

Canning Activity Centre

Local water management strategy

Prepared for City of Canning

By Essential Environmental

August 2016



essential 
environmental

Disclaimer and Limitation

This document is published in accordance with and subject to an agreement between Essential Environmental and the Client, City of Canning, for who it has been prepared for their exclusive use. It has been prepared using the standard of skill and care ordinarily exercised by environmental scientists in the preparation of such Documents.

This report is a qualitative assessment only, based on the scope of services defined by the Client, budgetary and time constraints imposed by the Client, the information supplied by the Client (and its agents), and the method consistent with the preceding. Essential Environmental has not attempted to verify the accuracy or completeness of the information supplied.

Any person or organisation that relies upon or uses the document for purposes or reasons other than those agreed by Essential Environmental and the Client without first obtaining the prior written consent of Essential Environmental, does so entirely at their own risk and Essential Environmental, denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this Document for any purpose other than that agreed with the Client.

Copying of this report or parts of this report is not permitted without the authorisation of the Client or Essential Environmental.

EXECUTIVE SUMMARY

This local water management strategy has been prepared to support the development of the Canning Activity Centre Structure Plan. The Canning Activity Centre Structure Plan provides a framework for the redevelopment and revitalisation of the Canning activity centre.

The Canning Activity Centre Local Water Management Strategy proposes that the redevelopment of the area will:

- i. Improve water quality within the stormwater system while maintaining the flood protection and conveyance capacity of the drainage system and ecological water requirements of the Liege St wetlands, Cannington Swamp threatened ecological community, Wharf Street (Civic Centre) wetlands and the Canning River.
- ii. Deliver an urban water environment that is reflective of the local identity and celebrates the linkages between the centre and the River through landscaping, green corridors and the development of an urban stream.
- iii. Optimise water use efficiencies including for irrigation and increase water reuse.
- iv. Achieve water sensitive landscapes (both public and private realm) which incorporate water quality management and reflect the Western Australian climate.

These objectives are to be achieved through the implementation of strategies and design criteria for stormwater and groundwater management; water resource use; and landscaping which have been developed in response to the proposed redevelopment and the local site conditions.

The environmental characteristics of the Canning Activity Centre study area are similar to much of the Canning plain, having flat topography, clayey soils overlain by sand (Figure 3) and largely a moderate to low risk of acid sulfate soils (Figure 4). There are a small number of contaminated sites identified in the Activity Centre study area, which are classified as remediated for restricted use and are not expected to be a significant constraint to redevelopment (Figure 4).

The redevelopment of the Canning Activity Centre is relatively unconstrained by water resources as it is already largely developed and contains existing infrastructure in an already modified environment. There are substantial areas of vacant land, some of which contains an area known locally as Cannington or Carousel Swamp, which is mapped by the Department of Environment and Conservation as a Conservation Category Wetland (Figure 5) and contains a Threatened Ecological Community. The Canning Activity Centre also contains two significant constructed wetlands; Liege Street and Wharf Street (or Civic Centre) wetlands (Figure 7). These wetlands were constructed in order to reduce nutrient loads to the Lower Canning River. The Liege Street wetland is classified as a Conservation Category Wetland. It is noted that no development is proposed in the vicinity of these significant water resources that is likely to impact on their values.

Stormwater and groundwater management

Groundwater is shallow across the Activity Centre area (Figure 7) and a combination of surface and subsurface drainage is used throughout the area to manage groundwater levels. There are three Water Corporation drainage catchments and one City of Canning drainage catchments that intersect the study area (figure 7). These are:

- Cockram Street Main Drain (Water Corporation)
- Wharf Street Main Drain (Water Corporation)
- Lacey Street Main Drain (Water Corporation)
- River Road Drain (City of Canning)

The Water Corporation have proposed a number of upgrades to the Cockram Street main drainage system within the boundary of the study area. Any development proposals will need to incorporate these upgrades or make alternative provisions to ensure that the capacity of the main drains is sufficient to meet the conditions of the Water Corporation's operating license.

There are two locations within the Canning Activity Centre where significant modifications to the existing main drainage system are proposed for the creation of urban streams. These are the Cockram Street Main Drain from Sevenoaks Street to Cecil Avenue Design and the section of existing open drain from Wharf Street to Pattie Street (Figure 8). In these two locations a detailed area plan will be required, supported by an urban water management plan which will include detailed designs for the modified drainage infrastructure. Designs will need to deliver the objectives of this local water management strategy but must also satisfy the standards and guidelines appropriate to urban main drainage infrastructure as defined by the Water Corporation's main drainage manual and the *Stormwater management manual for WA*.

Water resource use

Groundwater is used by the City for irrigation of public open space and water efficient landscape design and irrigation practices will be used to limit future public open space irrigation demand to current licensed volumes.

Because the study area is largely developed, there are extensive networks of all major services and it is unlikely that significant upgrades will be required to provide for the water and wastewater needs of the proposed redevelopment. This also means that widespread development of a fit-for-purpose water supply scheme is likely to be impractical. There are however, significant opportunities for industrial and commercial sites to incorporate rainwater tanks or greywater recycling systems on an individual basis and contribute to reducing the demand for potable water from the Water Corporation's integrated water supply system.

Landscaping

The Canning Activity Centre contains a large proportion of public open space and recreation areas and the re-landscaping of these areas to provide a more connected and functional network of open spaces integrating better urban water management outcomes will be critical to changing the character of the Activity Centre and promoting future urban renewal.

Implementation

As this area is an existing town centre and urban area, implementation of this local water management strategy will occur largely on an ad-hock basis, as development and redevelopment proposals are approved and constructed. The key opportunities for redevelopment include:

- Commercial development associated with Cecil Avenue and Westfield Carousel including creation of urban streams
- High density residential throughout the core
- Creation of landmark parklands and other public open spaces
- Residential intensification throughout the structure plan area

It is recommended that where Detailed Area Plans are prepared to guide subdivision, they are supported by an Urban Water Management Plan that provides further detailed designs and demonstrates how the objectives contained in this Strategy are to be achieved. Any subdivision and development should be in accordance with the objectives, strategies and design criteria contained in this Local Water Management Strategy, and development will need to be consistent with any relevant design guidelines.

CONTENTS

| | |
|--|----|
| Executive summary | i |
| 1 Introduction | 5 |
| 2 Proposed development | 7 |
| 2.1 The strategy area | 7 |
| 2.2 Existing Land use | 7 |
| 2.3 Planning process and approvals | 7 |
| 2.4 Proposed development | 8 |
| 3 Existing site characteristics | 10 |
| 3.1 Climate | 10 |
| 3.2 Topography and geology | 11 |
| 3.3 Flora and fauna | 11 |
| 3.4 Wetlands | 14 |
| 3.5 Heritage | 14 |
| 3.6 Surface water | 14 |
| 3.6.1 Stormwater management system | 18 |
| 3.7 Groundwater | 20 |
| 3.8 Water use | 21 |
| 3.8.1 Potable water supply | 21 |
| 3.8.2 Non-potable supply | 22 |
| 3.8.3 Water balance | 22 |
| 3.9 Wastewater services | 23 |
| 4 Water management strategy | 24 |
| 4.1 Stormwater and groundwater management | 24 |
| 4.1.1 Water Corporation drainage system | 24 |
| 4.1.2 Local stormwater and groundwater management | 25 |
| 4.1.3 Design criteria | 25 |
| 4.2 Water resource use | 26 |
| 4.3 Landscaping | 27 |
| 5 Implementation | 28 |
| 5.1 Requirements for future planning and development | 28 |
| 5.1.1 Detailed Area Plans | 28 |
| 5.1.2 Subdivision | 29 |
| 5.1.3 Development | 29 |
| 5.2 Review | 30 |
| 6 References and resources | 31 |

Appendices

Appendix 1 – City Centre Structure Plan

Appendix 2 – Cannington swamp vegetation mapping

FIGURES

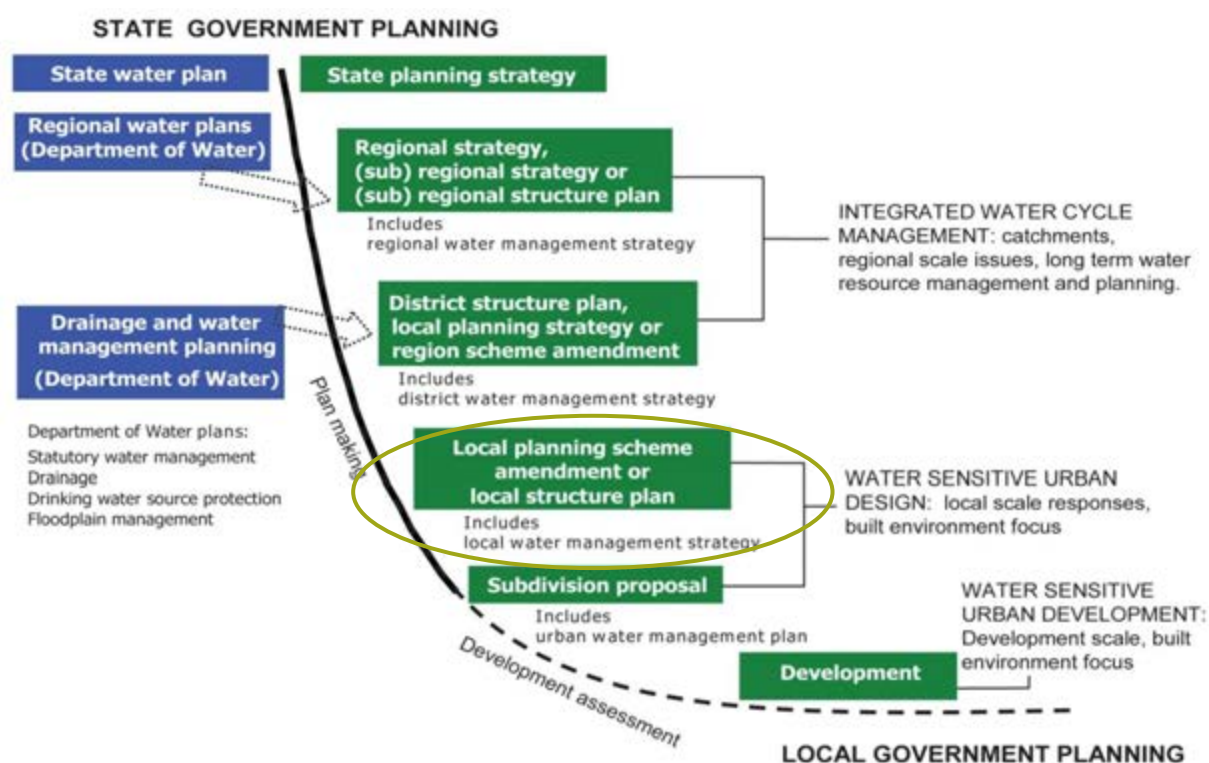
| | |
|--|----|
| Figure 1: Planning framework, integrating drainage planning with the land planning process | 5 |
| Figure 2: Strategy area and existing land use | 9 |
| Figure 3: Surface geology | 12 |
| Figure 4: Acid sulfate soil risk and contaminated sites | 13 |
| Figure 5: Wetlands and environmentally sensitive areas | 15 |
| Figure 6: Heritage | 16 |
| Figure 7: Existing hydrology and drainage | 17 |
| Figure 8: Proposed modifications to existing drainage system | 19 |

1 INTRODUCTION

This local water management strategy has been prepared to support the development of the Canning Activity Centre Structure Plan. The Canning Activity Centre Structure Plan provides a framework for the redevelopment and vitalisation of the Cannington activity centre.

Cannington is identified as a strategic metropolitan centre under *State Planning Policy 4.2: Activity Centres for Perth and Peel* (Western Australian Government, 2010). Strategic metropolitan centres are the main regional activity centres. They are multipurpose centres that provide a diversity of uses. These centres provide the full range of economic and community services necessary for the communities in their catchments.

Although an activity centre structure plan is not specifically mentioned in *Better urban water management* (WAPC, 2008a), much of the planning activity is at the local level. Thus a local water management strategy has been prepared to support the structure plan. The position of this strategy within the state government planning framework is defined in *Better urban water management* (WAPC 2008a) and *Planning bulletin no. 92, urban water management* (WAPC 2008b) and is outlined in Figure 1.



Note: The above diagram depicts the optimal process. In situations where there is existing zoning and a lack of guiding information, a flexible approach to implementation may be required. This is at the discretion of the Western Australian Planning Commission on advice of the Department of Water.

Figure 1: Planning framework, integrating drainage planning with the land planning process (WAPC 2008a)

In addition to *State Planning Policy 2.9: Water Resources* (Government of WA, 2006) and *Better urban water management* (WAPC 2008a), the following documents inform this plan's strategies and management principles:

- *Canning Plain Catchment Local Water Quality Improvement Plan* (SRT 2010)
- *Canning Plain Catchment Final Report and Action Plan* (SERCUL 2004)
- *Hydrological and nutrient modelling of the Swan Canning coastal catchments* (DoW 2010)
- *From Drains to living streams: Canning – integrated local area planning study* (CoC 1995)
- *Interim: Developing a Local Water Management Strategy* (DoW, 2008)

2 PROPOSED DEVELOPMENT

This development involves the revitalisation of an existing urban activity centre which includes large commercial areas, some residential areas, two Water Corporation main drains, a Western Power site, Greyhound track and a major transport route.

2.1 The strategy area

Canning Activity Centre occupies approximately 170 ha of land in Cannington bounded by Wharf St and Henry Street to the north and Station St and the Canning River to the south.

This local water management strategy considers an area slightly larger than the Activity Centre extending to include the Civic centre complex and wetlands, beyond Wharf St and Renou St in the north and to Nicholson Rd in the south east (Figure 2).

2.2 Existing Land use

Land use in the study area is largely retail including the Carousel shopping centre, encircled by residential with large areas set aside for recreational purposes and utilities, notably; a large Western Power site, WA Greyhounds and Coker Park. There is also a substantial amount of vacant land within the study area (Figure 2).

Broadly land use in the study area is broken down as follows:

- Residential (77 Ha)
- Education (8 Ha)
- Commercial/Industrial (85 Ha)
- POS/Recreation (31 Ha)
- Drainage & foreshore (27 Ha)
- Roads and reserves (84 Ha)
- Vacant (24 Ha)

2.3 Planning process and approvals

The bulk of the study area is currently zoned 'central city area' under the metropolitan region scheme, with the remainder being zoned 'urban' or 'public purposes (High School)'. Under the current town planning scheme number 40 the central study area is zoned 'city centre' and 'city centre deferred' with small areas of other zones including; residential, civic and cultural areas, public purposes, local park and recreation areas and private clubs and institutions.

Cannington is identified in the Department of Planning's *Directions 2031 and beyond* (2010a) as one of the 10 Strategic Metropolitan Activity Centres. The document highlights Cannington's importance at a strategic level and provides a general framework as to its significance in comparison with other centres across the Perth metropolitan region.

Strategic Metropolitan Centres are expected to function as a multi-purpose hub "providing a mix of retail, office, community, entertainment residential and employment activities and are well connected by high frequency public transport" (WAPC: 2010a pg 35).

Statement of Planning Policy No 4.2 Activity Centres for Perth and Peel (WAPC 2010b) specifies broad planning requirements for the planning and development of new activity centres as well

as the redevelopment and renewal of existing centres in Perth and Peel. It identifies distribution, function, broad land use and urban design criteria for activity centres, and establishes objectives for coordination of land use and infrastructure planning as well as integration with public transport.

The redevelopment of the Canning Activity Centre is likely to occur over an extended duration, given that the area is largely developed, albeit with substantial pockets of vacant land. The development of an improved public open space network incorporating better urban water management will be critical to changing the character of the Activity Centre and promoting future urban renewal.

The existing drainage network through the study area is owned and managed by the Water Corporation and the City of Canning and discharges to the Canning River via the Liege Street and Wharf Street (civic centre) wetlands. Modifications to this drainage system to provide better outcomes for the environment and community will need to be approved by:

- Department of Water
- Water Corporation – for works on an within their drainage infrastructure
- Swan River Trust – for works potentially impacting the Canning River
- Department of Environment and Conservation – for works potentially impacting the Liege Street Conservation Category Wetland, Cannington (Carousel) Swamp Conservation Category Wetland and associated Threatened Ecological Community

2.4 Proposed development

The draft *Canning Activity Centre Structure Plan* (2012) has been developed by Hames Sharley and is provided in Appendix 1. The proposed redevelopment of the Canning Activity Centre aims to increase the intensity and diversity of uses within the core area, activating Cecil Avenue as a **'main street'** and enhance the public domain through provision of landscaping and community spaces, supported by further increases in residential density throughout the structure plan area.

The draft *Canning Activity Centre Structure Plan* proposes a shift away from predominantly retail and service commercial within the core to a more intense and diverse city centre with increased mixed use and high density residential development. Its implementation will significantly increase the proportion of land allocated to office, residential, retail and entertainment areas, particularly within the core area. The growth plan outlines the following increases:

In Core

- 86,000 m² retail and entertainment floorspace including 8000 m² along the main street (Cecil Avenue)
- 80,000 m² office space
- 3220 residential dwellings (100 m²)

Out of Core

- 14,500m² large format retail
- 20,000 m² service commercial
- 22,500 m² storage
- 1,000 m² utilities
- 3400 residential dwellings (100 m²)

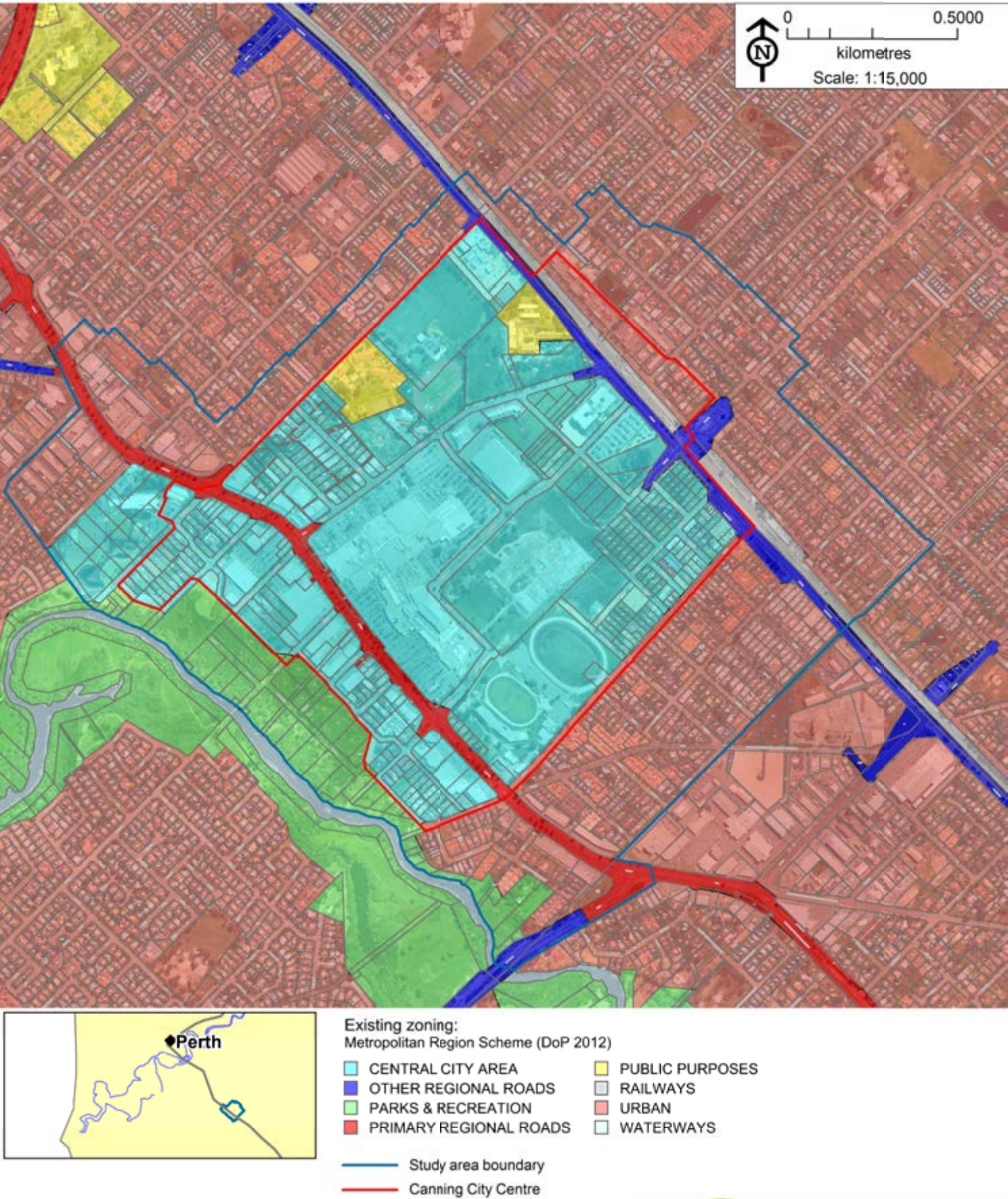
Existing residential areas

- Organic growth to increase the total number of dwellings from 1,260 to 1,510

It is anticipated that the implementation of the *Canning Activity Centre Structure Plan* will be opportunistically staged over a number of years.

City of Canning - Canning City Centre local water management strategy

Figure 2: Study area and existing land use



* ©2012. While Essential Environmental has taken care to ensure the accuracy of this product, Essential Environmental and the City of Canning make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Essential Environmental and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.
Data source: City of Canning, Landgate, DoW, DoP, DMP, DEC, DIA, HCWA. Created by: H Brookes. Projection: MGA: zone 50.



3 EXISTING SITE CHARACTERISTICS

3.1 Climate

The climate in the City of Canning is typical of the south-west of Western Australia with hot dry summers and cool wet winters. The nearest Bureau of Meteorology weather station is located some six kilometres away at Gosnells.

The average annual rainfall recorded in Gosnells since 1961 is 831 mm but has declined in recent years to an average of 795 mm since 1981 and 749 mm since 2001. The minimum recorded annual rainfall was in 2010 at just 500 mm and the maximum recorded was in 1965 at 1184 mm.

The majority of rainfall is experienced in the winter between May and September with the driest months being January and February.

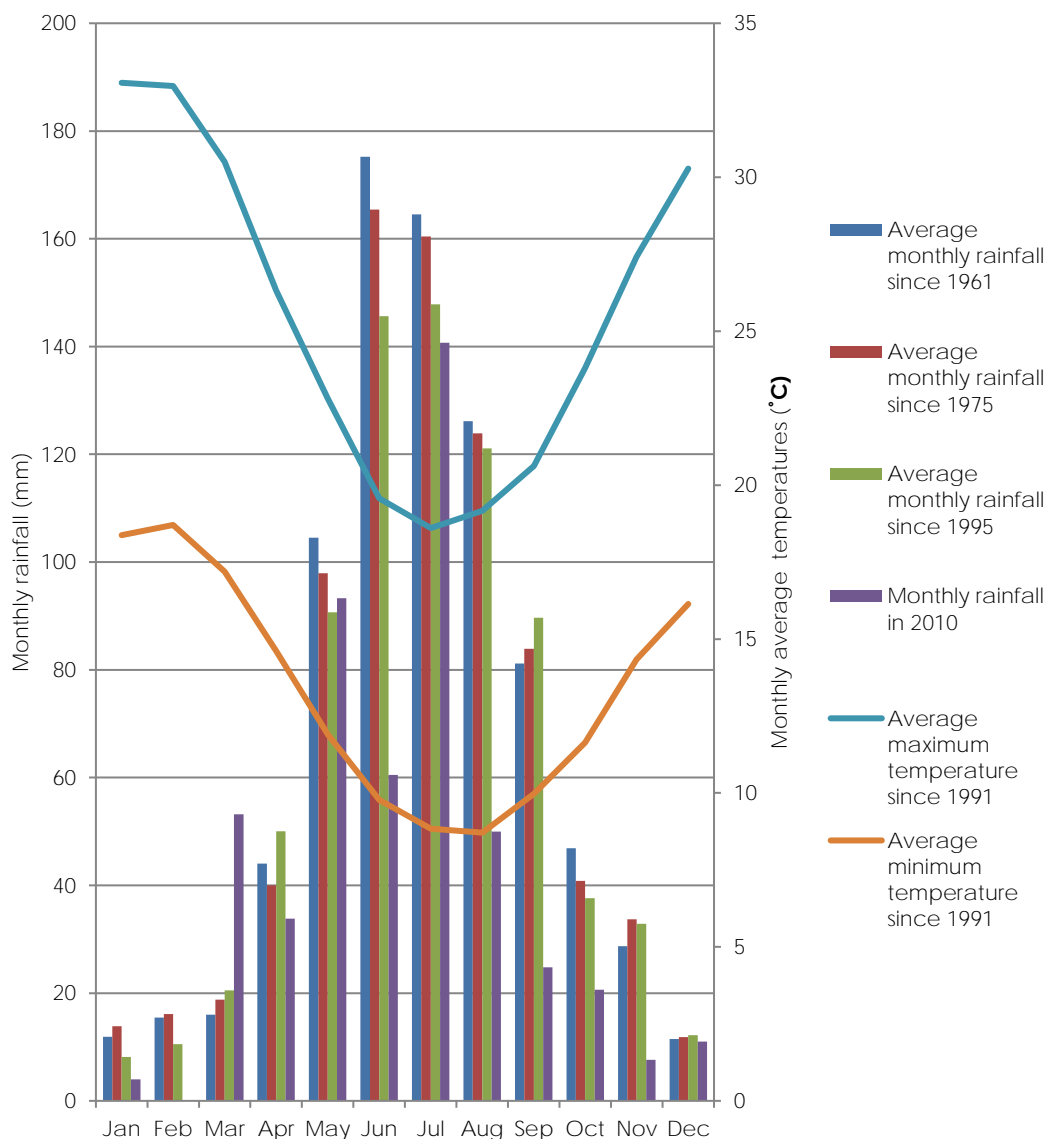


Chart 1: Climate summary data (Gosnells)

3.2 Topography and geology

The surface elevation of the study area is around 2 m AHD at the river, rising to about 4 m AHD at Albany Highway. It remains almost flat to the railway, only rising one metre further to reach around 5 m AHD at the railway.

The surface geology of the study area (Figure 3) is broadly classified as thin Bassendean sand over sandy clay to clayey sand of the Guildford Formation. The thin surface sand layer has very high permeability but the underlying formation ranges from low to moderate and may be expected to create localised perching of groundwater and will limit the efficacy of soakwells.

Acid sulfate soils

Acid sulfate soil risk mapping has been undertaken for the entire Swan coastal plain (DEC 2010) and the majority of the study area is classified as having a moderate to low risk of acid sulfate soils occurring within 3m of the natural surface but high to moderate risk of acid sulfate soils beyond 3 m of the natural surface. A large part of the area between the River and Albany Highway is classified as having a high to moderate risk of acid sulfate soils occurring within 3m of the natural surface and this area extends across the Highway beneath the Carousel shopping centre along the route of the original Cockram St drain.

Acid sulfate soil risk mapping is presented on Figure 4.

Contaminated sites

There are two registered contaminated sites within the study area (Figure 4); the western power site, and 24 River Rd both of which are classified as remediated for restricted use. There are three further sites just outside the study area boundary; again these are all classified remediated for restricted use.

3.3 Flora and fauna

The study area is highly urbanised and apart from the Canning River foreshore and Cannington swamp there is virtually no remnant vegetation.

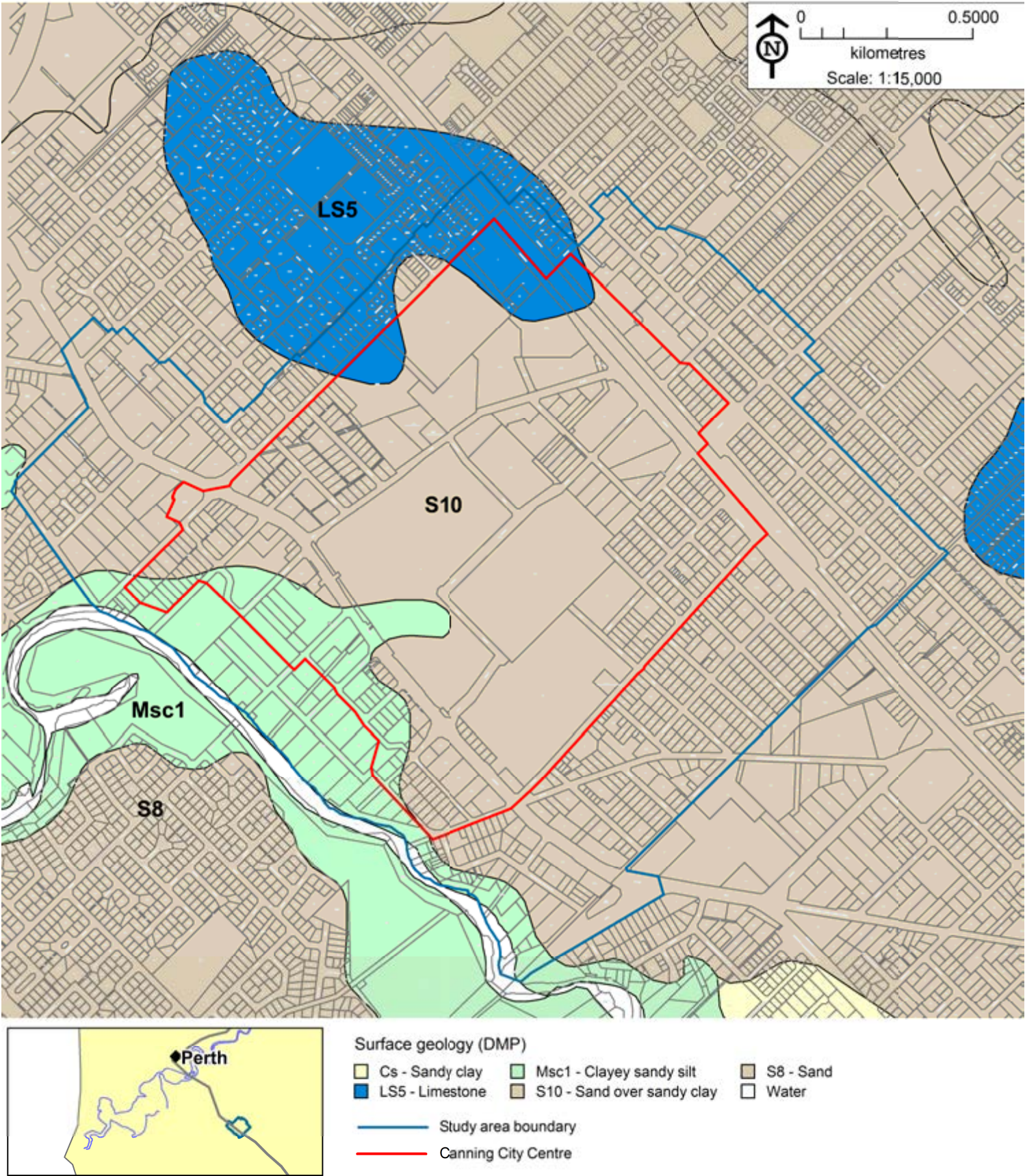
There is an identified Threatened Ecological Community in the Cannington Swamp area which has been subject to a flora and fauna investigation undertaken for Western Power by Woodman Environmental in 2005 (Appendix 2). They concluded that the remnant vegetation within the Cannington Terminal study area has very high conservation significance for the following reasons:

- It is situated within the Guildford Vegetation Complex which has less than 10% of its original area remaining vegetated.
- All of the remnant vegetation forms components of Threatened Ecological Communities, some of which are also listed under the Commonwealth *Environmental Protection and Biodiversity and Conservation Act 1999*.
- The presence of three Priority flora species.
- The presence of an unusually high number of aquatic species.

It was recommended that there be no further clearing within the vegetated areas of the study area and that these areas be rehabilitated where possible (Woodman Environmental, 2005).

City of Canning - Canning City Centre local water management strategy

Figure 3: Soil types



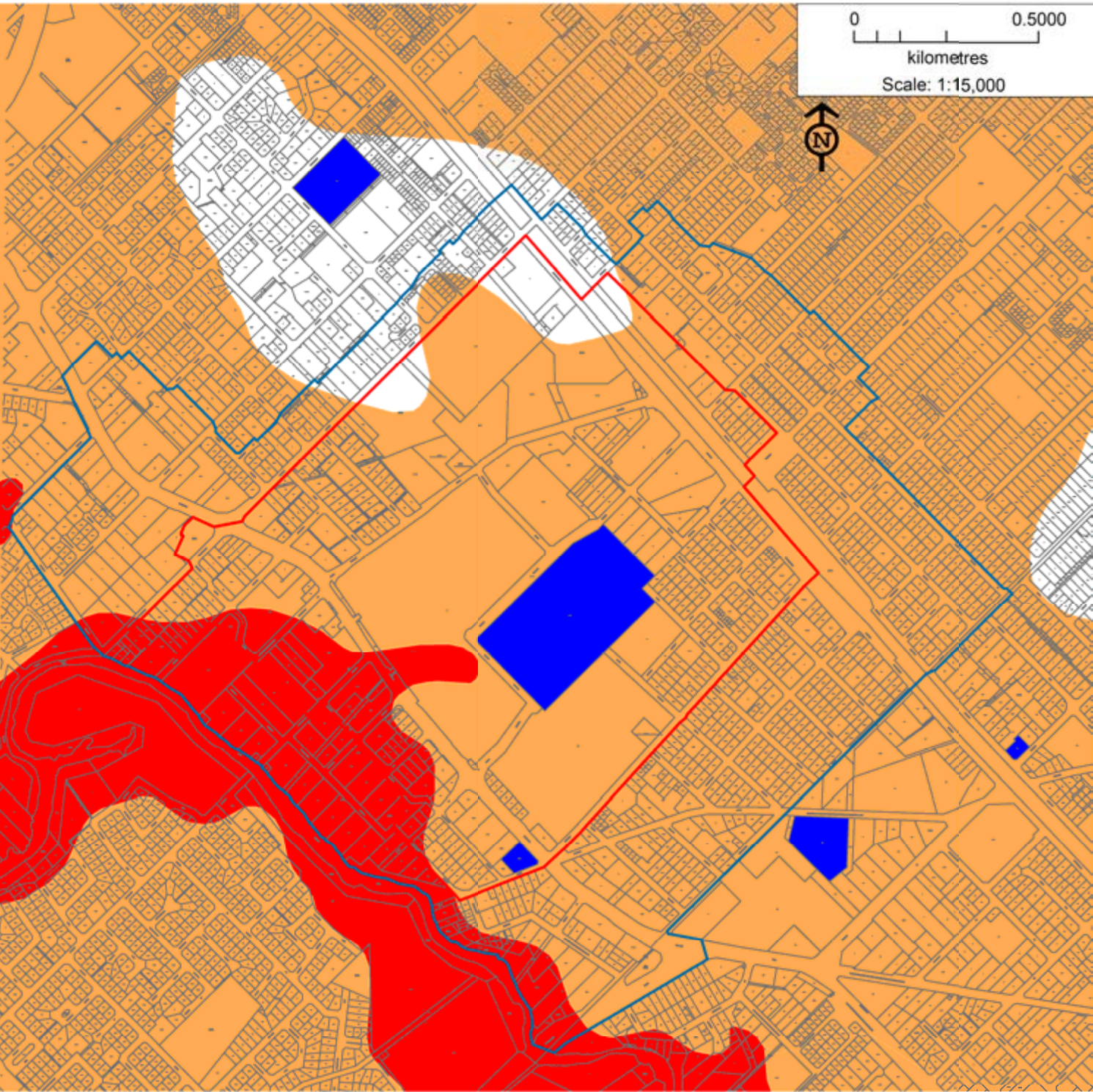
*©2012. While Essential Environmental has taken care to ensure the accuracy of this product, Essential Environmental and the City of Canning make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Essential Environmental and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: City of Canning, Landgate, DoW, DoP, DMP, DEC, DIA, HCWA. Created by: H Brookes. Projection: MGA: zone 50.



City of Canning - Canning City Centre local water management strategy

Figure 4: Acid sulfate soil risk and registered contaminated sites



- Study area boundary
- Canning City Centre
- Contaminated sites (DEC 2012)

Acid sulfate soil risk (DEC)

- High to moderate risk
- Moderate to low risk

* ©2012. While Essential Environmental has taken care to ensure the accuracy of this product, Essential Environmental and the City of Canning make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Essential Environmental and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: City of Canning, Landgate, DoP, DoP, DMP, DEC, DIA, HCWA. Created by: H Brookes. Projection: MGA: zone 50.



essential
environmental

3.4 Wetlands

The study area contains an area known locally as Cannington or Carousel Swamp, which has been mapped by the Department of Environment and Conservation as a conservation category wetland (figure 5). The wetland contains a Threatened Ecological Community as discussed in section 3.3.

The study area contains two significant constructed wetlands; Liege Street and Wharf Street (Civic Centre) wetlands (figure 5), both of which were constructed with the aim of reducing nutrient loads to the Lower Canning River. Liege Street wetland lies within the floodway of the Canning River and is classified as a conservation category wetland. Wharf Street wetland lies partly within the Canning River flood fringe but has not been included in geomorphic wetland mapping by the Department of Environment and Conservation.

3.5 Heritage

There has been a long history of use of Cannington by the local Nyoongar population, specifically the Beeloo and Beeliar tribes (Hughes-Hallet: 2010). The Canning River (traditionally known as 'Djarlgarra' signifying a 'place of abundance') was the primary focus as "the river and wetlands were an important source of food and shelter" and also served as a track to the Darling Ranges (Hughes-Hallet: 2010). There is a site of significance identified by the Department of Indigenous Affairs located on the southern bank of the River Canning opposite what is now known as Masons Landing (figure 6).

Of the post-European land uses in the area the only remaining heritage registered sites are the Woodloes Homestead and the City of Canning Town Hall (Heritage Council of WA). The Cannington War Memorial makes up the third heritage registered site but this falls outside the study area boundary.

3.6 Surface water

The study area is bounded on one side by the Canning River. The floodway of the River has been reserved and extends to approximately half way between the River and Albany Highway. There are further areas of flood fringe which extend towards Albany Highway. These areas largely contain light industrial and commercial land uses, although there are some residences.

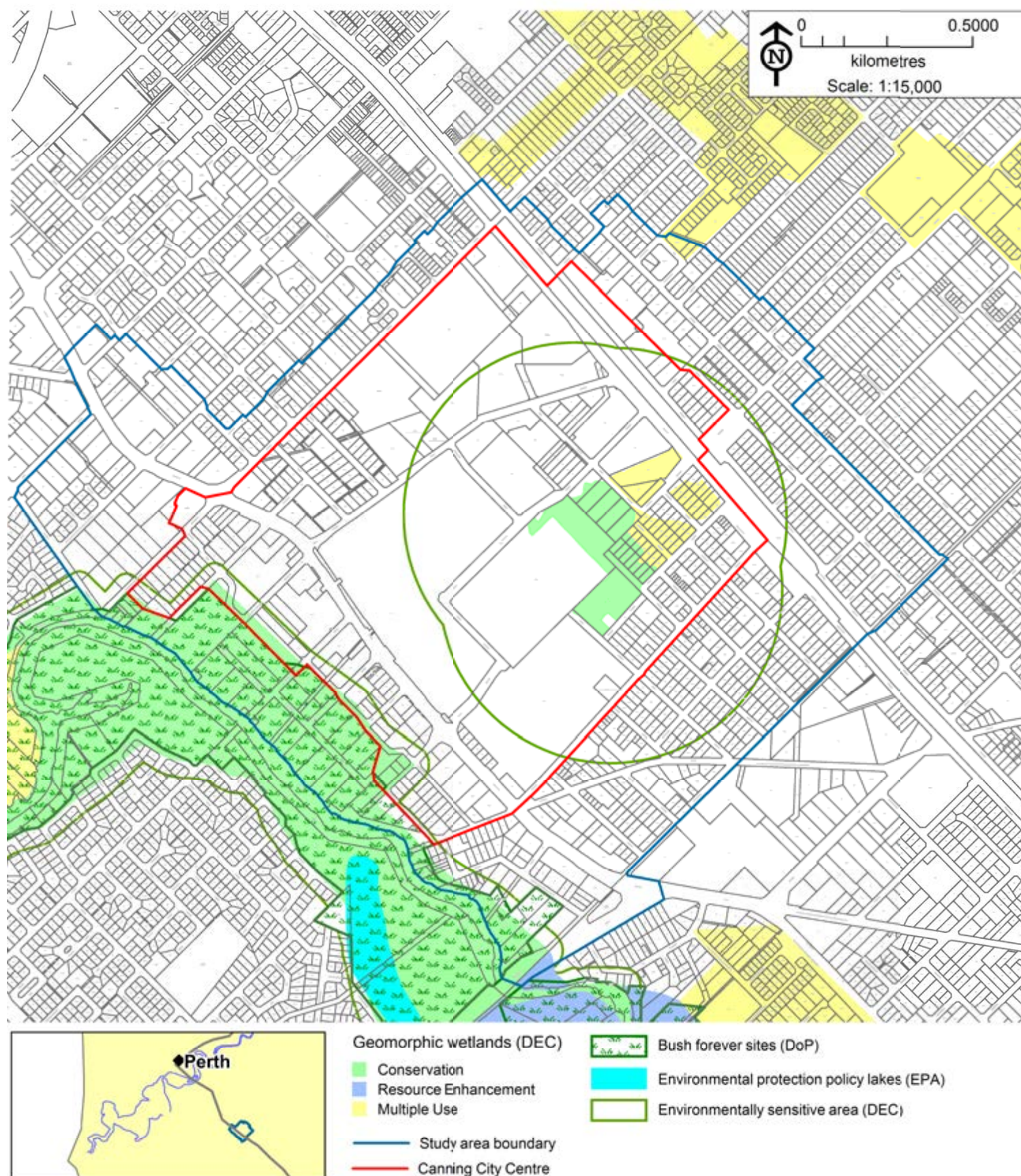
There are three Water Corporation drainage catchments and one City of Canning drainage catchments that intersect the study area (figure 7). These are:

- Cockram Street Main Drain (Water Corporation)
- Wharf Street Main Drain (Water Corporation)
- Lacey Street Main Drain (Water Corporation)
- River Road Drain (City of Canning)

The bulk of the study area lies within the lower catchment of the Cockram Street Main Drain which discharges to the Liege Street wetlands. The southern corner of the study area, including the Greyounds WA site is within the catchment of the River Road Drain. The Lacey Street Main Drain catchment lies to the south east and accounts for a small part of the study area, as does the Wharf Street main Drain catchment which lies to the north and terminates at the Civic centre wetlands.

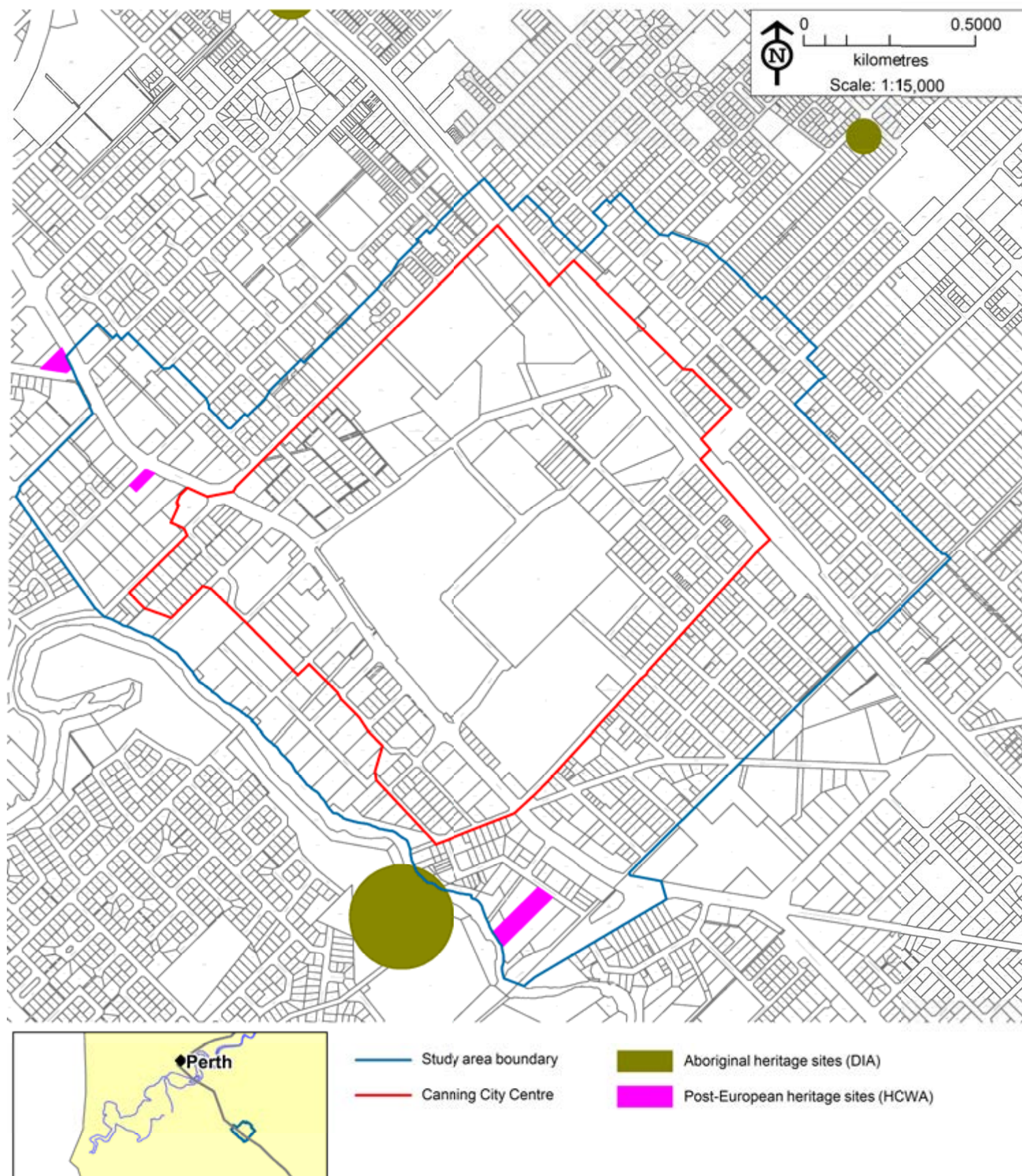
City of Canning - Canning City Centre local water management strategy

Figure 5: Wetlands and environmentally sensitive areas



City of Canning - Canning City Centre local water management strategy

Figure 6: Registered Aboriginal and Post-European heritage sites



* ©2012. While Essential Environmental has taken care to ensure the accuracy of this product, Essential Environmental and the City of Canning make no representations or warranties about its accuracy, completeness or suitability for any particular purpose. Essential Environmental and client cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

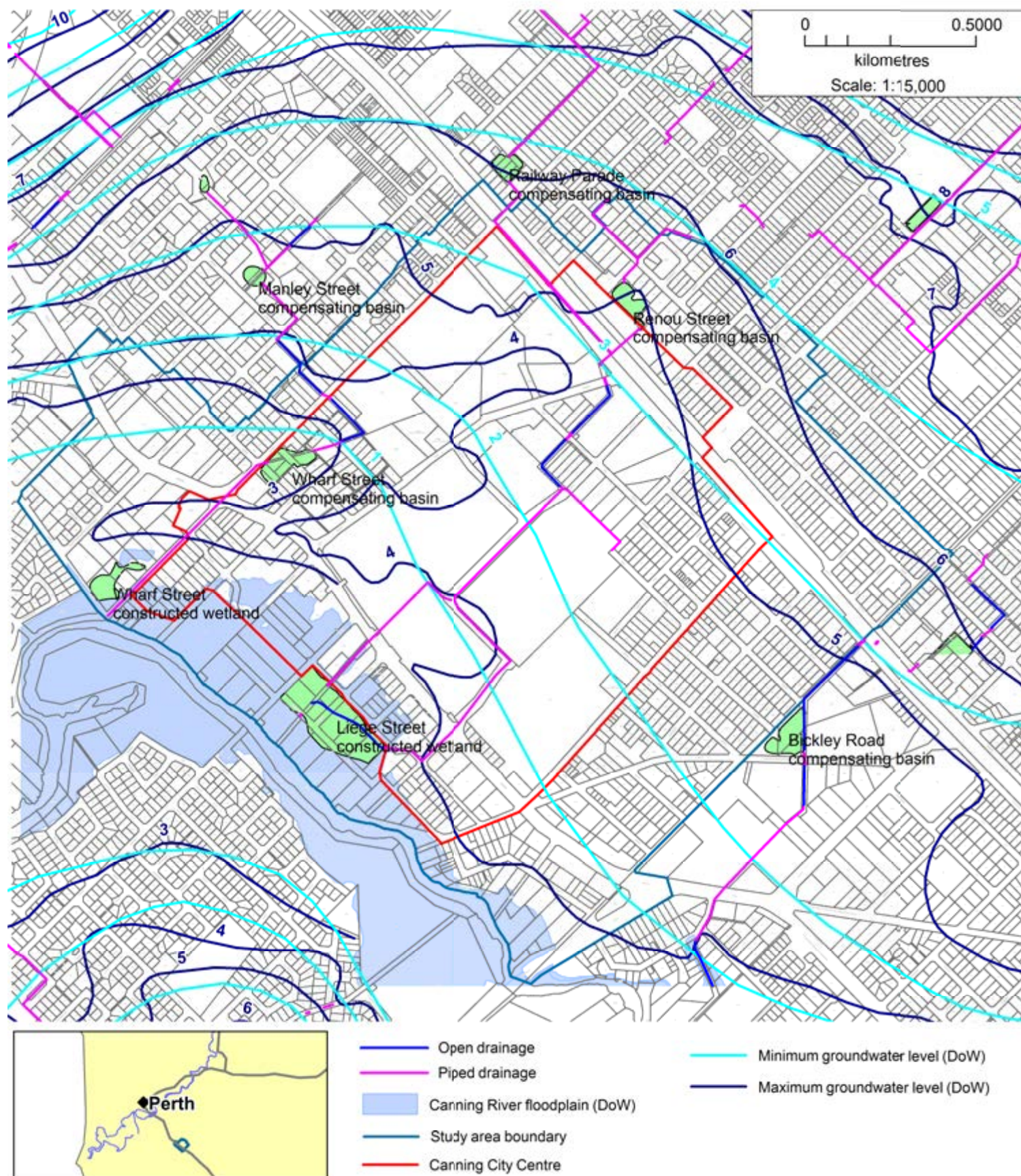
Data source: City of Canning, Landgate, DoW, DoP, DMP, DEC, DIA, HCWA, Created by: H Brookes. Projection: MGA: zone 50.



essential
environmental

City of Canning - Canning City Centre local water management strategy

Figure 7: Existing hydrology and drainage



Data collected at gauging station 616123 for the Liege Street Catchment from 2005-08 indicated annual flow ranged from 0.9 to 2.4 gigalitres per year. There was no flow data from the other main drains to determine annual flow (SRT 2010).

3.6.1 Stormwater management system

The Water Corporation have undertaken capacity review modelling of all three drainage catchments relevant to the study area and the results of their analysis are presented in tables 1 and 2. Any development proposals will need to incorporate these upgrades or make alternative provisions to ensure that the capacity of the main drains is sufficient to meet the conditions of the Water Corporations operating license.

Table 1: Surface water modelling results (Water Corporation 2003, 2007) – peak flow

| Location | Post-development | |
|---|------------------|----------|
| | 10 year | 100 year |
| Inlets: | | |
| • Cockram St MD at Renou St basin outlet | 1.06 | 1.20 |
| • George St BD at Railway Pde basin outlet | 0.32 | 0.35 |
| • Wharf St MD at Wharf St | 0.84 | 1.28 |
| Outlets: | | |
| • Liege St MD at Liege St wetland inlet | 3.45 | 3.78 |
| • Wharf St MD at River (model predates construction of Civic wetland) | 1.20 | 1.54 |
| Notes: | | |
| • All flows are in m ³ /s | | |

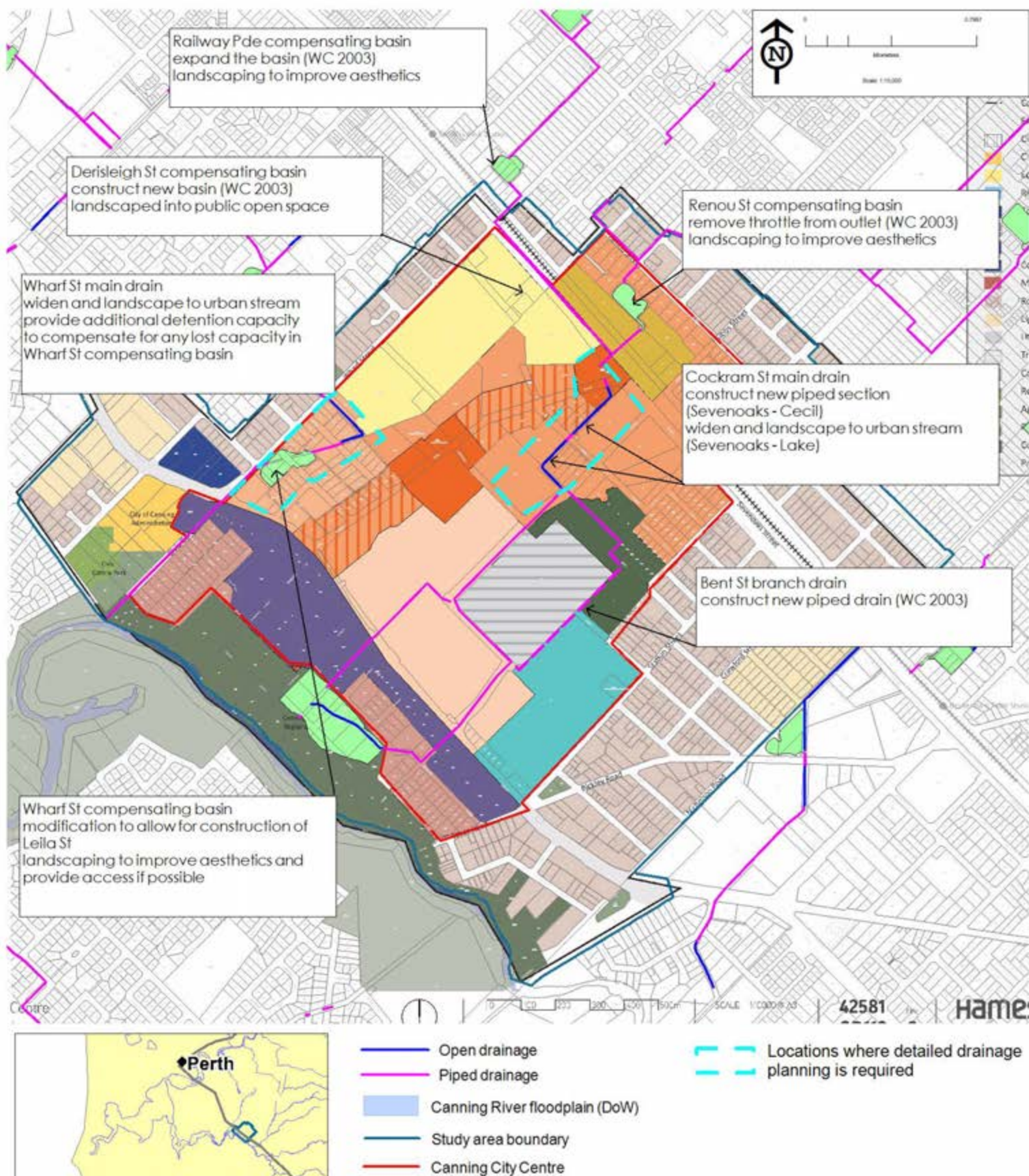
Table 2: Surface water modelling results (Water Corporation 2003, 2006, 2007) – top water level

| Location | Pre-development | | Post-development | |
|---|-----------------|----------|------------------|----------|
| | 10 year | 100 year | 10 year | 100 year |
| Inlets: | | | | |
| • Cockram St MD at Renou St basin | 4.92 | 5.24* | 4.87 | 5.26* |
| • George St BD at Railway Pde basin | 5.34 | 6.03* | 5.97 | 6.26* |
| • Wharf St MD at Wharf St | 2.29 | 3.14 | 2.54 | 3.31 |
| Outlets: | | | | |
| • Liege St MD at Liege St wetland | 1.03 | 2.51* | 1.07 | 2.51* |
| • Wharf St MD upstream of River (model predates construction of Civic wetland) | 2.33 | 3.43* | 2.48 | 3.70* |
| Notes: | | | | |
| • All levels are expressed as m AHD. | | | | |
| • *indicates that flooding to surrounding public open space is predicted at this location in the 100 year ARI event | | | | |

The Water Corporation modelled existing and 'ultimate development' scenarios based on structure planning available at the time to identify the existing and post-development capacity of the system. As a result of the modelling undertaken, the Water Corporation have proposed a number of upgrades to the Cockram Street main drainage system within the boundary of the study area (figure 8).

City of Canning - Canning City Centre local water management strategy

Figure 8: Proposed modifications to existing drainage system



These are:

- Expansion of Railway Parade compensating basin
- Removal of the throttle at the outlet of the Renou Street compensating basin
- Augmentation of Bent Street Branch Drain
- Construction of a new compensating basin on the George Street Branch Drain at Derisleigh St (recently completed)

Post-development model data presented in tables 1 and 2 assume that all of these upgrades have taken place. As stated earlier, any development proposals will need to incorporate these upgrades or make alternative provisions to ensure that the capacity of the main drains is sufficient to meet the conditions of the Water Corporations operating license.

There are two locations where significant modifications to the existing main drainage system are proposed within the draft Canning Activity Centre Structure Plan (Appendix 1). These are:

- Cockram Street Main Drain – It is proposed that the short section of open drain from Sevenoaks Street to Cecil Avenue is replaced with a piped drain. Downstream of this point the drain will remain open but will be widened and landscaped into an urban stream within linear public open space providing a connection from Cecil Avenue to Lake Street.
- Wharf Street Main Drain – It is proposed the section of existing open drain from Wharf Street to Pattie Street is widened and landscaped. It is hoped that sufficient capacity can be provided here to replace capacity in the Wharf Street compensating basin when Leila Street is extended through to Wharf Street.

In these two locations a detailed area plan will be required, supported by an urban water management plan which will include detailed designs for the modified drainage infrastructure. Designs must satisfy the standards and guidelines appropriate to urban main drainage infrastructure as defined by the Water Corporation's main drainage manual and the *Stormwater management manual for WA*.

3.7 Groundwater

According to the *Perth groundwater atlas* (DoW 2006) the maximum groundwater level within the study area is approximately at ground level, with minimum groundwater levels (DoW 2003) situated approximately 3 m below ground level (figure 7). Groundwater flows from the northeast towards the River in the southwest of the study area.

Because the study area is characterised by low to moderate soil permeability and shallow groundwater, lots are predominantly directly connected to the drainage system and little on site detention or retention is provided.

Hydrogeological investigations were undertaken by Parsons Brinkerhoff in 2005 in the Cannington swamp area, which is within the study area located between the Western Power site and the railway. These investigations suggest that there is a degree of perching of groundwater atop sandy clays found in the Swamp area that may be more extensive through the study area. During the investigations, regional groundwater levels were found to be close to their minimum at approximately 3 m below ground level, however it was observed that groundwater was present between the surface and 0.5 m below ground level and there was some standing water on the surface. There had been rainfall in the preceding 24 hours.

The study area is located within the City of Canning subarea of the Perth groundwater management area. The aquifers present in order of depth from the surface are:

- Unconfined Perth Superficial
- Confined Perth Leederville
- Confined Perth Yarragadee

There is currently no published allocation plan for the Perth groundwater management area. Generally both the Leederville and Yarragadee aquifers are over-allocated in this groundwater management subarea (see table 3 below) although some capacity to increase allocations from the Superficial aquifer remains.

Table 3: Groundwater allocation limits

| Aquifer | Allocation limit (kL/year) | Licensed allocation | Allocated, committed and requested |
|--------------------------|----------------------------|---------------------|------------------------------------|
| Perth – Superficial Swan | 3,500,000 | 2,249,549 | 2,316,549 (66%) |
| Perth – Leederville | 10,700,000 | 14,539,220 | 14,539,220 (136%) |
| Perth – Yarragadee North | 21,000,000 | 21,080,000 | 21,080,100 (100%) |
| Total | 35,200,000 | 37,868,769 | 37,935,869 |

Notes:

- Data provided by the Department of Water Allocations Branch – 20 January 2012

The City of Canning is currently licensed to take 4350 kL/year from the Perth Superficial Aquifer and 106,500 kL/year from the Perth Leederville Aquifer within the study area. Both of these licenses are for the purpose of irrigating public open space. The licenses cumulatively allow for irrigation of 14.78 ha at standard irrigation rates.

Other groundwater licenses from both the Superficial and Leederville Aquifers exist within the study area for the purpose of irrigating open space areas. License holders are:

- Department of Education
- Westfield Shoppingtown Pty Ltd
- Western Australian Greyhound Racing Authority

Groundwater quality

Groundwater salinity in the study area is typically in the range 1500 to 3000 mg/L. There are no long term water-quality monitoring bores located within the study area. Water from both the Leederville and Superficial aquifers in the groundwater management subarea is considered to be sufficiently good quality for irrigation of public and private open space without treatment.

3.8 Water use

3.8.1 Potable water supply

Because the study area is largely developed there are extensive networks of all major services.

The City of Canning is connected to the Water Corporations Integrated water supply system and preliminary servicing investigations suggest that planning for any necessary upgrades to serve the planned population increase is underway (VDM 2011).

3.8.2 Non-potable supply

There are limited opportunities to introduce widespread use of non-potable water in the Canning Activity Centre. Groundwater is currently used by the City for irrigation of public open space and this will continue, with water efficient landscape design and irrigation practices used to limit future public open space irrigation demand to current licensed volumes.

There are significant opportunities for industrial and commercial sites to incorporate rainwater tanks or greywater recycling systems on an individual basis.

Table 4: Annual summary water demands

| Scenario | | Drinking | Non-drinking | Irrigation | Total |
|--------------------|-------------|----------|--------------|------------|-------|
| Existing condition | Total | 235 | 156 | 351 | 742 |
| | Residential | 120 | 88 | 138 | 346 |
| Post-development | Total | 987 | 642 | 418 | 2,047 |
| | Residential | 669 | 455 | 196 | 1,320 |

Notes:

- All quantities are in ML/year

Table 5: Per capita annual residential water demands

| Scenario | Potable (in house) | Potable (ex-house) | Non-potable (in house) | Non-potable (ex-house) | Total |
|--------------------|--------------------|--------------------|------------------------|------------------------|------------|
| Existing condition | 55 | 53 | 0 | 0 | 108 |
| Post-development | 55 | 24 | 0 | 0 | 79 |

Notes:

- All quantities are in kL/person/year
- Approximate predevelopment population for the study area, calculated by the Water Corporation's Waterwise Land Development Toolkit – water balance tool is 3,300
- Approximate post-development population for the study area, calculated by the Water Corporation's Waterwise Land Development Toolkit – water balance tool is 14,100

3.8.3 Water balance

Table 6 provides a snapshot of the existing and post-development water balance for the Canning Activity Centre study area. Drainage is the most significant output from the system at approximately 63% of the total water cycle. This is because the site has shallow groundwater and an existing main drainage system which was originally designed to drain the land and make the area habitable. Since the construction of those drains, the Liege Street and Wharf Street (Civic Centre) wetlands have been constructed to provide water quality improvements prior to discharge into the Canning River. To ensure that these wetlands are sustained it will be important to maintain annual drain discharges into them and so stormwater harvesting is not recommended.

Table 6: Broad scale site water balance

| | Pre-development | Post-development |
|--------------------|-----------------|------------------|
| Inputs: | | |
| rainfall | 2824 | 2824 |
| IWSS | 764 | 1564 |
| groundwater | 208 | 208 |
| Total | 3796 | 4596 |
| Outputs: | | |
| evapotranspiration | 498 | 414 |
| drainage | 2662 | 2917 |
| recharge | 68 | 50 |
| wastewater | 610 | 1216 |
| Total | 3796 | 4596 |

Notes:

- All quantities are in ML/year
- Bulk catchment runoff coefficients = 0.65 pre-development, 0.74 post-development
- Irrigation input includes water sourced from the IWSS and Leederville aquifer (groundwater sourced from the superficial aquifer is disregarded since it is internal to the water balance)

3.9 Wastewater services

There are three main water corporation trunk mains passing through the study area. Two are located adjacent to the railway corridor and a third runs along Albany Highway. The Maida Vale main sewer passes through the catchment and there is a pumping station located on Richmond Street to the west of Albany Highway and the Carousel shopping centre.

4 WATER MANAGEMENT STRATEGY

The Canning Activity Centre Local Water Management Strategy proposes that the redevelopment of the area will achieve the following objectives:

- i. Improve water quality within the stormwater system while maintaining the flood protection and conveyance capacity of the drainage system and ecological water requirements of the Liege St wetlands, Cannington Swamp threatened ecological community, Wharf Street (Civic Centre) wetlands and Canning River.
- ii. Deliver an urban water environment that is reflective of the local identity and celebrates the linkages between the centre and the River through landscaping, green corridors and the development of an urban stream.
- iii. Optimise water use efficiencies including for irrigation and increase water reuse.
- iv. Achieve water sensitive landscapes (both public and private realm) which incorporate water quality management and reflect the Western Australian climate.

These objectives are to be achieved through the implementation of the following strategies design criteria for stormwater and groundwater management; water resource use; and landscaping.

4.1 Stormwater and groundwater management

4.1.1 Water Corporation drainage system

Any changes to the Water Corporation drainage system will need to be undertaken in consultation with the Water Corporation and will require further detailed design, justification and agreement. This includes consideration of the proposed Water Corporation upgrades outlined in tables 1 and 2 to ensure that the capacity of the main drains is sufficient to meet the conditions of the Water Corporations operating license.

The Canning Activity Centre Structure Plan proposes to enhance the stormwater and groundwater management system through the creation of two urban streams; firstly between the Cannington train station node and Carousel Road; and also the Wharf Street drain. It is also proposed that Leila Street be extended through the Wharf Street compensating basin. In order to deliver these urban streams and the extension of Leila Street, it will be necessary to undertake the following tasks prior to the redevelopment of any land adjacent to the sites.

- Undertake pre and post development modelling of the stormwater system to ensure run-off from future development scenarios is able to be adequately managed by the proposed stormwater system
- Design and construct identified urban stream pathways, having consideration of existing infrastructure capacity requirements and delivery of Activity Centre objectives
 - Cockram Street Main Drain – It is proposed to replace the short section of open drain from Sevenoaks Street to Cecil Avenue with a piped drain, downstream of this point the drain will remain open but will be widened and landscaped into an urban stream within linear public open space providing a connection from Cecil Avenue to Lake Street.
 - Wharf Street Main Drain – It is proposed to widen and landscape the section of existing open drain from Wharf Street to Pattie Street. It is hoped that sufficient capacity can be provided here to replace capacity in the Wharf Street compensating basin when Leila Street is extended through to Wharf Street.

As stated previously, the Water Corporation has already undertaken drainage planning for the area and has identified a number of upgrades to the system. These, together with the system upgrades as proposed above, are identified on Figure 8.

4.1.2 Local stormwater and groundwater management

The following additional actions are proposed to achieve improvements in the water quality of the stormwater system while maintaining the flood protection and conveyance capacity of the drainage system and the ecological water requirements (both quality and quantity) of the Liege St and Wharf St (Civic Centre) wetlands, the Canning River and Cannington Swamp threatened ecological community.

Detailed area plans, subdivision and development applications should:

- Integrate stormwater detention (drainage basins) into any proposed new or retrofitted area of public open space to improve water quality and increase the capacity of the drainage storage system if appropriate
 - Maximise retrofitting of stormwater management systems to achieve improved water quality outcomes through the installation of biofilters (raingardens), amended soils and the use of structural controls to address litter, sediment and vegetative materials at source
 - Where practical create vegetated buffer zones/verges and implement water sensitive urban design principles between waterways and turf in council reserves to help prevent herbicides, fertilisers and grass clippings entering waterways
 - Work with the Swan River Trust to ensure that surface and groundwater flows and quality meet the appropriate design and performance criteria for the Liege St and Wharf St (Civic Centre) wetlands and the Canning River
 - Identify low traffic areas including pathways and medians in parking areas and incorporate permeable pavements where practicable
 - Ensure developers, builders and landscapers implement best management practices to control erosion and sedimentation to protect waterways
 - Maintain street sweeping programs and develop a monitoring plan to assess the efficiency of current schedules and future procedures
- Use artwork and signage to emphasise environmental and hydrological connections between wetlands, groundwater and the Canning River

4.1.3 Design criteria

Any development within the Canning Activity Centre area should aim to meet the following specified design criteria using appropriate best management practices. Additional design criteria may need to be met, particularly where they are specific to particular precincts. These will be outlined in the relevant Detailed Area Plan or associated development guidelines.

- The post-development critical one-year average recurrence interval peak flow and volume shall be equal to or less than pre-development flows at the discharge points of all plan and/or development areas
- All flows from constructed impervious surfaces are to receive treatment prior to infiltration or discharge
- Flows from subsoil drains are to be treated prior to infiltration or discharge
- Runoff from events greater than the 1 in 1 year average recurrence interval event and up to the 5 year average recurrence interval event in residential areas and 10 year average recurrence interval event in commercial/industrial areas are to be

managed in accordance with the agreed post-development scenario, to the serviceability requirements of *Australian Rainfall and Runoff* (Engineers Australia, 2001) minor/major system.

- Roads and public open spaces are to be designed to cater for the surface overflow for more severe storm events with habitable floors at least 0.3 m above the 100 year average recurrence interval flood or storage level at any location
- Any changes in local post development hydrological conditions should be consistent with the requirements for maintenance and enhancement of the TEC and wetlands
- Water quality treatment systems and stormwater management structures should be designed in accordance with the *Stormwater Management Manual for Western Australia* (Department of Water, 2004-07) and *Australian Runoff Quality: A guide to water sensitive urban design* (Engineers Australia, 2006)
- All vegetation planted within developments close to the TEC are to be locally native and non-invasive species, followed by active weed management
- Adopt or maintain regular cleaning of gullies and stormwater pollutant traps to enable pollution spills to be contained and educted before entering the waterways

It is also recommended that some actions occur outside the study area. These are for the City of Canning to:

- Design and implement improvements in the existing detention basins on Wharf, Manley and Renou streets to incorporate water quality treatment and optimise recharge and storage capacity of the existing drainage system
- Develop and implement nutrient and irrigation plans for public open space and school reserves
- Work with SERCUL to expand the implementation of the Fertilise Wise program to facilitate appropriate use of fertilisers and pesticides within the community.

4.2 Water resource use

The following actions are proposed to optimise water use efficiencies and maximise reuse wherever possible. It is proposed that water use is no more than 80 kL/person/year, including no more than 60kL/person/year scheme water where an alternative source (rainwater tank or grey water system) is available.

Detailed area plans and development applications should:

- Harvest stormwater from impervious areas (excess roof water, paved areas and roads) for non-potable reuse or to recharge superficial aquifers where appropriate
- Maximise efficiency of groundwater usage for irrigation of any additional open spaces so that additional allocations are not required.
- Consider opportunities for new development to incorporate fit-for-purpose water supplies through the development of a local water balance
- Develop and implement design guidelines which require water use efficiency measures to be implemented in private and public open spaces and within developments, including:
 - water efficient fixtures, fittings and appliances, including WELS (Water Efficiency Labelling and Standards) rated flow controllers, toilets, taps and urinals;

- landscaping which incorporates the use of waterwise gardens, rain gardens, smart irrigation systems, and use of alternative sources of water;
 - smart metres for water in all new developments;
- Incorporate fit-for-purpose supply options and requirements into design guidelines
- Development to consider opportunities for wastewater recycling

It is also recommended that the City of Canning undertake an audit of water usage in all public open spaces and identify opportunities for modification to landscaping and irrigation systems to reduce water consumption and improve efficiency.

Although the Water Corporation runs an intensive water efficiency campaign, it is considered that the City of Canning could also promote water efficiency measures within the community and workplace including behaviour change and the retrofit of more water efficient fittings and fixtures.

4.3 Landscaping

The following actions are proposed to facilitate the use of water sensitive design to minimise heat island effects, including “above-grounding” of drainage and the incorporation of water quality treatment measures as part of landscaping.

Detailed area plans, subdivision and development applications should:

- Include bio-retention areas and tree pits in the (re)design of parking areas
- Use waterwise, locally native plants in all landscaped areas
- Consider creating stormwater flowpaths as a feature down Cecil Avenue and through the commercial areas
- Consider opportunities for roof gardens and green walls in new medium density commercial and residential areas
- Incorporate bio-retention areas and tree pits into streetscapes
- Consider opportunities to use groundwater in urban art

5 IMPLEMENTATION

As this area is an existing town centre and urban area, implementation of this local water management strategy will occur largely on an ad-hock basis, as development and redevelopment proposals are approved and constructed. The key opportunities for redevelopment include:

- Commercial development associated with Cecil Avenue and Westfield Carousel including creation of urban streams
- High density residential throughout the centre
- Creation of landmark parklands and other public open spaces
- Residential intensification throughout the structure plan area

5.1 Requirements for future planning and development

Although this Strategy provides guidance on water management in the Canning City Centre area, additional design and detail is required and will be provided via Detailed Area Plans in order to guide subdivision. Each Detailed Area Plan will need to be accompanied by an Urban Water Management Plan. Subdivision and development will then be required to be consistent with the Canning City Centre structure plan and detailed area plan.

The requirements for implementation of this Local Water Management Strategy are outlined below and summarised in Table 7.

5.1.1 Detailed Area Plans

More detailed information to guide the redevelopment will be provided at the precinct scale, via preparation of Detailed Area Plans. Each detailed area plan should be accompanied by an Urban Water Management Plan, which will need to be developed in consultation with the City of Canning and the Department of Water.

Each urban water management plan should be based on local site investigations appropriate to the proposal and level of risk to water resources, and contain more detailed design which demonstrates how the objectives, strategies and design criteria contained in this Strategy are to be achieved.

The urban water management plans should be consistent with the requirements of the **Department of Water's Urban water management plans: Guidelines for preparing plans and for complying with subdivision conditions** (DoW, 2008a), recognising that the area is a redevelopment area rather than a greenfield site.

There are two locations within the Canning Activity Centre where significant modifications to the existing main drainage system are proposed. In these two locations the urban water management plan will need to cover at least the area of drainage modification as indicated on Figure 8 to ensure that critical criteria and levels of performance are maintained. The urban water management plan will need to include detailed designs for the modified drainage infrastructure that satisfy the standards and guidelines appropriate to urban main drainage **infrastructure as defined by the Water Corporation's main drainage manual and the Stormwater management manual for WA**. Accordingly, consultation and negotiation will be required with the Water Corporation, as well as the Department of Water and City of Canning to obtain endorsement of the urban water management plans for these areas.

In addition, post-development monitoring is essential to assess hydrological impacts of larger redevelopment proposals, particularly where these have the potential to impact sensitive environments or may be affected by contamination or acidic or contaminated groundwater. Monitoring programs are to be designed in cooperation with the Department of Water, and in accordance with the *Stormwater Management Manual for Western Australia* (Department of Water, 2004-2007). The results of post-development monitoring programs should be reported to the City of Canning and the Department of Water, in a manner acceptable to each.

The urban water management plans are to be developed by the body responsible for preparation of the detailed area plan and should be lodged together with the detailed area plan for public comment, to be subsequently adopted with the final detailed area plan.

5.1.2 Subdivision

Subdivision should be undertaken in accordance with the approved detailed area plan and associated urban water management plan, as well as with the objectives, strategies and design criteria in this Local Water Management Strategy.

It is recognised that where subdivision is proposed in an area that is not covered by a detailed area plan, this is likely to involve less than 30 lots. In these instances, an urban water management plan will not normally be required; however development should be consistent with the objectives, strategies and design criteria in this Local Water Management Strategy.

The City of Canning and/or the Department of Water may, however, request preparation of an urban water management plan to support an application for subdivision where they consider additional information is required to demonstrate compliance with this Strategy. In this instance, the urban water management plan should be developed and assessed in accordance with **the Department of Water's Urban water management plans: Guidelines for preparing plans and for complying with subdivision conditions** (DoW, 2008a).

5.1.3 Development

All development is to be in accordance with the objectives, strategies and design criteria in this Local Water Management Strategy. Additional design criteria may need to be met, particularly where they are specific to particular precincts. These will be outlined in the relevant Detailed Area Plan, urban water management plan or associated development guideline.

Engineering and building drawings submitted to Council for development approval are to be supported by clear and auditable documentation, providing details outlining the water management requirements including any proposed staging, and demonstrating compliance with design criteria.

Where required, the City of Canning may seek the advice of the Department of Water regarding water management measures outlined in any development application.

Table 7: Summary of roles and responsibilities

| Planning action | Water planning requirement | Timing and responsibility | Additional comments |
|---|---|--|---|
| Canning Activity Centre Structure Plan | Supported by LWMS which includes objectives, strategies and criteria to be met as part of planning and development | LWMS accompanies the structure plan City of Canning | LWMS may be revised as detailed planning progresses or information comes to light |
| Detailed area plan (DAP) or precinct plan | Supported by an urban water management plan (UWMP) which demonstrates how the proposed development meets the objectives, strategies and criteria in the LWMS. | Required prior to any subdivision or development occurring City of Canning or proponent | Where the DAP covers the Cockram Street Main Drain from Sevenoaks Street to Cecil Avenue Design or the section of existing open drain from Wharf Street to Pattie Street, the UWMP will need to include detailed designs for the modified drainage infrastructure agreed by the Water Corporation |
| Subdivision | Must meet the requirements of the relevant UWMP (and LWMS) | Should not occur until DAP and UWMP completed Proponent | Unlikely that a UWMP will be required due to the small scale nature of likely subdivision |
| Development | Must meet the requirements of the relevant UWMP (and LWMS) | Should not occur until DAP and LWMS completed Proponent | Should be consistent with relevant design guidelines |

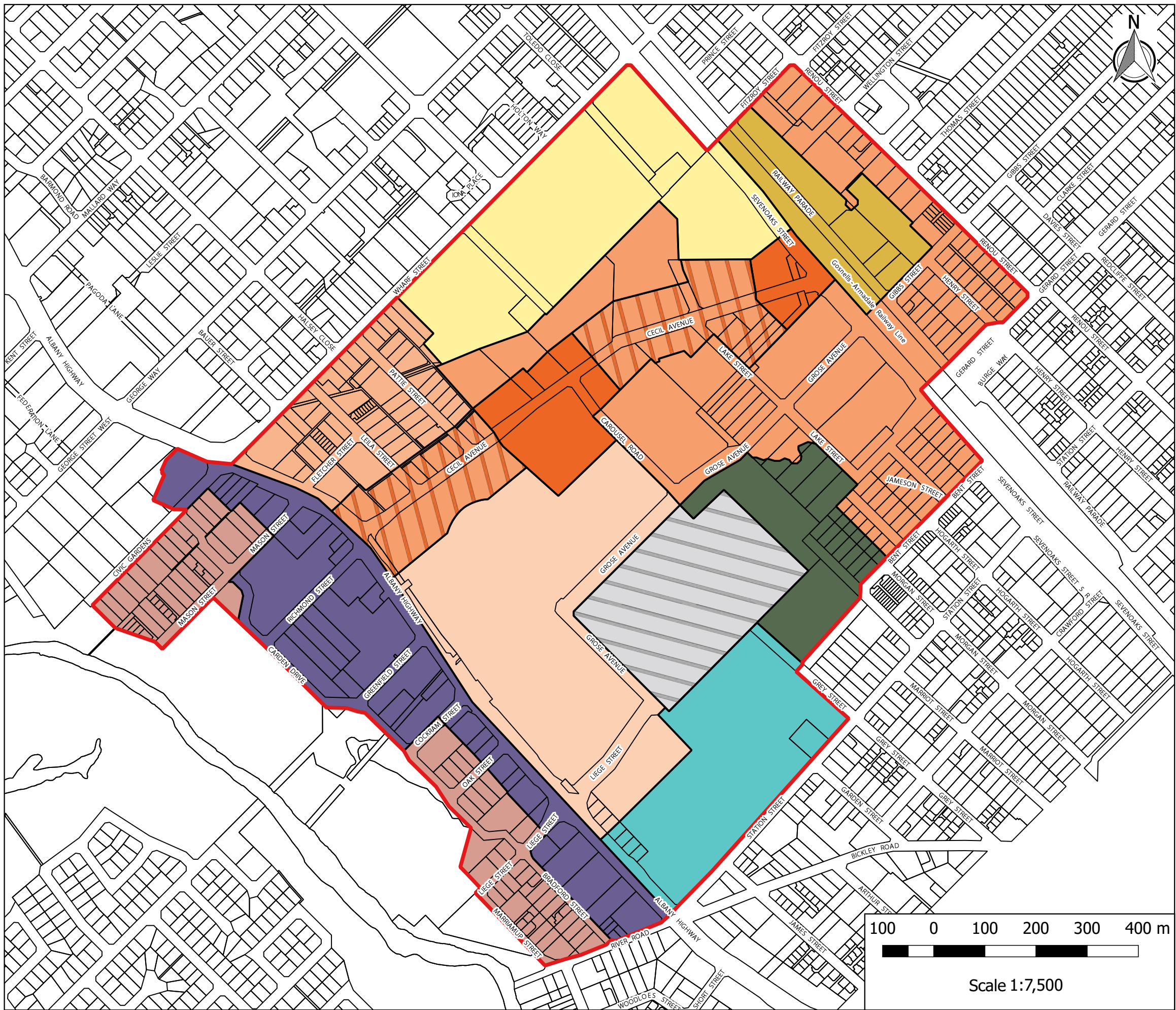
5.2 Review

This Local Water Management Strategy should be reviewed every 5 years or as required to ensure currency of recommendations and that ongoing, viable and sustainable water management solutions are being achieved.

6 REFERENCES AND RESOURCES

- ARMCANZ & ANZECC 2000, *Australian and New Zealand guidelines for fresh and marine water quality*, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
- Bureau of Meteorology 2011, <www.bom.gov.au>.
- Department of Environment and Conservation 2004, *River restoration manual*, Perth.
- Department of Environment and Conservation 2011, *Treatment and management of soils and water in acid sulfate soil landscapes*, Perth.
- Department of Water 2009, *Decision process for stormwater management in Western Australia*, Perth.
- Department of Water 2004–09, *Stormwater management manual for Western Australia*, Perth.
- Department of Water 2007, *Interim position statement: constructed lakes*, Perth.
- Department of Water 2008a, *Urban water management plan: Guidelines for preparing plans and complying with subdivision conditions*, Perth.
- Department of Water 2008b, *Interim: Developing a local water management strategy*, Perth.
- Department of Water 2010, *Water recycling and efficiency note: community bores*, Perth.
- Environmental Protection Authority 1992a, *Environmental protection (Swan coastal plain lakes) policy 1992*.
- Institute of Engineers Australia 2001, *Australian rainfall and runoff, a guide to flood estimation*.
- Institute of Engineers Australia 2006, *Australian runoff quality guidelines*.
- Western Australian Planning Commission 2003a, *Planning bulletin no. 64: acid sulfate soils*, Perth.
- Western Australian Planning Commission 2004, *Statement of planning policy no. 2.9: Water resources policy*, Perth.
- Western Australian Planning Commission 2007, *Liveable neighbourhoods edition 4*, Perth.
- Western Australian Planning Commission 2008a, *Better urban water management*, Perth.
- Western Australian Planning Commission 2008b, *Planning bulletin no. 92, urban water management*, Perth.

APPENDIX 1 – CITY CENTRE STRUCTURE PLAN



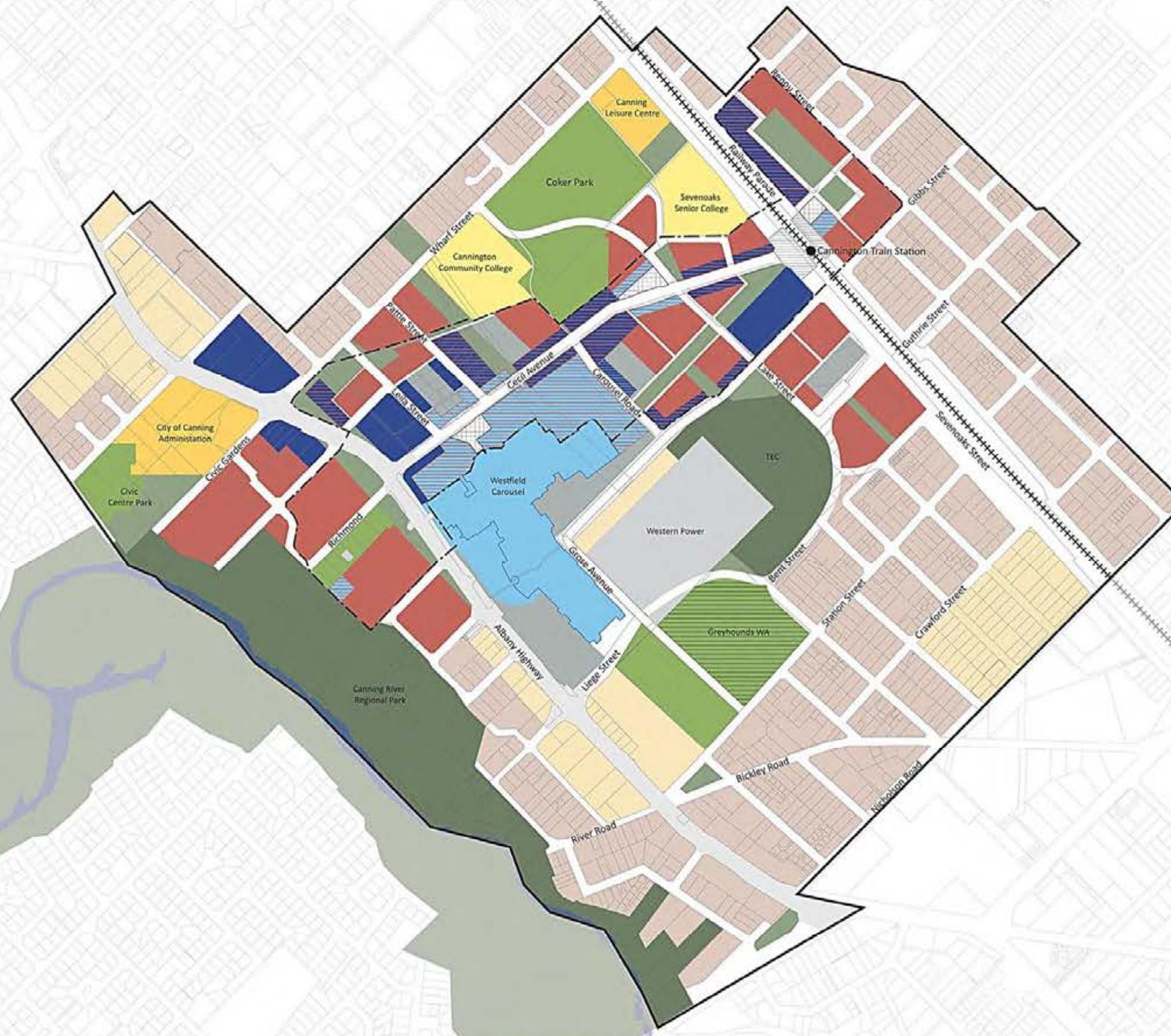
Legend

Precincts

- Civic & Recreational Precinct
- Utilities Precinct
- Riverside Residential Precinct
- Conservation (Cannington Swamp) Precinct
- Riverside Commercial Precinct
- Pattie Precinct
- Retail Precinct
- Cecil Other Precinct
- Cecil Main Precinct
- Railway Precinct
- Civic and Educational Precinct
- City Residential Precinct



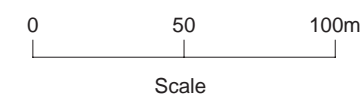
- LEGEND
- Structure Plan Boundary
 - Core
 - Existing Cadastral
 - Civic Square
 - Civic/Cultural/Community
 - Education
 - Retail
 - Commercial
 - Retail/Mixed-Use
 - Commercial/Mixed-Use
 - Commercial/Car Parking
 - Medium-High Density Residential
 - Residential
 - Light Industrial/Commercial
 - Utilities
 - Traffic Calming Treatment
 - Car Parking
 - Recreation
 - Agricultural Society
 - POS (Includes drainage)
 - Conservation
 - Primary Distributor Road



APPENDIX 2 – CANNINGTON SWAMP VEGETATION MAPPING



- LEGEND**
- W1:** Low Woodland of *Casuarina obesa* over a disturbed understorey dominated by *Cyathochaeta avenacea*, *Cynodon dactylon* and *Patersonia occidentalis* on sandy clay-loam
 - W1d:** Degraded areas of plant community W1
 - S1:** Degraded Shrubland of *Jacksonia sternbergiana* and *Hakea* spp. over *Acanthocarpus preissii*, *Xanthorrhoea brunonis*, *Mesomelaena pseudostygia* and *Watsonia meriana* var. *meriana* on grey sandy clay
 - S2:** Seasonally inundated degraded Shrubland of *Viminaria juncea* and *Melaleuca lateritia* over a herb layer dominated by weed species and sedges on grey sandy clay
 - S3:** Shrubland of *Viminaria juncea* over scattered shrubs including *Verticordia densiflora*, *Xanthorrhoea brunonis* and *Pericalymma ellipticum* var. *floridum* on brown clay
 - S4:** Seasonally inundated degraded shrubland of *Melaleuca raphiophylla* over *Verticordia densiflora* and *Hakea* spp. over a herb layer dominated by weed species on grey sandy clay
 - H1:** Heath dominated by *Melaleuca lateritia* over mixed species including *Meeboldina cana*, *Chorizandra enodis* and *Astartea affinis* ms in a seasonally inundated area on clay-loam
 - H2:** Heath dominated by *Verticordia densiflora*, *Patersonia occidentalis*, *Cyathochaeta avenacea* and *Centrolepis aristata* in a seasonally inundated area on clay-loam
 - H3:** Dense Heath of *Baumea juncea* on grey clay
 - D:** Highly degraded areas dominated by weed species
 - Dw:** Seasonally inundated, highly degraded areas
 - R:** Roads, tracks and existing infrastructure
 - Permanent Plot Locations
 - Ah** *Aponogeton hexatepalus* (P4)
 - Sc** *Schoenus capillifolius* (P2)
 - Vs** *Villarsia submersa* (P4)



**CANNINGTON TERMINAL
VEGETATION**

**WOODMAN ENVIRONMENTAL
CONSULTING PTY LTD**

A.C.N.088 055 903
PO Box 50, Applecross W.A. 6953
Tel: (08) 9315 4688 ~ Fax: (08) 9315 4699

| | | |
|---|-------------------|------------------|
| Author: G. Woodman | WEC Ref: WPC04-29 | Scale: 1:2,500 |
| Drawn: CAD Resources ~ www.cadresources.com.au | | Figure: 1 |
| Tel: (08) 9246 3242 ~ Fax: (08) 9246 3202 | | |
| CAD Ref: G1099_VEG.DGN | Date: May 05 | A3 Rev: A |



Client: City of Canning

| Report | Version | Prepared by | Reviewed by | Submitted to Client | |
|----------------------|---------|----------------|----------------|---------------------|---------------|
| | | | | Copies | Date |
| Draft report | V1 | HBr | SSh | Electronic | 27 March 2012 |
| Final draft | V2 | HBr | SSh | Electronic | 25 May 2012 |
| Final report | V3 | HBr | SSh | Electronic | 18 Oct 2012 |
| Updated final report | V4 | HBr | SSh | Electronic | 19 Aug 2016 |

Essential Environmental
land & water solutions
622 Newcastle St Leederville 6007
p: 08 9328 4663 | f: 08 6316 1431
e: info@essentialenvironmental.com.au
www.essentialenvironmental.com.au