ODP area, regardless of whether approval at R20 or greater is sought:

1. Schedule 6 - Application for Planning Approval

2. Plans (three copies and at least A3 in size) to a scale of not less than 1:500 showing:

    (i) the location of the site including street names, lot numbers, north point and lot dimensions;

    (ii) the existing and proposed ground levels over the whole of the land the subject of the application;

    (iii) the location, height and type of all existing structures, with details shown in respect to the structures to be retained and those which are to be removed;

    (iv) details of existing vegetation, with details shown in respect to the vegetation to be retained and that which is to be removed;

    (v) the proposed buildings to be constructed on the site;

    (vi) the proposed means of access and parking for vehicles to and from the site;

    (vii) the nature and extent of any open space proposed for the site (whether communal or private); and

    (viii) drainage details.

3. Plans, elevations and sections of any building proposed to be erected or altered and of any building it is intended to retain;

4. Where assessment of the development application is sought under the Performance Criteria of the R-Codes, a written statement is to be provided demonstrating how these criteria are met in accordance with Council's Residential Development Local Planning Policy 1.1.1 – see the R-Codes and LPP 1.1.1 for additional details.

5. A development application fee, which is set by State Government regulation at 0.31% of the cost of the proposed development. This fee is in addition to fees associated with the subdivision and building licence application approval processes.

The following information also needs to be provided in support of applications that seek approval at residential densities greater than R20:

1. Plans that demonstrate, in accordance with the City's Drainage Guidelines, how stormwater generated by events up to the 1 in 100 year average recurrence interval (ARI) is to be managed by one of the following measures (see following section for additional details):

    i. all stormwater from the proposed development site to be retained and infiltrated on site;

    ii. all stormwater from the proposed development site to be managed by a combination of on-site retention/infiltration and conveyance to an existing piped drainage system. In this event, the conveyance of stormwater from the proposed development site must be limited to the pre-development volume and rate; or

    iii. any other measure provided for by an adopted ODP that applies to the subject site.

2. Certification in the form of a report from a qualified civil or construction engineer or written confirmation from each relevant servicing agency that demonstrates that the proposed development is capable of being provided with the range of public utilities necessary to service that development (such as sewer, water, power and gas) – see following section on Availability of Infrastructure Services for additional details.

3. Where the development application involves land identified by State Planning Policy 5.1 or 5.4 as being potentially subject to significant transport related noise, it will be necessary to detail if there is a need for noise mitigation measures to be put in place and if so, what those measures will be - see following section on Noise Management for additional details.

The City will return development applications that do not address these information requirements to the applicant without being determined.

If it is not possible to prepare an application for development that meets these information requirements, then it is open to apply for consideration under the relevant development requirements of the lower (or base) split residential density code of R20.

Development Approval Conditions

In the event that the City approves a development application for residential land in the Central Maddington ODP area, the City may impose conditions, including but not limited to the following requirements:

- Certification that the site has been adequately filled and compacted for building on.
- Satisfactory arrangements being made to appropriately manage stormwater drainage.
- Construction of driveways, particularly when for communal use.
- Encouragement of water conservation measures in new and existing dwellings.
- Satisfactory arrangements being made to ensure prospective purchasers are aware of any factor that may limit or impact on the use or enjoyment of the land.
- Upgrading of any existing dwelling to be retained to standards set out in the R-Codes, including new car parking and storage provision.
- Installation and maintenance of landscaping.

Background and Rationale for Special Requirements - Split Residential Density Coded Land

Outline Development Plans

As detailed previously, Council has determined that ODPs are needed in certain areas.

Council has adopted a stance that development in these areas generally should not occur until an ODP has been prepared and approved, unless it can be demonstrated that development could proceed without making the task of planning for the area even more difficult or resulting in inequitable outcomes for other landowners.

Availability of Infrastructure Services

It is not always possible to check the availability and capacity of the complete range of infrastructure services like sewer, water, power, gas, drainage and communications to cater for the proposed development of each and every property included in the ODP area.

While the servicing agencies were consulted during the amendment process and preparation of the ODP, this did not identify any specific deficiencies or problems with existing servicing infrastructure. However attention was drawn to the fact that the potential exists for problems to emerge in future in terms of the capability of existing services to cope with the additional demand imposed by new development.

It is possible that upgrades to infrastructure may be required at some point in future. The servicing authorities can only undertake upgrades in a staged manner and may require developers to contribute to the cost. Requirements for developers to fund infrastructure upgrades can be applied separately to the City's approval process and may impact on a project's feasibility.

The City's requirement for a report from a qualified engineer or advice from each relevant servicing agency that demonstrates that a proposed development is capable of being provided with the range of public utilities necessary to service the needs of that development puts the onus on applicants to liaise with the authorities in respect to the servicing arrangements before decisions are made on development applications.

Water Management

Development of land, particularly where involving more compact forms of housing construction, usually results in an increase in hard or impervious areas when compared to pre-existing site conditions.

Given increasing demand for what is becoming a more scarce resource, there is also a need to ensure new development incorporates measures to minimise water use.

Stormwater runoff from denser forms of development is likely to impose an increased demand on the City's road drainage system, which may not readily accommodate additional stormwater and could add to the risk of flooding. An all-encompassing upgrade to the road drainage system is not viable, given the costs involved, the lack of funds available to do so and likelihood that any passing of such a cost onto developers could potentially make redevelopment unviable. In addition, a major pipe network upgrade would not be desirable for environmental reasons.

On-site infiltration and detention facilities or underground storage systems can provide temporary storage for stormwater runoff within the confines of the development area. The aim is to restrict the discharge from the site at a rate which the City's existing drainage system is capable of accommodating, mimicking the pre-development conditions or to upgrade the system to accommodate the increased flows.

While such an approach is common practice throughout Perth, the soil conditions and high groundwater table throughout much of the ODP area can limit the effective operation of on-site detention methods.

The City is presently undertaking, in partnership with Curtin University, investigations into soil conditions across the City. The study is aiming to profile the physical composition of soils and their capability to drain freely and in turn produce guidelines for the most effective means of on-site drainage disposal for different soil types.

While the study and guidelines are not due to be completed until mid year 2011, the preliminary findings reveal significant variety in soil types between and within different suburbs. Clay soils at depths between 0.5m and 1.5m (and likely deeper) have been regularly encountered in testing undertaken so far.

As an interim approach, the City will require drainage details to be provided in support of development applications clearly demonstrating how on-site stormwater disposal will be appropriately managed. It is suggested that in the absence of detailed drainage capability data, that a worst-case scenario (that is, clay-based soils) be assumed and designed for. Exceptions will be allowed where an applicant can demonstrate through site-specific geotechnical and soil permeability testing that more favourable drainage conditions prevail on-site and that a drainage system with reduced capacity can be designed and installed accordingly.

In terms of water conservation measures, the City will encourage the use of devices such as water-efficient fittings and appliances, rainwater tanks and grey water recycling systems in new and existing dwellings. Applicants should check the Building Code of Australia and Australian Standards as changes to mandatory requirements may be made from time to time.

Noise Management

Some properties with a split residential density code have been identified in State Government planning policies as potentially affected either now or in future by noise associated with freight and passenger railways and major roads.

State Planning Policy (SPP) 5.4 (Road/Rail noise), which is available on the Commission's website at www.wapc.wa.gov.au, should be referred to when preparing applications for subdivision and development to check if there are any relevant provisions to be addressed.

SPP 5.4 is a broader policy relating to properties that lie near major transport routes. A range of requirements are set out that vary depending on the proximity of a property to the transport route, the type of infrastructure and the volume of vehicle movement. The City has produced an assessment tool, which is available on the City's website, to assist applicants to determine relevant requirements.

Key Documents

Information in this Guidance Note is drawn from various documents, including those listed below. It is important to note that the Guidance Note is not a substitute for the regulations, standards and guidelines that apply to the subdivision and development process.

City of Gosnells Documents

- Town Planning Scheme No.6 (TPS 6)
- Local Planning Policy 1.1.1 – Residential Development (LPP 1.1)
- Local Planning Policy 3.2 – Outline Development Plan Requirements (LPP 3.2)
- Local Planning Policy 4.5 – Development – Landscaping (LPP 4.5)
- Engineering Guidelines (Drainage, Verges, Vehicle Crossovers)
- Building Services Information Sheets
- Guide to SPP 5.4 – Noise Policy

WA Planning Commission Documents

- State Planning Policy 3.1 - Residential Design Codes (R-Codes)
- State Planning Policy 5.4 – Road and Rail Transport Noise and Freight Considerations in Land Use Planning
- Development Control Policy 2.3 – Public Open Space in Residential Areas.
- Guide to Subdivision Application and Fees – Application for Approval of Freehold or Survey Strata Subdivision

Other Documents

- Building Code of Australia
- Australian Standards

Getting Help

It is recognised that there will be many people who own or may be thinking about buying a property within the ODP area that have little or no experience in land development.

Developing in an established suburban area is quite different to building on a vacant lot in a new estate.

If you are thinking about undertaking a subdivision or development, particularly if it will be for the first time, then it is sensible to engage professional expertise with qualifications and experience in this area.

Building companies specialising in infill development often advertise in the new homes supplements in the weekend newspapers, with many offering complete services including project feasibility assessment, planning and design, costing and application lodgement. They can also help with site surveying, obtaining building licences and construction.

Planning, architectural and surveying companies could also assist with parts of the process.

Want to find out more?

The City's website contains a wealth of information on the matters referred to in this Guidance Note, including links to the key documents, at www.gosnells.wa.gov.au

If you would like to receive regular e-newsletters on planning and development in the City, particularly updates on planning project initiatives such as the review of the ODP Requirements policy, progress with the soil profiling program or the corner lots density bonus, register now on the City's website.

Appendix C Drainage Strategy for Individual Lots

Central Maddington Outline Development Plan

Lot Drainage Strategy

Revision B

Calculation of required lot storage to maintain pre-development lot discharge to existing road reserve pipe network.

Table of Contents

1.0 Overview

This document describes and explains the calculation processes and assumptions that have been employed in estimating the stormwater storage to be required of individual lot owners within the Central Maddington Outline Development Plan. Comments are based on the appended Calculation sheets (Appendices 1, 2 & 3), various elements of which have been numbered to allow ease of reference, and the example concept sketch (Appendix 3).

1.1. Basis and Assumptions

The basis of this calculation, as described in the DCP is as follows:

> *"To accommodate the increased runoff without affecting a large scale pipe network upgrade, individual developers will instead be required to carry out certain measures within lots in order to ensure pre-development peak loads on the pipe network are not surpassed and appropriate flood protection is ensured.*
>
> *According to the Geotechnical Report for Lot 62 (27), Lot 1 (41) and Lot 20 (25) Camberwell Street (22 June, 2009), Section 3.2, "soils encountered are of low permeability and as such on site disposal of stormwater is likely to be problematic and will require engineered solutions." The use of direct infiltration methods for the disposal of stormwater (ie soakwells) has therefore been discounted in favour of detention storage sized to allow the 100 year ARI critical storm to be detained on site without surpassing predevelopment outflows to the existing network or causing nuisance flows or inundation."*

In accordance with the above comments, the drainage strategy prescribes that each land owner within the ODP area is to ensure that adequate storage is provided within the lot in order to maintain current (pre-development) lot runoff to avoid surcharging of the existing road pipe network and resultant flooding.

In addition to peak flow matching, this strategy supports the reasonable and practical recommendation made by the City of Gosnells, for the 1 year ARI event be detained for 6 hours in a filter medium to achieve a water quality, quantity and time of concentration that is favourable relative to pre development conditions. This strategy more accurately simulates the characterisation of minor (1 year) storm events.

The following underlying principles behind the calculation aim to rationalise the computation for application to developable lots of variable sizes within the ODP area.

1.2. Design Principles

That the proposed redevelopment of lots does not cause peak lot runoff outflows from any event up to the 100 year ARI to exceed the estimated pre-development design lot runoff outflows.

That the 1 year ARI critical storm be detained on site for a period of 6 hours prior to any outflows to the street drainage network occurring.

This is to be carried out in practice through the use of raingardens or similar detention/attenuation storage with a controlled base flow outlet. In meeting the stated objectives, the system must comply with the following:

- Up to the (critical) 1 year ARI event volume is to be attenuated on site within the treatment or rain garden area. Guidance for rain garden design can be found in document, Facility for Advanced Water Biofiltration (FAWB), on the Monash University website.
- Up to the (critical) 5 year ARI event volume is to be attenuated on site without causing nuisance inundation (defined as inundation of usable or mixed use areas surrounding a dwelling ie. gardens, driveways, paths, etc.) or surface flows.
- Up to the critical 100 yr ARI storm event volume is to be attenuated onsite via usable or mixed use areas as attenuation storage areas.
- For events exceeding the 100 year critical storm, excess flows are to be directed overland into the road reserve network.
- For all storms not exceeding the 100 year ARI event, outflows to the existing drainage network are to be via underground connections, and are to be restricted such that the relevant pre-development estimated flows for the lot are not exceeded.
- Time of concentration for all storms is to be matched or increased with respect to the estimated predevelopment times.

2.0 Description of Calculation Sheet

The following is an explanation of the appended calculation sheets, which have been used to estimate predevelopment flows and calculate storage requirements using the rational method as per The Institution of Engineers' Australian Rainfall and Runoff Volume 1 (1998). Each relevant section of each sheet has been numbered and referred to in the description below.

All calculations are based on two example lots and the lot drainage strategy is designed using these lots to be applied to all lots within the development area. The specifics of the strategy such as rain garden design and the storage options shown on the attached plans are provided as examples of lots conforming to the design principles. Other methods/strategies may be approved subject to detailed design and substantiation by a qualified engineer that the method complies with the above stated design principles.

2.1. Pre-development Calculations

The following numbers correspond to numbering on calculation sheet Appendix 1 – Predevelopment calculation sheet

1. Assumed lot size and shape parameters. Lot A represents a short wide lot, lot B represents a long narrow lot for comparison purposes
2. Fraction impervious – predevelopment assumption that 50% of existing lot area is hard stand to be used in the runoff coefficient calculations.
3. Runoff Coefficients
    a. Parameters used to calculate the runoff coefficients as per equations 1.11 – 1.13, Book Eight of AR&R (IEAust, 1998).

b. Table of factored runoff coefficient for the given ARI events to be used in predevelopment calculations.

4. Predevelopment lot surface ponding storage. This has been calculated based on the assumption that 1 year 1hr predevelopment flows are contained within depressions and ponding within the lots. Zero infiltration is assumed. This assumed storage volume is then inserted into larger storm Time of Concentration and runoff calculations.

5. Time of concentration calculations

   a. The time of concentration (Tc) calculator is an iterative calculator based on equation 1.2, Book Eight, AR&R (IEAust, 1998), modified to include allowance for the predevelopment storage 'puddles' as calculated in item 4 above.

   b. Result of the iterative calculations are presented for each event ARI considered.

6. Pre development runoff calculated using the rational method for critical events for each event ARI considered, taking into account the predevelopment surface 'storage'.

7. Outflow parameters calculated on a per square metre basis to be used for comparison between the two lot shapes considered.

8. Simple average of predevelopment outflows between the two lot shapes considered (Lot A and Lot B), to be used as post development outflow criteria.

2.2. Post development Calculations.

The following numbers correspond to numbering on both calculation sheets Appendix 2 & 3 – Post development calculation sheets

1. Assumed lot size and shape parameters. Lot A represents a short wide lot, lot B represents a long narrow lot for comparison purposes.

2. Fraction impervious – post development assumption that 85% of existing lot area is hard stand to be used in the runoff coefficient calculations.

3. Runoff Coefficients

   a. Parameters used to calculate the runoff coefficients as per equations 1.11 – 1.13, Book Eight of AR&R (IEAust, 1998).

   b. Table of factored runoff coefficient for the given ARI events to be used in predevelopment calculations.

4. For the example considered, it is assumed that the 1 year ARI 6 hour detention criteria will be achieved using a 'raingarden' of maximum allowable depth of 200mm. Design parameters as below have been estimated as an illustrative example of a conforming lot.

   a. Area of lot considered

   b. Detention time before runoff occurs (ie travel time through filter medium). In this case 6 hours has been used as reasonable and practical period of time.

c. Runoff coefficient used for the 1 year ARI raingarden design, taken from table above (item 3b).

d. Assumed depth of filter material used to achieve the required detention time.

e. Design parameters iterated to achieve appropriate depth of ~0.2m

    i. Base width of Rain Garden

    ii. Base length of Rain Garden

    iii. Area of base

    iv. Detention time in seconds (prior to runoff)

    v. Velocity of water through filter medium calculated to achieve the 6hrs detention based on a 1m thick layer. This velocity therefore also constitutes the k value of the filter material used

    vi. Outflow – Equated to velocity of flow through the filter material multiplied by area of the base. i.e. the flow rate required through the base of the garden to achieve the 6 hrs detention with the given area and filter layer thickness.

    vii. Storage volume calculated using Rational method (in-house spreadsheet).

    viii. Max depth of rain garden storage assuming vertical walls (i.e. volume/area).

    ix. Tc for the critical 1 year ARI event including storage filling time according to rational method (in-house spreadsheet).

5. Rain garden size

    a. Using the rational method, raingarden storage volume has been sized to allow the 6 hrs detention within 1m filter medium layer.

    b. Outlet flow represents total volume flowing through the filter medium during and after the storm. This is also the ultimate outlet flow (after 6 hours) for events up to the 1 year ARI critical event, via subsoil drainage of the filter zone.

6. Time of concentration (Tc)

    a. 1 year ARI critical Tc calculated using the rational method (in-house spreadsheet).

    b. 5 year ARI critical time of concentration calculated based on equation 1.2, Book Eight, AR&R, modified to include allowance for the rain garden storage.

This duration represents the shortest duration (highest intensity) storm that will fill the rain garden storage to capacity i.e. the minimum critical time of concentration for which runoff will occur during a 5 year event. As this number is higher than the estimated pre-developed critical Tc, it is deemed to comply with design principles with respect to matching concentration times pre and post development.

For events larger than the 5 year ARI, Tc can not be accurately calculated by the rational method due to the variable outflows within the model. However, it is assumed that due to increased storage volume relative to predevelopment, as well as restricted immediate outflows, Tc will not be reduced using this strategy for the 10 year and 100 year ARI design storm.

7. Pre development runoff values are calculated using the average per square metre values of the two design lots from predevelopment calculations, multiplied by the area of the post development lot. These are the values used as outflow rates within the rational method for the below storage calculations.

8. The 5 year storage value is a quantity over and above the rain garden 1 year ARI. This volume will retain the 5 year ARI critical event and restrict outflow to the predevelopment rate. Due to limitations of the rational method, our model uses the assumption that the 1 year ARI rain garden storage volume is full at commencement of the 5 year storm, and that the full 5 year outflow was available for the duration of the storm. This method was employed because the rational method does not allow for variable outflows over the duration of a storm. Therefore the calculation is conservative as it ignores any storage that would be provided by the rain garden if it were not full at the commencement of the storm.

9. The 10 year storage value is a quantity over and above the previous specified storages. It is calculated as per the above with similar assumptions. The volume may be provided as flood storage through inundation within the lot driveways, car parks etc.

10. The 100 year storage value is a quantity over and above the previous specified storages. It is calculated as per the above with similar assumptions. TKhe volume may be provided as flood storage through inundation of the lot, ensuring that all building floor levels are sufficiently above this level.

11. This is a summary table of the storage requirement per square metre for the given design ARI to comply with this strategy. Note that the storage for the 5, 10 and 100 year storm are extra over values to be provided on top of the storage already provided for the lesser storm. Total cumulative storage is the sum of all the values in the table. Outflows are given as total allowable outflows and not extra over flows as illustrated in the attached sketch. As the values rationed on a square metre basis are very similar for the two lots, average values over the two tables are considered sufficient. These values are presented in the summary table, Table 1 below.

3.0 Summary of lot strategy requirements

Based on the rational method, peak pre-development design lot runoff flows and concentration times for relevant design storms can be maintained by attenuating storm flows within individual lots using the storage volume requirements and base flow recommendations per square metre of developable area presented in Table 1. These values are based on the strategy illustrated in the attached sketch. If this method is not used, substantiation is required to confirm that the strategy adheres to the specific design principals.

In complying with the requirements of Table 1, lot strategies must also acknowledge and adhere to the 6hr detention time requirement in the design of the rain garden (or equivalent) and ensure the filter material permeability value allows for this detention.

Note again that the 5, 10 and 100 year ARI values for storage requirement given in Table 1 are extra over storages to be provided over and above the sum of preceding values.

ARI	Storage required	Allowable outflow
1 year	0.00617 m^3/m^2	0.000E+00 $m^3/s/m^2$
5 year (e/o)	0.00416 m^3/m^2	9.687E-06 $m^3/s/m^2$
10 year (e/o)	0.00198 m^3/m^2	9.687E-06 $m^3/s/m^2$
100 year (e/o)	0.0174 m^3/m^2	1.177E-05 $m^3/s/m^2$
Cumulative Total	0.0242 m^3/m^2	

Table 1 - Storage and outflow requirements per m^2 developable area (average of Lot A and Lot B values).

APPENDIX 1 - PRE DEVELOPMENT PARAMETERS & CALCULATION SHEET

	Lot A					Lot B				
1	Lot width		15	m		Lot width		10	m	
	Lot depth		25	m		Lot depth		50	m	
	Area		375	m2		Area		500	m2	
2	Fraction Impervious		0.5			Fraction Impervious		0.5		
3a	Runoff coefficient					Runoff coefficient				
	10,I,1		30.20	mm/hr	10 year 1 hr intensity	10,I,1		30.20	mm/hr	10 year 1 hr intensity
3b	C(ARI)	ARI Factor	runoff coef.			C(ARI)	ARI Factor	runoff coef.		
	C1	0.8	0.43		1 year ARI runoff co	C1	0.8	0.43		1 year ARI runoff co
	C5	0.95	0.51		5 year ARI runoff co	C5	0.95	0.51		5 year ARI runoff co
	C10	1	0.53		10 year ARI runoff co	C10	1	0.53		10 year ARI runoff co
	C100	1.2	0.64		100 year ARI runoff co	C100	1.2	0.64		100 year ARI runoff co
4	1 year 1 hr predev lot storage (assumes fine clay no runoff)					1 year 1 hr predev lot storage (assumes fine clay no runoff)				
	V		2.8	m3	from basin sheet	V		3.4	m3	from basin sheet
	outlet		0	m3/s		outlet		0	m3/s	
	This is assumed to be soil storage on lot					This is assumed to be soil storage on lot				
5a	Time of concentration calculator (with consideration for 1 in 1 storage *item 4 above*)					Time of concentration calculator (with consideration for 1 in 1 storage *item 4 above*)				
	L		29.15	m	diagonal path	L		50.99	m	diagonal path
	n*		0.03		Clay/loam/table 1.4	n*		0.03		
	S		0.01	m/m	Assumed fall of 0.3m over lot	S		0.01	m/m	Assumed fall over 0.3 over lot
	I		213.00	mm/hr		I		170.30	mm/hr	
	t		8.05	(min)		t		8.07	(min)	
5b	Tc (1 year)		20	min		Tc (1 year)		25	min	
	Tc (5year)		10	min	Iterations from spreadsheet	Tc (5year)		15	min	Iterations from spreadsheet
	Tc (10 year)		9	min	Ignores partial area effects	Tc (10 year)		13	min	Ignores partial area effects
	Tc (100 year)		5	min		Tc (100 year)		5	min	
6	Pre development runoff					Pre development runoff				
	1 year 1 hour		0.00	l/s		1 year 1 hour		0.00	l/s	
	1 year critical (72 hr)		0.06	l/s		1 year critical (72 hr)		0.07	l/s	
	5 year critical		4.40	l/s		5 year critical		3.82	l/s	From spreadsheet
	10 year critical		5.30	l/s		10 year critical		4.70	l/s	
	100 year critical		10.70	l/s		100 year critical		10.17	l/s	
7	Flow matching outflow parameters					Flow matching outflow parameters				
		Tc	outflow	outflow/m^2			Tc	outflow	outflow/m^2	

1 year	N/A	0	0.0000	l/s/m2	1 year	N/A	0	0.0000	l/s/m2
5 year	10	4.4	0.0117	l/s/m2	5 year	10	3.82	0.0076	l/s/m2
10 year	9	5.3	0.0141	l/s/m2	10 year	9	4.7	0.0094	l/s/m2
100 year	5	10.7	0.0285	l/s/m2	100 year	5	10.17	0.0203	l/s/m2

Post development allowable outflow per m2 (Average Lot A and Lot B)

8

1 year	0.000	l/s/m2	0 m3/s/22
5 year	0.010	l/s/m2	0 m3/s/22
10 year	0.012	l/s/m2	0 m3/s/22
100 year	0.024	l/s/m2	0 m3/s/22

APPENDIX 2 - POST DEVELOPMENT PARAMETERS & CALCULATION SHEET (Lot Size A)

		Lot A			
1	Lot width		15	m	
	Lot depth		25	m	
	Area		375	m2	
2	Fraction impervious		0.85		
3a	10,I,1		30.20	mm/hr	10 year 1 hr intensity
	C1,10		0.17		Pervious area runoff co
	C10		0.79		10 year ARI runoff Co

		ARI Factor	Runoff coef.	
3b	C1	0.8	0.63	1year ARI runoff co
	C5	0.95	0.75	5 year ARI runoff co
	C10	1	0.79	10 year runoff co
	C100	1.2	0.95	100 year ARI runoff co

4	Raingarden design for critical 1 in 1 year			
4a	Lot Area	375	m2	
4b	Detention time	6	hrs	(through infiltration media)
4c	Runoff coefficient	0.63		
4d	Depth of filter layer	1	m	

	i	ii	iii	iv	v	vi	vii	viii	ix
4e	Width (m)	Length (m)	Area (m2)	Time of det (s)	K of filter or Velocity (m/s)	Outflow (m3/s)	Storage (m3)	Depth (m)	Tc from calc sheet
	2	5.5	11	21600	4.63E-05	5.09E-04	2.33	0.211818182	46min
						Starts flowing after 6 hours	st. required	2.15	

5	1 year raingarden lot storage			
5a	v	2.33	m^3	From basin sheet
5b	outlet	0.51	l/s	

This is assumed to be soil storage on lot

Approximated critical 5 year time of concentration calculator for 1 in 1 storage (with consideration for 1 in 1 storage *item 5a above*) from AR&R when 1 year storage is empty at start of storm.

L	29.15	m	
n*	0.05		
S	0.01	m/m	
I	59.60	mm/hr	
t	16.05	min	Buffer time for 5 year storm

6a	Tc (1 year)		46	min	From above			
6b	Tc (5 year)		17	min	Time before 5 yr runoff occurs			
	Tc (10 year)	N/A		min	Storage assumes 5yr runoff occurs			
	Tc (100 year)	N/A		min	Storage assumes peak 10 year runoff			
7	Pre development runoff (average)						predev average/lot	
	1 year 1 hour		0.00	l/s			0	
	1 year critical (72 hr)		0.06	l/s			1.60E-04	160E-07
	5 year critical		3.63	l/s			9.69E-03	9.69E-06
	10 year critical		4.41	l/s			1.18E-02	1.18E-05
	100 year critical		9.16	l/s			2.44E-02	2.44E-05
8	Extra over 5 year storage							
	V		1.56	m3	assumes 1 yr. storage full at start of storm			
	Outlet		3.63	l/s	full 5 year outflow			
9	Extra 10 yr storage							
	V		0.74	m3	assumes 1 yr storage at start of storm			
	Outlet		3.63	l/s	full 5 year outflow			
10	Extra 100 year storage							
	V		4.46	m3	assumes 1 yr storage at start of storm			
	Outlet		4.41	l/s	full 10 year outflow			
11		ARI	Storage required		Outflow allowed	(non cumulative)		
		1	0.00621	m3/m2	0.000E+00	m3/s/m2		
		5 (e/o)	0.00416	m3/m2	9.687E-06	m3/s/m2		
		10 (e/o)	0.00197	m3/m2	9.967E-06	m3/s/m2		
		100 (e/o)	0.01189	m3/m2	1.177E-05	m3/s/m2		
		Cumulative Total	**2.42E-02**	**m3/m2**				

APPENDIX 3 - POST DEVELOPMENT PARAMETERS & CALCULATION SHEET (Lot Size B)

		Lot B							
1	Lot width		10	m					
	Lot depth		50	m					
	Area		500	m2					
2	Fraction impervious		0.85						
	Runoff coefficient								
3a	10,I,1		30.20	mm/hr	10 year 1 hr intensity				
	C1,10		0.17		pervious area runoff co				
	C10		0.79		10 year ARI runoff co				
		ARI Factor	Runoff coef.						
3b	C1	0.8	0.63		1year ARI runoff co				
	C5	0.95	0.75		5 year ARI runoff co				
	C10	1	0.79		10 year runoff co				
	C100	1.2	0.95		100 year ARI runoff co				
4	Raingarden design for critical 1 in 1 year								
4a	Lot Area		500	m2					
4b	Detention time		6	hrs					
4c	runoff coefficient		0.63						
4d	Depth of filter layer		1	m					
4e	width (m)	length (m)	area (m2)	time of det.(s)	k of filter or Velocity (m/s)	Outflow	Storage (m3)	depth (m)	Tc from calc sheet
	2	7.5	15	21600	4.63E-05	6.94E-04	3.06	0.20	45 min
						starts flowing after 6 hours			
							st. required	2.15	0.694444
5	1 year raingarden lot storage								
5a	V		3.06	m3	from basin sheet				
5b	outlet		0.69	l/s					
	This is assumed to be soil storage on lot								

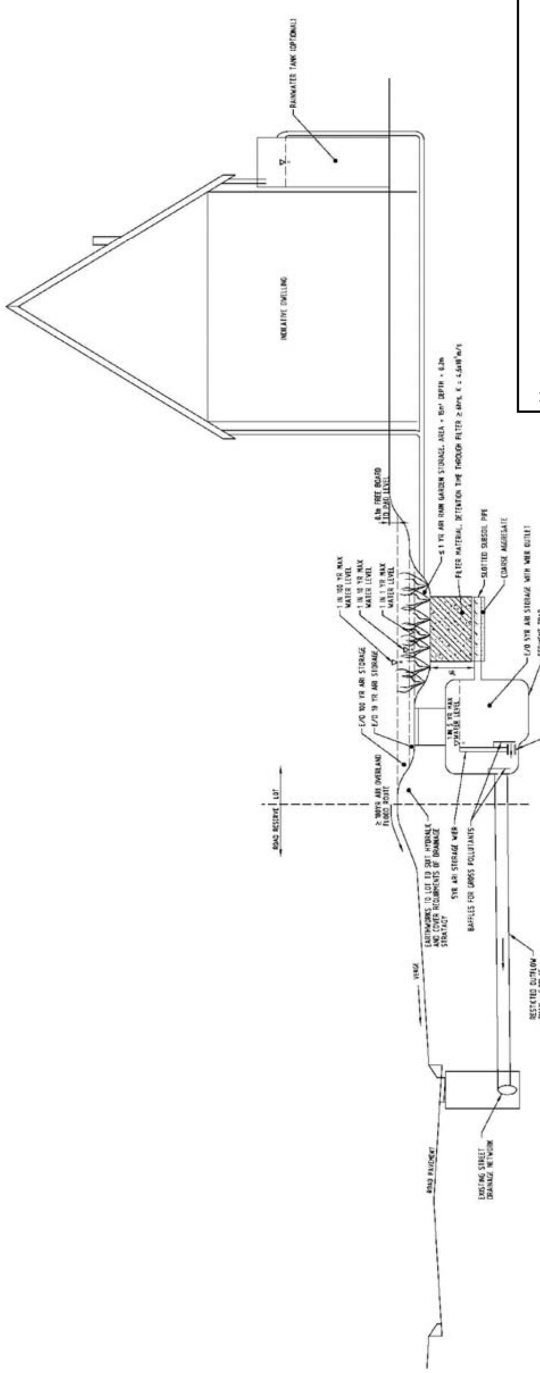
Approximated critical 5 year time of concentration calculator, (with consideration for 1 in 1 storage *item 5a above*)
from AR&R when 1 year storage is empty at start of storm.

L		50.99	m
n*		0.05	
		0.01	m/m
S			

	I	44.4	mm/h			
	t	25.41	min			
6a	Tc (1 year)	45	min	From above		
	Tc (5 year)	25	min	Time before 5 yr runoff occurs		
	Tc (10 year)	N/A	min	Storage assumes 5yr runoff occurs		
	Tc (100 year)	N/A	min	Storage assumes peak 10 year runoff		
7	Pre development runoff (average)					
					predev average/lot	
	1 year 1 hour	0.00	l/s		0	0
	1 year critical (72 hr)	0.06	l/s		1.60E-04	1.60E-07
	5 year critical	4.84	l/s		9.69E-03	9.69E-06
	10 year critical	5.88	l/s		1.18E-02	1.18E-05
	100 year critical	12.22	l/s		2.44E-02	2.44E-05
8	Extra over 5 year storage					
	V	2.08	m3	assumes 1yr. storage full at start of storm		
	Outlet	4.84	l/s	full 5 year outflow		
9	Extra 10 year storage					
	V	0.99	m3	assumes 1yr. storage full at start of storm		
	Outlet	4.84	l/s	full 5 year outflow		
10	Extra 100 year storage					
	V	5.79	m3	assumes 1yr. storage full at start of storm		
	Outlet	5.88	l/s	full 10 year outflow		

	ARI	Storage required		Outflow allowed	(non cumulative)
11					
	1	0.00612	m3/m2	0.000E+1	m3/s/m2
	5 (e/o)	0.00416	m3/m2	9.687E-06	m3/s/m2
	10 (e/o)	0.00198	m3/m2	9.687E-06	m3/s/m2
	100 (e/o)	0.01158	m3/m2	1.177E-05	m3/s/m2
	Cumulative Total	**2.38E-02**	**m2/m2**		

APPENDIX 4 - CONCEPT LOT DRAINAGE STRATEGY



CONCETUAL LOT DRAINAGE STRATEGY
EXAMPLE OF CONFORMING 500m² LOT
NOT TO SCALE

Notes

1. This drawing is only to be read in conjunction with Central Maddington Outline Development Plan Lot Drainage Strategy.

2. Volumes and levels are indicative only based on 500m² lot size. Refer to drainage strategy report for actual guidelines.

3. Drawing is indicative only of possible lot drainage concept all detailed designs are to be approved by Council prior to subdivisional approval being given.

4. Rain water tank is shown as optional and for illustration purposes. Provision of rainwater tanks is subject to the DAP and UWMP, and is not a direct requirement of this drainage strategy.

5. Rain garden design, soil and plan selection shall be subject to requirements of UWMP or equivalent.