

GLENFIELD STRUCTURE PLAN

November 2010

Modification 2 – October 2015



This structure plan is prepared under the provisions of the City of Greater Geraldton Local Planning Scheme No. 5 (Greenough).

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON:

Date

Signed for and on behalf of the Western Australian Planning Commission

an officer of the Commission duly authorised by the Commission pursuant to Section 16 of the *Planning and Development Act 2005* for that purpose, in the presence of:

Witness

Date

Date of Expiry

Table of Modifications to Structure Plan

Modification No.	Description of Modification	Date Endorsed by Council	Date Endorsed by WAPC
1	School site identified on Map. General update of Map to reflect approved subdivisions and subdivision guide plans prepared in accordance with section 5.2. Section 4.6 updated.	25 th August 2015	9 th November 2015
2	Private school site identified on Map. Tables 4, 5 & 6 and Section 4.6 updated.	27 th October 2015	20 th November 2015

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GLENFIELD STRUCTURE PLAN

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1 INTRODUCTION

1.1 Development of the Plan

The Glenfield strip bordered by Chapman Road to the west and the North-West Coastal Highway to the east was zoned for residential purposes under Town Planning Scheme No. 4 (Greenough), on 30 March 1984. The subsequent structure planning for the Glenfield area was undertaken sporadically, involving several drafts and rounds of public consultation prior to endorsement of the Glenfield Structure Plan by the former Shire of Greenough at its meeting held on 30 January 2002 and by the WA Planning Commission (WAPC) on 12 March 2002.

In August 2007, the WAPC advised that there was now not enough detail shown on the Glenfield Structure Plan to allow subdivision to be approved with confidence. They further advised that, *"...a decision has been made not to approve any further subdivision in the Glenfield locality until a structure plan with sufficient detail has been prepared and adopted ..."*

In light of this approach by the WAPC, the City undertook updates to the Glenfield Structure Plan regarding (amongst other things) Main Roads WA requirements for widening of the North-West Coastal Highway and engaged consultants to prepare a district drainage investigation.

A preliminary draft of the updated Glenfield Structure Plan was emailed in January 2008 to the [then] Department of Planning & Infrastructure, Geraldton office seeking preliminary feedback.

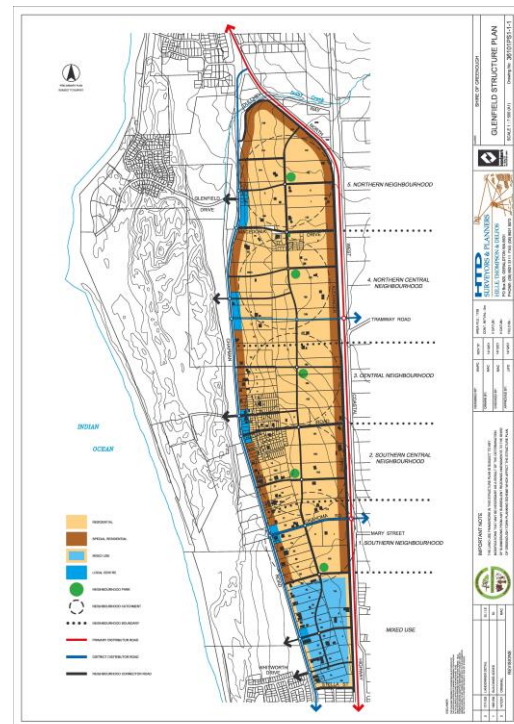
In March 2008, the WAPC *"...considered the currently endorsed Glenfield Structure Plan 2002 and resolved to advise the City that it is not prepared to support any further subdivision at this time and considers the Glenfield Structure Plan 2002 as suspended."* Additionally, the WAPC asked the [then] Department for Planning & Infrastructure to assist the City in developing a new Plan and also

advised that a request would be made for the WAPC to financially support the City in addressing specific issues.

Since then the City had been working with the Department of Planning on finalising a new Glenfield Structure Plan and significant progress was made in addressing the strategic issues identified.

In August 2008 the City received correspondence from the WAPC advising that it had now resolved to advise the City that the Department of Planning did not have any further resources available to assist in progressing the Glenfield Structure Plan and further, to issue conditional approval for the outstanding subdivision applications where they are in general accordance with the existing Glenfield Structure Plan 2002 (which had been suspended in March 2008).

As a result of this the City expedited the preparation of this new Structure Plan for Glenfield.



1.2 Purpose of the Plan

It is envisaged that with the future development of the Oakajee Industrial Site that considerable increases in the population of the northern suburbs of the City of Geraldton-Greenough will occur, and hence the City recognises the need to provide structure planning for existing residential zoned areas such as Glenfield.

The Glenfield Structure Plan will guide land use planning for the eastern portion of Geraldton's northern growth corridor, and aims to provide for more sustainable urban development.

The Structure Plan will be used by the WAPC, the Department of Planning, State Government agencies, the local government, landowners and the community to provide certainty about future development in the area and to inform further detailed planning for the site where required.

The Structure Plan will:

- a. Provide a clear (albeit broad) land use framework for more sustainable development and growth of the Glenfield locality;
- b. Establish the planning rationale for residential and commercial development in designated locations;
- c. Give certainty to landowners and investors purchasing land as to the intended future use;
- d. Indicate further planning requirements that are to be undertaken; and
- e. Assist the local government and other infrastructure providers to identify priorities of new infrastructure to meet the needs of the future community.



2 EXISTING SITE AND CONTEXT ANALYSIS

2.1 Location, Area and Ownership

The Glenfield Structure Plan area is located approximately 7km north of the Geraldton CBD and is situated in the northern growth corridor of the Geraldton townsite. It is located approximately 1km from the Indian Ocean coastline and fringes the Sunset Beach and Drummond Cove localities to the West (Figure 1).

The Structure Plan covers approximately 368ha of land and relates to the area generally bounded by the North-West Coastal Highway to the east and north-east, Chapman Road to the west, Dulchev Way to the north-west and Stella Street to the south (Figures 2 & 3).

The area comprises over 120 private land holdings, and whilst several properties are in common ownership, the area predominantly comprises multiple land ownership.

2.2 Existing and Surrounding Land Use

The major existing land uses within the Structure Plan area comprises of residential, rural-residential, market gardening and other mixed uses. The mixed uses invariably include a residence as well as some other activity. These other activities range from nursery activities to a large building material supply business. Market gardening has lessened as an activity in this locality over recent times and the predominant use is now low density and rural-residential.

Land to the north of the study area, on the east side of the North-West Coastal Highway has been mooted for "Special Residential" use and a small section known as "Drummond Heights Estate" has been developed. Also to the north a future neighbourhood shopping centre is proposed at the 440 Roadhouse site.

East of the study area the land is presently occupied by rural lots in the

range of 4-10ha. This area has been identified for future "Rural-Residential" development. The Waggrakine Development Scheme area is located to the south-east of the study area and facilitates traditional single residential development.

West of the study area, the coastal fringes require structure planning for future residential and associated land uses (such as schools and shopping) which connect the existing residential subdivisions of Sunset Beach in the south with Drummond Cove in the north.

Central to this area the Water Corporation's Geraldton Wastewater Treatment Plant No. 3 is located. Residential uses occur to the south of the study area with a neighbourhood shopping centre (Sunset) located south of Stella Street.



2.3 Landform

A dominant ridge dissects the area from Okahoma Road to Dulchev Way. Land situated above the ridge line gently slopes upwards towards Alexander Drive and has ocean and city views. The land below, west of the ridge extending from Macedonia Drive to Okahoma Road inclines from 20m to flatten out at 4m along Chapman Road. As the ridge veers eastward the topography below the ridgeline changes to gently undulating slopes which incline southwards. South of Okahoma Road the land dips and inclines to flatten out near Chapman Road.

The study area is situated on a belt of coastal limestone which is part of the pleistocene consolidated dune swale system of Tamala limestone. Two major soil types are prevalent in the study area.

A belt of deep red coarse to loamy sand on the seaward side, and a uniform yellow sand plain which commonly has a loose brown or dark brown loam sand surface over a yellowish brown loamy sand. Both soils show a high capability to sustain both urban and rural-residential developments as they are characteristically rapidly drained, allow for foundation soundness, ease of excavation, nil slope instability risk and have moderate agricultural potential.

2.4 Vegetation

The vegetation cover reflects the topography and rainfall patterns. A large proportion of the land has been cleared especially within a wide belt through the centre of the study area. Road reserves are generally lined by scrub and residential blocks close to these road reserves are landscaped with trees and bush.

Vegetation (based on Beard's vegetation mapping) associated with the deep red soils are *Acacia ligulata*, low woodland with *low refociffium* and *Acacia spathulatum* as other common trees. Remnants of the sand plain include open *Banksia/Acacia* woodland. Common species include *Acacia rostelifera*, *Banksia priomotes*, *Dryandra sessilis* and *Grevillea candelabroides*.

2.4.1 Regionally Significant Vegetation

The WAPC produced the Geraldton Regional Plan in 1999 to provide a regional framework for planning decisions. It was acknowledged by the Environmental Protection Authority (EPA) in its comments on the plan, that a regional native vegetation survey was required for the Geraldton region to provide a regional context for decisions on development proposals that have

the potential to impact on remnant vegetation. The EPA recommended that areas supporting regionally significant vegetation be identified for conservation.

In 2008, the WAPC in partnership with relevant State government agencies and local government, commenced the Geraldton Regional Flora and Vegetation Survey Project (GRFVS). The GRFVS has mapped and described vegetation types occurring in the Geraldton region, focusing on areas where significant land use change or development is proposed.

The GRFVS has identified that there is remnant vegetation in Glenfield that is *regionally significant*, as it is part of one of the largest remaining intact areas of *Banksia/Acacia* plant community in the Geraldton region.

An assessment of vegetation condition in the Glenfield Structure Plan area was also undertaken as part of the GRFVS (Figure 4).



2.5 Aboriginal Sites

A search of the Register of Aboriginal Sites indicates that there is 1 Aboriginal Heritage Site in the north of the area (refer to Appendix A).

Prior to any proposed development, so that no site is damaged or altered it is recommended that suitably qualified consultants be engaged to conduct ethnographic or archaeological surveys of the area.

3 PLANNING CONTEXT

3.1 Regional Planning

3.1.1 Geraldton Region Plan

The Geraldton Region Plan provides a broad regional planning framework for the growth and development of the greater Geraldton urban area over the next 20 to 30 years. It seeks to provide a framework for the future management, protection and coordination of regional planning in the region and allocates the general location and extent of land uses at a broad scale. The document identifies the Structure Plan area as future urban (Figure 5).

3.1.2 Northern Geraldton District Structure Plan (draft)

The purpose of this study is to provide a district structure plan for northern Geraldton that progresses key elements of the Greater Geraldton Structure Plan (produced as part of the Geraldton Region Plan 1999) and identifies principles that will guide future development within the study area. The district structure plan is in a draft stage only but incorporates many of the design elements within this Structure Plan.

3.2 Local Planning

3.2.1 Local Planning Scheme

Local Planning Scheme No. 5 (Greenough), zones the study area from just south of Okahoma Road north to Dulchev Way as "Development" requiring the preparation of a subdivision guide plan before subdivision can occur. The southern land is zoned "Special Use" for a future Glenfield Mixed Business area. Dissecting these two zones is an area set aside for "Road" (Figure 6).

3.2.2 Local Rural Strategy

The City's Local Rural Strategy provides strategies for development in the rural areas, recognising land use pressures and constraints and capabilities for

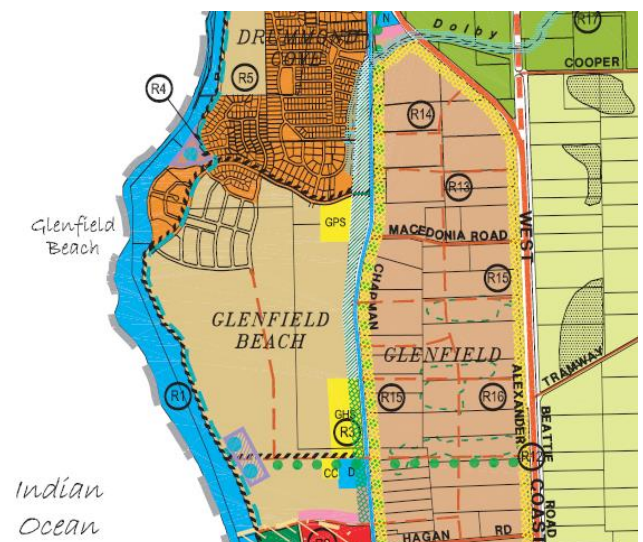
both rural and non-rural development. The Local Rural Strategy Map identifies the Glenfield Structure Plan Area as 'Other Areas' reflecting that it is not considered to be of agricultural significance and more suited to future urban development.

3.2.3 Local Planning Strategy

The Glenfield locality is identified as urban with the strategic direction to consolidate future residential development in the urban areas before considering the rezoning and subdivision of any new areas.

3.2.4 Geraldton-Greenough Retail and Services Strategy

In September 1996 Hames Sharley produced a strategic planning framework to guide future retail and commercial development for the City of Geraldton-Greenough. The identification of future showroom retailing was promoted in the south of the Structure Plan area and a Discount Department Store (District Centre) was also shown in the southern area. The location of this centre was based on a high growth scenario.



4 THE GLENFIELD STRUCTURE PLAN

4.1 Community Design

4.1.1 Sense of Place

Glenfield's identity will largely be forged by its close relationship with the future proposed district activity centre adjacent to the Structure Plan area. At full development the mixed use area proposed as part of this development will become the landmark, focal point for Geraldton's northern growth corridor.

The character for the area will be primarily for residential development with the southern area providing a unique opportunity to live and undertake larger scale home based type businesses.

The public open space will concentrate more on protecting vegetation and integrating urban stormwater management rather than providing traditional reticulated grassed areas.

4.1.2 Land Use Rationale

The objectives that have driven the Structure Plan land use classifications and layout are:

- Creation of an integrated mix of land uses that contribute towards and support the adjacent future district activity centre;
- Maintenance of the integrity of the existing land uses where appropriate;
- Facilitation of an urban typology for primarily residential development;
- Promotion of a general transition and intensification of uses within the Plan area; and
- Reducing impacts and conflicts with the North-West Coastal Highway.

The land use framework facilitates a diversity of residential densities and commercial, retail, light/service industry uses that reflect the existing activities in surrounding areas, while bringing additional opportunities – see Table 1.



Table 1 – PROPOSED BROAD LAND USES (indicative only)

Land Use	Area (ha)
Residential	251.83
Mixed Use	5.15
Special Use	44
Primary School	4
Public Open Space	30.71
Local Roads/Infrastructure – assumes 10 % of gross urban land is given to streets as per Liveable Neighbourhoods	32.04
TOTAL	368

4.2 Movement Network

The key to enabling the intensive, mixed use redevelopment of Glenfield is the establishment of a safe, legible and effective movement network for all users.

4.2.1 Road Network

4.2.1.1 North-West Coastal Highway

The major north-south road that runs through Geraldton is the North-West Coastal Highway which is classified as a primary distributor road. Currently full interchanges are provided onto the Highway from Macedonia Drive and Okahoma Road only.

The Highway's suitability for heavy vehicle usage should not be compromised and for this reason, future development along the Highway needs to minimise lot frontage and commercial activity. At present the Highway is constructed to a 2 lane undivided carriageway standard. Main Roads WA (MRWA) in their future planning have allowed for upgrading to a 4 lane divided carriageway standard.

The Structure Plan proposes to retain the connection from Macedonia Drive with the Highway and close the connection with Okahoma Road. A new connection is proposed north of Hagan Road on the northern boundary of Lot 123 which will provide the main east-west 'spine' connecting the Highway with the future district activity centre. A third, 4-way connection is proposed utilising the existing road reservation shown in the town planning scheme. This will provide permeability across the Highway from the Waggrakine residential area to the east.

4.2.1.2 Chapman Road

Chapman Road is classified as an integrator road primarily servicing the city centre. It is considered to provide the appropriate combination of traffic exposure and volumes to support

neighbourhood and district activity centres. No further road connections should be permitted other than those shown on the Plan.

Although at this stage direct access onto Chapman Road is permitted, it is envisaged that with the development of the Structure Plan that this access will be restricted.

Should direct access to Chapman Road from adjacent lots be restricted in the future, access is to be provided from a local road parallel to Chapman Road within the Structure Plan area. The exact alignment of the road will be determined at further detailed planning stages. Subdividers in this location may be required to provide land for road reserve purposes.

4.2.1.3 Other Roads

The road concept for the Structure Plan has been influenced in the first instance by the existing road configurations, and secondly by the need to achieve a basic grid configuration to maximise permeability, legibility and robustness. The roads are diagrammatically shown on the Structure Plan and are considered essential to ensure a basic level of permeability is achieved throughout the area. Other local road networks will be detailed through the subdivision process.

4.2.2 Public Transport

Bus services currently connect Sunset with Drummond Cove via Chapman Road. In the longer term it is proposed that this primary route be retained to connect the proposed activity centres. Additional routes may be provided along the three road connections with the North-West Coastal Highway.



4.2.3 Pedestrians and Cyclists

Currently pedestrian and cyclist infrastructure within the Structure Plan is non-existent. It will be important to create this infrastructure as part of the redevelopment of Glenfield, to ensure that pedestrians and cyclists are well catered for in terms of local trips and longer regional trips.

The future detailed urban design and planning must ensure that pedestrian movement and localised bicycle transport are given the highest priority in the design of the internal traffic networks and public open spaces.

The Structure Plan has provided for the broad linkages which provide strong east-west and north-south connections predominantly using the road network (Figure 7).

The diverse mixture of land uses within the Structure Plan area creates excellent potential for local trips to be made either by cycling or walking. Where necessary within the Structure Plan, shared use paths can be provided to facilitate cycling. Generally, cycling should be facilitated through the appropriate design of local streets. Shared use paths should only be provided where traffic volumes or other considerations make on-street riding unsafe or undesirable.

The provision of end of trip facilities for cyclists is critical to ensuring that cycling is a viable transport mode. Within the Structure Plan area it will be important to ensure that adequate parking facilities are available at key destinations including the mixed use and local activity nodes.



4.3 Activity Centres and Employment

4.3.1 Mixed Use

A mixed use classification has been applied to the land opposite the future district centre. Mixed use is a flexible land use classification which accommodates the establishment of a mix of residential development with small "boutique type" retail and commercial businesses in a residential scale environment that will compliment the district activity centre.

The location benefits afforded by having shopping and employment needs on the doorstep are likely to make the areas immediately surrounding the mixed use activity node a very attractive site for higher density residential development.

It is not possible for the Structure Plan to specify the types of commercial uses that should be established in the mixed use area. Market demand for residential and commercial uses will fluctuate over time and in the case of Glenfield will depend on the progress of surrounding development. Given that the time period for redevelopment in the Structure Plan area could be extensive, it is not possible to dictate the types of commercial uses, the amount of floorspace and the number of residential units that should be established.

The provision of retail/commercial floorspace was based on the floor space provision requirements of the WAPC Perth Metropolitan Centres Policy and the Guidelines for the Preparation of Local Structure Plans for Urban Release Areas June 1992 (ie. a total of 1.49m² per household). In order to determine the land area requirement

for commercial uses a floor space to land area ratio was adopted, which is reflective of the existing commercial centres in Geraldton and was used in the Northern Geraldton District Structure Plan. The retail calculations excluded retail/commercial facilities that may eventuate in the Special Use area – see Table 2.

Table 2 – RETAIL CALCULATIONS (indicative only)

Total Estimated Dwellings	5,324 dwellings	
NLA Floorspace Provision	1.49 m ² x 5,324 dwellings	7,933m ²
Land Requirement *	2.4 ha	
Mixed Use **	2.58 ha	

* Assumes 1/3 floor space and 2/3 land for parking, landscaping, access etc.

** Assumes 50% of land area will not be used for retail purposes.

4.3.2 Local Activity Nodes

Local activity nodes may quite appropriately occur throughout the Structure Plan area and are encouraged to provide for the needs of the communities and provide for the daily shopping needs. Market demand for these nodes will dictate the development of these areas and accompanying them should be a 'mantle' of medium density residential development in and around the nodes. It is anticipated that these areas will be developed to a density of R40. Retail use should be street based in its built form with any off-street car parking located to the rear of the properties.

4.3.3 Community Purpose Sites

Sites for community facilities such as community centres, meeting halls, branch libraries, kindergartens, pre-schools and day care centres are increasingly important for community development. The mixed use area should be the focus for locating high-end community facilities whilst the local activity nodes may also support other community based uses.

Specific sites are not shown on the Structure Plan and should be allocated as a result of detailed subdivision design and/or a community needs assessment.

Given the estimated number of dwellings, it is envisaged that 3 sites may develop over time.

4.3.4 Special Use

The City is keen to encourage a composite business/residential zone where residents may reside on larger lots and undertake large scale home based businesses. The Structure Plan proposes to create a low density special use development with minimum lot sizes of 1,250m². The Structure Plan recognises the existing large scale home based businesses in this area and the potential for similar uses to develop over time. The special use classification has been applied or two reasons:

1. To protect areas with existing light industrial uses from pressure to relocate as a result of any perceived or actual co-location of incompatible uses; and
2. To ensure employment opportunities in the Structure Plan area by providing enough suitably zoned and serviced land to allow a level of economic self-sufficiency for Glenfield.

4.3.5 Employment

Commercial and land use data collected by the Department of Planning over a substantial period of time suggests that retailing and offices could generate 1 employee per 30m² of floorspace.

Schools also provide significant opportunities for local employment. In this regard primary schools can be expected to offer up to 50 jobs.

The Special Use (composite business/residential zone) promotes large scale home based businesses and an assumption has been made that each lot could potentially generate 1 employment opportunity in addition to the resident conducting the business.

Based on the above assumptions it is expected that at full development the Structure Plan area could generate the following job opportunities:

Table 3 – POTENTIAL EMPLOYMENT (indicative only)

Land Use	Employees
Mixed Use Retailing / Commercial (7,933m ² floorspace)	264
Primary School	50
Special Use (1,250m ² lot sizes, 264 lots)	264
TOTAL	578



4.4 LOT LAYOUT

4.4.1 Lot Size and Variety

Residential densities and diversity of dwelling types should be achieved by providing a wide range of lot sizes and building forms. The Structure Plan proposes a wide range of residential densities from R5 to R80 which provides for greater housing and lifestyle choice.

4.4.1.1 Alexander Drive R5

It is proposed to accommodate larger lots that abut Alexander Drive to separate residences from the North-West Coastal Highway.

In its submission upon the Northern Geraldton District Structure Plan, MRWA noted that future upgrading of the North-West Coastal Highway is under consideration and may require the expansion of the Highway reserve to include Alexander Drive and Beattie Road when the ultimate upgrading is required. MRWA also noted that:

“The local structure plans, incorporating the subdivision, need to ensure direct access to primary and regional distributor roads is not required and also removes the need for parallel roads that have an affect on the suitability for heavy vehicle usage and the safety and amenity of through traffic. Main Roads requests the requirement for lot frontage be amended to reflect lot

frontage requiring access to the highway will not be permitted and access to all lots must be through internal subdivision roads. The use of 'service roads' is acceptable as an alternative for short distances but must not utilise the existing Alexander and Beattie Roads. Local roads that run parallel to a highway have safety issues that are difficult to address for intersections with local distributor roads being too close to the highway for safe vehicle movements and spill vehicle light affects on the higher speed through traffic on the highway."

Refer to Appendix B for Main Roads WA advice.

As a result of the above it is necessary to amend the previous Glenfield Structure Plan to accommodate the above comments and lots that originally 'fronted' Alexander Drive will now front an internal subdivision road. The lots will have a dual road frontage and there will be a need to identify building envelopes to 'set-back' housing from the Highway. The following condition will be requested at the time of subdivision.

A Restrictive Covenant, pursuant to section 129BA of the Transfer of Land Act 1893 (as amended) is to be placed on the Certificates of Title of the proposed lots advising of the existence of a restriction on the use of the land. Notice of this restriction to be included on the Deposited Plan. The restrictive covenant is to state as follows:

"No development is to take place outside the defined building envelope(s), unless otherwise approved by the local government."

As there is no defined timeframe for the upgrading of the North-West Coastal Highway it is considered appropriate that lots which abut Alexander Drive still be allowed access to this road. Accordingly it will be requested that at the time of subdivision the internal road

reserve is ceded by the subdivider but not required to be formally constructed until such time as MRWA formally advises of the future requirements for the Highway, or the future subdivision of the land.

4.4.1.2 Chapman Road R5/R40

It is intended that Chapman Road develops into the attractive and vibrant 'spine' of Geraldton's northern growth corridor as the residential community develops and demand grows for a diversity of lifestyle opportunities. Thus it is considered particularly important to ultimately allow for a higher density along Chapman Road than has previously been planned. This vitality will centre on the district and neighbourhood activity centres but should eventually stretch for the length of Chapman Road through the Structure Plan area connecting it to the Geraldton CBD.

4.4.1.3 Residential R20

The majority of the Structure Plan area is proposed for development to a density of R20 which will cater for single family housing traditionally associated with suburban Geraldton.

4.4.1.4 Residential R40

Medium density housing (R40) should be made more appealing by being located in high amenity areas such as overlooking parks or close to activity nodes.



4.4.1.5 Residential R60

Smaller lots and lots capable of supporting higher density (R60) are proposed surrounding the mixed use activity centre. This higher density will provide a minimum local resident population to support the activity node.

4.4.1.6 Mixed Use R80

The average density for residential use within the mixed use area is likely to be R80 although the actual densities will vary and be dependant on the area and development potential of each individual site.

4.4.1.7 Special Use

The Structure Plan proposes to create a special use area with minimum lot sizes of 1,250m² to encourage composite business/residential uses and large scale home based businesses.

4.4.2 Density Target and Population

Achievement of more sustainable urban outcomes will require higher residential densities in the Glenfield area. It is proposed to achieve a gross urban density of 16 dwellings per hectare. Assuming an occupancy rate of 2.3 persons per household the projected population for Structure Plan area is 12,245 people.

Table 4 – URBAN DENSITY CALCULATIONS (indicative only)

Structure Plan Area	368 ha	
Deductions	49.9 ha	
Public School Site	4 ha	
Private School Site	2.57ha	
POS	30.45 ha	
Mixed Use	5.15 ha	
Existing Roads	5.1 ha	
Road Widening	2.03 ha	
Community Purposes (x 3)	0.6 ha	
Gross Urban Land	318.1 ha	
Residential Dwellings *		
R5	24.13 ha	90 dwellings
R20	148.33 ha	2,472 dwellings
R40	28.36 ha	967 dwellings
R5/40 **	29.58 ha	1,008 dwellings
R60	13.85 ha	577 dwellings
Mixed Use R80 ***	5.15 ha	155 dwellings
Special Use (1,250m²)	44 ha	264 dwellings
TOTAL	5,533 dwellings	

* Assumes 25% of gross urban land is dedicated to streets.

** Assumes all land developed to R40.

*** Assumes 50% of land area will not be used for residential purposes.



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4.4.3 Climate Responsive Design

The Structure Plan proposes a modified grid pattern of streets predominantly on north-south / east-west alignments. This results in lots being able to be orientated to take good advantage of solar access.

4.5 PUBLIC PARKLAND

Through a focus on water sensitive urban design, sustainability and conservation, the Structure Plan aims to primarily protect regionally significant vegetation and integrate urban stormwater management whilst providing for a limited range of active recreation opportunities.

The Structure Plan features three types of public open space, being the linear 'living stream', the regionally significant vegetation and the neighbourhood park.

The City has concerns over the possible number and size of local or neighbourhood parks. The major issue is the on-going cost to the City of maintaining smaller areas of public open space. It is therefore preferable that the POS as shown on the Plan be the only land areas that are provided with cash-in-lieu contributions from other land parcels.

There is currently a small Reserve 48448 on Macedonia Drive that was given up for POS as part of a previous subdivision. This Reserve is only 524m² and there is an opportunity for this land to be converted to a freehold residential lot and sold, with the proceeds to be directed into POS development or land acquisition.

The Structure Plan area is located relatively close to the Indian Ocean to the west and as such it is considered that when this land is developed (enabling greater public access) that this foreshore and beach area will cater for a number of recreational pursuits.

Tables 5 & 6 below are a POS schedule that has been prepared for the purpose of this Structure Plan. Whilst exact areas of POS are likely to change in the future as a result of detailed subdivision designs, the principles that underlay the POS will not change and the general location of POS areas will also not change significantly.



Table 5 – OVERALL PUBLIC OPEN SPACE SCHEDULE (indicative only)

Structure Plan Area	368 ha
Deductions	60.88 ha
Public School Site	4 ha
Private School Site	2.57 ha
Mixed Use	5.15 ha
Special Use	44 ha
Existing Roads	5.1 ha
Road Widening	2.03 ha
Community Purposes (x 3)	0.6 ha
Gross Subdivisible Area	304.55 ha
POS (10%)	30.45 ha
POS Provided	
Regionally Significant Vegetation	15.60 ha
Living Stream	12.78 ha
Neighbourhood Park	2.07 ha



Table 6 – PUBLIC OPEN SPACE SCHEDULE BY LOT (indicative only)

Regionally Significant Vegetation	15.60 ha
Lot 146 Macedonia Drive	1.89 ha
Lot 131 Alexander Drive	2.59 ha
Lot 130 Alexander Drive	4.78 ha
Lot 125 Alexander Drive	6.34 ha
Living Stream	12.78 ha
Lot 35 Hagan Road	2.38 ha
Lot 120 Alexander Drive	2.56 ha
Lot 122 Alexander Drive	2.27 ha
Lot 118 Alexander Drive	2.46 ha
Lot 117 Oklahoma Road	3.16 ha
Neighbourhood Park	2.07 ha
Lot 135 Alexander Drive	2.07 ha

4.6 SCHOOLS

The Department of Education (DOE) requires three primary schools in the Glenfield/Drummond Cove/Sunset Beach localities, based on population numbers derived from the information for the draft Northern Geraldton District Structure Plan and the Geraldton Region Plan.

One school site has already been allocated in Sunset Beach (west of Chapman Road) and the DOE advises that this will serve a catchment of 1,570 lots. The second primary school site would also be located west of Chapman Road further north, and will serve about 1,550 lots.

DOE have acquired a primary school site from Lot 3 Bluefin Drive, north of Macedonia Drive as indicated on the structure plan. The timing of this proposed future public primary school is not known at this stage and would likely be determined in response to urban growth and demand for public education infrastructure.

The DOE have advised that another potential primary school site could be located around the central portion of Hagan Road and east of Chapman Road and will serve about 1,670 lots (Figure 8).

In its submission upon the draft Northern Geraldton District Structure Plan the DOE noted that it:

"would like the Hagan Road Primary School site to be on the flat land half way between Chapman Road and North-West Coastal Highway. As for the acquisition of this site, it would be up to the landowners to approach DET to initiate negotiations. We do not necessarily have to wait to acquire a site until we actually need it for construction but the actual timing would depend on the availability of funding in the Department's land acquisition budget."

The DOE has advised that as the land in Glenfield is under multiple ownership it would be prepared to purchase a site from the open market ahead of need, subject to the availability of funds. The Department would then be reimbursed by way of pro rata contributions from affected landowners as their subdivisions proceed. Preliminary subdivisions in the Glenfield locality have proceeded with a condition of subdivisional approval that payment be made to the DOE on pro rata basis for the later

acquisition of a primary school site off the open market.

Refer to Appendix C for the Department of Education's advice.

Lot 2 Alexander Drive has been acquired by an independent private school for development of school facilities which will cater for an increase in choice for primary and middle school education in Geraldton, for a catchment area which will extend beyond the immediate locality. The site has been selected based on the existing road network offering efficient connection on Macedonia between Chapman Road and NWCH. The size of the landholding is sufficient for the anticipated smaller number of students typical of private independent schools. Its development in this northern corridor generally accords with WAPC guidelines which delineates the average ratio of 1 to 3 for private schools to public primary schools in the catchment area.

4.7 URBAN WATER MANAGEMENT

A district drainage analysis with regional study options for stormwater drainage has been undertaken to guide water management in the Structure Plan area (refer to Appendix D).

Best planning practice for stormwater management involves integrating land and water planning and implementing water sensitive urban design. Water sensitive urban design seeks to incorporate stormwater drainage into the urban fabric, in a new manner that ensures the protection of surface and ground water quality and enhances opportunities for reuse of stormwater.

It is possible to incorporate the principles of water sensitive urban design within the Structure Plan area, however there are major difficulties coordinating drainage and siting of POS locations due to the variation in topography and soil types.

The other major issues in pre-planning a major drainage system for the Structure Plan area is the fragmented ownership, size of the area and the unknown sequence of development. The combination of these factors will most likely necessitate drainage systems of micro or minor nature that will tend to

be more self-contained rather than linked to a major system.

Developers should prepare Urban Water Management Plans at the detailed subdivision design stage to ensure that appropriate water sensitive design strategies are adhered to. There is a presumption against fenced drainage sumps for any subdivision within the Structure Plan area.

4.8 UTILITIES

4.8.1 Water

The Water Corporation has indicated that this area is presently serviced with an adequate water supply although some upgrading could be required. It was suggested by the officers of the Corporation that a staging of development within Glenfield should be considered as there is a need to try to achieve a frontal approach with respect to the provision of water in this area. Due to the location of existing services, it was suggested that the development of lots in either the northern or southern sections of the Structure Plan could take place first with infill toward the centre as later stages occur. The market will largely dictate that this approach is the most viable however if landowners are prepared to endure high up front costs for the provision of services to non-frontal development they should be permitted to do so.

4.8.2 Sewerage

There will be a need to service the area with a reticulated sewerage system as residential subdivision occurs. There is presently design and construction work being undertaken with respect to the provision of sewerage to the Sunset Beach Estate subdivision. It would be possible to service the northern section of the Structure Plan area by way of gravity feed to Chapman Road and then pump the effluent to the wastewater treatment plant at the southern end of the Ocean Heights Estate. The southern section of the Structure Plan area could be serviced relatively easily by way of gravity feed

direct to the existing mains in the Sunset Beach subdivision.

The Water Corporation's preference for development in relation to the sewerage, is that it proceed from the south to the north. The preferred option as suggested in this Report is to allow development to occur either way with only the possibility of the central section of the Structure Plan area having some difficulties in being serviced at this point in time. Again, a frontal approach to development was advocated by the Water Corporation.

It is intended that all lots will be ultimately connected to a reticulated sewerage system. The Water Corporation's sewerage planning has included the Chapman Road/Alexander drive R5 lots, however 'house lot' excisions and the Chapman Road/Alexander R5 lots, given their larger size, may not warrant connection and effluent disposal should be in accordance with the Country Sewerage Policy and other relevant legislation.

4.8.3 Power

With the recent introduction of the Chapman Substation to the south of this area, Western Power indicates that they have capacity available in their system sufficient to cater for full urban development of Glenfield. One 27MVA transformer is presently in place to service the area however, there is capacity within the substation to allow for expansion to an additional two or three such transformers which would adequately cater for the future densities of development.

The existing mains servicing the area could easily be extended along Alexander Road and Chapman Road by an 11,000V service feeding into the required underground residential development system to all lots. Padmounted substations within the subdivisions will then supply the required 240 volts to the residential lots. Provision within the subdivision may be required to cater for power infrastructure however, this will become a specific requirement at the subdivision stage.

5 IMPLEMENTATION

Implementation of the Glenfield Structure Plan presents some challenges due primarily to the fragmented ownership of the land. It is recommended that the following actions be undertaken to implement the findings of the Structure Plan.

1. In conjunction with the Department of Education, actively seek the acquisition of a school site from the open market. Once a school site has been acquired amend the Structure Plan accordingly.
2. Support subdivision provided that it generally accords with the Structure Plan and pays regard to:
 - Major land use locations;
 - Neighbourhood Connector and Integrator road locations; and
 - The need to ensure that adjoining landowners are not disadvantaged by any changes to the Structure Plan.
3. Require the contribution towards public open space at the time of all initial subdivision applications. The POS contribution shall be determined according to the created residential lot area and not the 'balance' land area which shall be subject to further POS contribution at the time of its further subdivision.

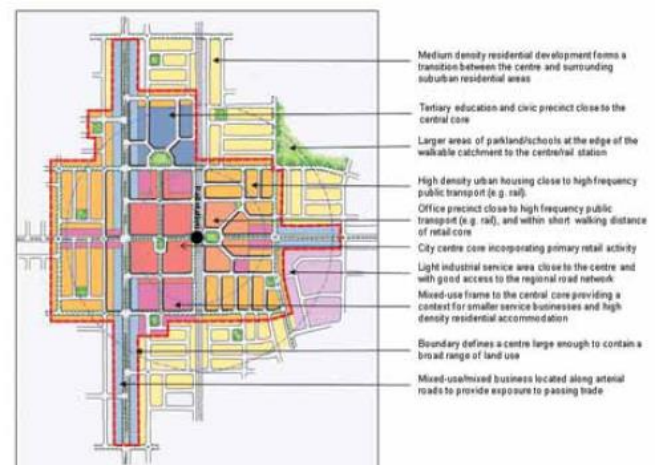
5.1 ACTIVITY CENTRE PLANNING

Activity centres are major generators of travel demand and have the physical capacity to accommodate a greater range and intensity of activity, therefore the appropriate design is likely to make a major contribution to creating a more sustainable urban environment.

Appendix 2: Model Centre Framework contained within the "State Planning Policy, Activity Centres for Perth and Peel" includes a detailed suite of actions that should be undertaken in the planning and design of activity centres in order to create a more sustainable urban environment.

These centre plans will be required prior to any development or subdivision of the Mix Use/Residential R80/Activity Centre land, (with the exception of 2,000m² lots fronting Chapman Road which require a detailed area plan). As part of the centre plans design guidelines should be prepared to address the following (where relevant):

- Height
- Plot Ratio
- Setbacks
- Car Parking
- Land uses and mix
- Heritage considerations
- Protection and enhancement of views
- Pedestrian access and movement
- Landscaping and streetscape
- Building materials and colours
- Public art and/or facilities
- Desired urban character.



5.2 SUBDIVISION GUIDE PLANS

To ensure that subdivision/development proceeds in an orderly and proper manner, and to avoid ad-hoc subdivisional approvals, it is a requirement that a subdivision guide plan be prepared (where considered warranted by the local government) to show how an individuals' lot design is part of an overall plan for an area (with the area defined by the local government on a case-by-case basis).

Once these detailed plans have been advertised to affected landowners (21 day period), and approved by the local government, the Structure Plan will be updated accordingly.

Guide plans should incorporate the following:

- Additional access streets that allow the urban fabric to respond to change;
- Intersection treatments that provide physical clues to assist in legibility;
- The retention of landmarks, habitats, significant vegetation with environmental connectivity where required;
- The location of public transport facilities, cycleways and pedestrian networks;
- The location of higher density housing; and
- The provision of a School site around the central section of Hagan Road, following advice from the Department of Education on the purchase of a site.

5.3 DETAILED AREA PLANNING

Detailed Area Plans (DAP's) are required for all the R5 lots along Alexander Drive and any interim R5 lots created abutting Chapman Road (excluding lots in the Special Use area).

The DAP's are required to address the issue of interim access from Alexander Drive, building envelopes, setbacks and dual road frontage. In addition it should clearly advise that Main Roads

WA will require Alexander Drive in the future to become part of the future North-West Coastal Highway and it will not provide direct road access to abutting residential properties.

For 2,000m² lots fronting Chapman Road in the residential area the DAP's will also need to show how future intensification of the lots can be achieved to an R40 standard including access arrangements taking into consideration future restrictions of access onto Chapman Road.

5.4 INTERIM SUBDIVISION

5.4.1 Chapman Road Residential R5

The previous intention for lots along Chapman Road was to retain the existing larger lot amenity and some subdivision of 2,000m² lots has already occurred.

In this urban fringe area it is acknowledged that larger lot residential land may be developed well in advance of the envisaged R40 development. In these instances a detailed area plan is required that facilitates future intensification.

In order to protect the integrity of the planning objective for Chapman Road support will not be given for 'in-between' lot sizes (ie. 350m² – 1,999m² lots) that could potentially lead to the proliferation of low density single residential housing.

The larger lot size of R5 (2,000m² lots) is considered large enough to facilitate a single house and also allow for future intensification. Lot sizes smaller than this could compromise the ability of the land to be redeveloped at a later stage.



5.4.2 Subdivision of Existing Housing

The Structure Plan provides for the retention of existing dwellings on larger lots and the City will continue to support the excision of 'house lots' without requiring reticulated sewer connection where those dwellings were existing or had building approval prior to or on the date of original adoption of the Structure Plan (13 March 2002). The size of the lot should have no further subdivision potential itself (generally up to 2,000m²), however, where improvements are pertinent to the dwelling, larger lot sizes may be approved.

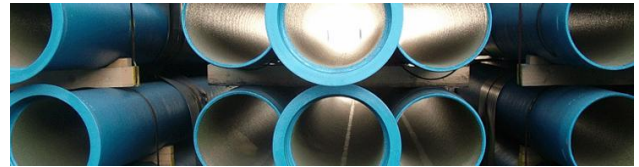
5.5 DEVELOPER CONTRIBUTIONS

The large physical size of the Glenfield area and the predicted slow rate of subdivision development could result in difficulties in operating an effective common cost fund. Due to problems experienced with managing common cost funds or costs associated with guided development schemes (such as Waggrakine), the City will minimise its involvement in cost sharing. To this extent the City will only be involved with cost sharing arrangements relating to public open space. The following describes the rationale behind the approach for common cost sharing in relation to items traditionally considered to form part of a common cost regime.

5.5.1 Drainage

In the past structure plans have provided for large areas for district drainage, accounting for all landowners in the area. Under this scenario redistribution of drainage common costs is complex. As the dual use of parks for recreation and drainage is now part of contemporary subdivision design, it would be almost impossible to arrange any common costs associated with drainage. If a number of landowners jointly develop, they can reach their own internal agreement as to the size and location of drainage requirements, alternatively individual subdividers can provide smaller areas to serve their individual

proposals. Either way the City need not be involved in the cost equities of district drainage facilities and subdividers will be responsible for their own drainage requirements at the time of subdivision.



5.5.2 Major Roads

The Structure Plan shows a basic road framework with the Neighbourhood Connector and Integrator roads forming the basis of the Structure Plan. The new North-West Coastal Highway alignment has down graded the function of Chapman Road to that of an Integrator A.

The City does not need to get involved in the cost equities associated with roads and individual subdividers will be responsible for construction of internal roads and contribution towards upgrading of existing abutting roads. Subdividers have the opportunity of reclaiming costs for road construction pursuant to the Planning and Development Act.



5.5.3 Schools

The Department of Education & Training has indicated that it is willing to purchase a suitable site for a Primary School from the open market and ahead of need. The City is not required to redistribute costs inequities as the Department organises a pro rata contribution from subdividers at the time of subdivision.

5.5.4 Servicing

All costs associated with the funding of infrastructure for water, power and sewerage, both permanent and temporary, are costs which are traditionally borne by the individual subdivider and need not involve the intervention of the City. In these cases it is normal practice for the subdivider to negotiate directly with the responsible authority to reach a mutually satisfactory outcome.

5.5.5 Public Open Space

The Structure Plan has promoted a 10% public open space contribution by means of land and/or cash-in-lieu contributions in accordance with the Planning and Development Act. Where it is not possible to achieve a totally equitable provision of open space for each individual landholding, cash-in-lieu will be used to acquire additional land in excess of the 10% requirement. The City need only be involved in maintaining a register of land that has contributed towards POS and managing cash-in-lieu funds.

All lots should be required to contribute towards public open space, including the larger lots fronting Chapman Road and Alexander Drive, 'house lot' excisions and lots within the Mixed Use area. These lots form part of the community planning philosophy and will clearly benefit from the public open spaces provided.



6 CONCLUSION

The Structure Plan provides a robust, contemporary planning framework for future development of the Glenfield locality consistent with Liveable Neighbourhoods. It is considered to have addressed the issues the WAPC has identified.

The Glenfield Structure Plan will assist the City in achieving part of its vision, to sustain a population of 80,000 to 100,000 people and be Western Australia's second city.



Figure 1 - LOCATION PLAN

SUBJECT LAND

DRUMMOND COVE

HIGHWAY

WAGGRAKINE

SUNSET BEACH

MORESBY

COASTAL

SPALDING

STRATHALBYN

WEST

GERALDTON

NORTH

DEPDALE

KARLOO

WANDINA

NARNGULU

RUDDS GULLY

Figure 2 - STRUCTURE PLAN AREA



**DRUMMOND
COVE**

ROAD

CHAPMAN

**SUNSET
BEACH**

HIGHWAY

COASTAL

WEST

NORTH

WAGGRAKINE

Figure 3 - AERIAL PHOTOGRAPH

GERALDTON

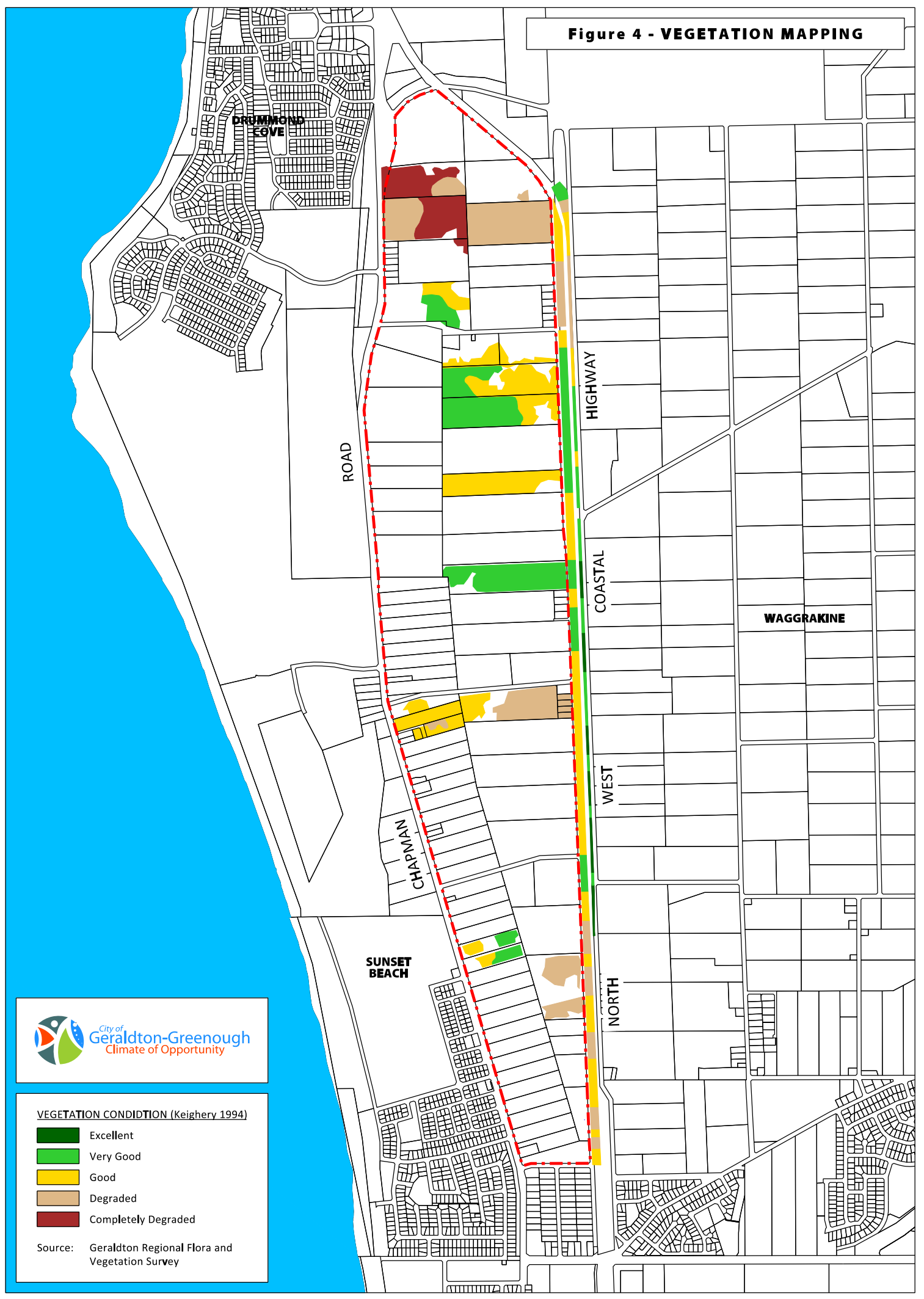
NWC HIGHWAY

CHAPMAN ROAD

440 ROADHOUSE



Figure 4 - VEGETATION MAPPING



VEGETATION CONDITION (Keighery 1994)

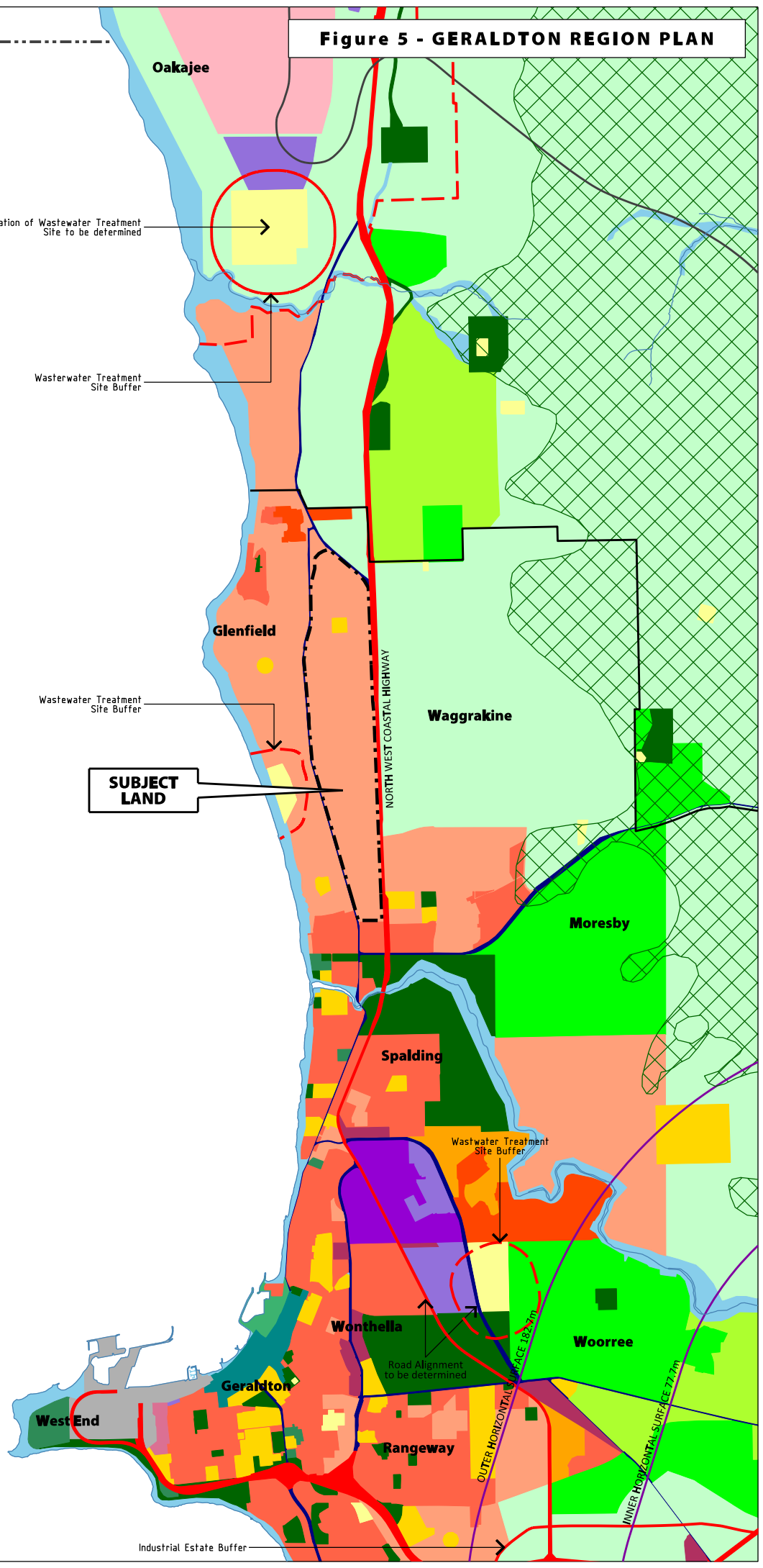
-  Excellent
-  Very Good
-  Good
-  Degraded
-  Completely Degraded

Source: Geraldton Regional Flora and Vegetation Survey

Figure 5 - GERALDTON REGION PLAN

LEGEND

- Urban
- Future Urban
- Special Residential
- Potential Special Residential
- Rural-Residential
- Potential Rural-Residential
- Tourism
- Future Tourism
- Community Purpose
- Public Utility
- City Centre
- Light Industry/Mix Business
- Future Light Industry/ Mixed Business
- General Industry
- Future General Industry
- Noxious and Hazardous Industry
- Strategic Industry
- Port Industry and Installations
- Moresby Range
- Rural
- Foreshore and River Systems
- Open Space and Recreation Reserves (Existing and Future)
- Buffer
- Primary Distributor Road
- District Distributor Road
- Railway Reserve
- Existing Rail Line
- Possible Future Rail Line
- Obstacle Limitation Surface
- Local Government Boundary
















Industrial Estate Buffer

Figure 6 - ZONING PLAN

CITY OF GERALDTON-GREENOUGH
 TOWN PLANNING SCHEME No. 3
 [GERALDTON]
 and
 LOCAL PLANNING SCHEME No. 5
 [GREENOUGH]
 (DISTRICT SCHEMES)

LEGEND





LOCAL SCHEME RESERVES

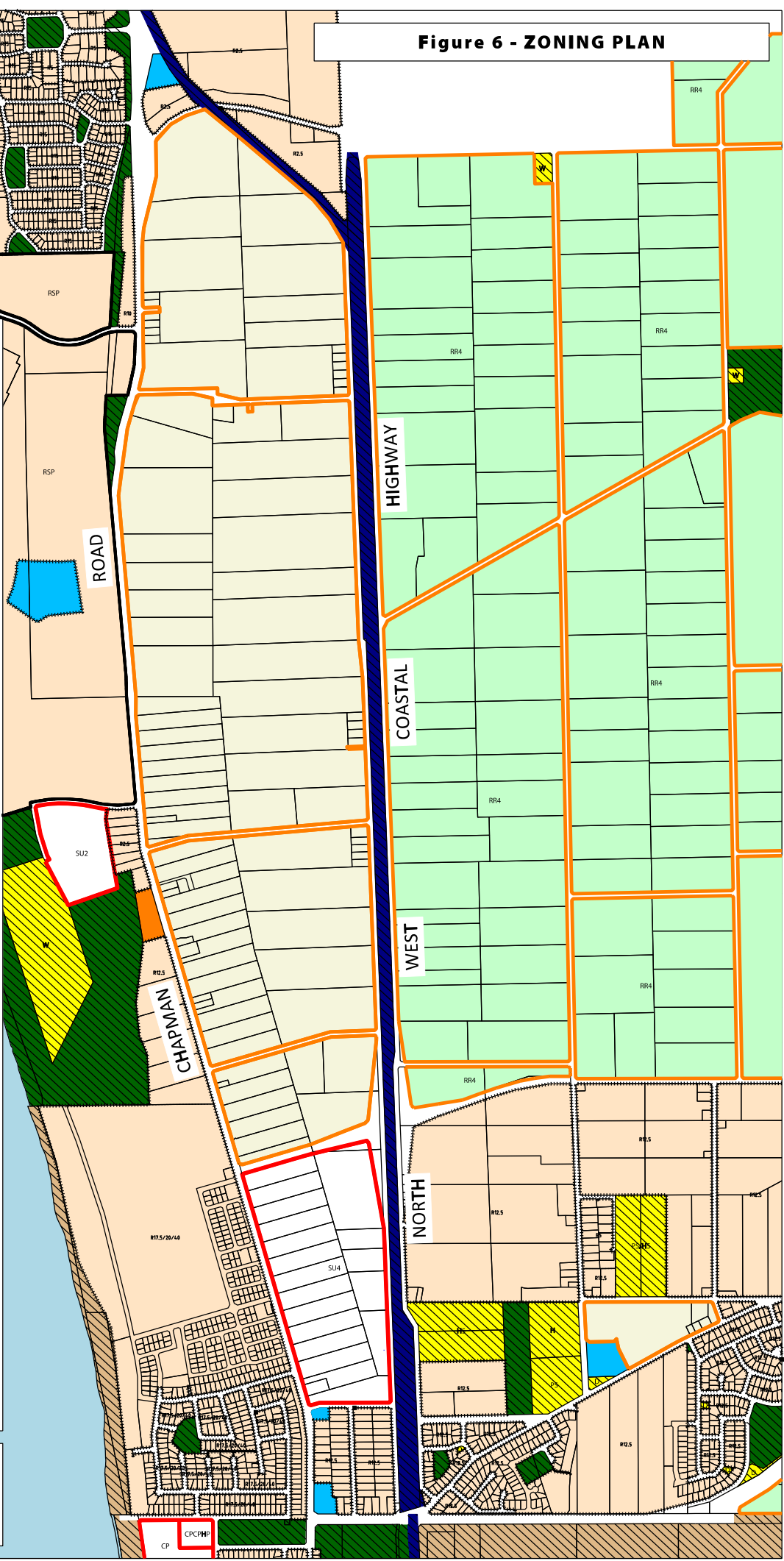
-  MAJOR ROAD
-  PARKS AND RECREATION
-  PUBLIC PURPOSES
Denoted As Follows:
-  D Drainage
-  FF Fire Fighting
-  H Hall
-  HS High School
-  PS Primary School
-  PS/HS Primary and High School
-  W Water
-  LANDSCAPE AND COASTAL PROTECTION
-  ROAD
-  WATERWAY

ZONES

-  DEVELOPMENT
-  RESIDENTIAL
-  TOURIST
-  COMMERCIAL
-  SPECIAL USE
-  SPECIAL USE
Denoted As Follows:
-  CP Caravan Park
-  CPCPHP Caravan Park/Chalets/ Park Home Park
-  CIVIC AND CULTURAL
-  RURAL
-  RURAL RESIDENTIAL

OTHER

-  R20 R CODES
-  SU 2 SPECIAL USE AREA
(See Scheme Text)
-  RR 2 RURAL RESIDENTIAL AREA
(See Scheme Text)
-  RSP RESIDENTIAL STRUCTURE PLAN
(See Scheme Text)



CPCPHP
 CP

Figure 7 - PEDESTRIAN & CYCLE NETWORK

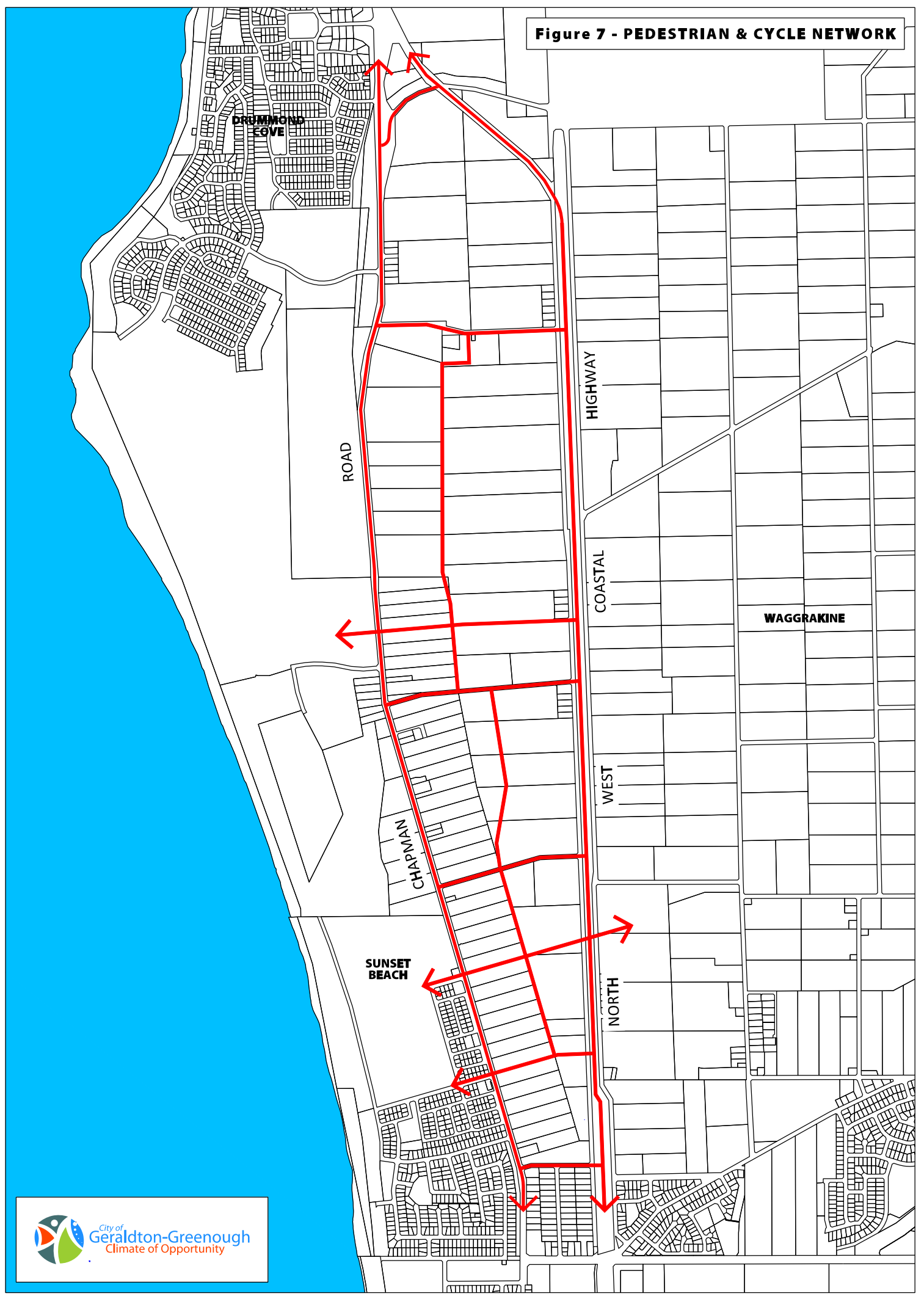
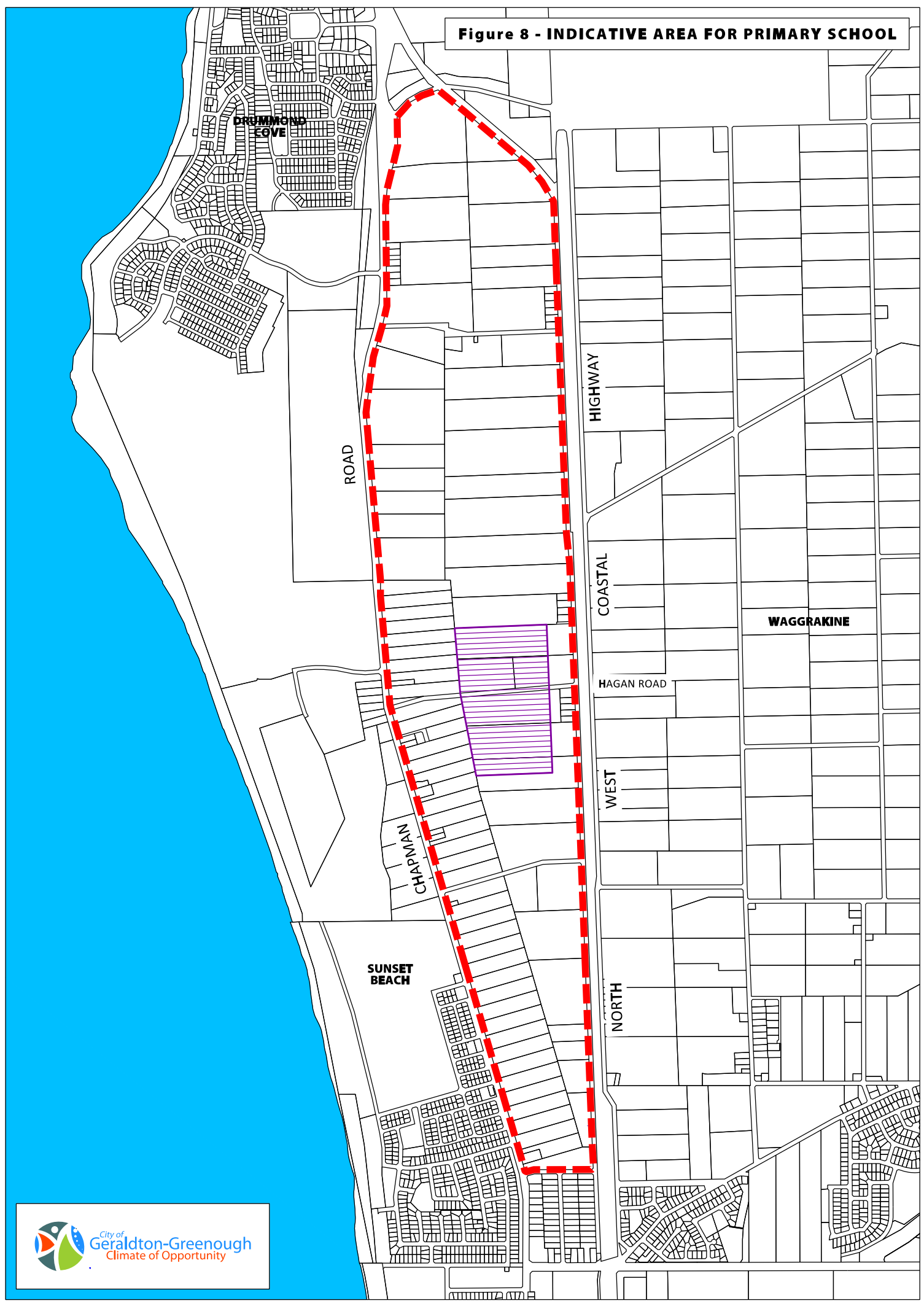
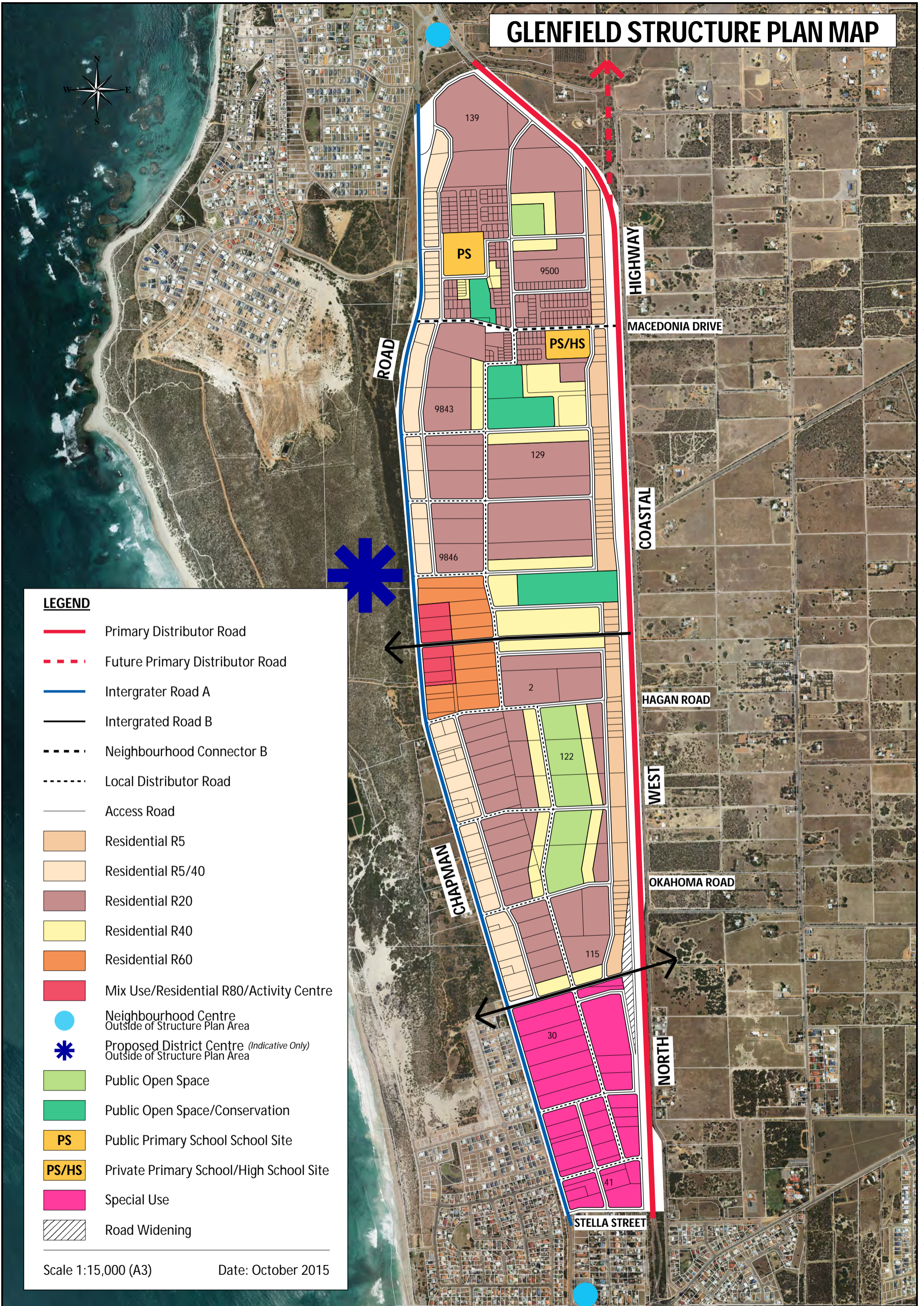


















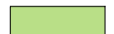




Figure 8 - INDICATIVE AREA FOR PRIMARY SCHOOL



GLENFIELD STRUCTURE PLAN MAP



LEGEND

-  Primary Distributor Road
-  Future Primary Distributor Road
-  Intergrater Road A
-  Intergrated Road B
-  Neighbourhood Connector B
-  Local Distributor Road
-  Access Road
-  Residential R5
-  Residential R5/40
-  Residential R20
-  Residential R40
-  Residential R60
-  Mix Use/Residential R80/Activity Centre
-  Neighbourhood Centre Outside of Structure Plan Area
-  Proposed District Centre (Indicative Only) Outside of Structure Plan Area
-  Public Open Space
-  Public Open Space/Conservation
-  PS Public Primary School School Site
-  PS/HS Private Primary School/High School Site
-  Special Use
-  Road Widening

Scale 1:15,000 (A3)

Date: October 2015

Appendix A – REGISTER OF ABORIGINAL SITES

REGISTER OF ABORIGINAL SITES



RPGSR
Reference No: AUID-710121

Search Criteria
 Easting: 268532mE; Northing: 6820811mN; Zone: 50
 Easting: 268250mE; Northing: 6820811mN; Zone: 50
 Easting: 268211mE; Northing: 6820796mN; Zone: 50
 Easting: 267572mE; Northing: 6823005mN; Zone: 50
 Easting: 267455mE; Northing: 6824380mN; Zone: 50
 Easting: 267486mE; Northing: 6824646mN; Zone: 50
 Easting: 267555mE; Northing: 6824898mN; Zone: 50
 Easting: 267552mE; Northing: 6825430mN; Zone: 50
 Easting: 267606mE; Northing: 6825861mN; Zone: 50
 Easting: 267665mE; Northing: 6825868mN; Zone: 50
 Easting: 267725mE; Northing: 6825999mN; Zone: 50
 Easting: 267801mE; Northing: 6825560mN; Zone: 50
 Easting: 268237mE; Northing: 6825560mN; Zone: 50
 Easting: 268343mE; Northing: 6825388mN; Zone: 50
 Easting: 268404mE; Northing: 6823825mN; Zone: 50
 Easting: 268420mE; Northing: 6823685mN; Zone: 50

Assessment Status ("Status")
L = Lodged: Lodged with Registrar, placed on Register, not assessed.
I = Insufficient Information: Lodged with Registrar, placed on Register, has insufficient information to complete assessment in terms of section 5 of AHA.
P = Permanent: Lodged with Registrar, placed on Register, lodged information assessed as meeting terms of section 5 of AHA.
S = Stored Data: Lodged with Registrar, placed on Register, lodged information assessed as not meeting terms of section 5 of AHA.
REGISTRAR ASSESSMENTS ONLY. NOTE: THESE SITES NEED TO GO TO ACMC FOR FINAL ASSESSMENT.
IR = Insufficient information (SAG): Provisionally considered to have insufficient information to complete assessment.
PR = Permanent (SAG): Provisionally assessed as meeting terms of section 5 of AHA.
SR = Stored Data (SAG): Provisionally assessed as not meeting terms of section 5 of AHA.
Site Assessment Group (SAG): Sites lodged with the Registrar are assessed under the direction of the Registrar of Aboriginal Sites. These are not to be considered the final assessment.
Final assessment will be determined by the Aboriginal Cultural Material Committee (ACMC).
C = Closed: Access to site file requires the written consent of persons recorded in the site file as primary Aboriginal informants. Contact DIA for details.
O = Open: Access to site file is open to the public.
V = Vulnerable: The current physical condition of the site may prevent access to the site.

Restriction ("Res")
N = No restriction: No restrictions are placed on viewing the information in the site file.
M = Male access only: Access to the site file is restricted to males.
F = Female access only: Access to the site file is restricted to females.

Legend

Copyright - Copyright in the information contained herein is and shall remain the property of the State of Western Australia. This includes, but is not limited to, information from the Register of Aboriginal Sites established and maintained under the Aboriginal Heritage Act 1972 (AHA).
Disclaimer - The AHA protects all Aboriginal sites in Western Australia whether or not they are registered. Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some sites that appear on the register may no longer physically exist. Consultation with Aboriginal people is on-going to identify additional sites or changes to registered sites.
Spatial Accuracy - Map coordinates (Easting/Northing) listed in this report only represent indicative locations of sites. They should not be interpreted as the centre of a site. All sites on the Sites Register have an area and should not be represented as points. The coordinates are based on the GDA84 datum. The Easting / Northing map grid can be accessed one or more zones. The zone is indicated for each Easting on the map in this report, i.e., '500000;250' means Easting=500000, Zone=50.
Coordinate Accuracy
 [Reliable] or "R": The spatial information recorded in the site file is deemed to be reliable due to the methods of capture.
 [Unreliable] or "U": The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Site ID	Site Name	Acc	Res	Status	Resolution	NA	05	39	Site Type	Additional Information	Informants	Recorders	Easting Northing	Field Code Site No.
442	DULCHEWAY	O	N	P	00088	A	C	A	C	Artefacts / Scatter		Date: 17/11/1995-[Ronan, Rob (Mr)], [Ronan, D.], [Schwece, Mead (Dr)]	267608mE 6825563mN Z50 R	SITE 3 S02947

REGISTER OF ABORIGINAL SITES SITE SEARCH MAP



Legend

- Selected Site
- Town
- Map Area
- Search Area

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Copyright for Native Title Land Claim and Local Government Authority boundaries shall at all times remain the property of the State of Western Australia, Dept of Land Information. All rights reserved.

Copyright for Mining Tenement boundaries shall at all times remain the property of the State of Western Australia, Dept of Industry and Resources. All rights reserved.

1 Aboriginal Heritage Sites found in Polygon

Coordinates:

Easting	Northing	Zone
268532	6820811	50
268250	6820811	50
268211	6820798	50
267572	6823005	50
267455	6824380	50
267486	6824649	50
267555	6824898	50
267552	6825430	50
267506	6825661	50
267606	6825801	50
267665	6825868	50
267725	6825899	50
267801	6825925	50

Appendix B – MAIN ROADS WA ADVICE

Page 1 of 1

Murray Connell

From: SWAAN Peter (PM) [petrus.swaan@mainroads.wa.gov.au]
Sent: Wednesday, 21 November 2007 2:45 PM
To: Murray Connell
Subject: Glenfield Structure Plan

Murray, as requested the wording in Main Roads comments on the Draft Northern Geraldton District Structure Plan in regards to the existing Alexander and Beattie Roads parallel to North west Coastal Highway were:

"Main Roads requests a stronger emphasis on ensuring existing local structure plans are revised subsequent to more detailed planning occurring before subdivision of larger Lots between local distributor roads and local roads. The local structure plans, incorporating the subdivision, needs to ensure direct access to primary and regional distributor roads is not required and also removes the need for parallel roads that have an affect on the suitability for heavy vehicle usage and the safety and amenity of through traffic.

Main Roads recommends the following amendments for consideration:

1. Item 5.1 under the heading 'Traffic analysis' refers to future development along North West Coastal Highway (NWCH) needing to 'minimise lot frontage' and 'service roads for lots fronting the highway'. Main Roads requests the requirement for lot frontage be amended to reflect lot frontage requiring access to the highway will not be permitted and access to all lots must be through internal subdivision roads. The use of 'service roads' is acceptable as an alternative for short distances but must not utilise the existing Alexander and Beattie Roads. Local roads that run parallel to a highway having safety issues that are difficult to address for intersections with local distributor roads being too close to the highway for safe vehicles movements and spill vehicle light affects on the higher speed through traffic on the highway.
2. Item 5.2 refers to 'reserve requirements for intersections' and needs to be expanded to include reserve requirements for future upgrading of the NWCH are also under consideration and subject to subdivision requirements to retain Alexander and Beattie Roads or replace the lot access onto these roads with access to local roads within the subdivision. Should the former be the scenario, not Main Roads preference due to comment 1 above, the reserve requirements will be to increase the reserve width beyond the existing Alexander and/or Beattie Road reserve to allow for sufficient separation of the local road from the highway when the ultimate upgrading of the highway is required."

Peter Swaan
SENIOR PLANNING OFFICER
Main Roads Mid West Region
Ph 9956 1226 Fax 9956 1240

21/11/2007

Appendix C – DEPARTMENT OF EDUCATION ADVICE

Page 1 of 1

From: WIJAY Sharmini [Asset Services]
Sent: Monday, 7 May 2007 3:22 PM
To: 'Lorraine.Elliott@bsd.com.au'
Subject: North Geraldton District Structure Plan
Hi Lorraine,

Thank you for meeting with me on 4 May 2007 to discuss the unresolved issues relating to school sites in the North Geraldton District Structure Plan.

The Department of Education and Training is pleased to note that the steering committee has resolved to retain the proposed Glenfield High School site on the western side of Chapman Road and exclude the rum jungle from the school site.

The Department would like the Hagen Road Primary School site to be on the flat land half way between Chapman Road and North West Coastal Highway. As for the acquisition of this site, it would be up to the landowners to approach DET to initiate negotiations. We do not necessarily have to wait to acquire a site until we actually need it for construction but the actual timing would depend on the availability of funding in the Department's land acquisition budget.

I also note that a primary school site will be shown in the medium term development in South Buller (currently marked as R6).

If you require more information or wish to discuss this further please feel free to contact me on 9264 4183.

Regards,

Sharmini Wijay
Senior Consultant Asset Planning

Asset Planning Branch
Department of Education and Training
151, Royal Street
East Perth 6004

Phone 08 9264 4183

Appendix D – STORMWATER AND DRAINAGE MANAGEMENT PLAN

Connell Wagner Pty Ltd
ABN 54 005 139 873
Unit 1
5 Chapman Road
Geraldton
Western Australia 6530 Australia

Telephone: +61 8 9964 2764
Facsimile: +61 8 9964 2053
Email: cwgetl@conwag.com
www.conwag.com

**Glenfield Structure Plan
Stormwater and Drainage
Management Plan
Department for Planning and Infrastructure**

22 December 2008
Reference 36866
Revision 1

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1. Background and Objectives

1.1 Background

A District Drainage Investigation was prepared in January 2008 by Connell Wagner for the City. The conclusions of the study were that water sensitive urban design within the study area is possible; however there are major difficulties in coordinating drainage and POS locations due to topography and soil types. Other difficulties identified were the fragmented ownership and unknown sequence of development. The investigation study suggested that the drainage systems will most likely be self-contained, rather than linked to any major district system, with the exception of one sub-catchment area, where there is potential to incorporate a drainage system into a linear POS network.

At its meeting in March 2008 the Western Australian Planning Commission (WAPC) considered that while the Glenfield Structure Plan (GSP) stated there was a general presumption against fenced drainage sumps and agreement to integrate stormwater drainage that the approach of handling drainage on a small subdivision by subdivision basis would make a more integrated drainage system difficult to achieve. The Commission believes that a coordinated drainage system incorporating water sensitive urban design principles within the GSP area will not be achieved without an overall approach to stormwater management, which will involve investigating the integration of the location of POS areas with a drainage function and cooperation between all landowner within the GSP area and specifying in more detail how drainage requirements will be achieved.

Connell Wagner was appointed by the WAPC to prepare an updated stormwater management plan in accordance with the study brief outlined in Appendix C.

1.2 Objectives of the Study

Best planning practice for stormwater management involves integrating land and water planning and implementing water sensitive urban design. An appropriate level of consideration needs to be given to the total water cycle at each stage of the planning system.

The overall objective of the study, in accordance with the study brief, is to prepare a Stormwater and Drainage Management Plan for the Glenfield Structure Plan area that:

- Takes in to consideration the principles, objectives and requirements for total water cycle management as outlined in the draft Water Resources SPP, Liveable Neighbourhoods, and the Stormwater Management Manual for WA;
- reviews and builds on the District Drainage Investigation for the GSP area undertaken by Connell Wagner in January 2008;
- identifies appropriate methods to locate future stormwater attenuation areas integrated with Public Open Space (POS);
- seeks to maximise the opportunity to achieve integration of stormwater disposal with open space reserves and vegetation protection across the GSP area;
- provides a guide for the coordinated disposal of stormwater, across the GSP area.

1.3 Limitations of the study

This study addresses the treatment and disposal of runoff from future road reserves. It has been assumed that Council policy will address the control of stormwater for residential house construction through the building licensing process. It is assumed that post-development conditions will meet pre-development conditions through the use of soakwells and/or rain water tanks within the lots using council building controls. To meet pre-development conditions the City of Geraldton Greenough may need to update existing policy.

Recommendations on areas to be allocated for use as stormwater attenuation are based on estimates derived from simplified calculations. The areas are substantially smaller than Public Open Space requirements. Further investigations including development of a rainfall-runoff model are required to confirm assumptions.

The recommendations of the study have been developed utilising the best available data. Soils information has been extracted from a 1:50,000 soil and landform inventory for the region. Remnant vegetation has been identified from mapping produced in 2005 which does not include detail on the quality of the mapped vegetation. Because of the limitations imposed by the accuracy of the data a probabilistic approach has been adopted to identifying potential constraints and opportunities present on the site. The recommendations should be primarily used for guiding further investigation.

2. Review of Current Plans

2.1 Draft revised Glenfield Structure Plan

A meeting was held with the CGG on 9 July 2008 to discuss the project and obtain a copy of the Draft Revised Glenfield Structure Plan (GSP). A copy of the plan was provided that incorporates the main change recommended in the Previous District Drainage Investigation. The draft revised GSP shows an area set aside for a linear POS network over the Eastern Portion of the Central and Southern Central Neighbourhoods.

The purpose of the Glenfield Structure Plan is to provide a concept plan to guide future subdivision of the area. There are six neighbourhood cells proposed in the structure plan. The report proposes that the detailed design of each neighbourhood unit be considered individually.

Detailed design of individual subdivisions would be subject to providing an overall plan for the area, the area being defined by local government on a case by case basis. Where contributions may be required, the GSP comments that their contribution areas may be defined by the neighbourhood units. The use of the planning unit provides scope to plan for cost sharing for Public Open Space and Infrastructure within each unit.

The GSP proposes that each neighbourhood unit be self contained for provision of Public Open Space (POS). POS requirements are drawn from 'Livable Neighbourhood'. Each neighbourhood planning unit is to contain one neighbourhood park of 3000-5000 square metres, a community purpose site of approximately 2000 square metres, and local parks to make up the difference. The GSP comments that neighbourhood parks be defined in the structure plan, and local parks to be determined at the detailed design stage.

An overall density of R12.5 is proposed in the GSP as a reasonable estimate of the net density of the area. This includes an allowance of road reserves to occupy approximately 30% of the entire site area.

2.2 Previous District Drainage Investigation for the GSP

Connell Wagner undertook an investigation report of options for stormwater drainage for the structure plan area in January 2008.

The report concluded that;

"It is possible to incorporate the principles of Water Sensitive Drainage Design within the study area. There are major difficulties however, coordinating drainage and siting of POS locations in the study area due to the variation in topography and soil types.

The other major issues in pre-planning a major drainage system for the Glenfield Structure Plan area are the fragmented ownership, size of the area and the unknown sequence of development. The combination of these factors will most likely necessitate drainage systems of micro or minor nature that will tend to be more self-contained rather than linked to a major system, with the possible exception of sub-catchment 2.

Sub-catchment 2 contains suitable soils, and topography for the provision of a major drainage system integrated in to a linear public open space network. The existing land use pattern is of an appropriate scale to incorporate an integrated land and water strategy over the entire sub-catchment.

It is recommended that a linear public open space network be further investigated at the detailed subdivision stage for land within sub-catchment 2 and that for the remainder of the site,

developers prepare Stormwater Management Plans at the detailed subdivision design stage to ensure that appropriate water sensitive design strategies are adhered to.”

2.3 Draft Northern Geraldton District Structure Plan

The GSP forms part of the Draft Northern Geraldton District Structure plan (NGDSP). The NGDSP makes several recommendations in relation to drainage.

The majority of the GSP area drains to an area known as the 'Rum Jungle'. This area is identified as future POS, Landscape and Recreation Reserves in the NGDSP. This will allow its existing drainage function to be maintained.

Detailed recommendations outlined in the NGDSP on drainage include;

- a presumption against the use of fenced drainage sumps;
- where possible drainage should make use of swales and compensating basins located in POS
- buffers to surface water features 10m for drainage lines, and 30m for creeklines

2.4 Approved and Proposed Subdivision Applications

A number of subdivisions have been proposed for the Glenfield area. The majority of subdivision applications have been deferred or not approved pending modifications to be made to the GSP and the endorsement of a modified structure plan by City of Geraldton - Greenough and WAPC.

The majority of approved subdivisions have occurred in the proposed R5 areas fronting Chapman Road and Alexander Drive. The approved subdivisions fix the location of some roads, however the limited number of approvals does not impose unreasonable restrictions on future planning. Three areas warrant further discussion; the proposed subdivision pattern over the seven lots fronting Chapman Road in the Central and Southern Central neighbourhood, lot 144 fronting Chapman Road in the Northern Neighbourhood, and former Lot 1 on D87978 (now lot 62 Macedonia Drive) in the Central Neighbourhood. These areas are discussed further in section 7 in the detailed analysis of individual neighbourhoods.

In order to achieve a more integrated approach to the drainage issues it is important that decisions made on subdivisions approvals fit within an agreed overall drainage plan.

3. Site Characteristics

3.1 Land Use

The current land use of the site is a mixture of large lot residential, special use/home based commercial industry, and small scale agriculture. The majority of the catchment is grassland, being largely cleared of native vegetation except for a few pockets of remnant vegetation.

3.2 Climate

The climate of the area is Dry Warm Mediterranean, characterised by warm to hot, dry summers and mild, wet winters. The summer season is characterised by high average maximum daily temperatures and high net evaporation. Average daily maximum temperatures range from 19C in July to 32C in February.

The average annual rainfall is approximately 475 mm, typically, most rainfall occurs during the months of May to August.

3.3 Site Geology

The majority of the site has been identified as the Tamala soil-landscape system. The landforms and soils associated with the study area are:

Teakle – Gently undulating sandplain with loose to soft, yellowish brown sand over yellow clayey sand over limestone.

Teakle 1 – Crests and ridges comprise a shallow variant, limestone at less than 500mm

Bookara 1 – Undulating rises and swales with loose, deep dark brown calcerous sands over limestone.

3.4 Surface Water and Waterways

Excess runoff from the site in its present condition has not formed any mappable channels or streams. The sandy soils in the area have high infiltration rates. Only larger events will result in runoff from the site.

The site discharges to two surface water features, Dolby Creek and the low lying area to the east of the Quindalup dune system along Chapman Road. There is limited information available on the characteristics or significance of these two surface water features. The Department of Water provided some information from the report undertaken by Cardno BSD “Glenfield Beach Estate Soil and Vegetation Assessment” (Cardno BSD, April 2006, Unpublished) which is discussed below.

The “Glenfield Beach Estate Soil and Vegetation Assessment” references the previous investigations for the Northern Geraldton District Structure Plan (Cardno BSD, 2005) noting that no specific studies exist that delineate the Dolby Creek channel or document its hydrologic or flooding characteristics. The creek is a blind system and discharges into a low lying swale area immediately east of the Quindalup Dune system which is known as the ‘Rum Jungle’. A portion of the GSP study area drains to Dolby’s Creek. The unknown flooding characteristics should be considered in developing management objectives.

The “Glenfield Beach Estate Soil and Vegetation Assessment” also notes that there is no Wetland Mapping for the area and provides the recommendation that the vegetation of the ‘Rum Jungle’ does not indicate that *“it is part of an active waterway or considered to be a wetland. It does however*

indicate that the site is likely to be part of a flood plain (that is likely to be) subjected to inundation and flooding during major storm events (in the order of 50 year or 100 year ARI events)." The 'Rum Jungle' area is considered locally significant and should be considered in developing goals and objectives for stormwater management within the study area.

The study area is bounded on the upslope side by the North West Coastal Highway and service roads. The modified landscape provides a barrier to any potential flow from upslope. The southern section of the adjacent North West Coastal Highway is constructed on a fill embankment providing a barrier to upslope runoff. On the northern section there is a sag point approximately 100m north of Macedonia Drive. A small (375mm) culvert discharges to a long wide drainage swale within the road reserve. The combined affect of road levels, table drains, and sump/infiltration areas within the road reserve minimise the potential for upslope runoff contributing to the study area.

3.5 Hydrogeology and Groundwater

There is limited data available on the groundwater conditions across the study area. Senior hydrologist Midwest – Gascoyne Region for the Department of Water, Lazarus Leonhard has provided a best of knowledge assessment of groundwater conditions based upon the available data extrapolated across the site and general dynamics of coastal hydrogeology in a coastal/limestone environment.

"The [Surface Water Level] SWL falls in a westerly direction from about 20 m below ground level (bgl) or 15 m AHD at the north eastern border to about 7 m bgl (3 m AHD) at the south western border.

Groundwater will be unconfined and located within unconsolidated sand (probably synonymous with the Tamala Sand of the Perth coastal region.

Regional groundwater flow will be in a general west - south-westerly direction.

Groundwater levels are expected to fluctuate an average of 0.5 to 1 m. The greatest fluctuations would be expected in the western central portion of the GSP area, within the "saddle" east of the coastal dune - surface elevation high (approx. centred point 267447mE & 6823825mN). Groundwater levels in this area, situated between surface elevation highs, will respond quickly to groundwater recharge events forming a localised and temporal 'mound' of groundwater.

The superficial formation would appear to be over 40 m in thickness and comprises about 20 m of sand overlying limestone. The thickness of sand will decrease in an easterly direction...The quality of groundwater would be expected to be fresh (500 mg/L) near the top of the aquifer. Groundwater salinity may increase with depth...The underlying sand will be highly transmissive...[and] Groundwater will be susceptible to the infiltration and movement of nutrients and agricultural/lawn chemicals."

3.6 Acid Sulphate Soils

The north eastern portion of the GSP area has a high risk of associated acid sulphate soil. There is areas of medium risk present adjacent Chapman Road along the Western boundary of the structure plan area. The rest of the site is mapped as having low risk of potential acid sulphate soils.

To determine the depths of potential acid sulphate soils drill sampling needs to be carried out. Investigations should be undertaken to below the lowest invert depth of any proposed sewer mains/pumping stations. Further assessment and management strategies can then be determined.

4. Proposed Development and Impacts

4.1 Proposed Development

The future development of the site consists of;

- a special use zone in the southern portion of the site;
- a commercial node fronting Chapman Road in the Central Neighbourhood;
- a proposed school site in the Central Neighbourhood (location to be confirmed) adjacent the commercial node;
- large lot residential (2000 square metre lots) fronting Chapman Road and Alexander Drive;
- and residential (550-800 square metre lots) for the remainder of the site.

The study area is currently made up of 111 parcels of land with potentially a similar number of owners. The sequence and nature of development is difficult to anticipate given that the existing owners are many and varied and may choose not to develop their land further than they have to date. The fragmented ownership of the land provides a challenge for implementing a co-ordinated approach to future development of the area.

4.2 Potential Impacts

The proposed development has the potential to adversely impact on existing water quality and quantity throughout the site. Development will result in an increase in the proportion of impervious areas across the site. This in turn will lead to an increase in the volume of runoff that can enter water bodies during rainfall events. Increased impervious areas will also increase the potential for pollutants such as hydrocarbons, sediment, etc, being discharged to the local water bodies. In addition to impacts on the surface waters an increase in the proportion of impervious areas across the site may have an impact on groundwater levels.

5. Water Management Objectives

To take in to account the principles, objectives and requirements for total water cycle management as outlined in the draft Water Resources SPP, Better Urban Water Management 2008, Liveable Neighbourhoods, and the stormwater Management manual for WA, a set of water management objectives are provided in Table 5.1. These water management objectives are based on a literature review, providing objectives for stormwater management, water conservation, and groundwater management.

Table 5.1 Water Management Objectives and Criteria

Objective	Criteria	Comments
Water balance and drain management (Stormwater Quantity)	To maintain the quantity of water to ensure protection of the ecosystem and environmental values in the area	1 in 1 year ARI discharges to the 'Rum Jungle' to match pre-development flows.
	To ensure that the quality of the modified runoff does not adversely affect the environmental values and meets all the statutory requirements	
	The post development flows shall be consistent with the pre development flows. For 1 year ARI the post development peak flows and volume shall be maintained relative to the pre development conditions.	Better Urban Water Management, WAPC 2008
	Flood management for the entire catchment up to 1 in 100 year ARI event to match predevelopment flows	Better Urban Water Management, WAPC 2008
Stormwater Quality	Minimise pollutants entering the waterways from stormwater runoff	
	Minimise runoff velocities and volumes to maximise retention times and allow for effective pollutant removal to achieve targets set	Excessive retention of stormwater to be avoided to enable riparian environmental flows to be maintained.
	Maintain stormwater quality at pre development levels, or alternatively achieving at least: <ul style="list-style-type: none"> • 80% reduction of total suspended solids • 60% reduction of total phosphorus • 45% reduction of total nitrogen • 70% reduction of gross pollutants 	Better Urban Water Management, WAPC 2008
	Comply with the requirements of the Department of Water Stormwater Management Manual for Western Australia	
Soil and water erosion control	Identify areas susceptible to erosion and implement BMP's	Areas with high slopes susceptible to erosion are identified in Appendix B
To achieve long-term Water Quality Objectives	No direct discharge of effluent, washwater or untreated stormwater to waterways	
Water Conservation	Potable water usage should be minimised where drinking water quality is not required	Better Urban Water Management, WAPC 2008
	Protect potential public groundwater supplies from contamination	

6. Approaches to Stormwater Management

To achieve the stormwater management objectives provided in section 5 a range of stormwater management tools are available. Stormwater management can be addressed through Source Controls, Conveyance Controls, and Discharge Controls. Overall management of stormwater systems can be aided through natural systems planning.

- **Source Controls** – Treating and disposing of excess stormwater at the source. May include measures such as retention, detention and infiltration systems.
- **Conveyance Controls** – Treating and disposing of stormwater during the conveyance of runoff from the source of generation to point of discharge. May include such measures as conventional kerb and gutter with a piped system, or a water sensitive urban design approach such as grass swales, bio-retention and natural channel designs.
- **Discharge Controls** – Treating and disposing of excess runoff at the point where water leaves the allotment, estate or catchment. Measures may include centralised stormwater retention/detention/infiltration facilities, and Gross pollutant traps.
- **Natural Systems Planning** – Natural systems planning is an approach to local area planning and neighbourhood design that recognises the essential hydrological and ecological functions of natural watercourses, floodplains, wetlands and remnant vegetation. Measures that can be incorporated include retaining natural drainage systems for trunk drainage and designing the neighbourhood features such as allotments, roads and public space around natural drainage systems, remnant vegetation, and contours.

The extent to which these measures and principles can be adopted will be limited by physical constraints of the site, the nature of the development proposed, and the sequence of development. The actual elements incorporated into any drainage strategy or subdivision design must therefore account for all local and regional environmental factors including climate, soils, groundwater, slope, vegetation, waterways, urban setting, and the existing pattern of land use. They should also be selected so as to minimise the life cycle cost of the system, particularly any ongoing maintenance/replacement costs.

The GSP plan area is suited to utilising Natural Systems Planning to develop a trunk drainage system based on the natural contours of the site. The high infiltrative capacity of soils, make the site suitable for incorporating Source and Conveyance Controls that utilise infiltration, such as swales and bio-retention. To maintain pre-development discharges for low flows a piped network will also be required. Some discharge controls may be required at the bottom of each catchment.

7. Analysis of Individual Neighbourhood Units

For each neighbourhood unit the following was undertaken;

- Topography and soil landscape mapping was reviewed to identify the most suitable locations for combining POS with drainage.
- The distribution of remnant vegetation based on mapping in 2005 was overlaid on the soil and landscape mapping to identify possible locations for combining retention of existing remnant vegetation with POS and drainage.
- The topography and proposed road network was reviewed to identify potential post development flow paths.
- A Site Analysis Plan was prepared and discussed with the CGG and DPI (Appendix A)
- Assumptions were made regarding the future pattern of landuse and acceptable drainage solutions.

The following sections on each neighbourhood briefly describe the topography, soils, distribution of remnant vegetation, pre-development conditions, post development conditions, proposed road network, and surface water drainage for each neighbourhood. This is followed by recommendations for combining POS with drainage and remnant vegetation. Further recommendations regarding drainage, and for providing a more coordinated approach to stormwater management across the structure plan area are also provided. A graphical representation of the recommendations is included in Appendix B.

7.1 Special Use Zone

Drainage management area 1, Appendix B.

Topography – The area consists of a gently sloping ridge, and moderate slopes extending from the ridge down to the gentle lower slopes. The lower slopes are widest at the northern end of the neighbourhood.

Soils – Expected to be Teakle for the majority of the catchment with possibly Bookara 1 adjacent Chapman Road. Deeper sands are expected through the lower slopes and along the depression on the Northern end of the neighbourhood.

Distribution of remnant vegetation – Remnant vegetation is shown covering parts of lots 29, 36, 38 fronting Chapman Road and lot 114 and 3 fronting Alexander Drive.

Pre-development conditions – The subcatchment area is approximately 51 hectares. Lot sizes ranging from 4,400m² to 7.1 hectares. Existing large scale home businesses are located in this area.

Post development conditions – Mixed uses with a minimum lot size of 1,250m².

Proposed Road Network – Three East-West and two North-South neighbourhood connector roads are shown on the draft structure plan.

Surface Water Drainage – Drainage is generally towards the North Western portion of the neighbourhood. It is difficult to assess whether or not this catchment is self contained, or if the catchment has an outlet and drains North along Chapman Road to the low lying area to the east of the Quindalup dune system along Chapman rd.

7.1.1 Recommendations

The Northern end of the neighbourhood is ideally suited to providing centralised drainage infrastructure. A shallow sided detention basin combined with POS in the northern portion of the area in the vicinity of lots 29,30,31,32 and 33 could be provided.

A small area of remnant vegetation with a local depression on Lot 29 may be suitable for a combined drainage and POS area.

Sizing of land requirements for reduction of peak flows to meet pre-development conditions is subject to a high degree of unpredictability due to the range of possible variables.

It is recommended that for reduction of peak flows to meet pre-development conditions 1-5% of the catchment area be allocated for stormwater attenuation. This is less than the POS allocation and will vary dependant on how much storage is provided in swales and other water sensitive urban design elements.

An indicative location for siting the stormwater attenuation and infiltration area combined with POS is shown in Appendix B.

To provide better coordination of stormwater management across the neighbourhood, North-South road linkages should be aligned with contours to provide better opportunities to manage stormwater at source. A revised internal road network has been developed over the drainage management area to provide an overland flow path to the centralised storage location.

It is recommended that this internal road network incorporate a wider road reserve to accommodate an approximately five metre wide swale drain, such as the example given in Liveable Neighbourhoods, Figure 19.

7.2 Southern and Southern Central Neighbourhoods

Drainage management area 2, 3, 4 and 5.

Topography – A ridge runs along the North Western side of the catchment. A wide depression extends from just north of Hagan Road to Okahoma Road, continuing on to Chapman Road. A slight ridge runs along the Southern end of the Southern Neighbourhood.

Soils – Expected to be Teakle 1 through the ridge along the North Western side of the catchment and on the steeper slopes, Teakle through the wide depression and the mild slopes associated with the ridge at the Southern end, and potentially Bookara 1 adjacent Chapman Road.

Distribution of remnant vegetation – Stands of trees and mapped remnant vegetation are located in the vicinity of the low point of the wide depression. Some mapped remnant vegetation exists on lot 2 fronting Okahoma Road and along the southern ridge over lots 27 and 28. Patches of remnant vegetation also occur on over lots 10, 11, 12, 121, 27, fronting Chapman Road.

Pre-development conditions – Rear lots along Alexander Drive generally 4 to 7 hectares while the lots fronting Chapman Road are approximately 2 hectares with some 2000 square metre lots where subdivision has already taken place.

Post development conditions – Standard residential development with a minimum lot size of 700m² and 2,000m² lots fronting Chapman Road and abutting Alexander Drive. POS is shown along the wide depression, and in the North Western corner of lot 118.

Proposed Road Network – Three East-West and two North-South neighbourhood connector roads are shown on the draft structure plan. A portion of road reserve for a local access road has been dedicated on lot 12, fixing the future location of the local access roads for the Western section of the Southern Central Neighbourhood.

Surface Water Drainage – The Eastern Section of the Southern and Southern Central Neighbourhoods drain towards Oakahoma Road. The western section of the Central Neighbourhood drains to Chapman

Road. The western portion of the Southern Neighbourhood is split by a ridge, some drainage being directed towards Oakahoma Road, while the majority of the area drains towards Chapman Road.

7.2.1 Recommendations

Discussion of the Southern and Southern Central Neighbourhoods is broken down in to four distinct drainage management areas;

- The eastern section of the Central Neighbourhood and including Lot 117 in the Southern Neighbourhood (Drainage management area 2)
- The remainder of the eastern section of the Southern Neighbourhood (Drainage management area 3)
- The western section of the Central Neighbourhood (Drainage management area 4), and
- The Western section of the Southern Neighbourhood (Drainage management area 5).

The eastern section of the Central Neighbourhood and including Lot 117 in the Southern Neighbourhood- Drainage Management Area 2

The wide depression that extends from just north of Hagan Road to Oakahoma Road, continuing on to Chapman Road provides an opportunity for consideration of a planned major drainage system incorporated in the neighbourhood urban design. Liveable Neighbourhoods *Figure 61: Example of Integrated Urban Water Management and Public Open Space – Cliff Sadlier Memorial Park, Daghish* illustrates the application of these principles.

The location of a combined drainage and POS area should take advantage of significant natural features such as mature stands of trees and remnant vegetation, and incorporate a series of informal shallow detention basins integrated with the topography and neighbourhood design

To assist in achieving better stormwater management outcomes it is recommended that the distributor road network be modified to focus neighbourhood urban design on the proposed linear drainage/ POS network. Realigning the North South distributor road with the alignment of the natural drainage depression will provide for better integration of local street and lot layout with drainage / POS.

It is recommended that planning mechanisms are incorporated in the structure plan, that require subdivision design to incorporate POS with drainage and where applicable vegetation protection, and to provide for connectivity for a major overland flow path following the low point of the natural wide depression. A 10-20m wide strip of land incorporating a living stream concept, bounded by local access roads, is required along the full length of the linear drainage / POS network to create an integrated corridor.

It is recommended that for reduction of peak flows to meet pre-development conditions 1-5% of the catchment area be allocated to stormwater attenuation integrated with POS. An indicative corridor location is shown in Appendix B.

The remainder of the eastern section of the Southern Neighbourhood- Drainage Management Area 3

Lots 115 fronting Alexander Drive and Lots 1 and 2 fronting Oakahoma Road drain in a North Westerly direction towards the corner of lot 2. Indicative grades are approximately 2.5 to 3 % across Lot 2 making it suitable for incorporating shallow detention basins. It is recommended that the potential for integrating POS, with drainage, on Lot 2 be further investigated.

It is recommended that for reduction of peak flows to meet pre-development conditions 1-5% of the catchment area be allocated to stormwater attenuation areas integrated with POS. An indicative location is shown in Appendix B. The gentle grades and favourable soil conditions associated with the

topography provide many opportunities for integrating source and conveyance controls in subdivision design to reduce this requirement.

It is recommended that the main North South distributor road shown on the GSP incorporates a widened road reserve to accommodate a 5m wide swale drain.

The western section of the Southern Central Neighbourhood- Drainage Management Area 4

The most suitable location for a centralised storage location is the natural low lying area fronting Chapman Road in the vicinity of lots 13, 14, 125, 130, and 124. Mapped remnant vegetation exists on Lots 10, 11, 12. Existing structures on Lot 14, 125, and 130 limit the area available for combination of remnant vegetation with POS.

The location of a proposed North South local access road has been defined and is shown over lots 10, 11, 12, and 13 on the draft GSP. The North South local access road shown generally follows the contour, however steep cross slopes will result in poor urban form and increased erosion risk. It is recommended that the road network be modified to provide North South access roads located at the top and bottom of the steep slopes, and that these roads incorporate a 5m wide central drainage swale.

It is recommended that each lot control drainage through suitable source and conveyance controls and that any additional land requirements for stormwater management be addressed at the subdivision scale.

Alternatively excess stormwater could be conveyed via drainage swales to the Chapman Road reserve area in the vicinity of abutting lots 12, 13, 14, 125, 130, and 124.

It is recommended that for reduction of peak flows to meet pre-development conditions 1-5% of the catchment area be allocated to stormwater attenuation areas integrated with POS.

An indicative swale drainage location is shown in Appendix B.

The Western section of the Southern Neighbourhood - Drainage Management Area 5

The most suitable location for a centralised drainage management area is the northern end of the Southern Neighbourhood. This area is an extension of the wide depression that runs through the eastern part of the Southern Central Neighbourhood and extends through to Chapman Road. There is a small area of overlap of remnant vegetation with the wide depression on Lot 23. However, existing structures on Lot 23 limit the area available for inclusion in POS.

It is recommended that for reduction of peak flows to meet pre-development conditions 1-5% of the catchment area be allocated to stormwater attenuation areas integrated with POS. An indicative location is shown in Appendix B.

A continuation of the living stream corridor along the natural low lying land that runs through the eastern part of the Southern Central Neighbourhood is recommended. The living stream corridor adjacent a local road could be provided as a 10-20m wide strip of land incorporating drainage and POS functions is recommended.

The anticipated initial sequence of development is for 2000 square metre lots fronting Chapman Road to be subdivided off the parent properties. To achieve a more coordinated approach to stormwater management it is recommended that planning mechanisms are incorporated in the structure plan, that require dedication of a widened road reserve, with a central drainage swale as shown in Appendix B, over lots 17, 18, 9000, 20, 21, 22, 23, 24, 25, 26, 27 and 28 fronting Chapman Road.

A suitable treatment is shown in Liveable Neighbourhoods, Figure 19.

The natural topography of the land should be utilised to drain the road swale drains to the living stream corridor along the low point of the drainage management area.

7.3 Central Neighbourhood

Drainage Management Area 6, 7 and 8

Topography – A ridge terminates at the centre of the neighbourhood. The South Eastern section of the Neighbourhood slopes gently to the South West. The remainder of the neighbourhood is characterised by an upper sand plain that moderately slopes to the west down to a gently undulating sandplain along the frontage to Chapman Road.

Soils – Expected to be Teakle through the upper sandplain and middle slopes. Teakle 1 through the section of the ridge and potentially extending to some areas of the middle slopes, and a combination of Bookara 1 and Teakle through the lower sandplain adjacent Chapman Road.

Distribution of remnant vegetation – A significant mapped remnant vegetation link is shown on lot 125 fronting Alexander Drive. Some mapped remnant vegetation exists on Lot 1 2, 3, 4, 7, and 8 fronting Chapman Road.

Pre-development conditions – Rear lots along Alexander Drive generally 4 to 7 hectares while the lots fronting Chapman Road range from 2 to 4 hectares.

Post development conditions – The area fronting Chapman Road has been identified as a potential neighbourhood centre with higher density mixed use development. The central area of the neighbourhood has been identified as a potential school site. The remainder of the neighbourhood is Standard residential development.

Proposed Road Network – Two East-West and three North-South neighbourhood connector roads are shown on the draft structure plan.

Surface Water Drainage – The South Eastern Section of the Neighbourhood drains to the wide depression that runs through the Eastern part of the Southern Central Neighbourhood. The remainder of the catchment drains towards Chapman Road.

7.3.1 Recommendations

The South Eastern section of the neighbourhood (Drainage Management Area 6) can be treated in a similar fashion to the Eastern part of the Southern Central Neighbourhood, with inclusion of a living stream corridor incorporated in a combination of POS and Road Reserves.

The North Eastern section of the neighbourhood (Drainage Management area 7) displays good site attributes for incorporating water sensitive design elements at a subdivision scale. Larger lots may be suitable for incorporating drainage elements in a POS network. Development should be controlled such that the sequence of development on larger lots does not diminish any opportunities for combining POS, with drainage at a subdivision scale.

It is recommended that the North South local access road running between Drainage Management Area 6 and 7 incorporate a widened road reserve to provide an overland flow path to the living stream corridor. A treatment such as the example given in Liveable Neighbourhoods, Figure 19 is recommended.

The most suitable area for a centralised drainage management area for the remainder of the neighbourhood (Drainage Management area 8) is in the vicinity of the area fronting Chapman Road on lots 5, 4, 3, 2, 1, and 10. There is an overlap with mapped remnant vegetation on lots 1, 2, 3 and 4. It is

recommended that this area be considered for further investigation for integration of drainage and POS within the proposed mixed use centre. It is recommended that for reduction of peak flows to meet pre-development conditions 1-5% of the catchment area be allocated to stormwater attenuation areas integrated with POS.

The area fronting Chapman Road, north of Hagan Road, in this neighbourhood has been proposed as a neighbourhood mixed use centre with a higher density of development. Drainage for this area will be subject to future detail design. Suitable source control methods could be integrated in to the design of streetscape elements. To achieve the objectives outlined for water quality management more technical water sensitive design elements requiring minimal land area could be utilised.

7.4 Northern Central Neighbourhood

Drainage Management Area 9

Topography – Gently undulating sand plain through the upper section of the catchment. The land moderately slopes to the west from the edge of the upper sand plain to a gently undulating sandplain along the frontage to Chapman Road.

Soils – Expected to be Teakle through the upper sand plain and middle slopes and a combination of Bookara 1 and Teakle through the lower sandplain adjacent Chapman Road.

Distribution of remnant Vegetation – Mapping indicates several large areas of remnant vegetation in this neighbourhood on lots 28, 131,130.

Pre development conditions- Lot sizes ranging from 3 to 10 hectares, with some smaller residential lots that have been created as part of subdivision of lot 2 fronting Macedonia Drive. A small area of POS has been dedicated as part of this subdivision.

Post development conditions – Standard residential development with a minimum lot size of 700m² and 2,000m² lots fronting Chapman Road and abutting Alexander Drive. An area of POS has been indicated on lot 2 fronting Macedonia Drive incorporating the existing POS.

Proposed Road Network - Two East-West and three North-South neighbourhood connector roads are shown on the draft structure plan.

Surface Water Drainage – The neighbourhood generally drains in a Westerly direction towards Chapman Road and is considered as one drainage management area (9).

7.4.1 Recommendations

The low lying area fronting Chapman Road would be the most suitable location for centralised drainage management that could be incorporated with POS. There are no specific areas which overlap with remnant vegetation.

The majority of the site is suitable for source controls such as infiltration trenches and soakwells, and conveyance controls such as swales and bioretention systems. Larger lots may be suitable for incorporating drainage elements such as road swales as part of the local access road system and a POS network incorporating stormwater attenuation areas. Development should be controlled such that the sequence of development on larger lots does not diminish any opportunities for combining POS, with remnant vegetation and drainage at a subdivision scale.

Sizing of land areas for inclusion of drainage in POS is subject to a high degree of variability due to the range of source and conveyance controls that could be utilised to treat and dispose of stormwater throughout the site. It is recommended that for reduction of peak flows to meet pre-development

conditions 1-5% of the catchment area be allocated to stormwater attenuation areas integrated with POS. Indicative locations are shown in Appendix B.

At the Northern End of the neighbourhood an existing natural swale traverses Macedonia Drive, and continues over lots 2, 131, and 52. Consideration should be given to utilising the swale to create a living stream corridor, incorporated where possible adjacent internal subdivision road reserves and remnant vegetation area with POS. A minimum width of 10-20m is recommended.

It is recommended that the proposed pattern of subdivision, and future POS shown on Lot 2 fronting Macedonia Drive be modified to incorporate a 10-20m wide living stream corridor, and POS location to accommodate the natural low point as shown in Appendix B.

The anticipated initial sequence of development is for 2000 square metre lots fronting Chapman Road to be subdivided off the parent properties. It is recommended that planning mechanisms are incorporated in the structure plan, that require dedication of a widened road reserve to incorporate a 5m wide drainage swale, at the base of the steeper slope over lots 11, 12, 13, 2, 1, 9843, 52, and 51. It is recommended that a similar treatment be provided at the top of the steep slope to reduce erosion risk. The natural topography of the land should be utilised to drain the swale drains to the living stream corridor.

7.5 Northern Neighbourhood

Drainage Management Area 10 and 11

Topography – Gently undulating sandplain through the Eastern section of the neighbourhood, with a wide shallow depression crossing over lots 1, 2, and 133 fronting Alexander drive. The western section of the neighbourhood is gently sloping to the West with some moderate slopes along the frontage to Chapman Road.

Soils – Expected to be Teakle through the majority of the catchment.

Distribution of Remnant Vegetation - Mapped remnant vegetation is shown on lot 146, 144, 143 and along Dolby's Creek.

Pre-development conditions – Lot sizes generally ranging from 2,000m² to 9 hectares.

Post development conditions – Standard residential development with a minimum lot size of 700m² and 2,000m² lots fronting Chapman Road and abutting Alexander Drive.

Remnant Vegetation - An area of remnant vegetation occurs on Lot 146.

Proposed Road Network – Two East-West distributor roads; one running the full width of the neighbourhood, the other terminating half way. Two North -South distributor roads. The boundary of the neighbourhood is defined by a distributor road shown following the alignment of Dolby's Creek to the North West Coastal Highway.

Surface Water Drainage – The upper section of the neighbourhood drains via the shallow depression to the adjoining neighbourhood over Macedonia Drive. A small section drains to Dolby's Creek while the remainder drains Westerly to Chapman Road and the outlet of Dolby's Creek.

7.5.1 Recommendations

Lot sizes are large, and the landform and soils are suitable for source controls such as infiltration trenches and soakwells, and conveyance controls such as swales and bioretention systems.

Development should be controlled such that the sequence of development does not diminish any opportunities for combining POS, with drainage requirements.

Sizing of land areas for inclusion of drainage in POS is subject to a high degree of variability due to the range of source and conveyance controls that could be utilised to treat and dispose of stormwater throughout the site. It is recommended that for reduction of peak flows to meet pre-development conditions 1-5% of the catchment area be allocated to stormwater attenuation areas integrated with POS.

There is an area of remnant vegetation on the north east portion of lot 146. There are no areas of remnant vegetation shown in the eastern section of the neighbourhood i.e. Drainage Management Area 10.

In drainage management area 10 a wide shallow depression occurs on lot 139 and provides a good opportunity for incorporating drainage elements into a living stream/POS corridor. Consideration should be given to utilising the natural low point of the depression to create the living stream corridor, to link into the northern end of drainage management area 9 and through to Chapman Road. A minimum width of 10-20m is recommended. Indicative location is shown in Appendix B.

The Western section of the neighbourhood (Drainage Management area 11) does not have any quality remnant vegetation. No areas have been identified as having substantially better attributes for location of POS with drainage. To provide a flow path to Chapman Road, an East West drainage link incorporating a living stream corridor is recommended adjacent a local access road reserve near lot 143 as shown in Appendix B. The corridor could form part of POS. A minimum width of 10-20m is recommended.

To provide better coordination of stormwater management across the neighbourhood a drainage swale network has been developed as shown in Appendix B. In these areas a widened road reserve is required to accommodate a central swale drain, such as the example given in Liveable Neighbourhoods, Figure 19.

The natural topography of the land should be utilised to drain the swale drains to the living stream corridor.

Along the frontage with Dolby's creek a buffer of 30m is recommended to preserve remnant riparian vegetation, in accordance with the drainage management recommendations of the NGDSP.

8. Summary of Recommendations

8.1 Special Use Zone - Drainage Management Area 1

- An area has been identified for further investigation for incorporating drainage in POS at the Northern end of the neighbourhood.
- A revised road network has been developed to provide overland flow paths along swale drains to a centralised storage location.

8.2 Southern and Southern Central Neighbourhoods - Drainage Management Area 2, 3, 4, 5

- The distributor road network be modified to focus neighbourhood urban design on the proposed linear drainage / POS corridor.
- The shape and configuration of POS be addressed through subdivision design, taking advantage of significant natural features.
- The structure plan incorporate planning mechanisms to provide for a major living stream corridor along the natural low point of the neighbourhood to its natural outlet on Chapman Road.
- An area in the vicinity of lot 2 fronting Alexander Drive has been identified for further investigation for incorporating drainage with POS.
- A modified road network has been developed to provide overland flow paths along central swale drains discharging to the living stream corridor, and to avoid locating North South roads on steep cross slopes.

8.3 Central Neighbourhood - Drainage Management Area 6, 7, 8

- The south eastern section of the neighbourhood overlaps with the linear drainage / POS network identified for the eastern part of the Southern Central Neighbourhood and warrants similar treatment.
- Development in the north eastern section of the Neighbourhood should be controlled such that the sequence of development on the larger lots does not diminish any opportunities for combining POS, with drainage at a subdivision scale.
- The North South distributor road reserve be widened for inclusion of a central drainage swale discharging to the living stream corridor.
- An area fronting Chapman Road has been identified for further investigation for combine drainage, POS and remnant vegetation.
- For the proposed neighbourhood mixed use centre it is recommended that suitable source control methods be integrated into the detailed design of the roads and streetscape of the mixed use centre.

8.4 Northern Central Neighbourhood - Drainage Management Area 9

- Development on larger lots should be controlled to ensure that the sequence of development does not diminish any opportunities for combining POS, with remnant vegetation and drainage.
- Consideration should be given to utilising the existing natural swale at the Northern end of the neighbourhood to create a living stream corridor.
- A modified road network has been developed to provide overland flow paths along central road swale drains discharging to the living stream corridor, and to avoid locating North South roads on steep cross slopes.

8.5 Northern Neighbourhood - Drainage Management Area 10

- Development should be controlled to ensure that the sequence of development does not diminish any opportunities for combining POS with drainage.
- An opportunity exists to site drainage elements along the widened road reserve adjacent lots 139 and 143.
- The wide natural shallow depression in the eastern section of the neighbourhood provides a good opportunity for creating a living stream corridor.
- An east west drainage link incorporating a living stream corridor is proposed over the western part of the neighbourhood.
- A modified road network has been developed to provide overland flow paths along road swale drains discharging to a living stream corridor
- Along the frontage with Dolby's creek a buffer of 30m is recommended to preserve remnant riparian vegetation and floodway functions.

9. Stormwater Quality

The Stormwater Management manual for Western Australia provides information on the pollutant removal efficiencies for bio-retention swales and basins with varying depths of ponding (pg104-105). Little data is available regarding the performance of treatment systems in Western Australia, particularly in the Geraldton area. Data is provided as an indicative guide only, based on eastern states research with different hydrologic conditions. MUSIC modelling and calibration to the hydrologic conditions of the area are required to provide more accurate assessment.

The data indicates that to achieve the treatment targets for total suspended solids, total phosphorous, and total nitrogen, the surface area of swales and basins should be in the order of 1 to 2% of the impervious catchment area. These requirements can be accommodated in the areas suggested as part of living streams, swales, and small detention basins.

It is recognised that there are some locations which will be directly piped and discharged to the 'Rum Jungle' based on the structure plan proposed. It is recommended that as a minimum a Gross Pollutant Trap be provided at these locations. Treatment for reduction of nutrients can be addressed by offsetting treatment with higher treatment in other areas.

10. Water Conservation

Water Conservation is identified as one of the management objectives. Under sustainability practices a local water resource is a potential source of water supply. For the study there are three potential local water sources that could be used to supplement the scheme supply, Rainwater, Surface Water, and Groundwater. It is recommended that potable water demand be minimised across the GSP area by incorporating alternative water supplies where possible.

Rainwater: A supplementary supply from rainwater tanks could be utilised on the lot scale and would have multiple benefits for stormwater management and demand reduction. However it is noted for the area that it has low rainfall with long dry spells. The cost effectiveness of rainwater tanks would be lower compared to other areas of the state.

Surface Water: There are no existing Local Surface Water Storages, however artificial surface water storages may be proposed as part of future development. The area is highly pervious and to achieve this would require utilisation of impervious liners. Due to the low and inconsistent rainfall in the area any ponded water body should be reviewed for long term water quality management and to avoid the creation of stagnant water bodies. Due to the low and infrequent rainfall, and soil types of the catchment direct collection and reuse in artificial surface water storages is not recommended.

Groundwater: As an alternative to surface water storage and reuse, localised aquifer recharge combined with groundwater extraction may be preferable for this area. This would create a more indirect reuse scheme which utilises the natural attributes of the area i.e. using the aquifer for storage/reuse. Larger bores for irrigation of POS are encouraged to supplement scheme water. Larger volume bores should be tested (down hole resistivity) to ensure that the quality of groundwater at depth is appropriate for the intended use. Domestic bores are a viable option for the GSP area and should be encouraged. Bores should be kept as shallow as possible to avoid intersecting saline groundwater.

11. Groundwater Management

The proposed land use scenario will not require the groundwater level to be controlled and/or fill to be imported to maintain minimum separation distances to the groundwater level where reticulated sewer is provided.

The expected high infiltration rates of the site will provide a potential pathway for nutrients and contaminants to be transported directly to the groundwater. It is recommended that all stormwater be provided with adequate pre-treatment prior to infiltration to protect groundwater quality.

Lazarus Leonhard - Senior hydrologist Midwest – Gascoyne Region for the Department of Water has recommended the following groundwater monitoring strategy;

“Groundwater monitoring strategies should include a minimum of 2 piezometers (observation bores) situated mid north east and south east along the eastern GSP boundary. These bores will provide a continuous base line data set comprising salinity (measured by electrical conductivity or EC) and SWL. It is considered that a minimum of 4 piezometers along the western border would be appropriate.”

In addition to the suggested groundwater monitoring strategy including a minimum of six monitoring bores along the eastern and western boundaries of the structure plan area, an additional monitoring bore in the western central portion of the GSP area, within the saddle east of the coastal dune is recommended.

12. Wastewater Management

The majority of the GSP area will require servicing with reticulated sewer. Lots greater than 2000 square metres, in particular those fronting Chapman Road, may require additional controls and/or filling to comply with Department of Health Guidelines for on site sewerage disposal. It is recommended that groundwater levels be confirmed along the Western Boundary of the GSP area to confirm adequate separation distances are available.

13. Conclusions

The previous district drainage investigation concluded that drainage systems would most likely be self contained, rather than linked to any major district system, with the exception of a linear POS network proposed over the Eastern portion of the Southern Central neighbourhood. This report investigated the opportunities for combining POS with drainage and mapped remnant vegetation for each neighbourhood planning unit identified in the draft revised GSP. Recommendations have also been made for providing a more coordinated approach to stormwater management across the structure plan area.

Areas have been identified to promote the retention of existing drainage functions, and combining these with the retention of remnant vegetation where possible. Field investigations are required to confirm assumptions regarding soil types, topography and vegetation. Where areas have been identified for further investigation the overall requirements of POS need to be considered. The designation of POS will be guided by other factors external to drainage considerations such as provision of useable POS readily accessible to residents, and protection of natural areas.

The fragmented ownership of lots provides a challenge for coordinating stormwater disposal across the structure plan area. Modifications to the road network have been suggested to provide a more coordinated approach to stormwater management. The network of distributor roads can be utilised to provide continuity in drainage management across lot boundaries, and as an overall arterial drainage network to accommodate major events. Further modelling will be required if a development contribution plan is to be developed.

Due to the low rainfall, high porosity of the soil and good access to the superficial aquifer, a suggested form of recycling and reuse is to maximise recharge of the aquifer and provide groundwater bores for reuse. Surface water retention may not be as cost effective as indirect reuse via the groundwater aquifer.

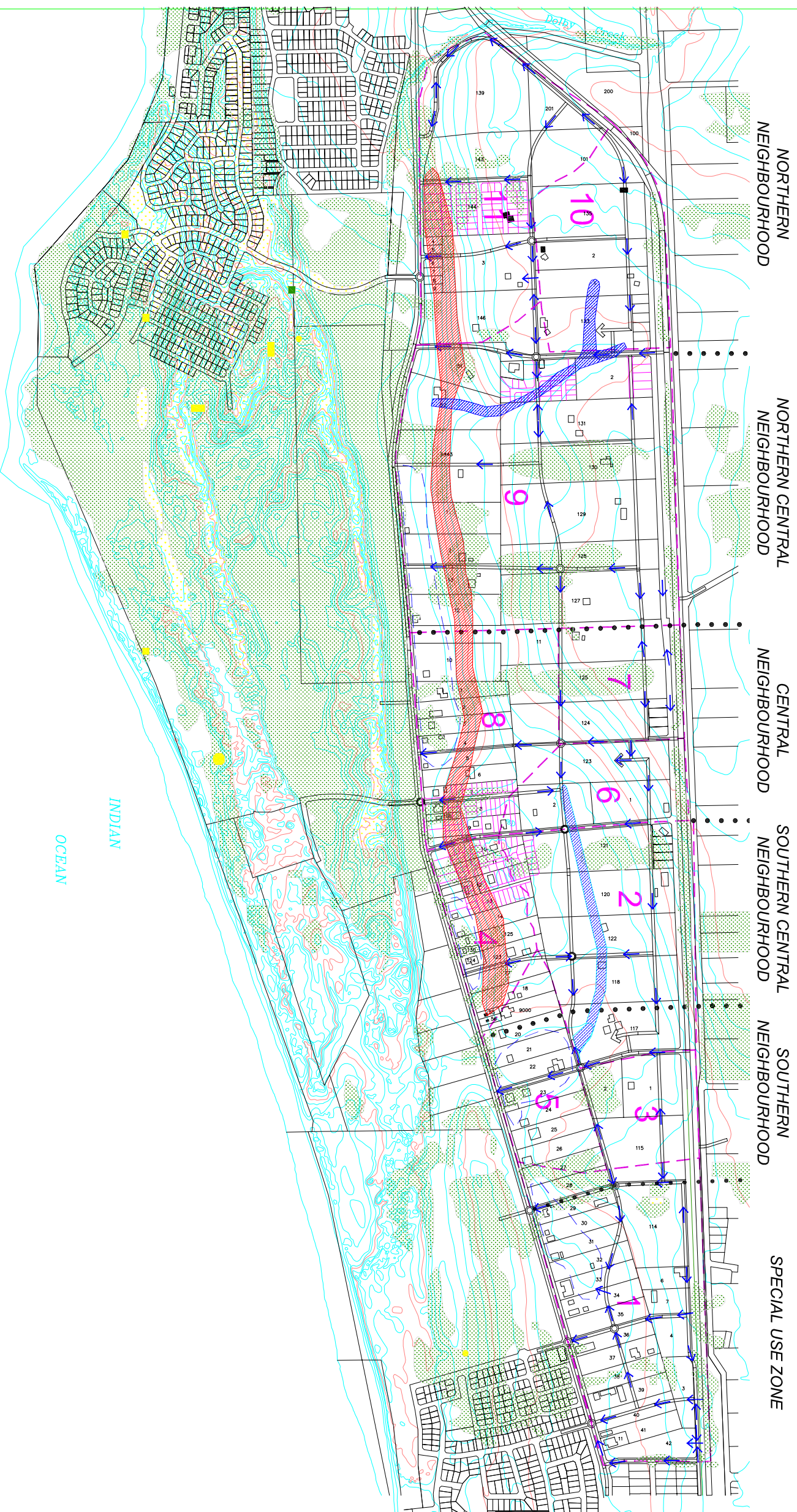
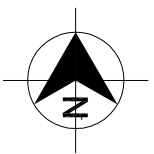
The individual design of subdivisions will need to take in to consideration the recommendations provided, and incorporate their own source controls and conveyance controls to achieve the stormwater management objectives outlined in Section 5. Prior to approval of subdivision layouts applicants should demonstrate that the design principles incorporated in the Stormwater Management Manual for WA have been included and that the objectives outlined in section 5 have been addressed.

Compliance should be addressed on a neighbourhood by neighbourhood basis.

Appendix A – Site Analysis Plan

Appendix B – Recommendations

Appendix C – Study Brief



- NEIGHBOURHOOD BOUNDARY
- MAJOR CONTOURS (10M)
- MINOR CONTOURS (2M)
- PROPOSED SUBDIVISION PATTERN
- EXISTING SUBDIVISION PATTERN
- CONSTRAINED LAND (CONCRETE TOWER, POTENTIAL ROCKY OUTCROPS)
- MAPPED REMNANT VEGETATION
- FUTURE ARTERIAL DRAINAGE FLOW PATHS
- FURTHER INVESTIGATION AREAS FOR FUTURE MAJOR OVERLAND FLOW PATHS AND/OR STORAGES
- 2 DRAINAGE MANAGEMENT AREAS
- FURTHER INVESTIGATION AREAS FOR FUTURE MAJOR EVENT STORAGES
- DRAINAGE MANAGEMENT AREAS BOUNDARIES

NORTHERN NEIGHBOURHOOD NORTHERN CENTRAL NEIGHBOURHOOD CENTRAL NEIGHBOURHOOD SOUTHERN CENTRAL NEIGHBOURHOOD SOUTHERN NEIGHBOURHOOD SPECIAL USE ZONE

INDIAN OCEAN

No.	Date	Revision Details	Dwn	Ver	App
01	18.12	FINAL ISSUE	RVN		

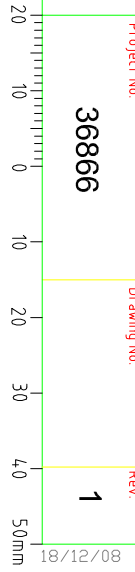
Connell Wagner PN
 Connell Wagner Pty Ltd ABN 54 005 139 873 Telephone: +61 08 9223 1900
 1st Floor, 256 Adelaide Terrace, Perth Facsimile: +61 08 9223 1605
 Western Australia, 6000, Australia Email: enquiries@connellwagner.com

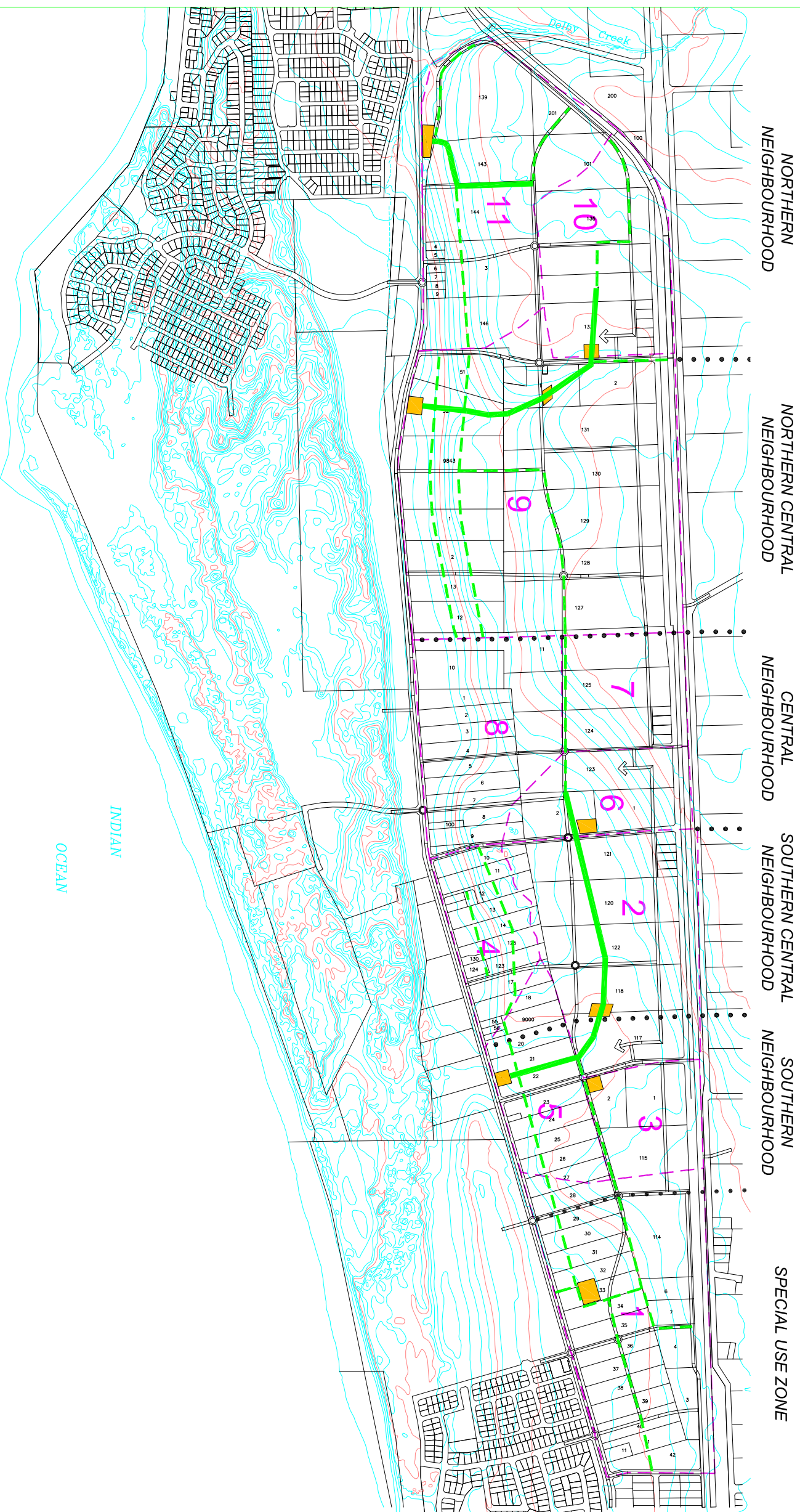
Client:
DEPARTMENT FOR PLANNING AND INFRASTRUCTURE

Project:
GLENFIELD STRUCTURE PLAN STORMWATER AND DRAINAGE MANAGEMENT PLAN

Drawing Title:
SITE ANALYSIS PLAN APPENDIX A

Drawn	RN	Date	16.10.08
Designed	RN		
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- 1** DRAINAGE MANAGEMENT AREAS
- DRAINAGE MANAGEMENT AREA BOUNDARIES

INDICATIVE LOCATION OF STORMWATER ATTENUATION AREAS INTEGRATED WITH POS

5 METRE WIDE DRAINAGE SWALE INCORPORATED IN ROAD RESERVE

LIVING STREAM CORRIDOR

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Connell Wagner PN

Connell Wagner Pty Ltd ABN 54 005 139 873 Telephone: +61 08 9223 1900
 1st Floor, 256 Adelaide Terrace, Perth Facsimile: +61 08 9223 1605
 Western Australia, 6000, Australia Email: enquiry@connellwagner.com

Client:

DEPARTMENT FOR
PLANNING AND
INFRASTRUCTURE

Project:

GLENFIELD STRUCTURE
PLAN STORMWATER AND
DRAINAGE MANAGEMENT
PLAN

Drawing Title
RECOMMENDATIONS
APPENDIX B

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