



APPENDIX 6

LANDSCAPE AND PUBLIC OPEN SPACE STRATEGY

LANDSCAPE & PUBLIC OPEN SPACE STRATEGY

LOT 50 COCKRAM STREET, MUNDIJONG

Prepared for Peet Ltd
February 2013

LANDSCAPE & PUBLIC OPEN SPACE STRATEGY
 LOT 50 COCKRAM STREET, MUNDIJONG

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Executive Summary

This report has been prepared by Emerge Associates to accompany the Lot 50 Cockram Street, Mundijong Local Structure Plan submission to be developed by Peet Limited. The report outlines the proposed Public Open Space (POS) and streetscapes landscape strategy for the Development Area.

The Development Area has the established township of Mundijong to the eastern boundary. Mundijong Road runs along its southern boundary while open farmland exists to the north. The western boundary comprises land reserved for further residential development. Between this Development Area and the adjoining subdivision is Reserve land for the future extension of the Tonkin Highway with an adjoining sixty metre wide Service Corridor.

All landscape concepts outlined in this report and shown on the included Landscape Concept Masterplan, have been prepared based on the Development Plan prepared by Taylor Burrell Barnett Town Planning and Design with considerable inputs from the project's Environmental Scientist, Civil Engineer and Landscape Architect.

The report details existing site conditions and environment, typical POS typologies and generic landscape treatments of POS areas, including but not limited to:

- Typical POS Recreation Facilities Provided,
- Treatment of Proposed Stormwater Drainage in Landscaped Areas,
- Retention of Existing Significant Vegetation,
- Irrigation Strategy, and
- Landscape Maintenance.

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1 Existing Site Conditions and Environment

1.1 Site Character and Adjacent Land Uses

1.1.1 Generally

The existing site is best described as flat to gently undulating and exhibits minimal change in ground elevation with the low point being at approx 26m AHD in the north western corner, rising evenly to approx 31m AHD in the south eastern corner.

The existing site's former land use as a grazing / pastoral property has resulted all but a very small percentage of the existing vegetation being cleared. The occasional remnant tree remains, which has been supplemented with occasional introduced tree plantings which could have been acting as windbreaks to paddocks and / or for spatial definition around sheds and other farming infrastructure. Fruit trees indicate a possible small orchard previously existed on part of the site. No understorey vegetation exists at all with the exception of pasture grasses.

1.2 Focal Points and Views

1.2.1 Generally

Given the site's gentle undulation as outlined previously, there are no strong views or vistas from vantage points located within the site.

The important focal points and views to be considered, retained and reinforced through the urban and landscape design process relate to the dominant landform features surrounding the site, of which there are two distinctive features, being :

1. The Darling Scarp
2. Swan Coastal Plain

All of the subject site is located on the low lying, gently undulating Swan Coastal Plain. The nature of the landscape of the Swan Coastal Plain in the immediate vicinity is largely unvegetated, with a predominant rural character. Views are dominated by the Darling Scarp to the east.

The Darling Scarp is the most dominant physical feature of the South West of Western Australia and the retention of views from the subject site onto the Scarp will be critical in ensuring a rural character with green values can be promoted to enhance the built environment.

The views and vistas to the Scarp will typically occur through the creation and reinforcement of long vistas along east west aligned roads and public open space links within the proposed development. These views and vistas should be reinforced and /or framed through the consideration of tree placement.

1.3 Recreation Connections

1.3.1 Generally

There are no existing recreation connections around the existing site. The site is located at the end of Cockram St and therefore is within 500m walking distance to the existing Mundijong Sporting Oval.

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The installation of a dual use path along Cockram Street to the existing town centre and sporting oval would create a strong recreation connection to the proposed open space areas within the Development Plan.

1.4 Significant Trees

1.4.1 Generally

The extensive pasture / grazing activity during the site's previous land uses has resulted in little to no remnant vegetation remaining on the site and as such significant trees that could be retained within the development are few and far between. There are the occasional examples of endemic and introduced trees which could be incorporated into the urban design and / or public open space to provide instant amenity as follows :

Towards to southern boundary of the site, a group of approximately six (6) *Corymbia calophylla* (Marri) exist which could be incorporated into an entry statement of Mundijong Road. It is planned that these trees be retained in a widened verge on the major boulevard running north south in the Development Plan. Also within close proximity to this stand of Marri trees are three (3) *Kingia australis* (Bullanock) which if unable to be incorporated in the urban design are able to be relocated to public open space.

At the current Cockram Street cul-de-sac end of the site on the eastern boundary a number of introduced trees exist which appear to have been related to the previous farming operations of the site. A group of *Eucalyptus camaldulensis* (Northern River Red Gum) are the main species in this location which are suitable for retention in Public Open Space (POS) only due to the propensity of this species to unpredictably drop large limbs. If retained in POS, it should be ensured that these trees are retained in garden beds away from POS infrastructure such as playgrounds or bench seats.

In addition to the Northern River Red Gum's a variety of exotic trees exist which could possibly be relocated into POS areas, including the following species :

- One (1) *Citrus limon* (Lemon Tree)
- One (1) *Liquidamber styraciflua* (American Sweetgum)
- One (1) *Caesalpinia ferrea* (Leopard Tree)
- Two (2) *Erythrina indica* (Coral Tree)
- One (1) *Pinus radiata* (Monterey Pine)

Towards the northern boundary of the site, adjacent Sparkman Road, another group of approximately five (5) *Corymbia calophylla* exist which could be incorporated into the urban design if possible. A further four (4) *Kingia australis* are also present in this location which are suitable for transplant into POS areas.

In the north western corner of the site, a large triangular grove of *Casuarina obesa* (Swamp She-Oak) have planted in regularly defined rows. The density of planting and the locally wet depression that these trees are located has resulted in the no opportunity for incorporation of these specimens in a worthwhile urban design or POS outcome and their removal is recommended.

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In the north eastern corner of the site, a north south orientated row of Eucalyptus plantings exist as a windbreak, which sit just in the adjacent landowners property, but are planned to be retained in the Development as part of the road layout in this area.

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2 Landscape Design / Public Open Space Strategy

This section of the report describes the basic principles of the overall Public Open Space (POS) strategy for Lot 50 Cockram Street, Mundijong. The proposed residential subdivision is to be developed around a range of open space opportunities. There are 3 different categories of open space described which include:

- Multiple Use Corridors
- Large Parks
- Pocket Parks

It is envisaged that no resident will be more than approximately 400m away from an open space area. A preliminary Landscape Masterplan Concept for the Development Area is included, which outlines the landscape design for all POS areas.

2.1 Public Open Space Principles

2.1.1 Generally

The landscape strategy behind public open space development is to provide a readily useable, aesthetic and liveable environment to potential residents from day one. Landscaped open space areas shall incorporate features and facilities to both encourage residential growth and to provide public, aesthetic and site character building amenities to residents. Landscape works shall contain and maximise both aesthetic and functional uses where possible.

Part of the successful delivery of aesthetic and functional POS areas will be the retention of the site's existing significant trees where possible in accordance with proposed Civil Engineering design levels. The retention of existing significant trees will assist in establishing the site's Sense of Place, which will be reinforced through the landscape materials palette.

2.1.2 Materials Palette

It is proposed that close attention to detail will be provided in the landscape detailing and materials selection to ensure the development comprises a palette that is relevant to its locality while creating a quality open space environment.

The inclusion and use of some the following detailing is proposed to achieve this outcome within the project area:

- Paving styles and colours will be chosen to create visual interest, assist in differentiation between area uses and provide hard-wearing surfaces of varying textures.
- Wall detailing through the use of local stone features and laterite coloured limestone retaining where required.
- Durable street furniture of a style and colour palette to co-ordinate with the overall POS design.

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- Tree and shrub planting palettes that are aesthetically pleasing while responding to the surrounding natural environment, incorporating water sensitive design species while creating view shafts to develop community value.

2.1.3 Planting Palette

It is proposed that the following indicative planting palette will be used in the amenity areas of the public open space and streetscape hierarchies.

INDICATIVE PUBLIC OPEN SPACE AND STREETSCAPES PLANTING PALETTE

LATIN NAME	COMMON NAME
TREES	
<i>Corymbia calophylla</i>	Marri
<i>Eucalyptus ficifolia</i>	Red Flowering Gum
<i>Eucalyptus leucoxylon rosea</i>	White Ironbark
<i>Eucalyptus lane-poolei</i>	Salmon White Gum
<i>Eucalyptus marginata</i>	Jarra
<i>Eucalyptus rudis</i>	Flooded Gum
<i>Eucalyptus wandoo</i>	Wandoo
<i>Fraxinus raywoodii</i>	Claret Ash
<i>Jacaranda mimosaeifolia</i>	Jacaranda
<i>Liquidamber styraciflua</i>	Liquidamber
<i>Melaleuca preissiana</i>	Modong
<i>Melaleuca raphiophylla</i>	Swamp Paperbark
<i>Platanus acerifolia</i>	London Plane Tree
<i>Platanus orientalis digitata</i>	Cut Leaf Oriental Plane Tree
<i>Pyrus calleryana 'Bradford'</i>	Bradford Pear
<i>Pyrus nivalis</i>	Snow Pear
<i>Pyrus ussuriensis</i>	Manchurian Pear
<i>Ulmus parvifolia</i>	Chinese Elm
<i>Zelkova serrata</i>	Japanese Elm
SHRUBS	
<i>Adenanthos sericea</i>	Albany Woolly Bush
<i>Acacia lasiocarpa</i>	Panjang
<i>Agonis flexuosa 'nana'</i>	Dwarf Willow Peppermint
<i>Agonis linearifolia</i>	Swamp Peppermint
<i>Allocasuarina humilis</i>	Dwarf She-oak
<i>Anigozanthos sp</i>	Kangaroo Paws
<i>Callistemon 'Little John'</i>	Dwarf Bottlebrush
<i>Callistemon phoenicis</i>	Lesser Bottlebrush
<i>Calothamnus quadrifidus</i>	One-sided Bottlebrush
<i>Conostylis candicans</i>	Grey Cottonheads
<i>Dianella 'Little Jess'</i>	Dwarf Flax Lily
<i>Dianella revoluta</i>	Flax Lily
<i>Dianella revoluta variegata</i>	Variegated Flax Lily
<i>Hypocalymma angustifolium</i>	White Myrtle
<i>Leucophyta brownii</i>	Silver Cushion Bush
<i>Melaleuca lateritia</i>	Robin Red-breast
<i>Melaleuca 'Little Nessie'</i>	Dwarf Nesophila
<i>Melaleuca teretifolia</i>	Banbar
<i>Melaleuca uncinata</i>	Broom Bush
<i>Melaleuca viminea</i>	Monah
<i>Olearia 'Little Smokie'</i>	Coastal Daisy Bush
<i>Patersonia occidentalis</i>	Purple Flag
<i>Pimelea sp.</i>	Rose Banjine
<i>Verticordia plumosa</i>	Plumed Feather Flower
<i>Westringia fruticosa</i>	Native Rosemary
<i>Westringia fruticosa variegata</i>	Variegated Native Rosemary

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GROUNDCOVERS

Acacia drummondii
 Acacia cognata 'Limelight'
 Casuarina glauca 'Cousin It'
 Dampiera diversifolia
 Dryandra nivea
 Eremophila glabra
 Eremophila 'Kalbarri Carpet'
 Grevillea bipinnatifida
 Grevillea crithmifolia
 Grevillea 'Gin Gin Gem'
 Grevillea thelmanniana
 Scaevola sp.
 Westringia 'White Rambler'

Drummond's Wattle
 Acacia
 Casuarina
 Dampiera
 Honeypot Dryandra
 Emu Bush
 Emu Bush
 Fuchsia Grevillea
 Coastal Grevillea
 Grevillea
 Spider Net Grevillea
 Fan Flower
 Prostrate Native Rosemary

RUSHES / GRASSES

Baumea articulata
 Baumea juncea
 Carex appressa
 Carex fascicularis
 Ficinia nodosa
 Juncus pallidus
 Juncus pauciflorus
 Lomandra longifolia
 Lomandra 'Seascape'
 Lomandra 'Tanika'
 Viminaria juncea

Jointed Twig Rush
 Bare Twig Rush
 Tall Sedge
 Tassel Sedge
 Knotted Club Rush
 Pale Rush
 Loos Flower Rush
 Mat Rush
 Fine Leaf Mat Rush
 Mat Rush
 Swishbush

Table 1: Indicative Public Open Space & Streetscapes Planting Palette

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2.2 Multiple Use Corridors

Three major Public Open Space [POS 4, 8 & 9] areas have been designated to include the site's overland drainage paths whilst also designed to accept major and minor stormwater drainage events in an attractive landscape setting. (Refer to the attached Landscape Masterplan). Ranging in size between 6,769 square metres and 4.3 hectares, these open space areas will contain the swales and overland flow path that will be created, contoured and stabilised where necessary to provide a multiple use - drainage / landscaped response. This will be critical to establishing an immediate informal active and passive recreation opportunity as the centrepiece to the development area.



Plate 1: Typical Multiple Use Corridor Landscape Response.

To facilitate multiple uses, it is proposed 1:1 year and 1:10 year stormwater events will be contained within landscaped drainage channels within the POS and the 1:100 year stormwater event contained within the adjacent drainage basins. The drainage channels will typically be planted with side slopes no greater than 1:3 or grassed areas with maximum side slopes of 1:6 grade to allow for ongoing maintenance activities and safe egress in the event of a large stormwater event. Occasional small walls no greater than 900mm in height could exist to provide definition to the drainage channels.

All outlet structures into POS areas will incorporate stabilised water entry points, smooth and even grading of contours and mass planting of suitable native water tolerant tree and shrub species for maintenance minimisation.

All associated landscape infrastructure such as picnic shelters, playgrounds, footpaths and the like will be constructed above the 1:10 year stormwater flood levels. The 1:10 year stormwater levels will not exceed 900mm deep in POS areas and similarly the 1:100 year stormwater flood levels will not exceed 1100mm deep when full.

Pedestrian crossings over the drainage channels will be incorporated into the overall footpath network which will be constructed of all metal subframe with timber or composite decking products as agreed

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with the Shire. Balustrading will be provided where the fall heights exceed the requirements of the Building Code of Australia (typically 900mm in height)

There is currently limited to no remnant native vegetation on a large portion of the MUC area proposed within the development area. The existing vegetation over the site has been highly modified through previous farming and land use practices. Several large existing trees are to be retained adjacent to the north-eastern MUC and will remain elevated above any drainage basins to ensure their long term health and viability. These trees [and any other retained vegetation through the site] will have remedial pruning undertaken to ensure accordance with the requirements of fire management techniques.

Edge treatment to the swales will include planted garden beds with mowing kerbs and / or hard edge treatments as a maintenance edge between adjoining turf areas within the open space. Hard edge interfaces will include either one of the following:

- Limestone retaining wall
- Concrete mowing kerb
- Informal granite rockwork



Plate 2: Typical Edging Treatment between Landscape Interfaces.

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Plate 3: Typical Multiple Use Corridor Recreational Facilities.

The MUC areas shall incorporate dual use and pedestrian path systems with built in vehicular crossing and access points for maintenance purposes. Dual use and pedestrian systems shall provide smooth and easy access to all features of the open space and link accordingly into residential and other areas adjacent as part of a greenbelt system across the development. Disability access will be given a high priority and will be designed in accordance with relevant Australian Standards.

2.3 Large Parks

One large Public Open Space will be developed as part of the development plan. It will be positioned central to the development and co-located to a proposed Primary School incorporating a shared playing field. This POS will be 4.3 hectares in size and shall incorporate dual use and pedestrian path systems with built in vehicular crossing and access points for landscape maintenance purposes. Dual use and pedestrian systems shall provide smooth and easy access to all features of the open space and link accordingly into residential and other areas adjacent. Disability access will be given a high priority in all large parks and will be designed in accordance with relevant Australian Standards where practicable.

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Plate 4: Typical Large Park Amenity Facilities.

The large park will be a parkland area which will offer a range of recreation and community facilities. This area will provide both informal active and passive recreation functions. The parkland shall consist of open grassed spaces bounded and defined by both feature avenue trees and native tree groupings. The western boundary will be defined by a swale with drifts of native plantings and a three row avenue of street trees running up the central boulevard.

Shrub plantings are planned to strategic areas to provide spatial definition and colour where required. Shrub planting shall primarily consist of lower growing species to enable clear vision and security through passive surveillance. It is proposed that the shrubs will consist of native species, with consideration and adherence to Waterwise principles.

Access to the large central POS shall be via the path system running along the east-west tending MUC as well as four additional pathways leading from the central boulevard spine across the swale. These entrances will incorporate gateway features principally situated along the axes of side streets. Through the development of manicured landscaped areas and its associated facilities will be the provision for picnic settings and informal gathering spaces. One of these gathering spaces will be located adjacent to the formal playing field. A shelter will allow surveillance over both the playing field and the informal recreation area to the other side. A piece of play equipment and BBQ will enable a variety of use.

A main playground with feature shelter is to be located adjacent to the north south aligned boulevard road through the development but with strong views and vistas across the open space and from the proposed road network to draw users into the space. Shelters, seating, BBQ's and shade trees will position this as the predominant passive and community activation space within the POS. Positioning of all facilities within the large park will maximise available views towards the Darling Range wherever possible.

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The large park will be required to accept some stormwater runoff from the surrounding development area in a multi-use drainage channel as outlined in the Multiple Use Corridor section of this report.

2.4 Pocket Parks

A series of eight (8) smaller to medium sized POS areas, ranging in size from 486sqm up to 2106sqm will also be provided within the development. (POS areas 1-3, 5-7 and 10 on the attached Landscape Masterplan). These parks shall incorporate elements of all the items outlined previously, with the exception of larger informal recreation / kickabout areas and communal features such as BBQ's. The five (5) smallest POS areas will act as enlarged road reserves as a transition from the smaller lot densities to large lifestyle sized lots and consist of feature paths, turf with tree and amenity shrub planting. These Pocket Parks are not designed to accept any stormwater drainage. Their path systems will link to the adjoining residential streets to provide access as necessary. Avenues of trees and minimal shrub planting are preferred. Species will be a mix of native and exotic tree species and native groundcovers that are Waterwise.

The three (3) largest of these parks will typically consist of a central built feature such as a picnic shelter or playground only. The Pocket Park adjacent to the end of Cockram Street will retain a group of existing trees. The elements proposed for this POS will be positioned around these plantings to maximise shade and amenity values whilst considering the tree species habit outlined previously in this report.



Plate 5: Typical Pocket Park Play Area.

2.5 Streetscapes

Streetscapes throughout the development shall incorporate a variety of treatments in response to the road hierarchy system. In all cases landscape works shall incorporate tree planting in accordance with accepted traffic standards on the standard street tree alignment in relation to the service utility corridor. Treatments may include soft works such as street trees, hedge planting and groundcovers.

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Final tree species are yet to be agreed however an indicative street tree plan has been included in the appendix to this report and primarily consist of Australian native and West Australian native species. The timing of installation will be to occur at the completion of civil engineering works, prior to the construction of homes. Street trees shall be allocated at one per lot for standard lots and three per lot for corner blocks. Trees will be placed typically centre of lot and / or a minimum of 8m from any boundary to allow for driveway crossovers and in accordance with the corridor provided by utility service providers, being 2.7m from lot boundary.

The retention of existing significant trees to the Mundijong Road boundary and the main boulevard running from that road will enhance the project's landscape theme. The trees will serve an important visual buffer and amenity function in reinforcing the rural character of Mundijong. Within the entrance from Mundijong Road the road reserve has been increased to allow for the proposed retained trees to be accommodated within a wide verge to allow suitable width for long term tree health and maintenance minimisation.



Plate 6: Example of Retained Eucalypts in Medians

2.6 Irrigation Strategy

In general terms the project is committed to undertaking water sensitive design with minimal impact on good quality groundwater sources and preserving water quality.

It is anticipated that irrigation water will be provided through a series of deep aquifer groundwater bores constructed across the open space areas. The flow rate of the production bores will determine the number of bores required, however, it is envisaged that up to three deep aquifer bores will be required for this development. The use of large droplet format sprinklers within turf areas and subsurface drip line irrigation within garden beds will assist in reducing evaporation and aid water conservation.

All irrigation shall be installed to the local authorities' standard specifications and industry best practice. Maintenance minimisation processes will apply in all circumstances. Controllers shall be

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keyed and accessed in accordance with the local authorities standards. Irrigation shall be designed to incorporate stations that can be terminated as agreed upon planting establishment and maintenance handover to the Council in accordance with relevant policies.

2.7 Landscape Maintenance

The industry accepted standard Developer funded and managed landscape and irrigation maintenance period is typically two (2) summers as outlined in Liveable Neighbourhoods. Following this period, the landscape and irrigation maintenance will be handed over to the Serpentine Jarrahdale Shire to manage, unless otherwise negotiated.

Typically the first year is an establishment period, followed by a second year of consolidation. Irrigation requirements are to be scheduled to be wound back during this period to a point of almost self sufficiency at the time of handover to the Council.

As part of the ongoing approval process, every public open space landscape and irrigation design will be submitted to and approved by the Serpentine Jarrahdale Shire for Development Application prior to construction commencing.

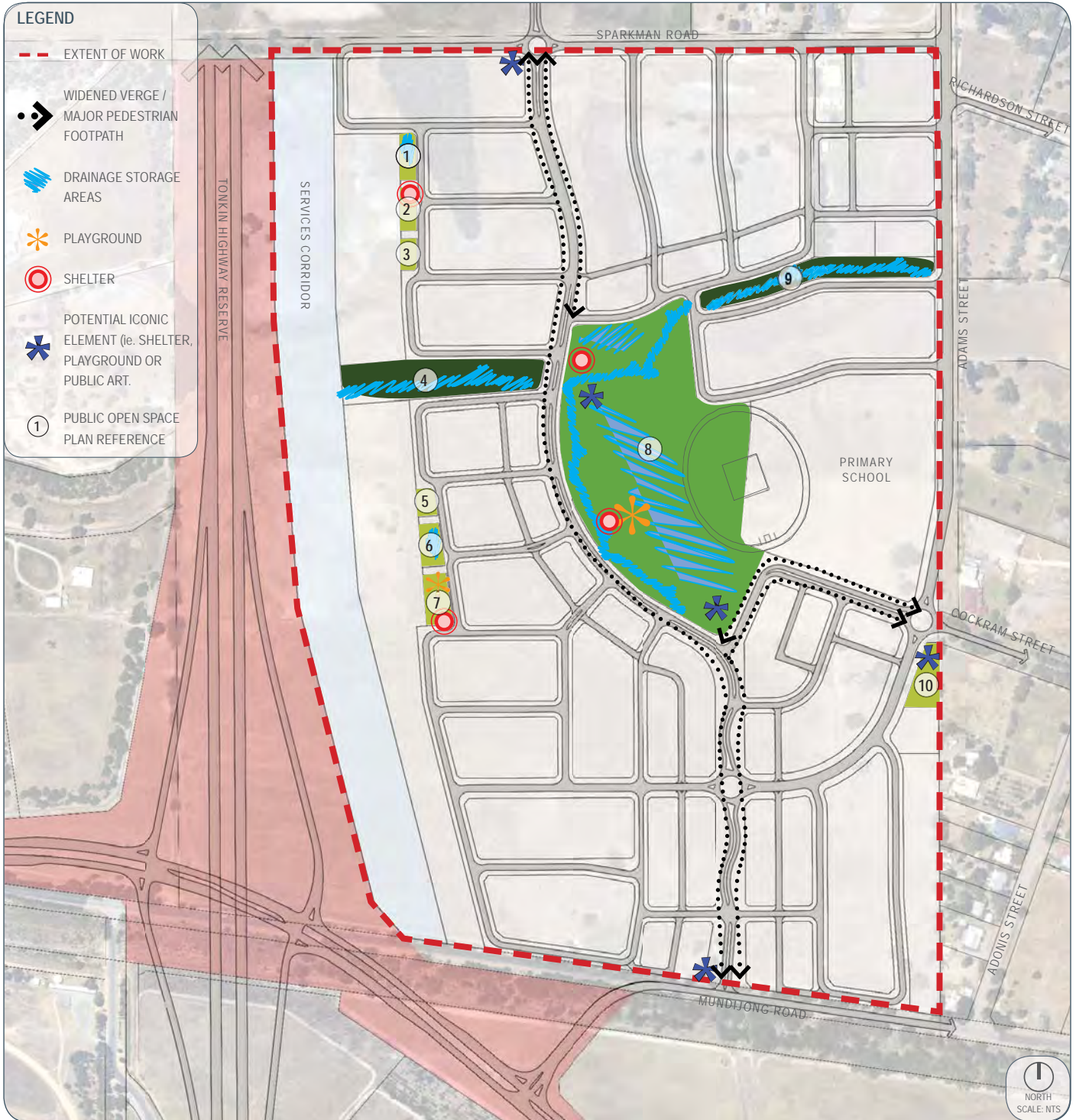
The Landscape Design will incorporate recreation and environmental requirements, whilst focusing on maintenance minimisation principles and techniques. The developer is committed to working with the local authority to deliver outcomes in this process to reflect best practice throughout the development.

APPENDIX A



LANDSCAPE STRATEGY PLANS

LANDSCAPE STRATEGY PLAN



PUBLIC OPEN SPACE SUMMARY



LOCAL PARK (POS 1, 2, 3, 5, 6, 7 & 10)

- Predominantly native planted areas with pockets of turf.
- Retention of existing significant trees where possible.
- Small gathering nodes and basic picnic facilities with shade structures.
- Path network which links into the greater development.
- Primary focus on passive recreation.
- Fully irrigated.



LINEAR POS / DRAINAGE SWALE (POS 4 & 9)

- Predominantly native planted areas with pockets of turf.
- Retention of existing significant trees where possible.
- Drainage retention and conveyance through a vegetated and stabilised swale.
- Pedestrian bridge crossings over landscaped drainage swales.
- Informal active recreation uses on open grassed areas.

- Small gathering nodes with picnic / BBQ facilities.
- Path network which links into the greater development.
- Manicured landscape areas fully irrigated.



NEIGHBOURHOOD PARK (POS 8)

- Centrally located and easily accessible to the greater community.
- Predominantly native planted areas with pockets of turf.
- Retention of existing significant trees where possible.
- Drainage retention and conveyance through vegetated and stabilised swales.
- Formal active recreation uses through shared oval with School site.
- Informal active recreation used on open grassed areas.
- Playground with informal seating.
- Large gathering nodes with picnic / BBQ facilities and shade structures.
- Path network which links into the greater development.
- Manicured landscape areas fully irrigated.

LOT 50 COCKRAM ST, MUNDIJONG - STRUCTURE PLAN

LANDSCAPE JOB NUMBER : MG01 : MARCH 2013 : REV B

LANDSCAPE MASTER PLAN



CONSIDERED



HOMELY



COMFORTABLE



INTERACTIVE



TEXTURAL



CONNECTED

LOT 50 COCKRAM ST, MUNDIJONG - STRUCTURE PLAN

LANDSCAPE JOB NUMBER : MG01 : MARCH 2013 : REV B

STREET TREE MASTER PLAN



Liquidambar styraciflua - Red Gum



Corymbia ficifolia - Red Flowering Gum



Eucalyptus wandoo - Wandoo



Corymbia calophylla - Marri



Eucalyptus marginata - Jarrah



Eucalyptus lane-poollei - Salmon White Gum



LOT 50 COCKRAM ST, MUNDIJONG - STRUCTURE PLAN

LANDSCAPE JOB NUMBER : MG01 : MARCH 2013 : REV B

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POS TREE PLANTING PALETTE



Corymbia calophylla



Melaleuca preissiana



Eucalyptus rudis



Liquidamber styraciflua



Ulmus parvifolia



Corymbia ficifolia



Eucalyptus lane-Poolei



Eucalyptus wandoo



Melaleuca raphiophylla



Jacaranda mimosifolia



Eucalyptus leucoxylon rosea



Eucalyptus marginata



Kingia australis



Pyrus nivalis



Xanthorrhoea preissii

LOT 50 COCKRAM ST, MUNDIJONG - STRUCTURE PLAN

LANDSCAPE JOB NUMBER : MG01 : MARCH 2013 : REV B

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POS TYPOLOGY

- Neighbourhood Park.

SIZE

- 43,910m² + 3,390m² verge.

CONCEPT

- Provide an active recreation POS with a large flat grassed oval for formal recreation in a shared arrangement with the proposed school site (primary school sized oval).
- Drainage retention and conveyance through vegetated and stabilised swales.
- Grassed amphitheatre for viewing sporting activities.
- Possible small community building (by others) to provide public facilities such as a toilets / changerooms / meeting rooms in conjunction with oval uses.
- Large gathering nodes with picnic / BBQ facilities and shade structures.
- Large adventure playground with informal seating opportunities co-located with picnic / BBQ facilities.
- Path network to disability codes which links into the greater development.

FUNCTIONS / MATERIALS

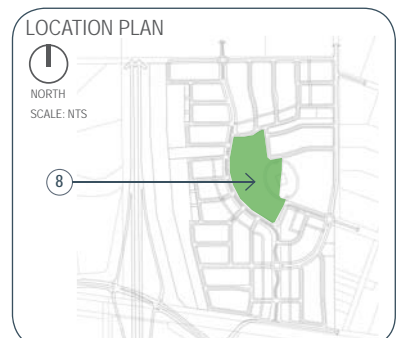
- Provide for stormwater retention and conveyance through vegetated and rock stabilised swales and streams.
- Provide for formal active recreation uses on a large grassed area in a shared arrangement with the proposed school.
- Provide for a large adventure playground with informal seating.

ENVIRONMENTAL CONSIDERATIONS

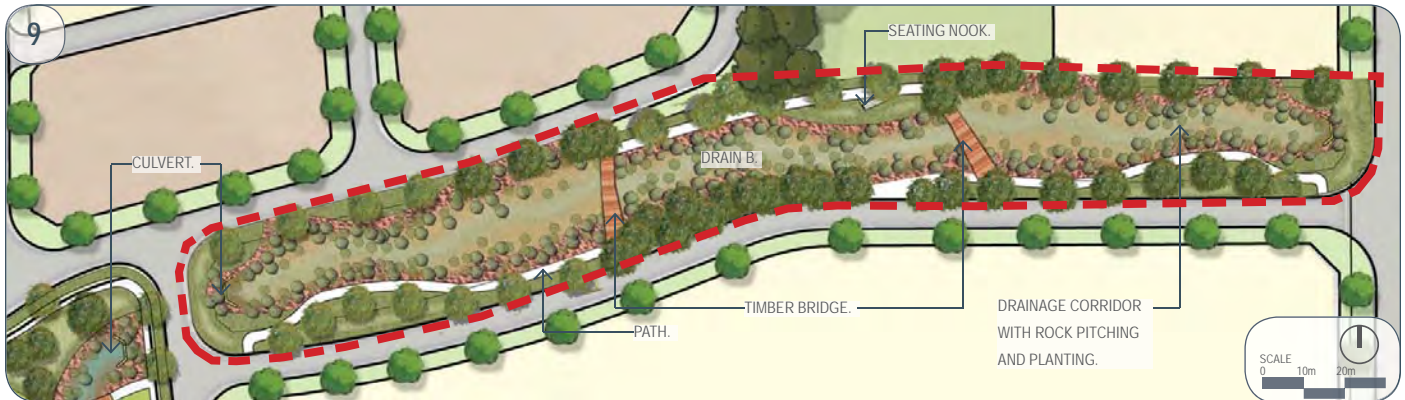
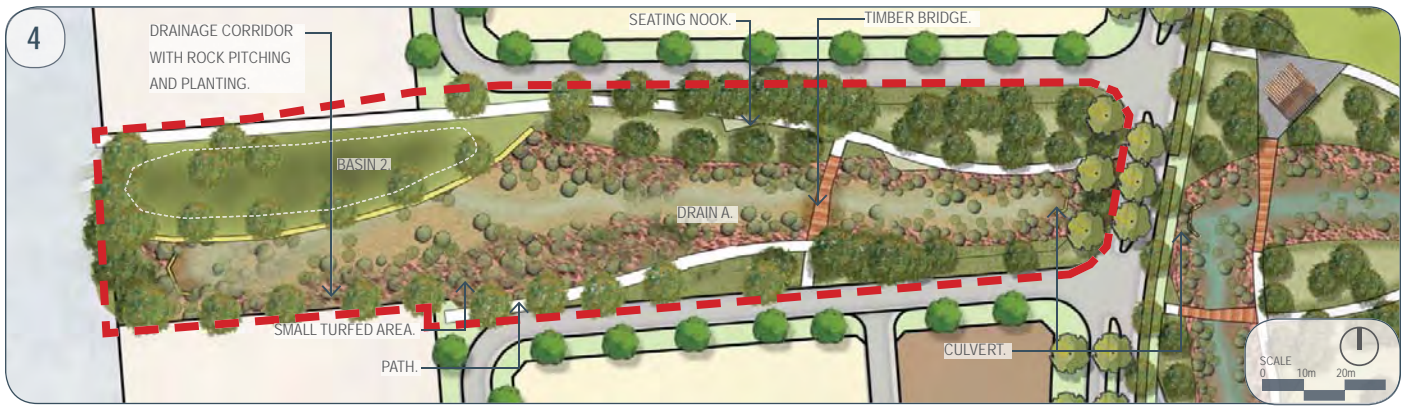
- Retention and polish of stormwater runoff
- Waterwise Plant Strategy.
- Hydrozoning of plant species.
- Controlled fertiliser application to landscape areas.
- Retain existing trees (where possible).

DRAINAGE CONSIDERATIONS

Basin 4	1:1yr Storm Volume = 480m ³ 1:5yr Storm Volume = 1,600m ³ 1:100yr Storm Volume = 1,900m ³
Basin 5 & 6	1:1yr Storm Volume = 1,750m ³ 1:5yr Storm Volume = 5,700m ³ 1:100yr Storm Volume = 7,000m ³
Basin 7	1:1yr Storm Volume = 1,710m ³ 1:5yr Storm Volume = 3,400m ³ 1:100yr Storm Volume = 3,900m ³
Drain A	1:5yr Flood Width = 9m 1:100yr Flood Width = 10m
Drain B	1:5yr Flood Width = 7m 1:100yr Flood Width = 10m



POS 4 & 9 CONCEPT



POS TYPOLOGY

- Linear POS / Drainage Swale

SIZE

- POS 4** - 7,154m² + 1,210m² verge.
- POS 9** - 4,663m² + 1,761m² verge.

CONCEPT

- Provide a POS which caters for drainage retention and conveyance through a vegetated and stabilised swale.
- Path network to disability codes which links into the greater development.
- Shaded seating nooks along path network.

FUNCTIONS / MATERIALS

- Provide for stormwater retention and conveyance through vegetated and rock stabilised swales and streams.
- Provide for informal recreation uses with small gathering nodes with picnic / BBQ facilities.

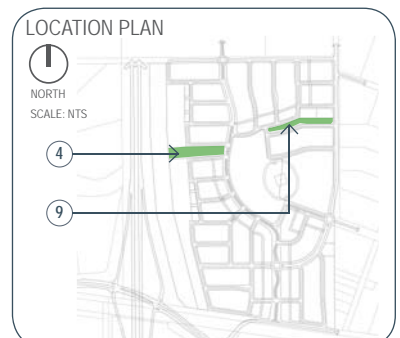
ENVIRONMENTAL CONSIDERATIONS

- Retention and polish of stormwater runoff
- Watwise Plant Strategy.
- Hydrozoning of plant species.

- Controlled fertiliser application to landscape areas.
- Retain existing trees (where possible).

DRAINAGE CONSIDERATIONS

Basin 2	1:1yr Storm Volume = 540m ³ 1:5yr Storm Volume = 1,000m ³ 1:100yr Storm Volume = 1,300m ³
Drain A	1:5yr Flood Width = 12m 1:100yr Flood Width = 15m
Drain B	1:5yr Flood Width = 8m 1:100yr Flood Width = 11m



POS 1-3 & 5-7 CONCEPT

POS TYPOLOGY

- Local Parks

SIZE

- POS 1 - 734m²
- POS 2 - 672m²
- POS 3 - 490m²
- POS 5 - 486m²
- POS 6 - 887m²
- POS 7 - 1,265m²

CONCEPT

- Provide a series of POS' primarily focussed on passive recreation with pockets of turf and feature nodes, on key axis'.
- Feature shelters with picnic and BBQ facilities.
- Provide seating nooks along path network.
- Predominantly native planted garden beds.
- Small playground with informal seating.

FUNCTIONS / MATERIALS

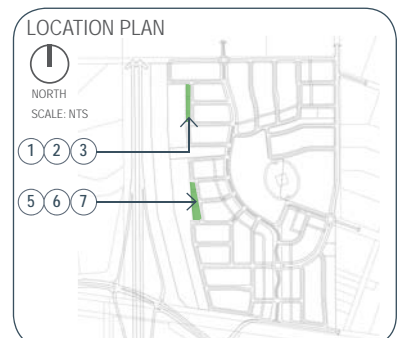
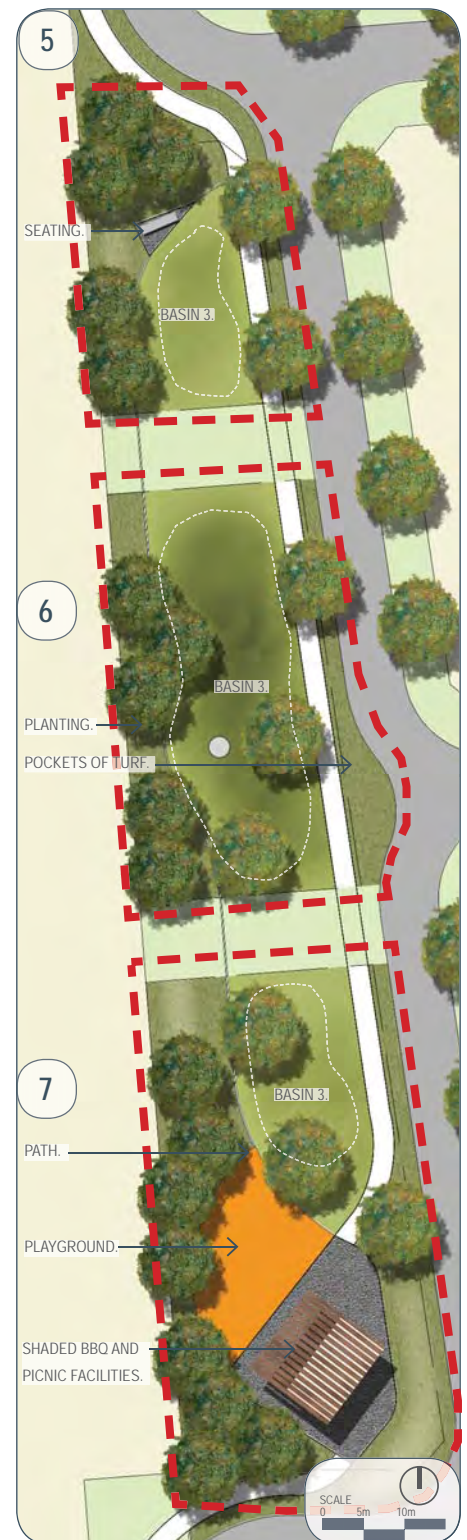
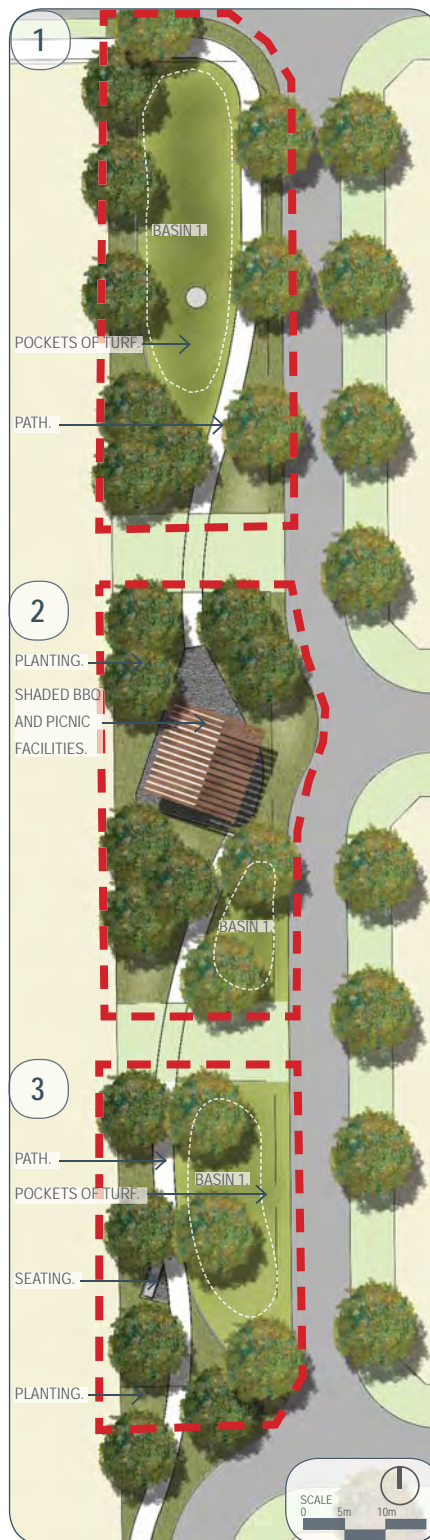
- Provide for stormwater retention in turf and vegetated swales.
- Provide for informal recreation uses with small gathering nodes with picnic / BBQ facilities.

ENVIRONMENTAL CONSIDERATIONS

- Waterwise Plant Strategy.
- Hydrozoning of plant species.
- Controlled fertiliser application to landscape areas.
- Retain existing trees (where possible).

DRAINAGE CONSIDERATIONS

Basin 1	1:1yr Storm Volume = 370m ²
	1:5yr Storm Volume = 1,000m ²
	1:100yr Storm Volume = 1,300m ²
Basin 3	1:1yr Storm Volume = 1,050m ²
	1:5yr Storm Volume = 1,800m ²
	1:100yr Storm Volume = 2,300m ²



POS TYPOLOGY

- Local Park

SIZE

- 1,437m² + 623m² verge.

CONCEPT

- Provide a POS primarily focussed on passive recreation with pockets of turf and seating nooks.
- Predominantly native planted garden beds.
- Retention of existing trees.

FUNCTIONS / MATERIALS

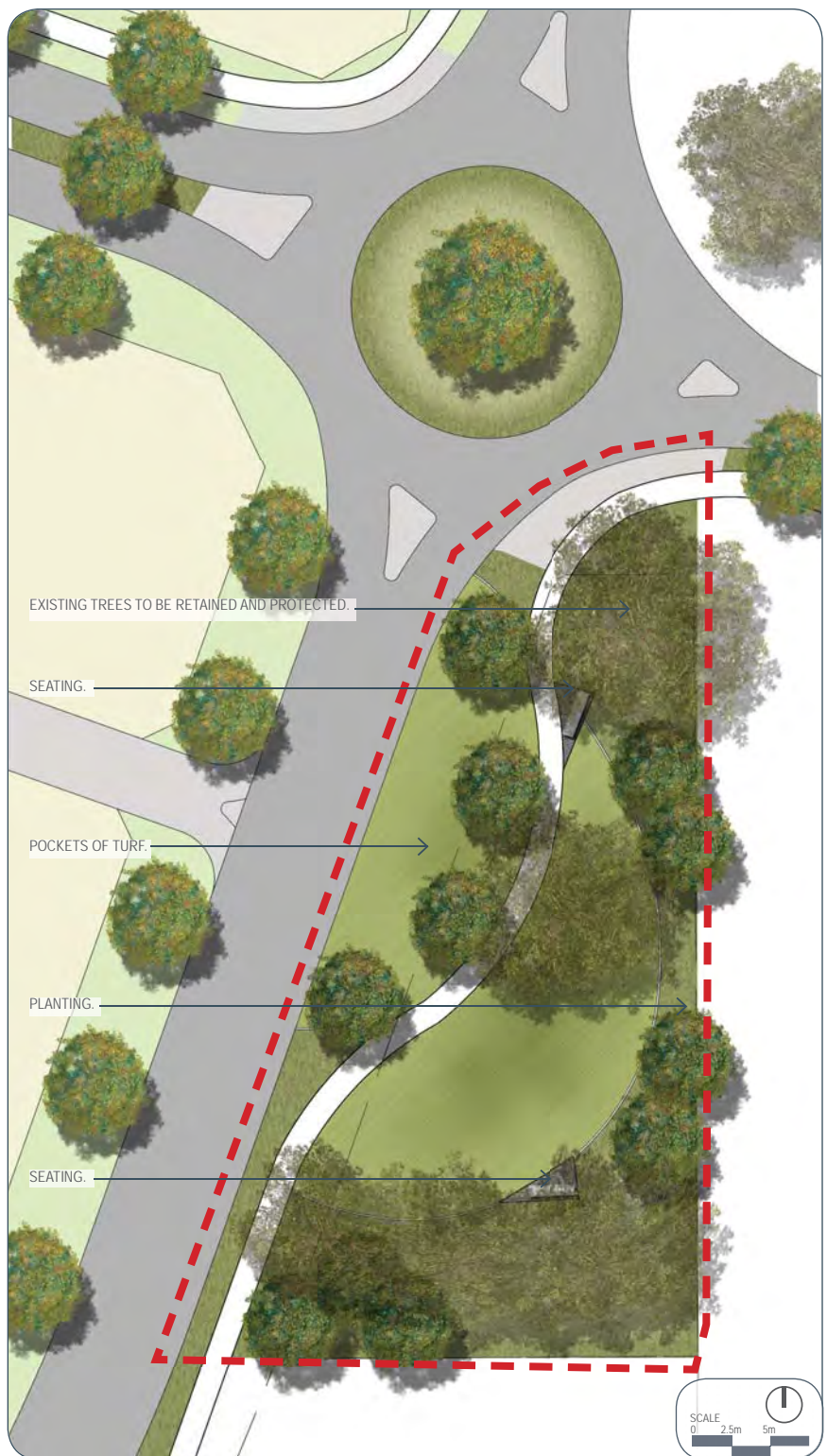
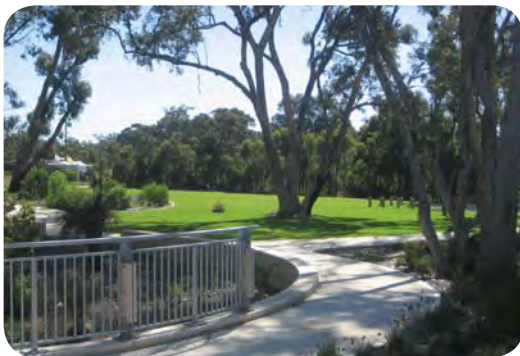
- Provide for informal recreation uses with small gathering nodes.

ENVIRONMENTAL CONSIDERATIONS

- Waterwise Plant Strategy.
- Hydrozoning of plant species.
- Controlled fertiliser application to landscape areas.
- Retain existing trees (where possible).

DRAINAGE CONSIDERATIONS

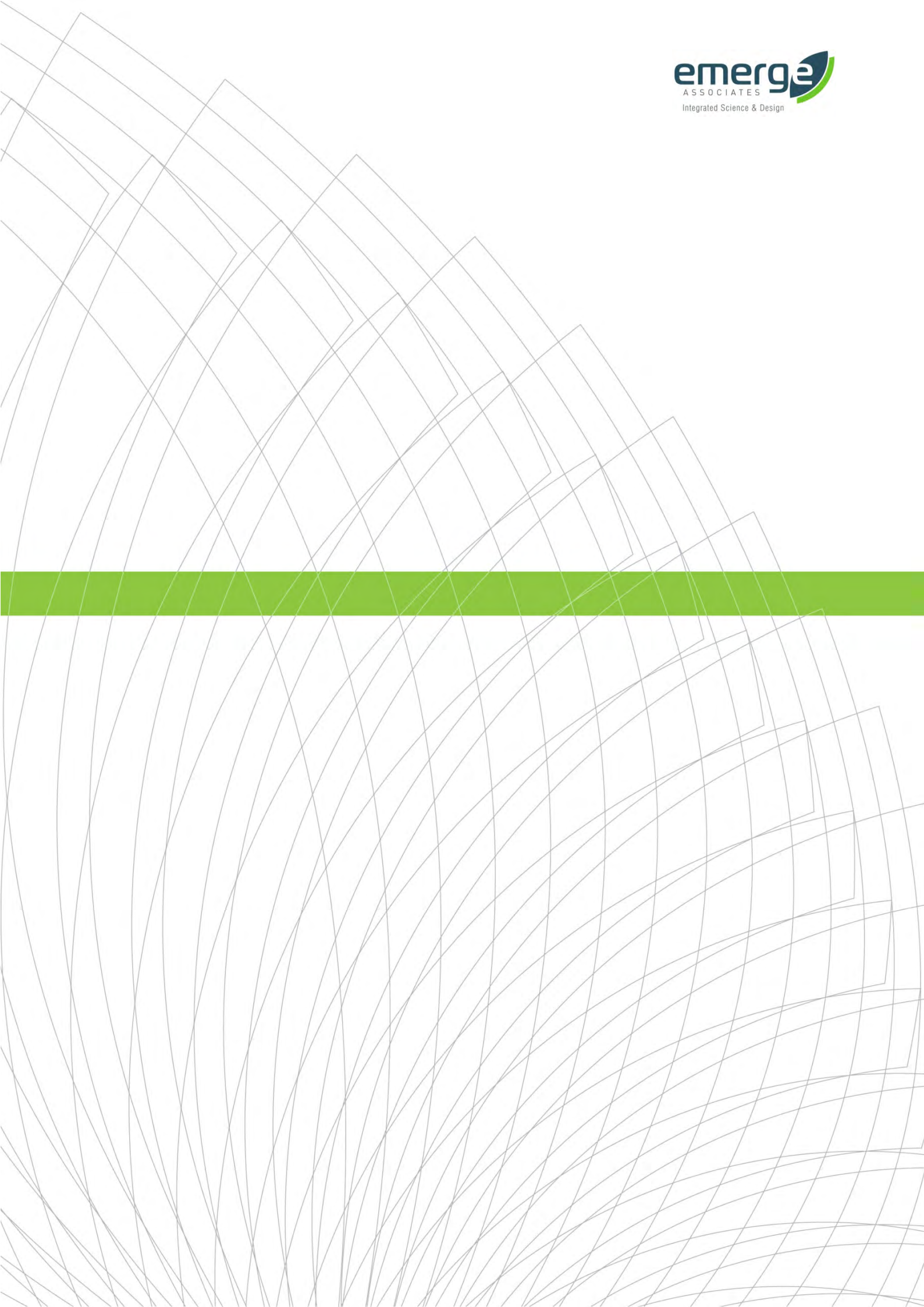
N/A



LOCATION PLAN

NORTH
SCALE: NTS

10





APPENDIX 7

STRUCTURE PLAN TRAFFIC REPORT

PEET 88 PTY LTD

LOT 50 MUNDIJONG ROAD, MUNDIJONG

STRUCTURE PLAN TRAFFIC REPORT

September 2012



PO BOX Z5578

Perth WA 6831

0413 607 779 Mobile

Issued on	12 September 2012	Amendments	Date
Version	V2	Road network amendments	August
Reference	648		

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- 3.0 TRAFFIC GENERATION AND DISTRIBUTION
- 4.0 DEVELOPMENT TRAFFIC IMPACTS
- 5.0 ACCESS
- 6.0 THE INTERNAL ROAD NETWORK
- 7.0 PEDESTRIANS, CYCLISTS AND PUBLIC TRANSPORT

1.0 EXECUTIVE SUMMARY

Riley Consulting has been commissioned by Peet 88 PTY LTD to consider the traffic and transport impacts of developing Lot 50, Mundijong Road. The development proposes residential dwellings west of Taylor Street between Sparkman Road and Mundijong Road, Mundijong. The key findings of the traffic overview are:

- Lot 50 Mundijong Road is to be developed to provide about 532 dwellings. It is expected that with full development the site will generate about 4,256 vehicle movements per day.
- The traffic assessment undertaken for the structure plan for Lot 50 Mundijong Road has used a Saturn model to derive daily traffic flows on local streets. The model includes traffic generated within the Whitby-Mundijong district structure plan to ensure adjacent development traffic movements are fully considered.
- The development of Lot 50 Mundijong Road has already been included in the traffic planning undertaken for the Whitby-Mundijong district structure plan. The longer term road network requirements should be included in the Whitby-Mundijong district structure plan.
- Development of Lot 50 Mundijong Road in isolation is shown to have little impact to the current operation of the surrounding road network. All external roads are shown to maintain current Levels of Service, except Mundijong Road west, which has a reduced Level of Service from B to C. This is considered a good operating environment.
- Access to Lot 50 can be achieved from Mundijong Road and in the longer term to Adams Street and Cockram Road to include the subdivision within the residential environment of Mundijong. Analysis of the access to Mundijong Road indicates that a priority controlled tee intersection can accommodate the full development of Lot 50.
- In the longer term, as development proceeds to the north of Lot 50 Mundijong Road, additional road links will attract traffic through Lot 50 to access Mundijong Road. Analysis indicates that a single lane roundabout could accommodate the longer term

traffic demands as a result of the development of the Whitby-Mundijong district structure plan. The need for intersection control can be reviewed once the priority tee intersection is deemed to require upgrading. It is considered that development to the north may result in the need for this intersection to be upgraded.

- The road hierarchy developed for Lot 50 Mundijong Road is cognisant of the road network planning for the Whitby-Mundijong district structure plan. Adams Street is shown as a neighbourhood connector. All other streets are shown to carry traffic demands appropriate for access streets. A minimum road reservation of 20 metres is suggested for neighbourhood connectors, 16 metres for higher order access streets and 15 metres for lower order access streets.
- The internal road network has been planned to achieve a 40kph local traffic speed and no additional traffic management measures are considered to be required. Internal intersections are recommended for roundabout control where daily volumes are above the criteria set by *Liveable Neighbourhoods*, or high turning movements are expected.
- All access streets have low daily traffic volumes and are considered appropriate for on-street cycling. A principal shared path is indicated in the Whitby-Mundijong district structure plan adjacent to the future Tonkin Highway. This path provides a convenient north-south connection, but access to the structure plan area may be compromised by the proposed service corridor. This matter need to be addressed once regional planning has determined the accessibility over the service corridor.
- The majority of dwellings in Lot 50 Mundijong Road will be within 400 metres of the proposed bus route identified in the Whitby-Mundijong district structure plan.

2.0 THE SITE AND SURROUNDING ROAD NETWORK

Mundijong is located approximately 40 kilometres south east of Perth. The area falls within the Shire of Serpentine - Jarrahdale and is accessed from the South Western Highway and Mundijong Road. Figure 1 shows the location of the subject land. Roads of importance are discussed below.

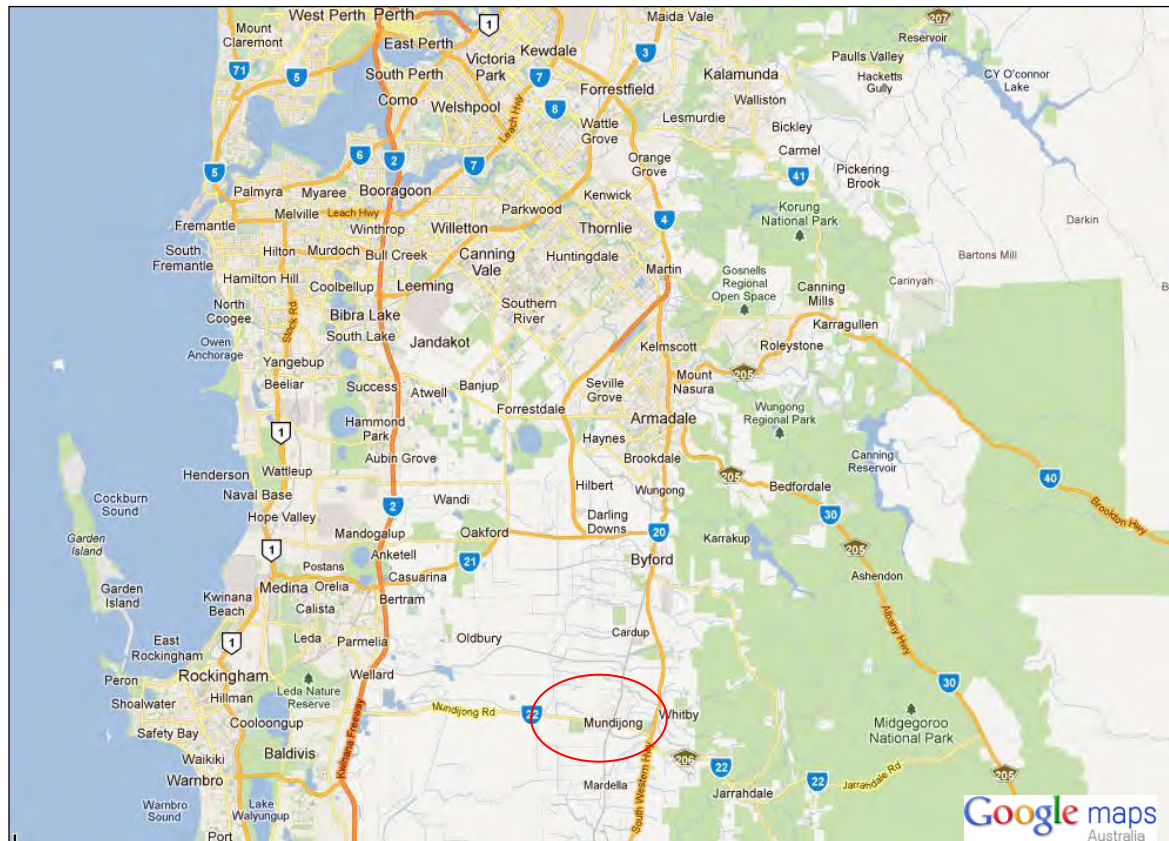


Figure 1 Site Location

South Western Highway

The South Western Highway is a primary regional road under the control of Main Roads Western Australia (MRWA). It provides a major traffic and freight route between Pinjarra to the south and the eastern industrial areas of Perth (Kewdale and the airport etc). It also provides connectivity at a regional level to the Tonkin Highway and Albany Highway.



Photograph 1 South Western Highway

Photograph 1 shows the view looking north along the South Western Highway to Watkins Road (Mundijong Road).

The South Western Highway is generally constructed as a rural standard single lane road with 2 traffic lanes. A northbound overtaking lane exists at the intersection of Watkins Road, which will make egress from Watkins Road difficult and potentially dangerous during busy periods. A right turn deceleration lane is provided on the highway for southbound traffic. The South Western Highway has a posted speed limit of 90kph adjacent to the locality of Mundijong.

Current traffic data provided by MRWA indicates 9,110 vehicle movements per day (11.8% HGV) to the south of Watkins Road. This daily volume picks up the regional freight movements from Jarrahdale Road to the south.

Watkins Road – Mundijong Road

Watkins Road is the continuation of Mundijong Road to the east of the Perth – Bunbury rail line. It is constructed as a single carriageway road with 2 traffic lanes. A standard 7.2 metre carriageway is provided. A controlled level crossing is provided at the railway line. A 60kph posted limit applies through the townsite area. To the west, about 200m west of Patterson Street, an 80kph posted limit applies. Approximately 50 metres west of Adonis Street a 100kph posted limit applies.



Photograph 2 shows Watkins Road looking towards Mundijong. Photograph 3 shows Mundijong Road west of the town looking to the west.



Current traffic data (2008/09) provided by MRWA indicates 2,400 vehicle movements per day on Watkins Road to the west of the South Western Highway. The current level of traffic movements at this location supports the current provision of yield control to Watkins Road.

Traffic data sourced for Mundijong Road shows:

- 3,280vpd west of Patterson Street
- 2,790vpd east of Baldivis Road
- 3,430vpd east of the Kwinana Freeway

Overall it can be seen that Watkins Road and Mundijong Road are operating well within their derived operational capacity and will experience very good Levels of Service.

Patterson Street / Soldiers Road

Patterson Street is the main street to the Mundijong townsite and is constructed with a wide



Photograph 4 Patterson Street

9 metre carriageway (approximate).

Photograph 4 shows Patterson Street at Mundijong town centre. Patterson Street links Mundijong Road to Abernethy Road in Byford. It is classified as a district distributor type A road in the MRWA *Functional Road Hierarchy*. Historical traffic data from MRWA (2004/05) indicates 2,200 vehicle movements per day. It

is unlikely that this daily volume has changed significantly.

Bishop Road

Bishop Road provides an east-west connection between Kargotich Road and Soldiers



Photograph 5 Bishop Road

Road. It is classified as a local distributor road and lies to the south of the freight rail line and to the northern side of the Mundijong structure plan area. Photograph 5 shows the view looking along Bishop Road.

No traffic data is available, although it can be expected that current volumes are well below 500 vehicles per day. Close to the intersection

of Soldiers Road is a school that can be expected to increase traffic flows at the eastern end. However, such increases would only affect school pick-up / drop-off periods typically between 08:15 – 09:00 and then 14:30 to 15:30.

Kargotich Road

Kargotich Road is classified as a district distributor type B road in the MRWA *Functional Road Hierarchy*. It provides a currently important north-south connection between Mundijong Road and Thomas Road. However, construction of the future Tonkin Highway will attract the majority of traffic using this road.

Traffic data from MRWA indicates 1,730 vehicle movements per day to the north of Bishop Road.

Taylor Road / Adams Street

Classified as local distributor roads, Taylor Road and Adams Street provide a convenient



Photograph 6 Taylor Road

north-south link between Richardson Street and Bishop Road. Photograph 6 shows the view looking north along Taylor Road close to Lang Road.

The current sealed width of Taylor Road / Adams Street is about 6 metres (approximately) and may require additional width to cater for significant increases in traffic

demand. There is an existing bridge over Manjedal Brook approximately 400 metres south of Bishop Road.

At Bishop Road a left-right stagger leads to Hopkinson Road, which is classified as a district distributor type B road. Hopkinson Road provides a convenient link to the south of Armadale and may be attractive to commuter traffic. However, the development of the Tonkin Highway will negate Hopkinson Road as a desirable route.

Livesey Street and Tonkin Street

These two streets are existing east-west connections between Patterson Street and Adams Street. Constructed with standard 7.2 metre wide carriageways, these streets are rural residential in nature.

Cockram Street

Cockram Street is a local access street that links Adonis Street through to Patterson Street. It is bounded by larger residential lots and provides access to local sporting facilities. It is constructed with a standard 7.2 metre wide carriageway (approximate). Present day traffic

movements would be expected to be less than 500 vehicles per day. West of Butcher Street a standard 20 metre wide road reservation is provided.

Adonis Street

Adonis Street is a local access street that links Richardson Street to Mundijong Road. It is bounded by larger lots and provides access to about 8 properties south of Cockram Street. It is constructed with a standard 7.2 metre wide carriageway (approximate). Present day traffic movements would be expected to be less than 500 vehicles per day.

Kiernan Street

Kiernan Street is a local access street providing an east-west connection between Patterson Street and Taylor Road. Photograph 7 shows the view along Kiernan Street.



Photograph 7 Keirnan Street

No traffic data is available for Kiernan Street, but based on current levels of development accessed from this link, a daily flow of less than 500 vehicles would be expected.

Tonkin Highway

To the west of Lot 50, an existing road reservation is set aside for the construction of the future Tonkin Highway. At present the construction of the Tonkin Highway is not in the MRWA 4-year programme. It can be expected to be required at the time when daily volumes on the South Western Highway reach about 15,000vpd. At this point a poor Level of Service will exist for regional movements and widening would be warranted. However, the construction of the Tonkin Highway would negate the need to widen the South Western Highway.

Appendix A shows the current MRWA / DPI planning for the Tonkin Highway adjacent to Mundijong. As part of the highway proposal, a re-alignment of Mundijong Road to provide a connection to Jarrahdale Road has been indicated.

Current traffic volumes on the Tonkin Highway north of Armadale Road are about 13,000vpd. It would be expected that the future extension would carry about 9,000vpd on opening.

Mundijong – Whitby District Structure Plan

A district structure plan has already been prepared for the Whitby – Mundijong locality and is provided on the Shire of Serpentine – Jarrahdale website. Traffic forecasts have been provided and are attached as Appendix B.

As a result of the traffic forecasting for the district, the following works can be expected:

- Mundijong Road – Forecast flow of 12,000vpd. Single lane road would operate but with increased delay in peak periods. If railway crossings removed, the volume increases to 16,000vpd. Therefore assume road reservation of 30 metres for future duplication to be required.
- Taylor Road / Adams Street – Forecast flow of 5,000vpd. Therefore assume road reservation of 20 metres for neighbourhood connector to be required.

Figure 2 shows the local structure plan used for the traffic analysis.



3.0 TRAFFIC GENERATION AND DISTRIBUTION

The development of residential land at Mundijong will provide for the growing population forecast for Perth and the south eastern rural areas.

Reference to trip generation source documents suggest that the trip generation of a typical household can vary from 5 trips to 11 trips per day. Traffic analysis of similar development to the north of Mundijong identified a residential trip rate of 8 trips per dwelling per day, which is slightly higher than the Perth metropolitan average rate of 7 trips per day. The trip rate is based on typical R20 density which is attractive to families.

It is understood that other developments have indicated a higher density level of development in Mundijong that may be expected to generate a lower average rate per household. However, the use of 8 trips per dwelling will provide a robust assessment of the road network and provide flexibility for future planning to meet customer demands.

The concept plan indicates a yield of 532 residential lots and on the basis of 8 trips per lot the site can be expected to generate (532 x 8) 4,256 vehicle movements per day.

Lot 50 Mundijong Road is expected to generate 4,256 trips per day.

The subject land will provide a primary school which will retain traffic within the developable area.

Distribution

Table 1 shows the distribution assumptions by trip purpose used to assign traffic onto the external road network.

The traffic generation and distribution has been used to prepare a matrix for the Saturn traffic model.

Table 1 Composition of Residential Trips

Purpose of trips	% of Total	North Tonkin	North SW Highway	East	South – SW Highway	South - Freeway	West Rockingham / Freeway north
Home Based – Work	29%	30%	8%	2%	10%	10%	40%
Home Based – Education	Assigned by school						
Home Based – Other	36%	15%	5%	5%	10%	15%	50%
Home Based – Evening	21%	30%	10%	0%	0%	10%	50%
Non-Home Based	14%	50%	5%	0%	3%	7%	35%

Traffic Modelling

The development of Lot 50 Mundijong Road will need to be considered in regard to development within the Mundijong district structure plan area as indicated in Appendix C. A traffic model has been created using Saturn to assign traffic to the future road network. The model uses the trip generation and distribution assumptions discussed above applied to the district structure plan area.

The following assumptions have been made with regard to traffic accessing the surrounding road network. The speeds are the estimated journey time speeds including movement delays at intersections etc - they may not match the free-flow posted speed.

- New residential roads operate with a speed of 40kph and 30kph.
- Neighbourhood connectors operate at 50kph.
- Mundijong Road operates at 60kph between Tonkin Highway and the rail crossing, then 70kph.
- Tonkin Highway / Mundijong Road re-alignment operates at 80kph (long term)
- South Western Highway 110kph
- Freeway and Tonkin Highway 100kph
- Bishop Road operates at 60kph
- Soldiers Road operates at 60kph and 70kph north of Bishops Road

Trips to schools are based on the Education Department's assessment of 0.35 pupils per household. 30% of home based other trips are assigned to localised shopping (Whitby district centre and Mundijong town centre).

4.0 DEVELOPMENT TRAFFIC IMPACTS

The development of Lot 50 is anticipated to generate a total of 4,256 trips per day and it can be expected that this development may be one of the first to occur. Assuming that direct access is taken to Mundijong Road and developments to the north are not connective, Figure 3 shows the forecast traffic movements. The daily flows indicated assume no facilities within Lot 50 such as a primary school and local shops (thus 100% of traffic leaves the site) Table 2 shows the anticipated road network impacts.

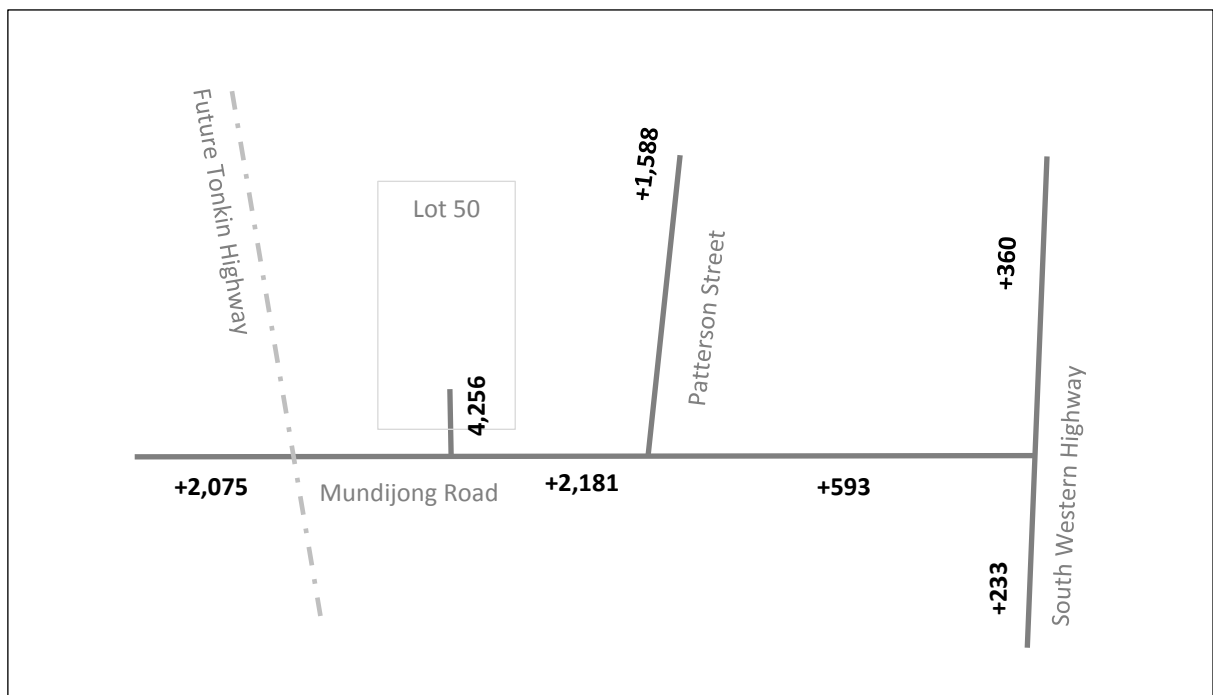


Figure 3 Forecast Traffic Flows

Table 2 is based on current traffic flows in the locality. Whilst it could be argued that growth will occur to current traffic flows, the traffic “growth” will be as a result of development in the locality and thus factoring up current data to a forecast year would result in an artificially higher traffic flow (in effect, double counting the proposed developments). Table 2 shows that the development of Lot 50 in isolation would not warrant any upgrading to the existing road network.

Table 2 Lot 50 Traffic Volumes and Levels of Service

Road	Type	Lot 50	Forecast	LoS
Mundijong Rd west of Patterson St	1	2,181	5,461	C
Mundijong Road east of Tonkin	1	2,075	4,865	C
Mundijong Rd east of Baldivis Rd	1	1,343	4,133	B
Watkins Rd	1	593	2,993	B
South Western Highway north	1	360	9,470	D
Patterson St	1	1,588	3,788	B
Soldiers Rd	1	1,588	3,788	B
Lot 50 Access Rd	1	4,256	4,256	B
Taylor Rd	1	0	500	A
Adams St	1	0	500	A

The LoS is based on Appendix A

Analysis of the proposed access to Mundijong Road is provided within the Access section of this report to determine if any form of control is required in the interim periods prior to development to the north being connective.

The existing road network can accommodate the development of Lot 50.

Development within the Whitby – Mundijong DSP

As has been stated, Lot 50 falls within the Whitby – Mundijong district structure plan and the traffic associated with the proposed development of Lot 50 has already been considered from a district perspective. Based on the traffic forecast of the district structure plan (attached as Appendix B), the following district road upgrades can be expected.

Mundijong Road

Full development of the Whitby - Mundijong structure plan area will result in significant traffic increases to Mundijong Road west of Mundijong townsite. The modelling undertaken indicates that a future demand of up to 16,000vpd could be experienced between the Mundijong Road re-alignment and the access to Lot 50. A boulevard would be expected to cater for this forecast demand, but would operate with lower Levels of Service during peak periods. As the access of Mundijong Road to the Mundijong Road re-alignment is likely to be controlled by traffic signals in the longer term, capacity of Mundijong Road will be

controlled by the intersection. The duplication of Mundijong Road is unlikely to provide any additional capacity.

It is noted that a 40m blue road reservation is included in the MRS west of the Tonkin Highway alignment that would accommodate a four-lane divided road. To the east a 20m road reserve is shown with an additional 40m indicated to the south. The whole road reserve is indicated as being subject to Bush Forever.

Between the Tonkin Highway and the Mundijong Road re-alignment, a four-lane divided road would be required. Future planning has already indicated that Mundijong Road west of the Tonkin Highway would be upgraded to provide a four-lane divided road.

It is considered that regional planning has set aside sufficient land for any future widening of Mundijong Road within the Whitby-Mundijong district structure plan area.

Whilst indicatively the forecast volume on Mundijong Road may suggest duplication, it is considered that such duplication will achieve little benefit.

Lot 50 Access Road

Primary access to Lot 50 and development to the north will be taken via the Lot 50 access road. Ultimately, the daily traffic volumes on this link are shown to be in the order of 10,000vpd approaching Mundijong Road, but quickly dissipate as the road heads north. The forecast traffic flow can be accommodated by a standard 7.2 metre wide carriageway, although widening at major intersections may be necessary.

It should also be noted that the higher volume using the Lot 50 access road could be reduced by traffic redistributing to Adonis Street. The modelling indicates that this is not a desirable route for Lot 50 traffic accessing Mundijong Road, but would be attractive to development further north.

Adams Street / Taylor Road

Adams Street is currently provided with a 20 metre road reservation. In isolation, Lot 50 is highly unlikely to increase traffic movements on Adams Street / Taylor Road until the development connects to Adams Street. This connection will be progressively upgraded as adjacent land is developed.

5.0 ACCESS

Lot 50 is presently accessed from Mundijong Road and has a frontage to the road reserve of Adams Street (unmade) and also frontage to Sparkman Road to the north. It is possible to develop Lot 50 in isolation with access taken purely from Mundijong Road. In the longer term, the development of Lot 50 would become part of Mundijong and will accommodate the neighbourhood connector of Adams Street / Taylor Road.

Access to streets other than Mundijong Road will be created as new streets are planned in accordance with *Liveable Neighbourhoods*. The operation of these streets is considered in the next section of this report.

As discussed, access to Lot 50 will be taken directly to Mundijong Road and in the first years of development would operate as a priority controlled intersection. In the longer term, traffic associated with developments to the north will pass through Lot 50 and affect the operation of the proposed intersection with Mundijong Road.

Based on the traffic modelling, Figure 4 indicates the anticipated peak hour movements (indicative) with Lot 50 developed in isolation and with the full development of the district structure plan area.

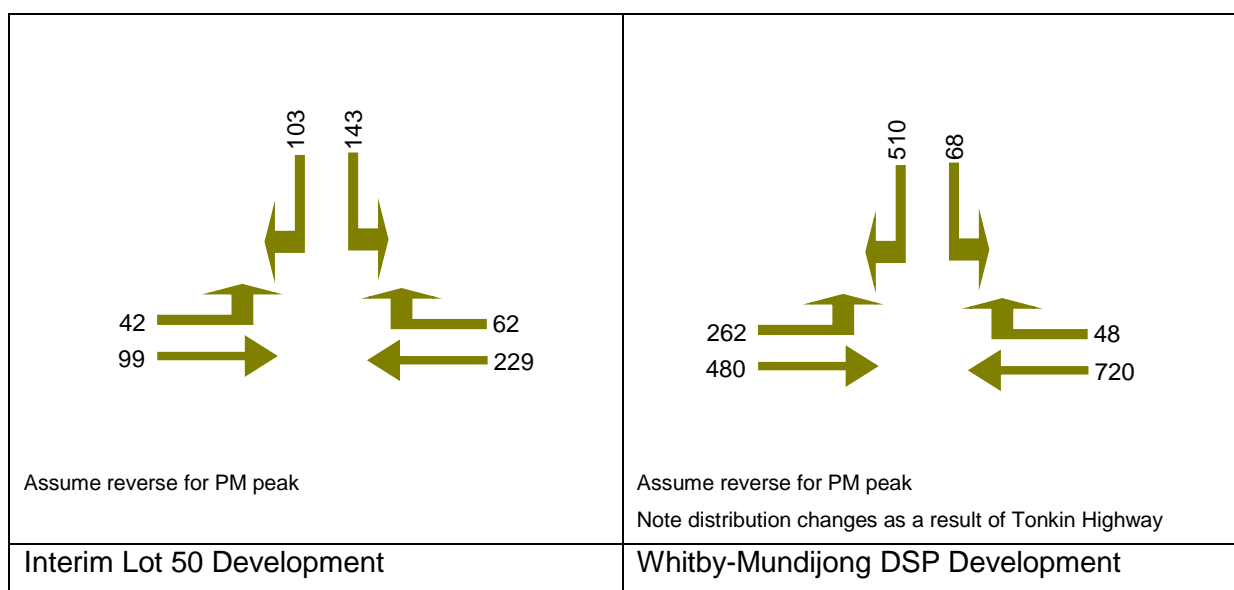


Figure 4 Lot 50 Access / Mundijong Road Forecast AM Peak Hour Movements

The Sidra analysis of the intersections is attached as Appendix F for the full development of Lot 50 in isolation and Appendix G for the Lot 50 Access with full development of the district structure plan. Table 3 provides a summary of the analysis shown in Appendix F.

Table 3 Lot 50 Access to Mundijong Road - Peak Hour Assessment

Approach	V/C	Delay	LoS
AM Peak			
Mundijong Road east	0.126	2s	A
Lot 50 Access	0.233	11s	A
Mundijong Road west	0.079	2.5s	A
PM Peak			
Mundijong Road east	0.151	5.9s	A
Lot 50 Access	0.116	12.3s	B
Mundijong Road west	0.186	2.6s	A

Where V/C = volume of capacity
 Delay is average delay per vehicle
 LoS = Level of Service

Table 3 indicates that the full development of Lot 50 need only be provided with a simple tee intersection to Mundijong Road. It is recommended that an urban standard right turn lane be provided to shelter turning traffic.

A simple tee intersection to Mundijong Road will support full development of Lot 50.

Whitby – Mundijong District Structure Plan

At some future time, land to the north of Lot 50 will be developed and the traffic forecasts indicate a potential for about 9,000vpd to use the Lot 50 access to Mundijong Road. As a result of development elsewhere, traffic flows are forecast to increase on Mundijong Road and the DSP modelling suggests an increase to 12,000vpd (refer Appendix B). Figure 4 shows the likely peak hour traffic demands at the Lot 50 Access with the traffic from the DSP modelling. It is a given that with a demand of 12,000vpd on Mundijong Road, a priority tee intersection will fail to operate in a safe and acceptable manner. It is anticipated that a single lane roundabout would provide sufficient capacity to cater for the forecast movements. The analysis is attached as Appendix G and summarised in Table 4.

Table 4 Lot 50 Access to Mundijong Road with DSP - Peak Hour Assessment

Approach	V/C	Delay	LoS
AM Peak			
Mundijong Road east	0.984	48.5s	D
Lot 50 Access	0.645	17.2s	B
Mundijong Road west	0.525	5.1s	A
PM Peak			
Mundijong Road east	0.509	7s	A
Lot 50 Access	0.48	17s	B
Mundijong Road west	0.838	5.8s	A

Where V/C = volume of capacity
 Delay is average delay per vehicle
 LoS = Level of Service

Table 4 indicates that the provision of a single lane roundabout should be able to cater for the forecast traffic demands at the Lot 50 Access to Mundijong Road, based on the forecast of 12,000vpd using Mundijong Road. However, it should be noted that a roundabout will be sensitive to fluctuations in turning movements and traffic movements should be checked when upgrading of the priority intersection occurs.

The future provision of a roundabout to the Lot 50 Access to Mundijong Road will be as a result of other development in the locality. The cost of the roundabout should therefore be a condition of future development to the north of Lot 50. However, if additional use of Adonis Street is made, a roundabout may not be necessary.

6.0 THE INTERNAL ROAD NETWORK

The traffic model has been used to determine the anticipated daily traffic flows on local streets. Figures 5 through 8 show the modelled forecast flows. The forecasts assume full development of the Mundijong and Whitby localities.

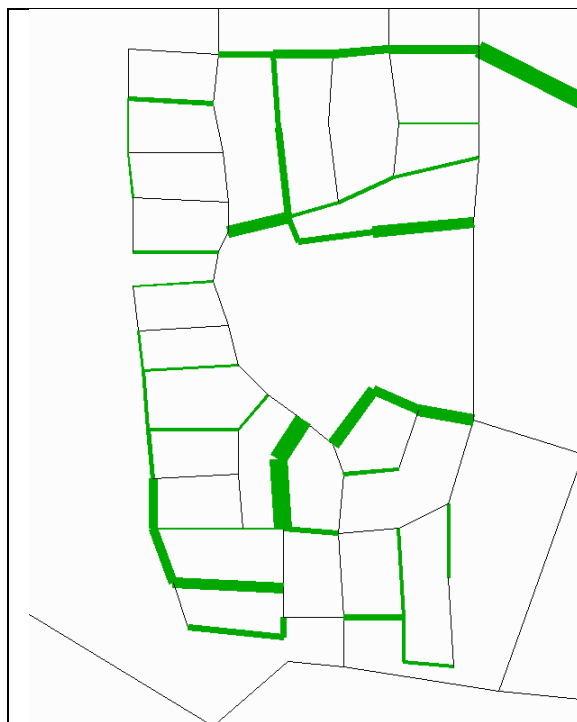


Figure 5 Roads less than 1,000vpd

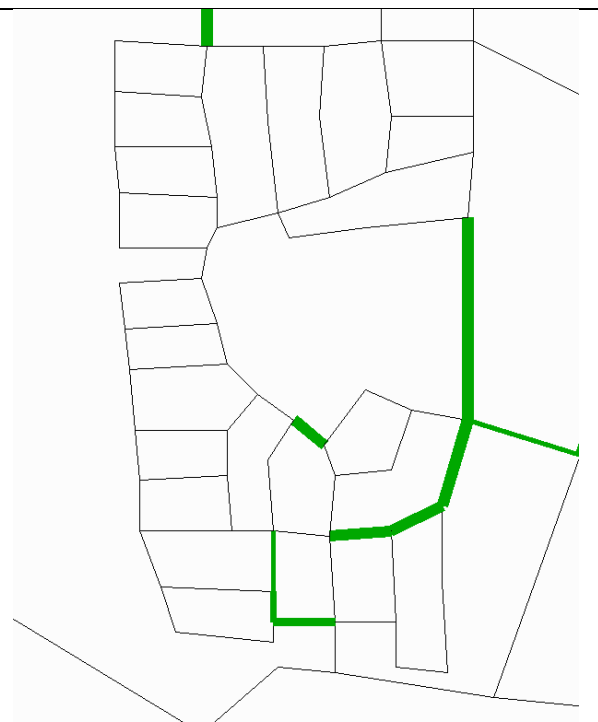


Figure 6 Roads 1,000-3,000vpd



Figure 7 Roads 3,000 – 7,000vpd

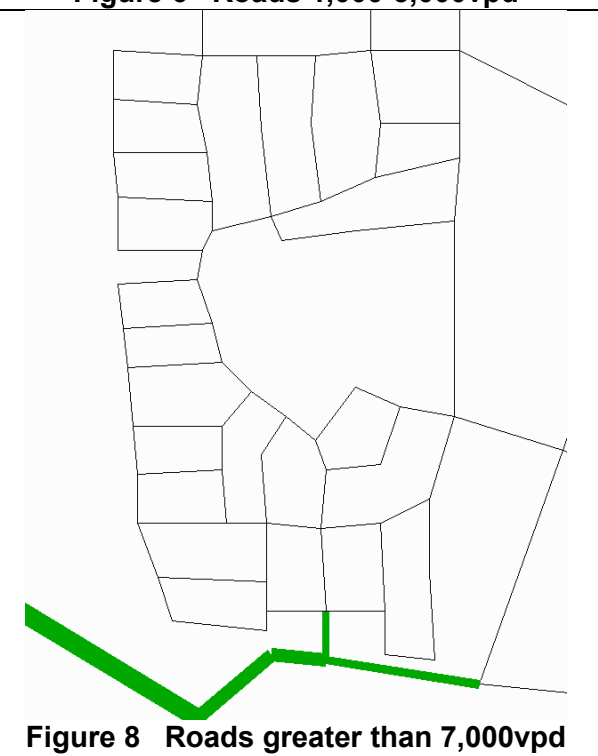


Figure 8 Roads greater than 7,000vpd

The forecast traffic flows provide a basis to develop an internal road hierarchy. Table 5 reproduces the advice on road types recommended by *Liveable Neighbourhoods*.

Table 5 *Liveable Neighbourhoods Road Hierarchy*

Indicative Traffic Flow*	Daily	Designation	Street Characteristics
< 1,000 vpd		Access Street	Narrower access streets (5.5 to 6m) may be appropriate in locations further away from centres and activity where traffic flows are less than 1,000 vpd and a low on-street parking demand exists.
1,000 vpd to 3,000 vpd		Higher Order Access Street	Wider access streets (7 to 7.5m) cater for higher traffic volumes and are located closer to neighbourhood centres.
3,000 vpd to 7,000 vpd		Neighbourhood Connectors	Generally 2-lane undivided. These are 'special' streets and their design needs to have regard to context, function and adjacent land uses.
7,000 vpd to 20,000 vpd		District Distributor Type B	Typically will have 1 clear lane of travel in each direction and a parking / manoeuvring lane.
15,000 vpd to 35,000 vpd		District Distributor Type A	Typically have service roads and development frontage with ample on-street parking to support a mixture of land uses. Direct vehicle access from adjoining property should be limited where no service roads are provided.

* Function of streets needs to be considered as well as traffic volume.

The road hierarchy considers those streets that have a connective function and assigns an appropriate classification based on volume and continuity of movement.

Figure 9 shows the suggested road hierarchy for Lot 50 Mundijong.

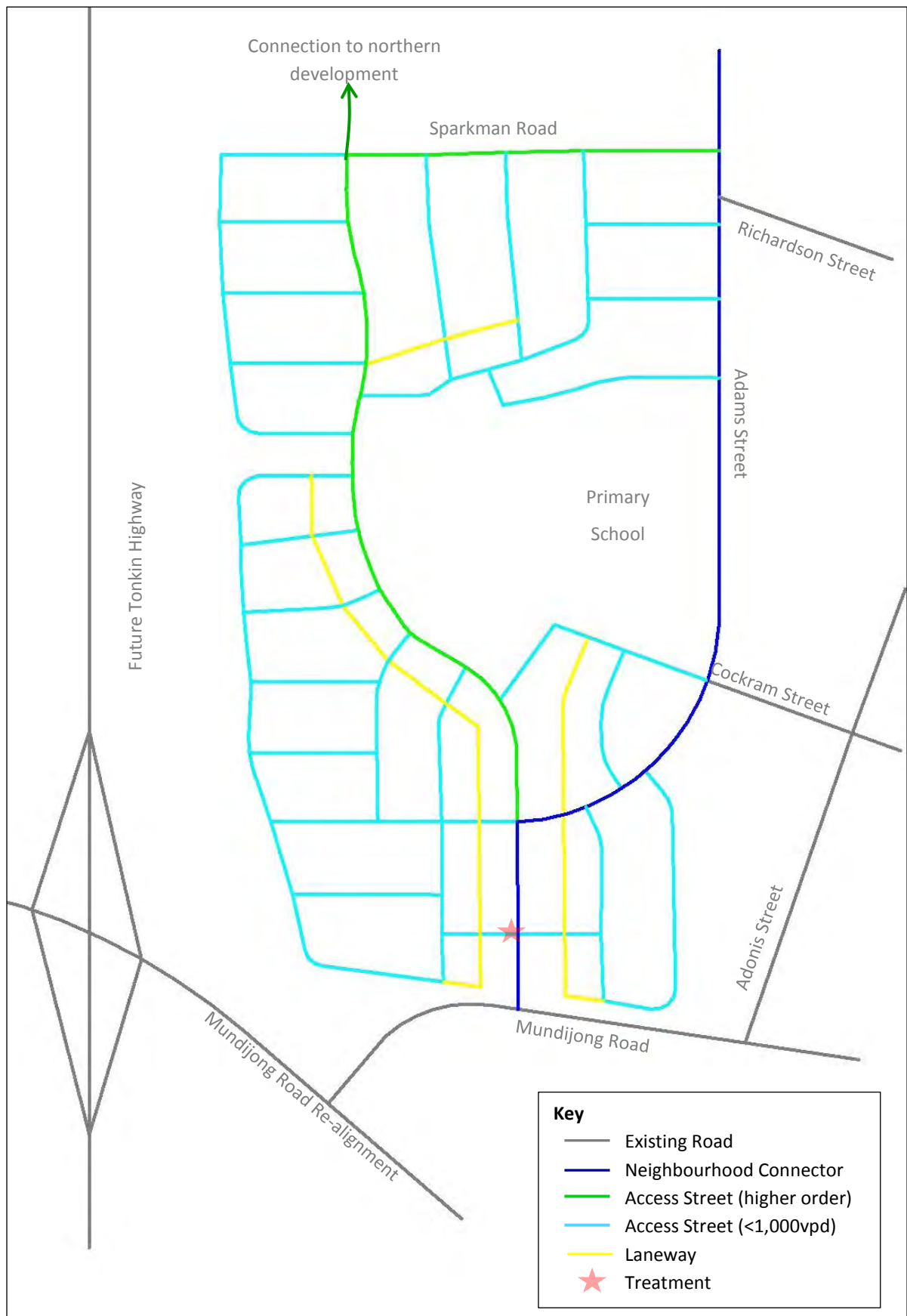


Figure 9 Road Hierarchy

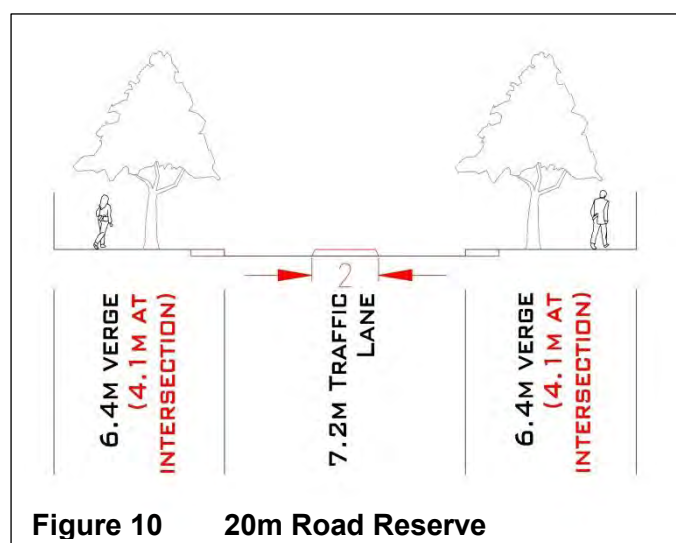
The following section provides guidance on the suggested hierarchy with regard to reserves and cross-sections. The cross-sections indicated are the minimum widths recommended for the various street types. The philosophy of providing constrained streets is to encourage a slower speed environment. However, wider reservation widths may be used to suit the character of the development and increase the opportunity for landscaping and frontage activity.

Neighbourhood Connectors

Liveable Neighbourhoods provides the following comment on neighbourhood connectors:

Neighbourhood connectors link neighbourhoods and towns, are carefully designed to calm traffic, limit noise and facilitate pedestrian use. They have frequent local street connections. They should not attract substantial long distance through traffic, but provide for safe and convenient local travel to and from arterial routes, usually at signal controlled intersections.

Roads shown blue in Figure 9 are considered as neighbourhood connectors as they provide the primary access to the structure plan area. Daily traffic flows on these roads are well within the 7,000 vehicles per day recommended. These streets can be provided with a standard 7.2m carriageway, which is suited to bus movements. A footpath to both sides of the street is required, although one side may be designated as a shared path. Figure 10 shows a suitable cross-section with localised widening at intersections.



At intersections, median islands of 2.0m width would be desirable to provide safer pedestrian crossing points and to highlight the intersection. A residual verge width of 4.1m will occur where such medians are provided.

A minimum 20.0m cross-section is recommended for neighbourhood connectors

Access Streets

Access streets are the main residential streets within the development and provide direct lot access. A typical access street would be provided with a 6.0m to 7.0m carriageway depending on bus routes and Local Government requirements. It is recommended however, that the minimum carriageway width be provided to encourage a slower speed environment. Unfortunately many streets with 7.0m+ carriageways and low density lots frequently experience traffic speeds well in excess of the posted 50kph limit. A reduced carriageway width will assist in achieving a more appropriate 40kph typical travel speed.

Higher Order Access Streets

Access streets carrying between 1,000vpd to 3,000vpd are considered to be higher order

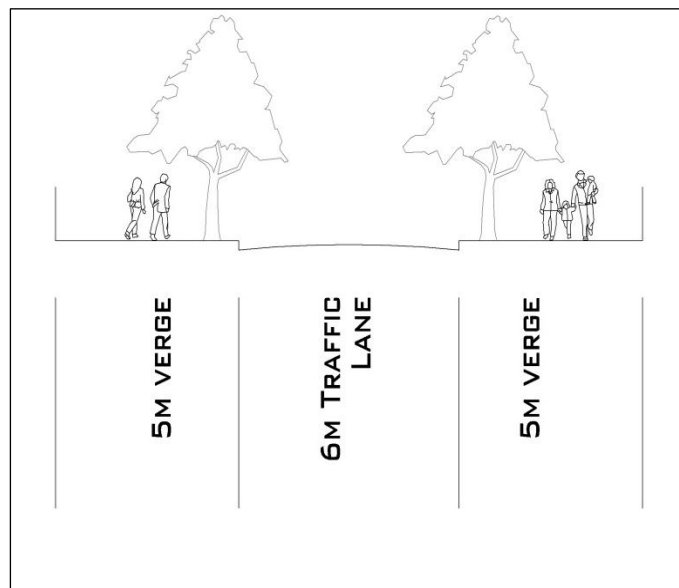


Figure 11 16m Road Reserve

access streets and a slightly wider road reservation is suitable. Figure 11 shows a typical cross-section for a 16.0m wide road reservation providing a 6.0m carriageway and two 5.0m verges.

Liveable Neighbourhoods suggests that these streets would be considered as “typical residential streets” (LN notation as access street C) and a carriageway width of 7.0 metres within a 15.4m – 16.0m road reservation is appropriate. However, the 7.0m wide carriageway is not supported in residential areas as it will tend to encourage a higher traffic speed. A 6.0m carriageway is preferred to encourage a 40kph target speed. A wider carriageway is only recommended where buses or large vehicles are expected.



Photograph 8 16m Road Reserve

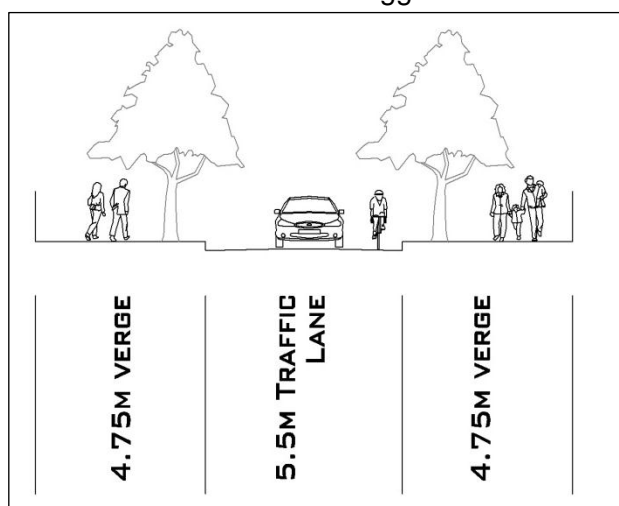
In higher density areas, the provision of parking embayments is a preferred treatment, rather than an increased carriageway width. Photograph 8 shows a typical residential street with a 6.0m carriageway.

It should be noted that from a road network capacity basis, a 6m wide carriageway could accommodate two-way traffic flows up to 1,100 vehicles per hour (indicatively 11,000vpd), but as a residential street should be restricted to less than 3,000vpd to maintain appropriate residential amenity. A wider carriageway is not required from a traffic movement perspective.

A minimum 16.0m cross-section is recommended for higher order access streets.

Lower Order Access Streets

Where daily traffic volumes are shown to be less than 1,000 vehicles per day, *Liveable Neighbourhoods* suggests that a reduced road reservation is acceptable. A carriageway width of 5.0m to 5.6m is suggested within a 14.2m road reservation. Figure 12 shows a



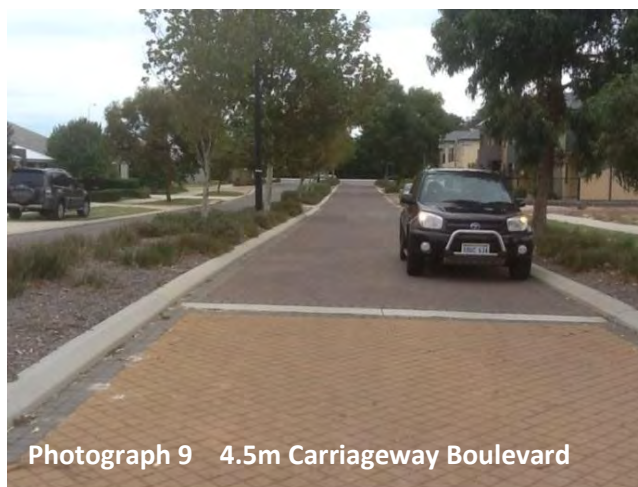
typical cross-section of a lower order access street with a 5.5m wide carriageway in a 15.0m road reservation. The road reservation can accommodate parking embayments.

A minimum 15.0m cross-section is recommended for lower order access streets

Figure 12 15m Road Reserve

Boulevards

The development of local streets as boulevards adds opportunity for landscaping and reduces the visual level of blacktop. The use of divided carriageways with median treatments requires that a minimum road width of 4.1m is provided to conform to Austroads. Commonly, boulevards are provided with a carriageway width of 4.5m, often designated as a 3.0m traffic



Photograph 9 4.5m Carriageway Boulevard

lane and a 1.5m cycle lane. Photograph 9 shows a 4.5m wide carriageway boulevard without cycle lanes and indicates that ample width exists (using 4.5m) to pass a stationary

vehicle in the event of a breakdown. Figure 13 shows a boulevard cross section with a 5.0m carriageway that includes cycle lanes. It should be noted that *Liveable Neighbourhoods* suggests a road reservation of 24.4 metres for boulevards where on-street parking is to be provided.

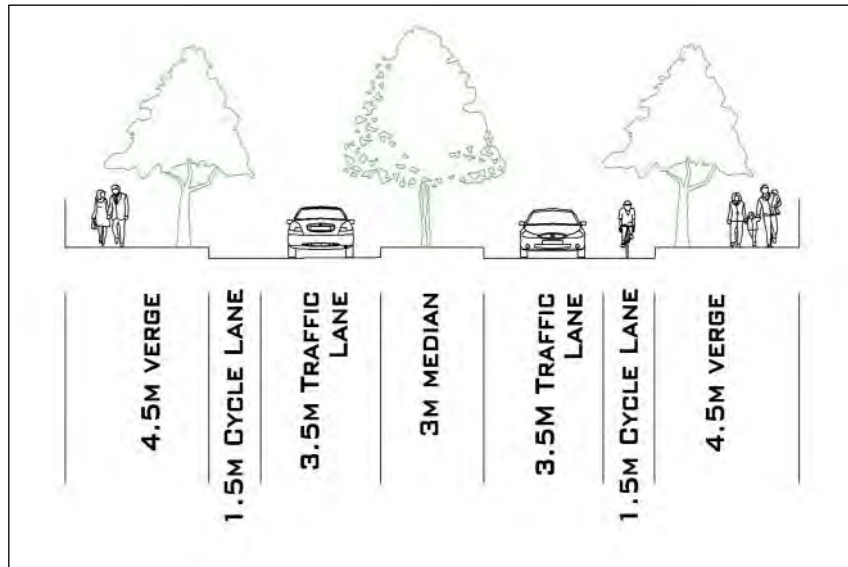


Figure 13 Boulevard Treatment 22m Road Reserve

It is recommended that a check be made on frontage activity before applying a boulevard road reservation of 22 metres.

6.4 Roads Adjacent to Open Space

Where the road reservation abuts POS, bushland, golf courses etc, there is limited need to provide a verge. The verge may be reduced where parking and/or services are not required

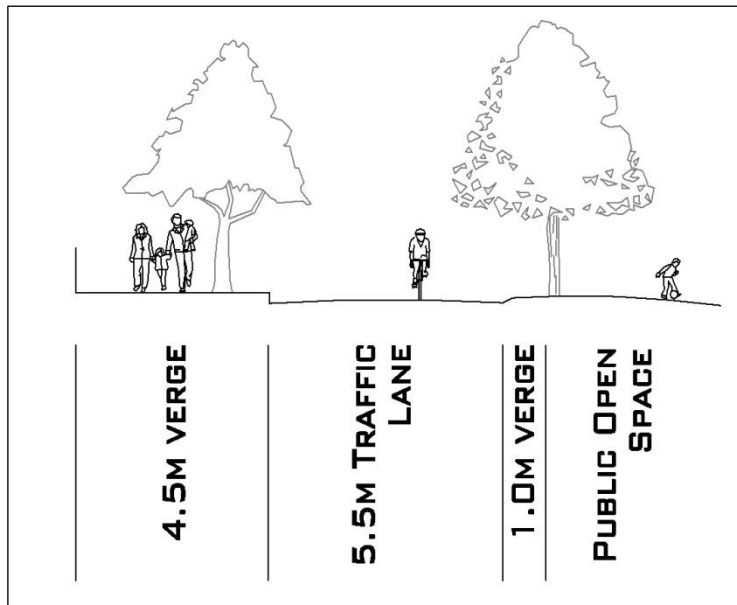


Figure 14 Roads Adjacent to POS

and should be considered at the time of subdivision. A minimum verge of 1.0m is advised by current road planning standards to accommodate street furniture. Footpaths do not need to be adjacent to the road where POS is provided, but must be provided in a safe and appropriate manner. Figure 14 shows an example of a reduced road reservation adjacent to open space.

6.6 Four-way Intersections

Within the structure plan area daily traffic volumes are shown to be low and the use of four-way intersections is appropriate. Figure 15 shows an extract from *Liveable Neighbourhoods* on the preferred treatment of four-way intersections.

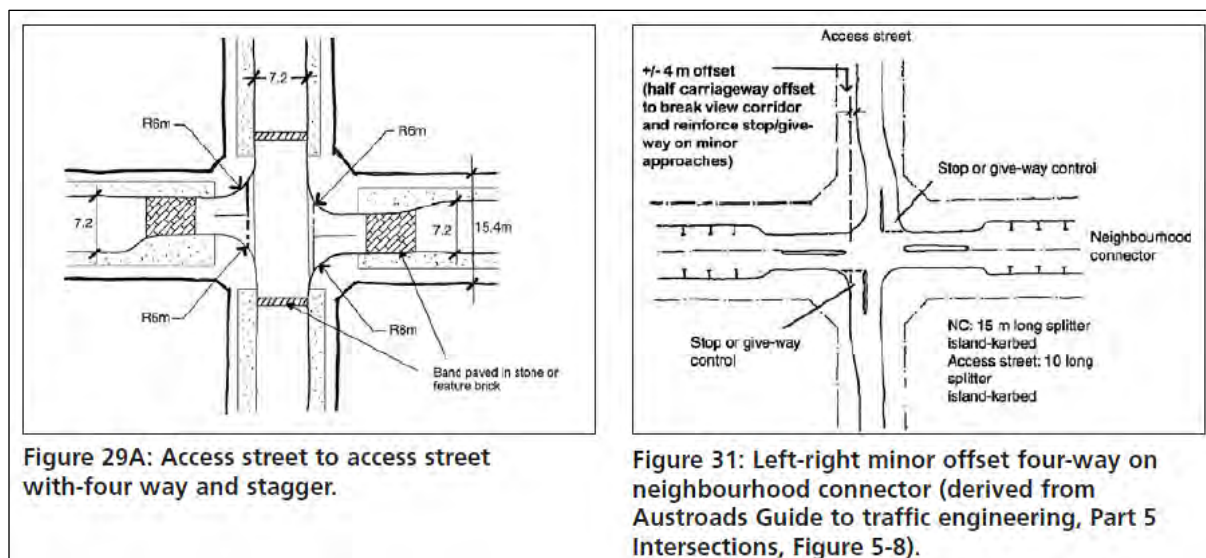


Figure 15 Liveable Neighbourhoods Four-way Intersections

Liveable Neighbourhoods suggests that four-way intersections are an appropriate treatment at the meeting of two access streets and where daily flows through the intersection are less than 2,000vpd. Approach legs should be limited to a maximum length of 160 metres with some form of speed reducing feature where the length is greater than 80 metres.

Access streets meeting neighbourhood connectors and some arterial streets are considered acceptable, but will generally require a treatment as indicated in Figure 15. In these instances *Liveable Neighbourhoods* would require a maximum of 4,000vpd passing through the intersection with a maximum combined flow of 1,000vpd on the minor legs.

Introducing four-way priority intersections on arterial streets is not recommended.

Figure 16 shows the location of four-way intersections within Lot 50 Mundijong Road and these are discussed below.

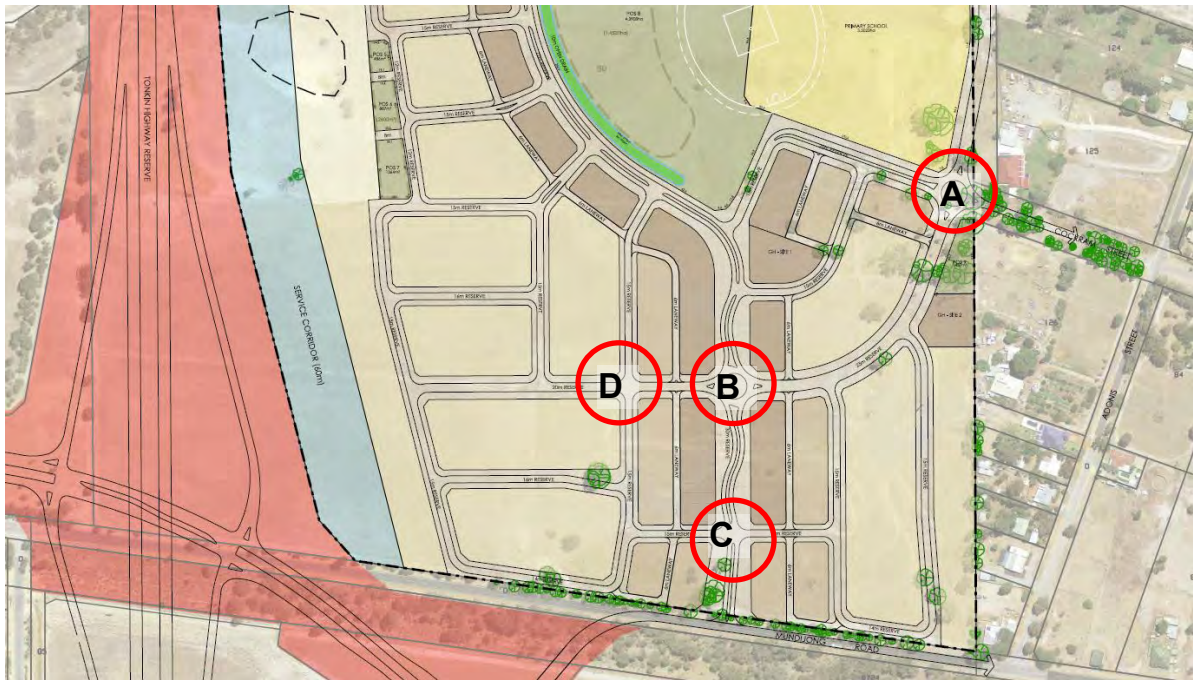


Figure 16 Four-way Intersections

- A The intersection of Cockram Street / Adams Street has a forecast volume of about 2,000vpd on Cockram Street and about 3,000vpd on Adams Street. It is recommended that a roundabout be provided to control this intersection.
- B The termination of Adams Street with the Lot 50 Access Road. It is expected that high turning demands will occur at this intersection and a roundabout will be required.
- C Lot 50 Access Road is forecast to carry about 10,000vpd and a four-way priority controlled intersection is not acceptable. This street is expected to be developed as an entry statement boulevard and thus the side roads can be restricted to left-in / left-out movements only.
- D Intersection D is a local internal road intersection with a forecast traffic demand of about 1,500vpd. North-south crossing movement will be very low and priority should be provided to the east-west movement. The intersection accords with the principles of *Liveable Neighbourhoods*.

All streets within Lot 50 are of relatively short lengths and high traffic speeds would not be expected. Further, the narrower carriageway widths proposed in low traffic residential streets will assist in reducing the attraction for speeding making a safer environment for local children.

No specific traffic management features are considered to be required within Lot 50 Mundijong.

Local Intersection Design

To reduce the opportunity for speeding it is recommended that corner radii advised by *Liveable Neighbourhoods* be used within the subdivision. The recommended radii are:

- 6.0 metres - access street / access street intersections
- 9.0 metres - access street / neighbourhood connector

Where larger vehicles are expected, such as buses accessing the school, larger radii may be required and should be considered at subdivision stage. It should be noted that adjacent to the proposed school, the minimum 6.0m radii is preferable to ensure side road traffic enters the major road at 90⁰ to improve visibility to pedestrians. The tighter radii will also ensure traffic cannot enter or depart the side road at speed.

7.0 PEDESTRIANS, CYCLISTS AND PUBLIC TRANSPORT

The structure plan provides for a primary school which is within a pleasant walking distance for the majority of households. Adjacent to the school and on identified walking routes, it is desirable to provide a footpath to both sides of the street.

Current planning guidelines suggest that all streets should be provided with a footpath where ever possible. Where traffic flows exceed 1,000 vehicles per day, a footpath to both sides of the road should be provided. Figure 17 shows those streets where a footpath is required to both sides.

Cycling

Cycling would be safe on the majority of local streets where traffic flows are less than 1,000 vehicles per day. On the neighbourhood connectors shared paths should be provided to provide a safe alternative to on-road cycling. A principal shared path is indicated in the district structure plan adjacent to the future Tonkin Highway. It is desirable to provide linkages to this path, although the future service corridor may preclude such access.

Public Transport

Mundijong already has a rail station on the Perth to Bunbury line, the Australind service, which does stop. However, this is a twice a day service with scheduled departure times that make commuting to Perth CBD awkward.

Armadale is about 21 kilometres to the north of Mundijong, where the metro rail line service to the CBD currently terminates. There is discussion of the service being extended to Byford, although this is a very long term proposal. The Perth – Mandurah line can be accessed at Wellard, Rockingham and Safety Bay. These stations are probably closer than Armadale to the north and have been developed as park and ride stations. It can be expected that commuters to Perth will be split 60/40 to the Perth – Mandurah line.

There are 2 bus services passing through the locality, routes 252 and 253. The services connect to Armadale railway station. The district structure plan sets out to provide a bus route along Taylor Road / Adams Street that would terminate to the north side of Mundijong Road. Figure 18 shows the proposed bus route and the 400 metre walkable catchment. Figure 18 shows that the majority of Lot 50 is within easy walk of the future bus service.

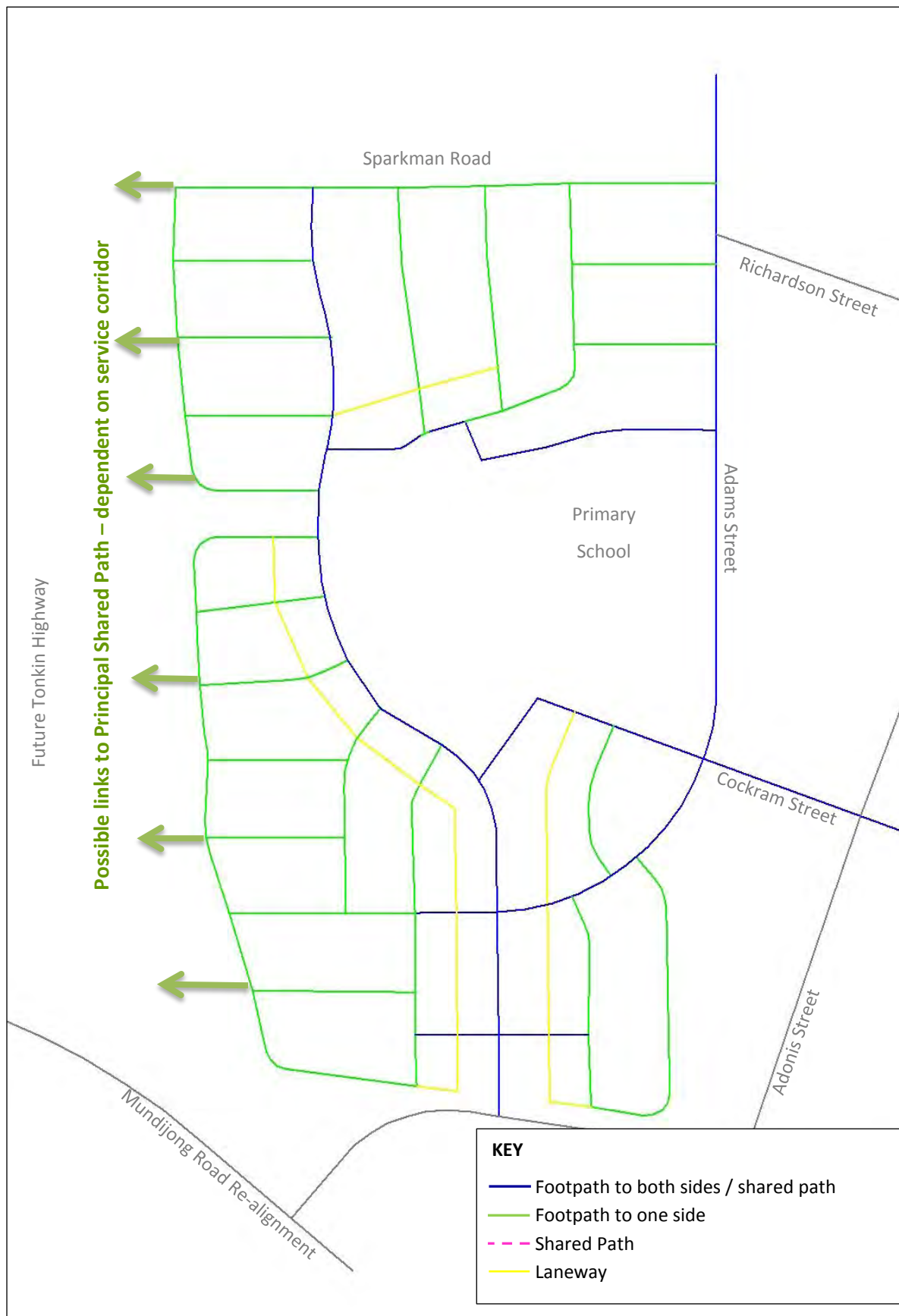


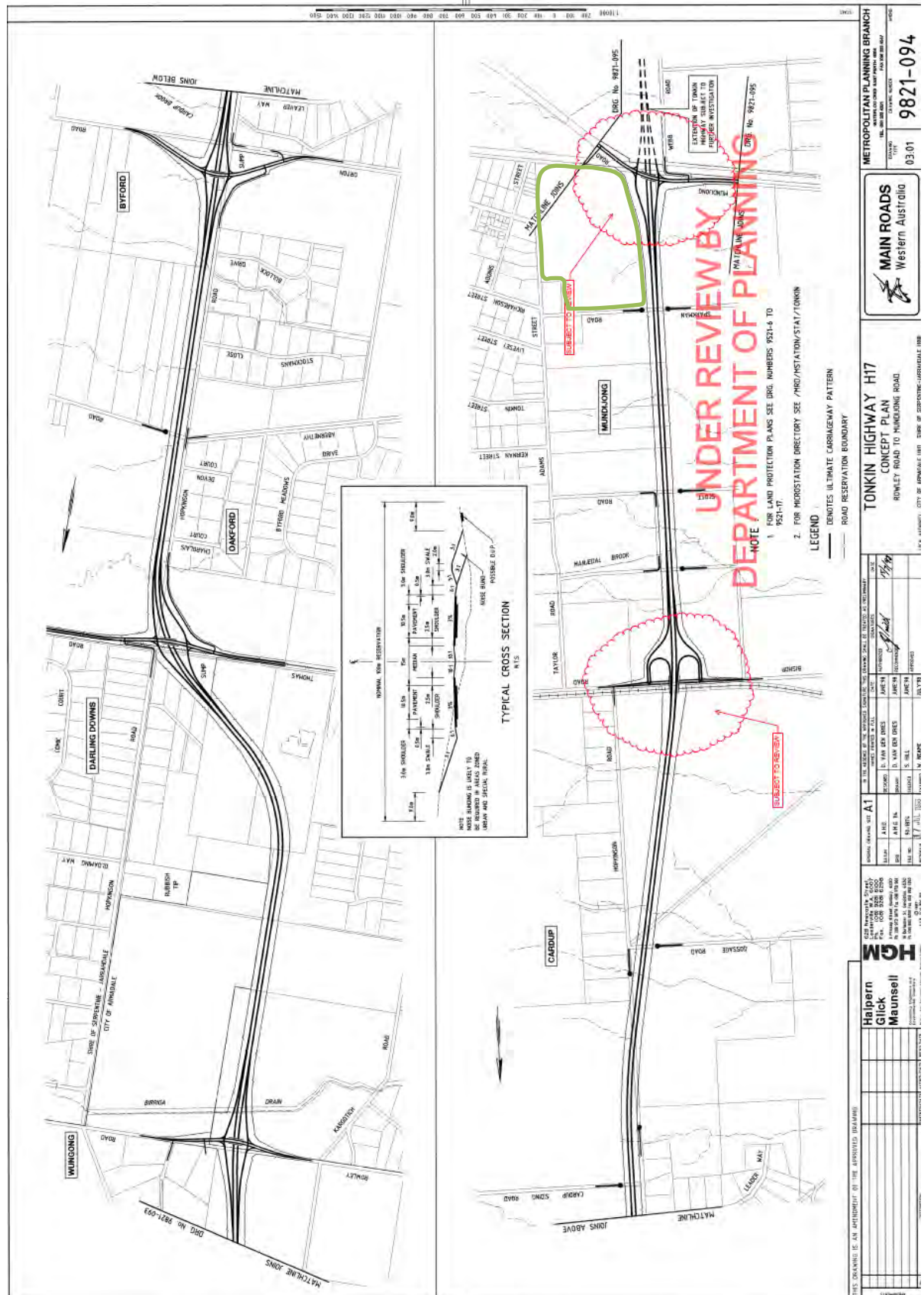
Figure 17 Footpaths and Cycle Paths



Figure 18 Roads for Future Bus Services

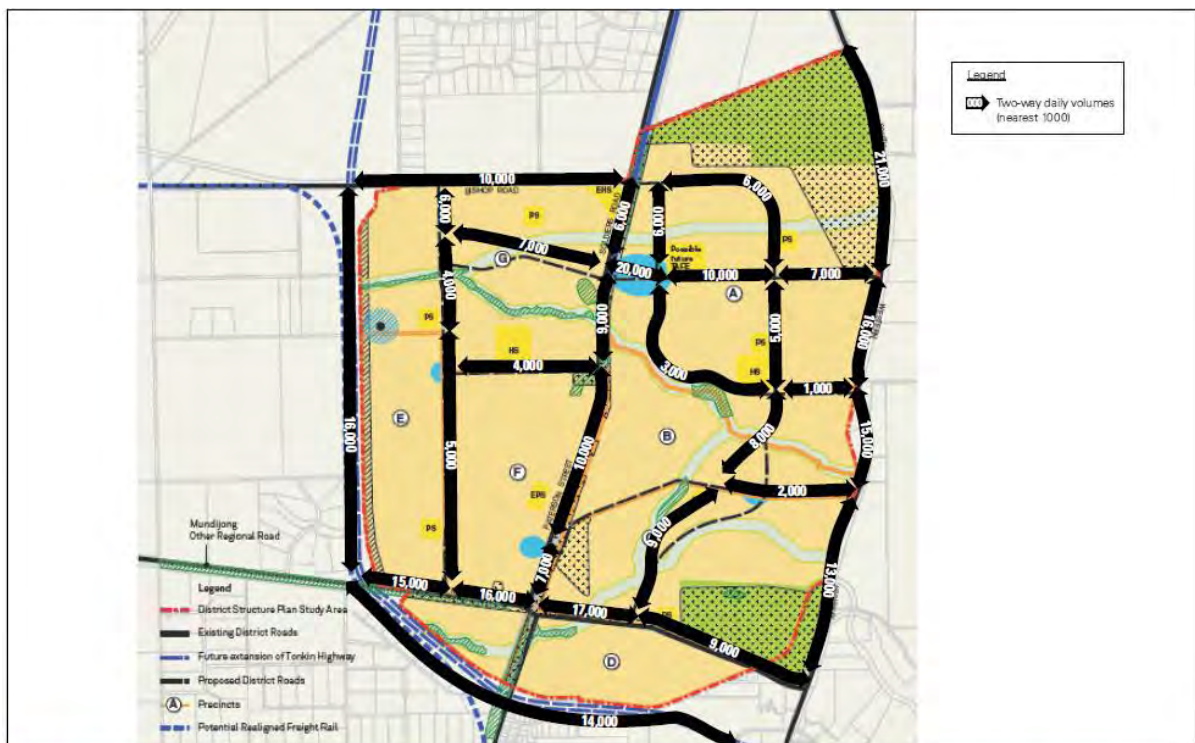
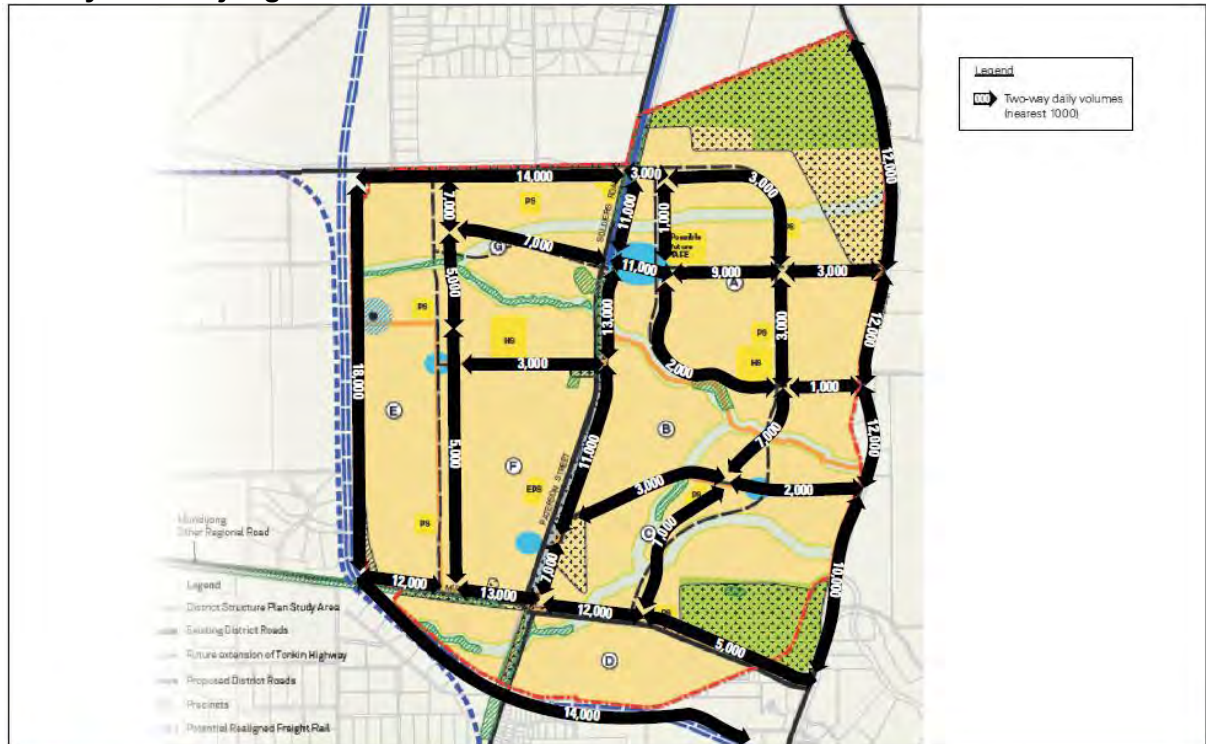
APPENDIX A

Tonkin Highway Concept Plan



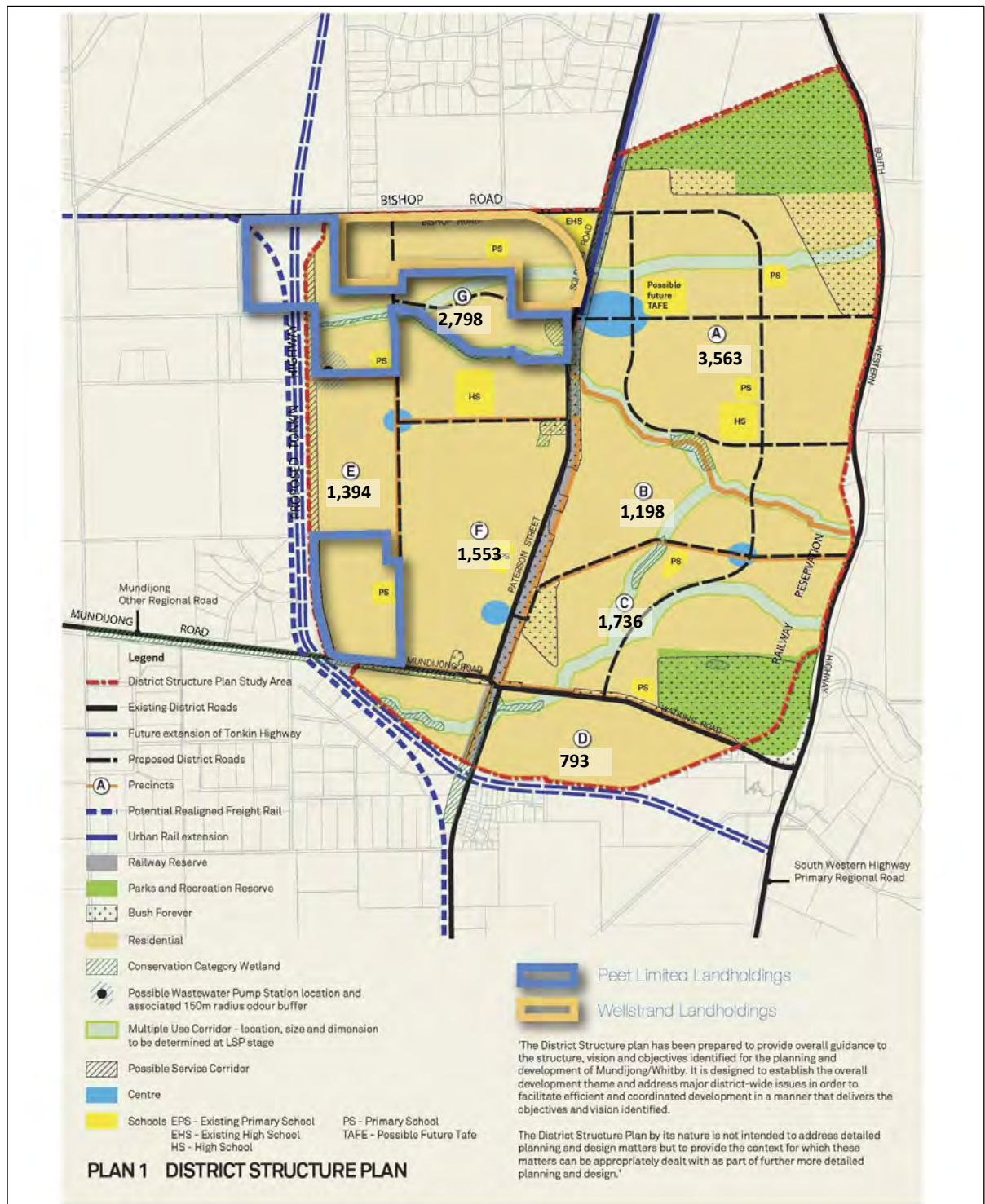
APPENDIX B

Whitby – Mundijong District Structure Plan Traffic Forecasts



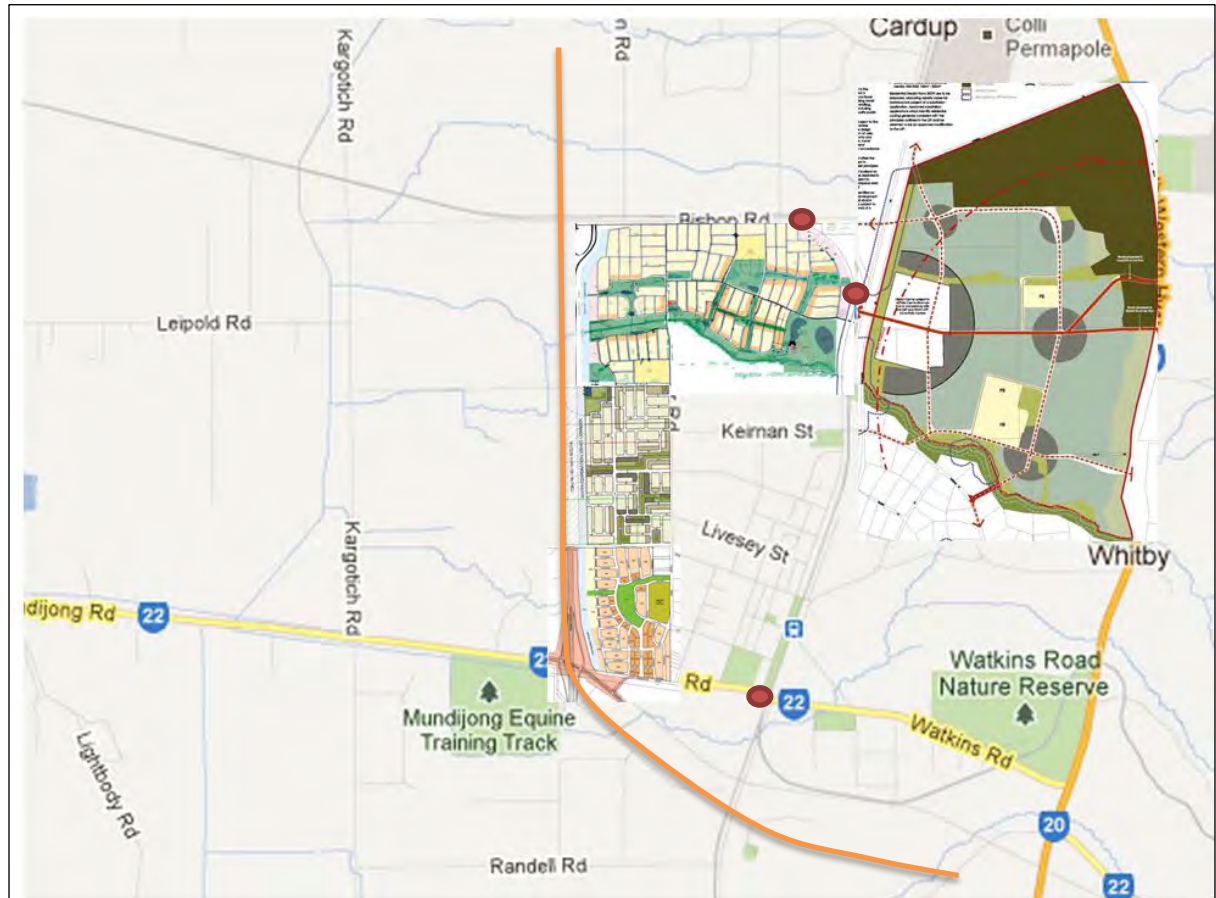
APPENDIX C

Whitby - Mundijong District Structure Plan



Expected dwelling yields

APPENDIX D Traffic Model Area



Mundijong Modelled area and Rail Crossings

APPENDIX E**Table 1 Levels of Service by Road Type**

LOS	Single Carriageway ¹	2-Lane Boulevard ²	Dual Carriageway (4-Lanes) ³	Dual Carriageway (4-lane Clearway) ³
Road Type	1	2	3	4
A	2,400vpd	2,600vpd	24,000vpd	27,000vpd
B	4,800vpd	5,300vpd	28,000vpd	31,500vpd
C	7,900vpd	8,700vpd	32,000vpd	36,000vpd
D	13,500vpd	15,000vpd	36,000vpd	40,500vpd
E	22,900vpd	25,200vpd ⁴	40,000vpd	45,000vpd
F	>22,900vpd	>25,200vpd ⁴	>40,000vpd	>45,000vpd

¹ Based on Table 3.9 Austroads - Guide to Traffic Engineering Practice Part 2² Based on single carriageway +10% (supported by Table 3.1 Austroads - Guide to Traffic Engineering Practice Part 3) – Boulevard or division by medians.³ Based on RRR Table 3.5 - mid-block service flow rates (SF.) for urban arterial roads with interrupted flow. Using 60/40 peak split.⁴ Note James Street Guildford passes 28,000vpd.

APPENDIX F

Lot 50 Access to Mundijong Road

Lot 50 - Mundijong Road Give Way -Interim Years AM Peak Giveaway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Mundijong Road east											
5	T	241	3.0	0.126	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R	65	3.0	0.052	8.8	LOS A	0.3	1.9	0.26	0.62	47.9
Approach		306	3.0	0.126	1.9	LOS A	0.3	1.9	0.05	0.13	56.9
North: Lot 50 Access											
7	L	151	3.0	0.143	8.9	LOS A	0.7	5.0	0.25	0.64	47.8
9	R	108	3.0	0.233	14.2	LOS A	1.2	8.4	0.59	0.86	43.2
Approach		259	3.0	0.233	11.1	LOS A	1.2	8.4	0.39	0.73	45.8
West: Mundijong Road west											
10	L	44	3.0	0.079	8.3	LOS A	0.0	0.0	0.00	0.91	49.0
11	T	104	3.0	0.079	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		148	3.0	0.079	2.5	LOS A	0.0	0.0	0.00	0.27	56.2
All Vehicles		714	3.0	0.233	5.3	NA	1.2	8.4	0.17	0.38	52.2

Lot 50 - Mundijong Road Give Way -Interim Years PM Peak Giveaway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Mundijong Road east											
5	T	104	3.0	0.054	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
6	R	151	3.0	0.151	9.9	LOS A	0.8	5.5	0.44	0.71	47.1
Approach		255	3.0	0.151	5.9	LOS A	0.8	5.5	0.26	0.42	51.6
North: Lot 50 Access											
7	L	65	3.0	0.075	9.9	LOS A	0.3	2.4	0.39	0.69	47.2
9	R	44	3.0	0.116	15.8	LOS B	0.5	3.8	0.61	0.87	41.9
Approach		109	3.0	0.116	12.3	LOS B	0.5	3.8	0.47	0.76	44.9
West: Mundijong Road west											
10	L	108	3.0	0.186	8.3	LOS A	0.0	0.0	0.00	0.91	49.0
11	T	241	3.0	0.186	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		349	3.0	0.186	2.6	LOS A	0.0	0.0	0.00	0.28	56.1
All Vehicles		714	3.0	0.186	5.2	NA	0.8	5.5	0.17	0.41	52.5

APPENDIX G

Lot 50 Access to Mundijong Road with Full Development of DSP

Lot 50 - Mundijong Road Roundabout - full development AM Peak
Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Mundijong Road east											
5	T	758	3.0	0.984	48.0	LOS D	38.8	285.3	1.00	1.91	25.9
6	R	51	48.0	0.991	55.9	LOS D	38.8	285.3	1.00	1.86	25.7
Approach		808	5.8	0.984	48.5	LOS D	38.8	285.3	1.00	1.91	25.9
North: Lot 50 Access											
7	L	72	3.0	0.645	12.0	LOS A	8.6	61.9	0.88	0.93	44.2
9	R	537	3.0	0.644	17.9	LOS B	8.6	61.9	0.88	0.96	41.4
Approach		608	3.0	0.645	17.2	LOS B	8.6	61.9	0.88	0.96	41.7
West: Mundijong Road west											
10	L	282	3.0	0.524	5.9	LOS A	6.8	49.2	0.41	0.48	49.9
11	T	505	3.0	0.525	4.6	LOS A	6.8	49.2	0.41	0.40	50.4
Approach		787	3.0	0.525	5.1	LOS A	6.8	49.2	0.41	0.43	50.2
All Vehicles		2204	4.0	0.984	24.3	LOS B	38.8	285.3	0.76	1.12	35.9

Lot 50 - Mundijong Road Roundabout - full development PM Peak
Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Mundijong Road east											
5	T	505	3.0	0.509	6.1	LOS A	5.5	39.8	0.71	0.57	48.1
6	R	72	3.0	0.508	13.3	LOS A	5.5	39.8	0.71	0.80	46.3
Approach		577	3.0	0.509	7.0	LOS A	5.5	39.8	0.71	0.60	47.9
North: Lot 50 Access											
7	L	51	3.0	0.481	12.4	LOS A	5.2	37.2	0.95	0.95	43.8
9	R	276	3.0	0.480	18.3	LOS B	5.2	37.2	0.95	0.97	41.2
Approach		326	3.0	0.480	17.4	LOS B	5.2	37.2	0.95	0.97	41.5
West: Mundijong Road west											
10	L	537	3.0	0.838	6.5	LOS A	20.1	144.2	0.71	0.47	48.0
11	T	758	3.0	0.838	5.3	LOS A	20.1	144.2	0.71	0.44	48.0
Approach		1295	3.0	0.838	5.8	LOS A	20.1	144.2	0.71	0.45	48.0
All Vehicles		2198	3.0	0.838	7.9	LOS A	20.1	144.2	0.75	0.57	46.8



APPENDIX 8

LOCAL WATER MANAGEMENT STRATEGY