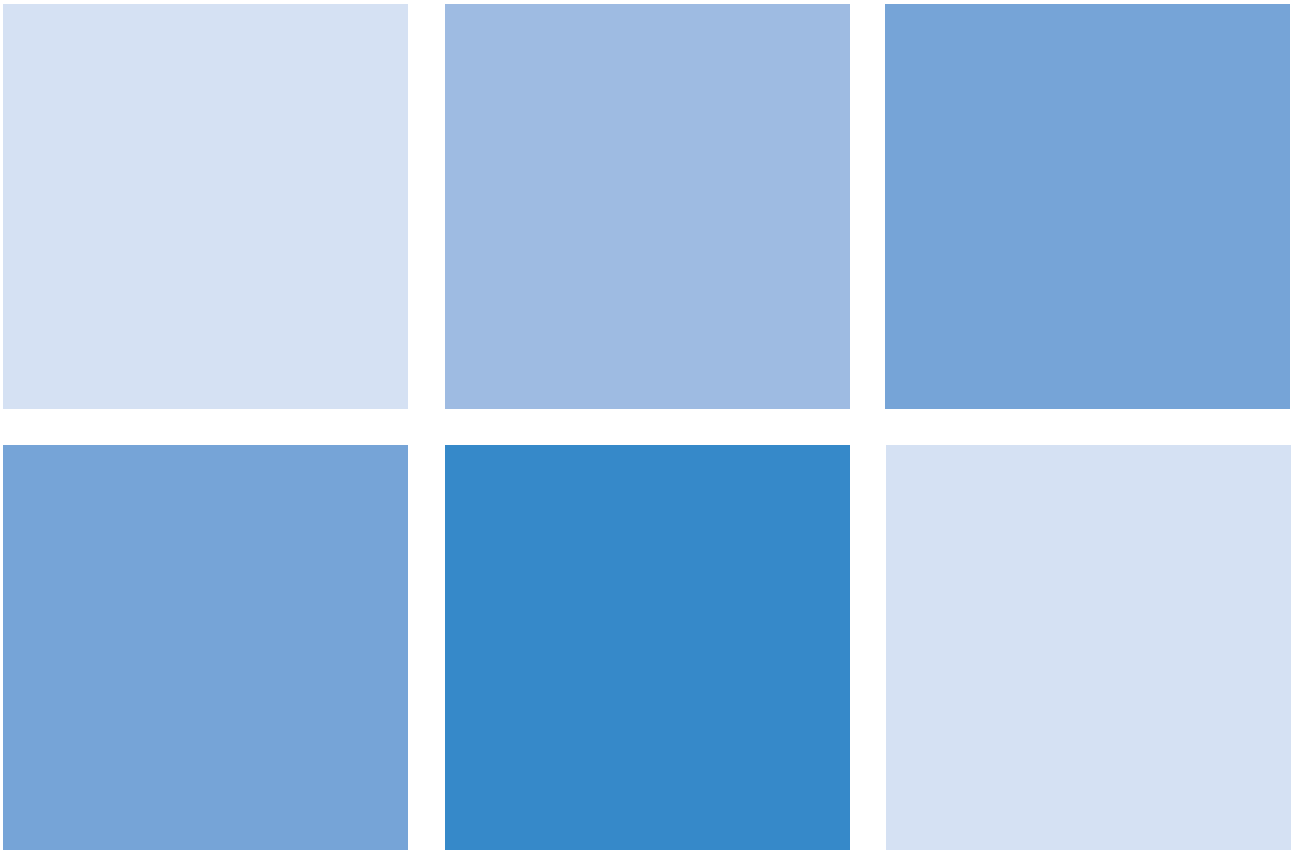
Structure Plan Report

Lots 58-60 Centre Road &
Lot 27 Westfield Road, Camillo



Structure Plan Report

Lots 58-60 Centre Road & Lot 27 Westfield Road, Camillo

Prepared by:

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Report Number: PR123878-1
Version / Date: 1.4 December 2016

Prepared for:

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IMPORTANT NOTE

We have prepared this report for the sole purposes of Seville Corporation Pty Ltd ("**Client**") for the specific purpose of only for which it is supplied ("**Purpose**"). This report is strictly limited to the purpose and the facts and matters stated in it and do not apply directly or indirectly and will not be used for any other application, purpose, use or matter.

In preparing this report we have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request or enquiry were complete, accurate and up-to-date. Where we have obtained information from a government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware of any reason why any of the assumptions are incorrect.

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Document Status

Version	Purpose of Document	Orig	Review	Review Date
1.0	Draft Structure Plan Report	C. Hearn	D. Drown	4.12.14
1.1	Final Structure Plan Report	C. Hearn	M. Young	05.01.15
1.2	Revised Structure Plan Report	C. Hearn	S. Day	11.01.16
1.3	Structure Plan Report	C. Hearn	D. Drown	24.02.16
1.4	Modified Structure Plan as per WAPC letter 12/12/16	M. Young	D. Drown	21.12.16

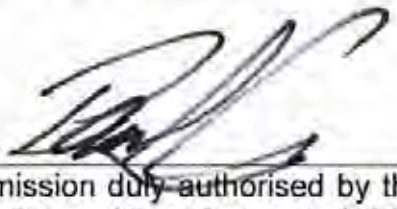
Approval for Issue

Name	Signature	Date
Matthew Young		22.12.16

This structure plan is prepared under the provisions of the City of Armadale Town Planning Scheme No.4

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON: 13 JANUARY 2017

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

13 January 2017 Date

Date of Expiry: 13 JANUARY 2027

Contents

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Executive Summary

RPS acts on behalf of Seville Corporation Pty Ltd of Lot 60 Centre Road and Lot 27 Westfield Road, Camillo (the subject land). This report is intended to provide detailed planning justification for the proposed Structure Plan, which applies to Lots 58-60 Centre Road, and Lot 27 Westfield Road, Camillo. While Seville Corporation Pty Ltd has an interest only in Lots 27 Westfield Road and Lot 60 Centre Road, the designation of these lots as 'Development Area 9' under City of Armadale Town Planning Scheme No. 4 requires a Structure Plan to be prepared over Lots 58 and 59 Centre Road to ensure that orderly and proper planning is achieved and that subdivision and development is properly integrated with surrounding land uses.

This Structure Plan has been prepared in accordance with the provisions of both part 6A, and Schedule 12 of the City of Armadale Town Planning Scheme No. 4, and is compliant with all State and local strategies, schemes, policies and legislation. The Structure Plan provides a responsive and appropriate layout over the subject site which will serve as a guide to future development to ensure appropriate and integrated land use over the subject site.

The land is appropriately zoned and all services infrastructure is available to future development. No negative off-site impacts are anticipated.

The subject land is conveniently located within an existing urban area, close to public transport, education, employment and shopping facilities. The land's close proximity of the Kelmscott town centre and railway station, being upgraded by the Metropolitan Redevelopment Authority, justifies residential development up to R40 in accordance with the existing zoning and R-Codes.

Table 1 - Structure Plan Summary Table

Item	Data	Section number referenced in report
Total area covered by the Structure Plan: • Lots 58-60 Centre Road • Lot 27 Westfield Road	*7.9501 hectares* 5.7541 hectares 2.1906 hectares	Section 1.0
Estimated Lot Yield	Approximately 174 multiple dwelling lots (subject to detailed design) and 156 single lots (subject to detailed design)	Part 2 Section 1.2.4
Open Space, Drainage	4,400m^2	Part 2 Section 1.2.5

The Structure Plan comprises the following:

- Part One – Statutory Section
- Part Two – Non-statutory (Explanatory) Information; and
- Appendices – Technical reports, plans, maps and supporting documents.

Part One includes only the structure plan map and statutory planning provisions and requirements.

Part Two of the structure plan is used as a reference guide to interpret and justify the implementation of Part One.

PART ONE

IMPLEMENTATION

1.0 Structure Plan Area

This Structure Plan applies to Lots 58-60 Centre Road and Lot 27 Westfield Road being the land contained within the inner edge of the line denoting the Structure Plan boundary on the Structure Plan Map (refer **Figure 1**).

The details of the land subject of the Structure Plan are as follows:

Lot Details	Total Land Area (hectares)
Lot 27 on P2706	2.1906ha
Lot 58 on P2706	2.2004ha
Lot 59 on P2706	2.1145ha
Lot 60 on P2706	1.4392ha
TOTAL	7.9501ha

1.1 Structure Plan Requirements

1. This Structure Plan provides a framework for future subdivision and development of Development Area 9.

2. Residential development shall be in accordance with the Residential Design Codes and City of Armadale Local Planning Policies.

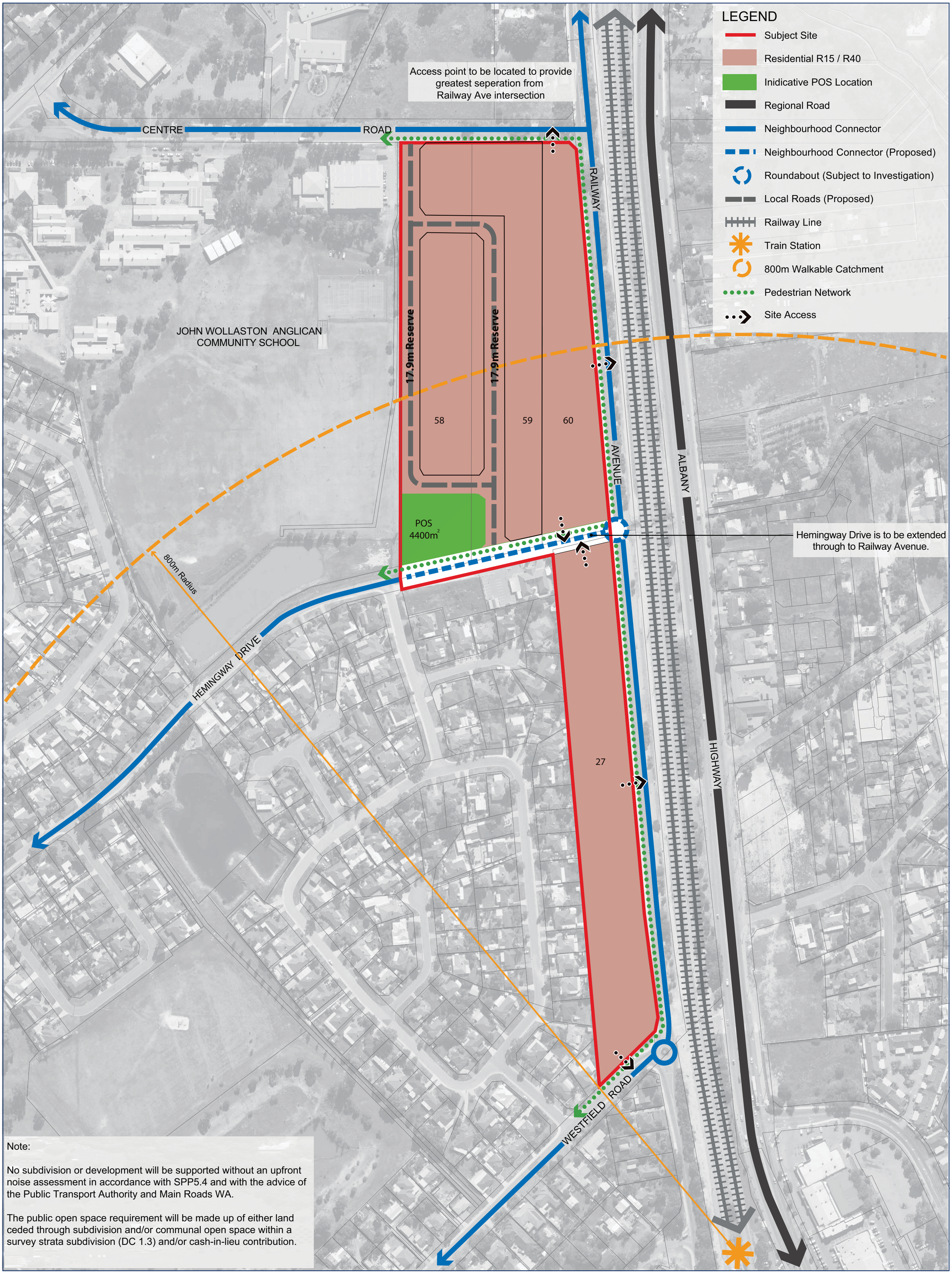
3. Significant vegetation shall be identified and retained through detailed design and survey.

4. Development of Lots 60 Centre Road and Lot 27 Westfield Road will need to take into consideration site level interface to existing residential development to the west; Refuse disposal and access arrangements.

5. Hemingway Drive is to be extended through to Railway Avenue.

6. No subdivision or development will be supported without an upfront noise assessment in accordance with SPP5.4 and with the advice of the Public Transport Authority and Main Roads WA.

7. The public open space requirement will be made up of either land ceded through subdivision and/or communal open space within a survey strata subdivision (DC 1.3) and/or cash-in-lieu contribution.



Note:

No subdivision or development will be supported without an upfront noise assessment in accordance with SPP5.4 and with the advice of the Public Transport Authority and Main Roads WA.

The public open space requirement will be made up of either land ceded through subdivision and/or communal open space within a survey strata subdivision (DC 1.3) and/or cash-in-lieu contribution.

Lots 58- 60 Centre Road & Lot 27 Westfield Road, Camillo

Structure Plan

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Scale 1:2000@A2 / 1:4000@A4 I **Date** December 2016 I **Project No** 123878-2-001d

2.0 Structure Plan Content

The proposed Structure Plan comprises the following:

- Part One - Implementation
- Part Two – Explanatory Section; and
- Appendices – Technical reports, plans, maps and supporting documents.

Part One includes only the structure plan map, planning provisions and information requirements.

Part Two of the Structure Plan submission is used as a reference guide to interpret and justify the implementation of Part One.

3.0 Interpretations and Relationship with the Scheme

Unless otherwise specified in this part, the words and expressions used in this Structure Plan shall have the respective meanings given to them in the City of Armadale Town Planning Scheme No. 4 (the Scheme) including any amendments gazetted thereto.

The Structure Plan map (**Figure 1**) is consistent with the underlying Residential R15/R40 zoning under the Scheme. This Structure Plan will act to guide future subdivision and subsequent development of the subject site, and will come into effect on the date specified by the WAPC.

4.0 Operation

In accordance with Part 6A 3 of the Scheme, this Structure Plan shall come into operation when it is adopted by the City pursuant to clause 6A.3.15.

5.0 Land Use and Subdivision

The Structure Plan Map outlines land use, zones and reserves applicable within the Structure Plan Area. The zones and reserves designated under this Structure Plan to apply to the land within it as if the zones and reserves were incorporated into the Scheme. The lots are zoned Residential under the Structure Plan in accordance with their zoning under Town Planning Scheme No. 4.

5.1 Land Use Permissibility

Land use permissibility within the Structure Plan area shall be in accordance with the Residential zoning under the Scheme.

5.1.1 Dwelling Target

To provide for a minimum 312 dwellings on over the Structure Plan Area, with other uses and exact yields to be confirmed at the Development Application stage.

5.2 Public Open Space

Unless otherwise specified, Public Open Space is to be provided at 10% of landholding, as required by Liveable Neighbourhoods. Where POS is not provided at 10%, cash in lieu may be considered as per the Residential Design Codes of Western Australia.

Lot 27 Westfield Road and Lot 60 Centre Road if provided as a Strata/Survey Strata development is to adhere to the WAPC Development Control Policy No. 1.3: Strata Titles (clause 3.3.3), which states that:

"The WAPC may allow a maximum of 50 per cent of the total 10 per cent public open space to be provided as communal open space within the survey strata subdivision subject to the open space being useable and developed for general recreation purposes. The remainder of the provision may be provided outside of the subdivision or by way of cash-in-lieu."

In the instance that Green Title Subdivision is proposed over Lot 27 Westfield Road or Lot 60 Centre Road, then 10% credited Public Open Space will be provided as part of the subdivision, in accordance with Liveable Neighbourhoods and WAPC Development Control Policy No. 1.3: Strata Titles (clause 3.3.3).

5.3 Reports / Strategies Required Prior to Subdivision

Prior to the lodgement of subdivision applications to the WAPC, the following management plans are to be prepared, as applicable, to the satisfaction of the relevant authority and provided with the application for subdivision:

- Acid Sulfate Soils Investigation (Department of Environmental Regulation)
- Stormwater Management Plan (City of Armadale and Water Corporation)
- Waste Management Plan (City of Armadale)

5.4 Other Requirements

The following provisions also apply to the Structure Plan Area:

5.4.1 Traffic Management

1. As a condition of subdivision, strata subdivision or development approval, the following works are to be completed by the subdivider or developer to the satisfaction of the City, and land ceded to the crown free of cost if required, for the purposes of the following

   a) Construction of abutting portions of Hemingway Drive extension to Railway Avenue;

   b) Construction of left-turn slip lanes and median treatments for right turn pockets for access/egress to/from Railway Avenue (including the Hemingway Drive extension);

   c) Any required modifications to left-turn slip lanes and median treatments for right turn pockets at the intersection of Railway Avenue and Centre Road; and

   d) Any other modifications or upgrades to existing traffic management devices in abutting road reserves arising from future subdivision or development in the Structure Plan area.

   The City may accept funds from the subdivider/developer it agrees are equal to the above works, in order to carry out the works on behalf of the subdivider/developer

2. Prior to subdivision, strata subdivision or development of the land, subdividers or developers shall cede to the crown free of cost land required for the widening of the Hemingway Drive and Railway Avenue intersection, to the satisfaction of the City.

3. Access/egress to/from Railway Avenue shall be limited to the locations illustrated on the Structure Plan.

4. Access/egress to/from Westfield Road shall be limited to the location illustrated on the Structure Plan and limited to left-in/left-out movements only.

5.4.2 Water Management

Prior to subdivision, strata subdivision or development of the land the subdivider or developer shall prepare an urban water management plan, storm water management plan or such other water management plan that implements the strategies of the approved LWMS, to the satisfaction of the City.

5.4.3 Waste Management

A Waste Management Plan (WMP) is to be prepared to the satisfaction of the City of Armadale and lodged with any subdivision or development application.

Waste collection for any strata titled development is to occur on site and any development must incorporate bin collection areas and bin storage areas, sufficient to accommodate all rubbish and recycling bins required for the development. Internal vehicle access ways in any subdivision or development shall be designed so as to allow all waste collection vehicles to move in forward gear at all times.

PART TWO

EXPLANATORY SECTION

1.0 Planning Background

1.1 Introduction and Purpose

The purpose of this report is to facilitate the adoption of the proposed Structure Plan over Lots 58-60 Centre Road and Lot 27 Westfield Road. While the proposed development involves Lot 60 Centre Road and Lot 27 Westfield Road, development of any of the aforementioned lots requires a Structure Plan to be prepared to ensure integration with the remainder of the Development Area.

This report outlines the relevant schemes, strategies, policies and legislation as they apply to the subject land and justifies the layout of the proposed Structure Plan. The information contained within this Structure Plan report is intended to provide a detailed explanation of the technical issues associated with the development of the subject land, and the integration of the proposed development within the Structure Plan area. The content of this report has been informed by detailed desktop analysis and on-site investigations that have identified the opportunities and constraints of the site in terms of development, and how these have influenced the final layout of the Structure Plan.

The provision of residential development in this location is considered appropriate given the close proximity to high frequency public transport, the proposed Kelmscott Town Centre, areas of public and regional open space, the Champion Lakes sports precinct and education facilities. Furthermore, the increase in population associated with the increased housing stock will add to the viability of the proposed Kelmscott Town Centre.

1.2 Land Description

1.2.1 Location

The subject site is located in the suburb of Camillo, approximately 22.5km south-east of the Perth CBD (refer **Figure 2**). The subject site is bound to the east by Railway Avenue, to the north by Centre Road, to the west by the John Wollaston Anglican Community School and residential development; and to the south by the Kelmscott Town Centre (refer **Figure 3**).

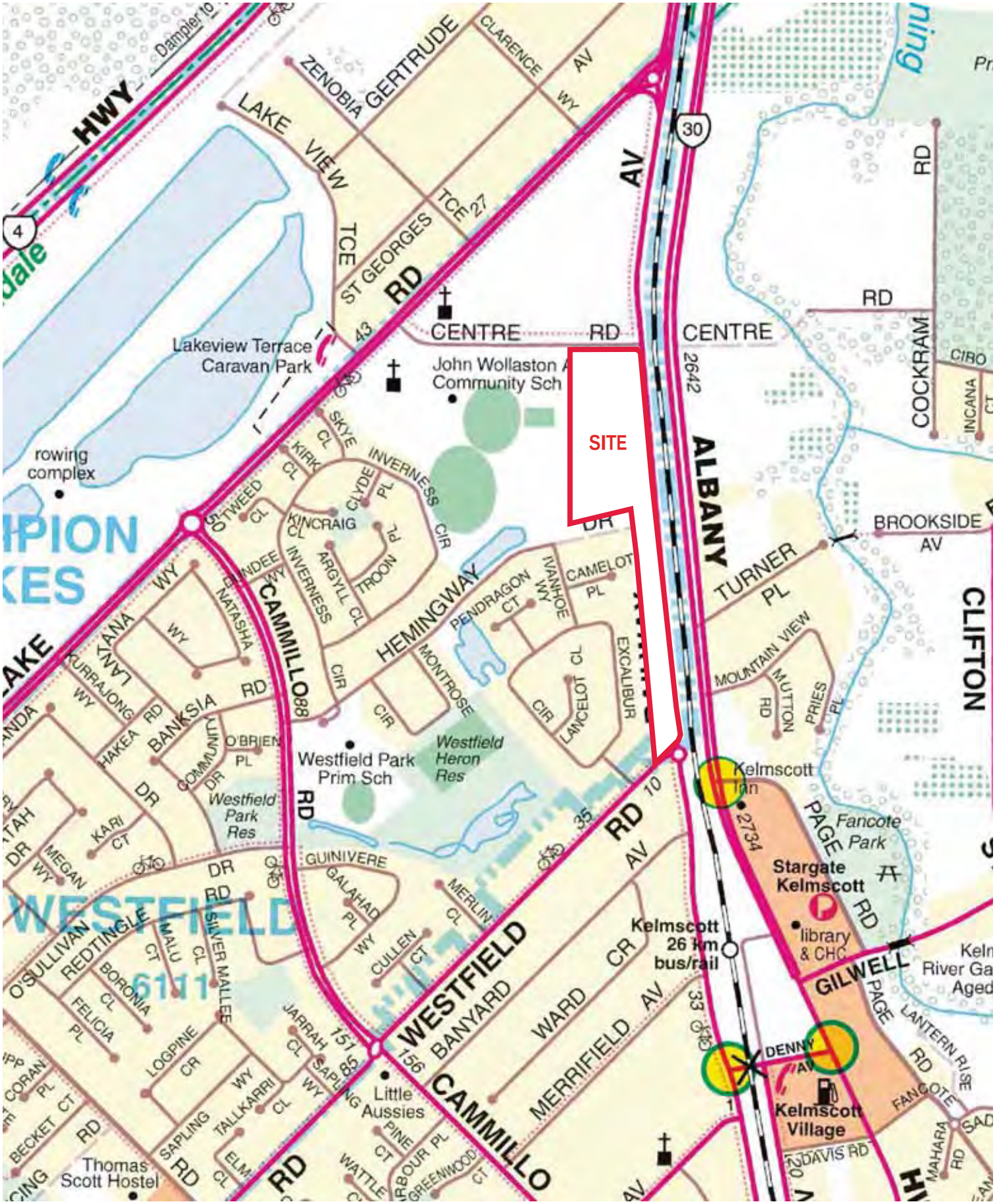
The Champion Lakes regional aquatic sporting facility is located adjacent to the Tonkin Highway 500m to the west. This international standard facility is used for rowing, kayaking and dragon boat racing. Extensive areas to the east cover various Regional Parks, including Darling Range, Gosnells, Wungong and Korung.

The Armadale regional centre is located just over 4 kilometres to the south and provides a diverse range of services and facilities.

1.2.2 Area and Land Use

The site is an elongated rectangle land parcel with an area of approximately 7.95 hectares. The site has a dense grass covering with a group of both young and mature trees near the middle and along the eastern boundary. There is a dwelling with associated outbuildings on the southern end of Lot 27 Westfield Road, the Westminster Presbyterian Church Site on Lot 60 Centre Road and a dwelling fronting Centre Road on Lot 59. The subject land is located immediately to the north of the Kelmscott Town Centre redevelopment site outlined in the Armadale Redevelopment Scheme, therefore development of the subject land will endeavour to provide a functional and attractive interface with the town centre.

The site comprises four (4) land parcels with an area of approximately 7.95 hectares and a 754m frontage to Railway Avenue, 146m frontage to Centre Road and a 70m frontage to Westfield Road.



Disclaimer

The contents of this plan are conceptual only, for discussion purposes. All areas and dimensions are approximate only subject to relevant studies, Survey, Engineering and Council approval.

Lots 58- 60 Centre Road & Lot 27 Westfield Road, Camillo
Location Plan

0 250 500

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PRELIMINARY FOR DISCUSSION PURPOSES ONLY **Scale** 1:10000@A4 | **Date** November 2014 | **Project No** 123898-05-002

Disclaimer

The contents of this plan are conceptual only, for discussion purposes. All areas and dimensions are approximate only subject to relevant studies, Survey, Engineering and Council approval.

Aerial Information derived from : Google Pro 2012

Lots 58-60 Centre Road & Lot 27 Westfield Road, Camillo

Site Plan

0 100 200

PRELIMINARY FOR DISCUSSION PURPOSES ONLY

Scale 1:4000@A4 | **Date** November 2014 | **Project No** 123898-5-001

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Lot 27 contains a single dwelling fronting Westfield Road with associated outbuildings. The remaining portion of the land is cleared and grassed, with the exception of a stand of trees central to the site. Lot 27 abuts 19 single residential lots on the western boundary. The northern boundary abuts a drainage line, which links drainage reserved to the west through to the Canning River to the east. Around this location it is anticipated that Hemmingway Drive should be extended to connect to Railway Avenue

The Westminster Presbyterian Church is located on the central portion of Lot 60 Centre Road, with access off Centre Road. The site in and around the church and access/car park contains mature vegetation.

Lot 59 contains a single dwelling fronting Centre Road with associated outbuildings. The balance of Lot 59 and abutting Lot 58 are cleared and grassed, with occasional trees.

Lot 58 abuts the John Wollaston Anglican Community School on the western boundary and for the most part contain a large indoor sports centre, car parking, playing fields and tennis courts.

North of Centre Road is the Kelmscott Church of Christ (on the corner of Lakes Road), the John Wollaston Early Learning Centre and undeveloped residential land. With the exception of the church and school facilities it is anticipated that this land will be progressively developed for residential uses.

1.2.3 Land use and Subdivision

The City of Armadale Town Planning Scheme No. 4 zones this land Residential and designates this as Development Area 9. The Scheme states for Development Area 9:

> *"A Structure Plan is to be prepared and adopted prior to subdivision or development of land within this Development (Structure Planning) Area in accordance with Part 6A of Town Planning Scheme No.4."*

Clause 4.2.1 of the Scheme states that the objectives of the Residential zone are:

> *"(a) To provide for a range of housing and a choice of residential densities to meet the needs of the variety of household types which make up the community.*
>
> *(b) To provide for a range of associated compatible activities and development, which will assist in the creation of efficient and sustainable residential neighbourhoods.*
>
> *(c) To facilitate and encourage high quality design, built form and streetscapes throughout residential areas."*

The Scheme also designates a residential density code of R15/R40, as indicated on the Scheme map. Clause 5.2.4 of the Scheme states:

"5.2.4 Notwithstanding 5.2.3 above, the City may permit development above the lower density code in the following circumstances subject to an Application for Planning Approval being granted by the City in accordance with Local Planning Policy 3.1 Residential Density Development —

(a) Where land is identified on the Scheme Map as R10/25, R12.5/25, R15/25 or R17.5/25 -

(i) up to R25 in the case of all properties;

(ii) up to R30 in the case of properties fronting more than one street or abutting a public open space reserve, where the design will result in development providing surveillance of the streets or public open space reserve respectively; and

(iii) up to R40 in the case of properties abutting public access ways (PAWs), where the design will result in development providing surveillance of the PAW.

(b) Where land is identified on the Scheme Map as R15/40, R25/40 or R15/60 up to the higher density code -

(i) where the property is provided with reticulated sewerage, adequate drainage and a footpath/cycleway system; and

(ii) where the proposal is located in close proximity to the following facilities —

(a) a public transport stop or station;
(b) a convenience shopping site;
(c) a recreational open space or other recreational facility; and
(d) a community facility."

The subject land meets all of the above criteria and is capable and suitable to be developed up to a density of R40, subject to obtaining Development Approval.

Residential development will provide an appropriate interface with the Kelmscott Town Centre redevelopment, providing continued frontage to Railway Avenue. This will also aid to provide an interface between the active street frontages of the proposed Kelmscott Town Centre and the largely undeveloped/rural residential land to the north of the subject land, while providing appropriate medium density residential development abutting a town centre.

1.2.4 Dwelling Targets

This proposal seeks to provide for a minimum of 174 dwellings over Lot 27. A single lot subdivision of Lots 58-60 could yield the following based on the assumption that of 30% will be provided for roads, 10% of open space and 60% of developable area.

Lot 58:

- Lot Area = 2.202ha
- Approx Developable Area (60%) = 1.321ha
- Approx Number of Lots (220m² average) = 60

Lot 59:

- Lot Area = 2.115ha
- Approx Developable Area (60%) = 1.269ha
- Approx Number of Lots (220m² average) = 57

Lot 60:

- Lot Area = 1.443ha
- Approx Developable Area (60%) = 8658m²
- Approx Number of Lots (220m² average) = 39

Total:

- Lot Area = 5.760ha
- Approx Developable Area (60%) = 3.455ha
- Approx Number of Lots (220m² average) = 156

Development of all or part of these lots for Grouped and/or Multiple Dwellings in accordance with the R40 Code will increase this anticipated yield.

1.2.5 Legal Description and Ownership

The subject site can be legally described as Lot 58, 59 and 60 Centre Road on Plan 2706; and Lot 27 Westfield Road on Plan 2706.

1.2.6 Public Open Space

Public open space has been provided over Lot 58 & 59 Centre Road in accordance with the 10% area requirement under liveable Neighbourhoods, which incorporates drainage. At the time of subdivision of either Lot 58 or 59 Centre Road, 10% credited Public Open Space is to be ceded to the City of Armadale by the developer in accordance with Liveable Neighbourhoods.

An area of POS has been shown in the south west corner of Lot 58 & 59, equating to the 10% provision. This is to be further justified at time of subdivision.

Open space on Lots 27 & 60 is to be provided in the form of private (strata) open space, with any shortfall to the 10% requirement to be provided as cash in lieu to the City of Armadale.

1.3 Planning Framework

1.3.1 Directions 2031 and Beyond

Directions 2031 and Beyond provides a high level spatial framework and strategic plan for the future growth of metropolitan Perth and Peel. The strategy identifies a range of desired outcomes in supporting a 'Connected City' form of development, with those relevant to this amendment described as follows:

- Increase the level of employment self-sufficiency in sub-regional areas.
- Facilitate and retain employment land to support economic growth and a balanced distribution of employment across the metropolitan Perth and Peel region.
- Protecting and enhancing the natural environment, agricultural land, open spaces and our heritage and community wellbeing.
- Reducing energy dependency and greenhouse gas emissions.
- Ensuring that economic development and accessibility to employment inform urban expansion.
- Planning and developing key public transport corridors, urban corridors and transit oriented developments to accommodate increased housing needs and encourage reduced vehicle use.

Central to the strategy vision is the aim to achieve a 50 per cent improvement on current infill residential development trends, which are currently at between 30 and 35 per cent. A target of 47 per cent or 154,000 of the required 328,000 new dwellings by 2031 is to be provided as infill development.

The proposed amendment will assist in achieving the Directions 2031 vision and objectives by facilitating the following positive outcomes:

- Planning and developing key public transport corridors, urban corridors and transit oriented developments to accommodate increased housing needs and encourage reduced vehicle use.
- Developing and revitalising activity centres as attractive places in which to invest, live and work.

- Encouraging the use of public transport through the orderly location of development on a high frequency public transit corridor; that is also destined to accommodate higher densities of residential development.
- A high quality urban form guided by sufficiently robust statutory planning frameworks that will improve the physical amenity of the centre and appropriately embrace and activate the surrounding street network.
- Enhancement of the local streetscape and natural environment generally through the establishment of landscaping in appropriate locations.

The proposal provides infill residential development within an established locality, adjacent to high frequency public transport, public open space, education facilities and bordering the future Kelmscott Town Centre precinct furthers the strategic objectives of Directions 2031 and Beyond. This proposal will significantly increase residential density within the Perth Metropolitan region, in a location which can adequately service the increase in density.

1.3.2 State Planning Policies

1.3.2.1 State Planning Policy 3 Urban Growth and Settlement

State Planning Policy No.3 – Urban Growth and Settlement (SPP3) provides high-level policy objectives relating to the desired pattern of urban development in Western Australia. This reflects the higher order principles of Directions 2031 and draft Central Metropolitan Sub-Regional Strategy. SPP3 provides the following objectives being of particular relevance to the proposed Scheme Amendment:

- To build on existing communities with established local and regional economies, concentrating investment in the improvement of services and infrastructure and enhancing the quality of life in those communities.
- To manage the growth and development of urban areas in response to the social and economic needs of the community and in recognition of relevant climatic, environmental, heritage and community values and constraints.
- To promote the development of a sustainable and liveable neighbourhood form which reduces energy, water and travel demand whilst ensuring safe and convenient access to employment and services by all modes, provides choice and affordability of housing, and creates an identifiable sense of place for each community.

In keeping with the objectives of SPP3, the proposed development presents an opportunity to benefit mutually from the additional housing to be established on Railway Avenue, within a mature urban locality having the benefit of a high frequency transit service on the corridor, and providing an urban extension to aid the viability of the proposed Kelmscott Town Centre. The location of the proposed development is entirely appropriate for urban development, and provides for growth in an established locality that will provide a high level of amenity for future residents.

1.3.2.2 State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning

State Planning Policy 5.4 (SPP 5.4) aims to deal with the land use project between major transport routes/infrastructure and residential developments, in recognition that excessive noise and vibration can have adverse impacts on individual and community wellbeing. Given the proximity of the proposed development to both the Railway line (freight and passenger) and Albany Highway which is a Primary Regional Road, this development could be considered a 'Noise-Sensitive Development' under section 5.2.

Therefore it is possible that a detailed noise assessment may be required to ascertain levels and corresponding design solutions. However, this can be dealt with at the development application phase, where the detailed design of housing, landscaping and engineering can be assessed against the requirements of SPP 5.4.

1.3.3 City of Armadale Town Planning Scheme No. 4

The City of Armadale Town Planning Scheme No. 4 (the Scheme) outlines the statutory requirements for the development of land within the locality, in order to provide strategic direction for development and achieve desired objectives. The subject land is zoned as both Residential R15/40 and 'Development Area 9' under the Scheme (refer **Figure 4**). The designation of Development Area 9 in Schedule 12 of the scheme stipulates that any development of these lots will require the preparation of a Structure Plan, which is the subject of this report.

According to Schedule 12, in addition to usual requirements of a Structure Plan, must specifically address stormwater and nutrient management due to high groundwater levels, and the ground level interface with surrounding areas of existing development must also be carefully managed. Stormwater management requires a detailed approach to design which integrates significant water sensitive urban design requirements with an attractive and functional built form. As such, the requirement for water management/nutrient management on site will be specifically addressed at the subdivision/development application stage, where detailed design and engineering can be implemented to manage water on site.

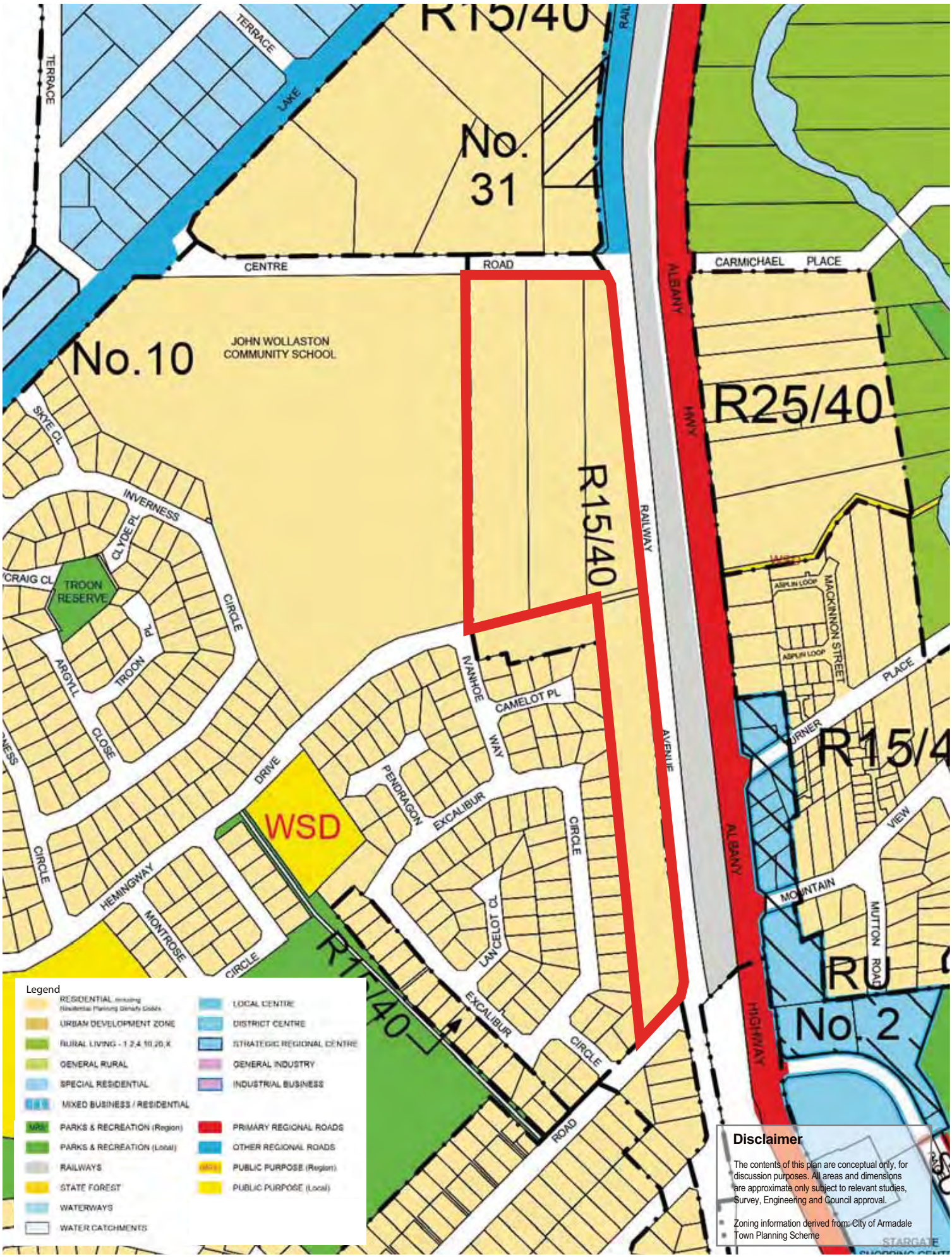
The Structure Plan has provided an indicative design which responds to issues of vehicular access, residential density, communal open space, vegetation retention, pedestrian linkages/networks and interface with existing built form. The layout of this structure plan is in accordance with part 6A of the Scheme, and provides a guide to development which will provide an appropriate interface with surrounding development and infrastructure.

1.3.4 Armadale Redevelopment Scheme

The Armadale Redevelopment Scheme is administered by the Metropolitan Redevelopment Authority. While the subject site is not contained within a Redevelopment Area, the southern portion of the subject site borders the Kelmscott Town Centre. Given the nature and location of the subject land, careful consideration of how development of this site will integrate effectively with the Kelmscott Town Centre will be required.

The Kelmscott Town Centre is identified as Precinct 5 under the Armadale Redevelopment Scheme 2004, and covers a total area of 7.95 hectares. The Kelmscott Town Centre Precinct is characterised by underutilised public and private land, fronting both Albany Highway and Railway Avenue centred around the Kelmscott train station. The focus of the precinct is to encourage development that provides integration, especially with regard to an east-west connection across, Albany Highway and the railway. The Redevelopment Scheme proposal is intended to improve the functionality, viability, range of services and vitality of the Kelmscott Town Centre, however it will not challenge the primacy of the Armadale Regional Centre.

The residential development of this land will ensure an attractive and functional interface with the Kelmscott Town Centre (refer **Figure 5**), providing an appropriate medium density residential development abutting a future District Centre. The increased population will aid to enhance the level of patronage and vitality of the Kelmscott Town Centre, which will in turn provide local employment opportunities and services.



Legend

- RESIDENTIAL (including Residential Planning Density Codes)
- URBAN DEVELOPMENT ZONE
- RURAL LIVING - 1,2,4,10,20,X
- GENERAL RURAL
- SPECIAL RESIDENTIAL
- MIXED BUSINESS / RESIDENTIAL
- PARKS & RECREATION (Region)
- PARKS & RECREATION (Local)
- RAILWAYS
- STATE FOREST
- WATERWAYS
- WATER CATCHMENTS
- LOCAL CENTRE
- DISTRICT CENTRE
- STRATEGIC REGIONAL CENTRE
- GENERAL INDUSTRY
- INDUSTRIAL BUSINESS
- PRIMARY REGIONAL ROADS
- OTHER REGIONAL ROADS
- PUBLIC PURPOSE (Region)
- PUBLIC PURPOSE (Local)

Disclaimer

The contents of this plan are conceptual only, for discussion purposes. All areas and dimensions are approximate only subject to relevant studies, Survey, Engineering and Council approval.

- Zoning information derived from: City of Armadale Town Planning Scheme

Lots 58-60 Centre Road & Lot 27 Westfield Road, Camillo

Zoning Plan

0 100 200

PRELIMINARY FOR DISCUSSION PURPOSES ONLY

Scale 1:5000@A4 I **Date** November 2014 I **Project No** 123898-5-003

RPS Australia East Pty Ltd
ACN 140 292 762
ABN 44 140 292 762

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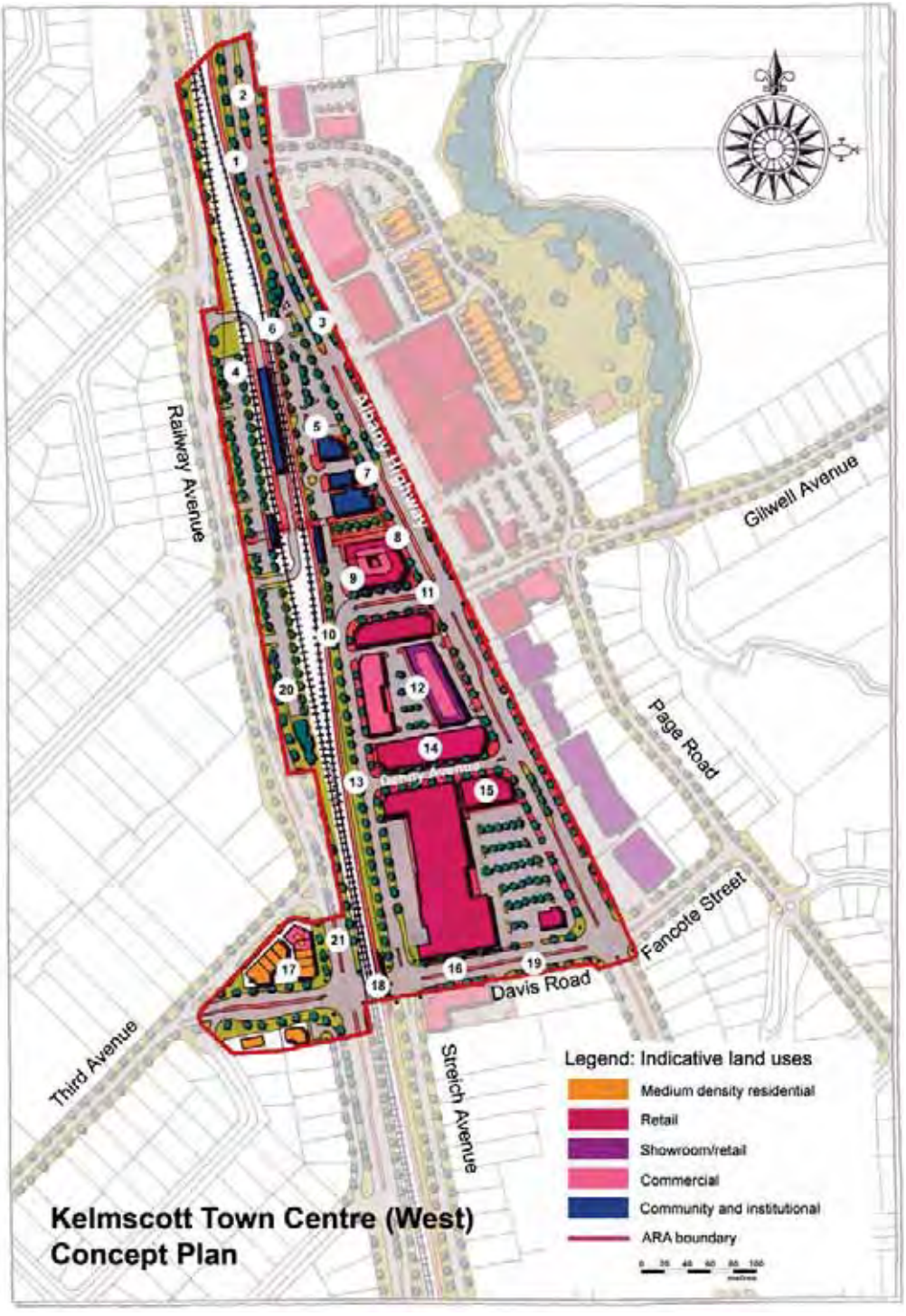

Railway Avenue
Gilwell Avenue
Page Road
Fenoole Street
Davis Road
Third Avenue
Streich Avenue
Legend: Indicative land uses
Medium density residential
Retail
Showroom/retail
Commercial
Community and institutional
ARA boundary
Kelmscott Town Centre (West)
Concept Plan

1.3.5 City of Armadale Draft Local Planning Strategy

The City of Armadale Draft Local Planning Strategy (2014) provides a revision to the existing Local Planning Strategy, in response to rapid growth and development in recent years. The Draft Strategy aims to achieve a vision of being a connected, progressive, strategic metropolitan community. This involves creating a vibrant regional centre while still maintaining the attractive urban-rural lifestyle, scenic landscape and rich cultural heritage attributes.

The vision will be achieved through long term planning objectives, policy statements and a suite of subsequent strategies including:

- Housing Strategy
- Urban Development Strategy
- Heritage Properties Planning Strategy
- Metropolitan Redevelopment Authority Normalisation Strategy
- Activity and Retail Centres Strategy
- Hills Orchards Strategy
- Rural Hills Visual Landscape Strategy
- Bushfire Protection Strategy, and
- Biodiversity Strategy

Housing Strategy

The nature of this proposal is for residential development in an area identified by the strategy as falling under an urban residential zone. The Housing Strategy is commensurate with the strategic objectives of Directions 2031 and Beyond, and provides some scope for increased densities around the commercial centres of Armadale and Kelmscott, as well as near local centres and train stations. The Housing Strategy identifies the following objectives relating to the provision of housing in the locality:

- A range of housing and opportunities for home businesses in community neighbourhoods that are developed on good design principles;
- Meeting housing targets as identified in the Directions 2031 Annual Report Card (2012);
- Greenfields development at an increasing density with the aim of achieving the Directions 2031 objective/target of 15 dwelling per hectare;
- Future urban growth focussed in and around retail and employment centres, transit-oriented developments and high frequency public transport corridors;
- Higher R-codes applied to areas that have close proximity to community facilities and services;
- New facilities, infrastructure and service provision assisted by appropriate forms of contributions from new developments.

The proposed development will create an attractive and functional interface to the proposed Kelmscott Town Centre, providing linear development along the railway line and frontage to Railway Avenue. The proposed residential development will provide an increased level of patronage and vibrancy to the proposed Kelmscott Town Centre, which will in turn provide services and local employment. In accordance with the Residential Neighbourhood Strategy this proposal will achieve objectives by enhancing the benefits of the natural and built environment and fostering a distinctive character for the City based on good design principles.

Urban Development Strategy

The Urban Development Strategy aims to identify suitable land for urban residential development, taking into account the rapid growth in population and development occurring in recent years, expected to continue into the future. Urban areas already identified under the District Planning Scheme and Metropolitan Region Scheme are considered appropriate locations for future urban development, as well as additional areas which form extensions of these areas as identified under this Strategy. The Strategy seeks to encourage development in areas deemed suitable for future development, which will aid the economic development and housing provision in the locality.

The subject site is located within an area identified for 'Urban Residential' development, which is commensurate with the residential nature of this Structure Plan. The provision of housing is in accordance with the Strategy and forwards the objectives of the Strategy by providing residential development in an appropriate location.

1.3.6 Local Planning Policies

1.3.6.1 PLN 2.6 Water Sensitive Design

This local planning policy recognises the need for sustainable water management outcomes to occur both during and post development, and seeks to integrate quality urban development with the natural environment. This policy aims to prevent the contamination of stormwater, use of appropriate technologies and revegetation of the City's drainage system with native species.

The Structure Plan has incorporated Water Sensitive Urban Design principles in order to effectively manage stormwater, in accordance with Part 6A of the Scheme. However, this Structure Plan is intended as a guide to urban form only, and specific WSUD measures will need to be demonstrated at the development application or subdivision stage.

1.3.6.2 PLN 2.9 Landscaping

The landscaping policy recognises the important role landscaping can play in restoring biodiversity and the quality of ecosystem services throughout the locality. The policy seeks to achieve the vision of a city that is "clean, green and prosperous", achieve or exceed the recommended target of 30% of native flora to be utilised in landscaping for new developments, to encourage the use of plants that will grow without the need for irrigation.

The policy also recommends that any remnant native vegetation be retained where possible or it is deemed worthy of retention. A pre-development survey has been undertaken by Ausurv Surveyors in July 2014, which has identified all vegetation on site. The proposed development will take into account all physical features of the landscape, and where possible, retain any significant vegetation that is present.

The landscaping plan for the proposed development should also utilise native species as a priority in order to further the goals of this policy, however the exact species mix and landscaping plan will be determined at the development application stage. Native vegetation can be integrated into communal open space, roads verges and within private access ways. Low water/drought resistant native plants will be preferred.

1.3.6.3 PLN 3.1 Residential Density Development

The Residential Density Development policy aims to provide guidance on density development within the City in general and provide clarity on the intent of Clause 5.2.4 of Town Planning Scheme No.4. This clause gives Council discretion to approve development of Grouped and Multiple Dwellings on dual coded lots, (R10/25, R12.5/25, R15/25, R15/60, R17.5/25 and R25/40) up to the higher density. The Scheme requires that this discretion be exercised in accordance with PLN 3.1.

The objectives of this policy are as follow:

a) To locate density development in residential areas where it can successfully integrate into the surrounding environment and where existing access arrangements, open space, shopping, public transport, community services, drainage and sewerage facilities are capable of accommodating more intensive development;

b) To promote the use of structure plans to co-ordinate the development of medium density housing in "street blocks";

c) To encourage an attractive streetscape setting which enhances and complements the visual character, bulk and scale of the surrounding built form;

d) To achieve a high quality building development in relation to architectural design, site layout, materials, colour, tone, texture and fencing;

e) To provide safe, functional and attractive access arrangements in and out of the site, which contribute to the overall aesthetics of the development;

f) To provide for safe and convenient placement and storage of waste to the development's future residents; and

g) To provide for the safe and convenient collection of rubbish bins by the City's waste disposal vehicles.

This Structure Plan provides for residential density development in an appropriate location, within close proximity to community services, the Kelmscott railway station, schools, a high frequency bus route, shops and can be adequately serviced via connection to existing infrastructure. A traffic study and Local Water Management Strategy have been provided (refer **Appendix C** and **Appendix D**) as part of this proposal, and adequately address water management and traffic management issues.

The Structure Plan provides numerous scenarios for access to the site from Hemingway Drive, Centre Road and Westfield Road, with internal road layouts and built form to be addressed at the development application stage. The proposed Structure Plan therefore meets the requirements of PLN 3.1, with further detail regarding waste management, built form and public open space locations to be determined at the subdivision/development application stages.

2.0 Site Conditions and Constraints

2.1 Biodiversity and Natural Area Assets

The subject site is characterised by dense grass cover, with a cluster of trees (including some native trees) in the middle of Lot 27 Westfield Road, as well as numerous trees providing a buffer to Railway Avenue for the length of the Structure Plan area. The Structure Plan area has been previously cleared, and remnant vegetation on the site is heavily degraded and of little significance. Lot 60 Centre Road contains the Westminster Presbyterian Church – Kelmscott, and numerous trees which have been retained/planted along the driveway and lot boundary with Railway Avenue. Lot 59 Centre Road contains a single residential dwelling on the northern boundary, with the remainder being extensively cleared. Lot 58 Centre Road contains a small number of remnant trees in the north – western corner, with the remainder of the lot being completely cleared of any significant vegetation.

2.2 Landform and Soils

The geotechnical study undertaken by Galt Geotechnics has found the soils on site consist largely of clay, with extensive evidence of clay related surface movement (refer **Appendix B**). The site is predominately flat with an elevation of RL 21m AHD, with a slight rise to RL 25m AHD at the southern edge of the site. The soft and unstable foundations mean that in its current state, the site would be unsuitable for development and classified "P" under the AS 2870-2011 "Residential Slabs and Footings" code. A minimum thickness of 0.8m of compacted clean fill is recommended prior to any development commencing over the subject land.

The study undertaken by Galt Geotechnics did not extend to the presence of Acid Sulfate Soils (ASS) however an investigation is required to be undertaken by the subdivider.

The entirety of the subject site is identified by Department of Environment Regulation (DER) mapping as having a "moderate to low risk of ASS occurrence within three metres of the natural ground surface but with a high to moderate ASS risk beyond three metres of the natural ground surface". DER guidelines identify investigations for ASS are required when soil disturbance occurs below the water table in "moderate to low ASS risk" areas; this includes any dewatering activities. Therefore prior to subdivision an investigation will be required to determine the presence/absence of ASS.

2.3 Groundwater and Surface Water

A study was undertaken by Galt Geotechnics in April 2014 in order to ascertain key information relating to soil composition and groundwater levels. At the time this assessment occurred, it was the latter stages of a significant dry spell, and no groundwater was encountered at any of the sample holes (at a depth of 6m). However, given that the site is relatively low lying, the ground water during winter months is expected to be at a much higher level, with possible surface pooling of water. However it is noted in the report that during winter months the groundwater table is likely to be significantly higher, and recommend that the site be raised approximately 1m by the importation of sand fill.

A Stormwater Management Plan is required to be prepared by the subdivider in order to ensure effective management of the quantity and quality of stormwater runoff. This is of particular concern given the existing lower ground levels to the west of Lot 27 that is developed for residential development. The existing ground levels will need to be filled and stormwater retained to ensure there are no off-site impacts.

2.4 Waste Management

The City of Armadale has indicated that a Waste Management Plan will be required to ensure that waste disposal occurs effectively, efficiently and sustainably, minimising the effects on the community and the environment during both construction and operation. Specific attention is required at the planning approval or subdivision stage to ensure that refuse disposal for residential development is designed such that access and bin locations take into consideration the City's waste management vehicles and the positioning of bins, to minimise impacts on residents and vehicular movements.

The Waste Management Strategy will need to address design features and operational controls required to ensure that the plan can be implemented effectively.

Bin collection is to occur on site in an any strata titled development to avoid road verges being used for rubbish collection, as the use of road verges will be obstructed by on street parking, may impede footpaths and will detract from the visual amenity of the locality.

3.0 Conclusion

This report requests the City of Armadale's approval of a Structure Plan for Lots 58-60 Centre Road, and Lot 27 Westfield Road, Camillo to facilitate the land's subdivision and development for residential purposes.

The designation of these lots as 'Development Area 9' under City of Armadale Town Planning Scheme No. 4 requires a Structure Plan to be prepared over Lots 58-60 Centre Road, and Lot 27 Westfield Road to ensure an appropriate development in the future. This Structure Plan has been prepared in accordance with the provisions of part 6A of the City of Armadale Town Planning Scheme No. 4.

As demonstrated throughout this report, the proposed Structure Plan accommodates the various elements affecting the subject site and achieves the objectives of the City of Armadale's and it's Town Planning Scheme No. 4. The proposed road and indicative development layout reflects the proposed land uses and integrate with the surrounding land uses.

This Structure Plan has been based on existing adopted and recently released State and Local planning strategies/policies. Key planning principles have been incorporated into the design in order to produce a Structure Plan that could adapt to market demands.

The proximity of the Structure Plan area to high frequency public transport, the proposed Kelmscott Town Centre precinct, education facilities, public and regional open space, the Armadale Regional Centre and the significant recreation/leisure centre of Champion Lakes. In addition, the proposed Structure Plan has addressed provisions of the draft City of Armadale Planning Strategy, complying with both the subsidiary Housing Strategy and Urban Development Strategy.

In broad terms this proposal:

- is consistent with existing policy;
- is consistent with the orderly and proper planning of the locality;
- can be connected to all necessary infrastructure services and is capable of residential development; and
- will not prejudice the environmental values of the immediate locality.

On the basis of the above, it is requested the City of Armadale and the Western Australian Planning Commission adopt the Structure Plan for future residential development as it is consistent with the residential zone assigned to the subject site under the City of Armadale Town Planning Scheme and Urban zone under the Metropolitan Region Scheme.

APPENDIX A

Certificates of Title and Survey Plans

2831H

REGISTER NUMBER	
27/P2706	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	13/8/2014

WESTERN AUSTRALIA

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 1008 FOLIO 712

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 27 ON PLAN 2706

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

GINO CASTAFARO OF 6 WINSTANLEY ROAD, ROLEYSTONE
AS EXECUTOR OF THE WILL OF MARIA CASTAFARO WHO DIED ON 30-8-2004
(TA M715873) REGISTERED 24 JULY 2014

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. TITLE EXCLUDES THE LAND SHOWN ON O.P. 10217.

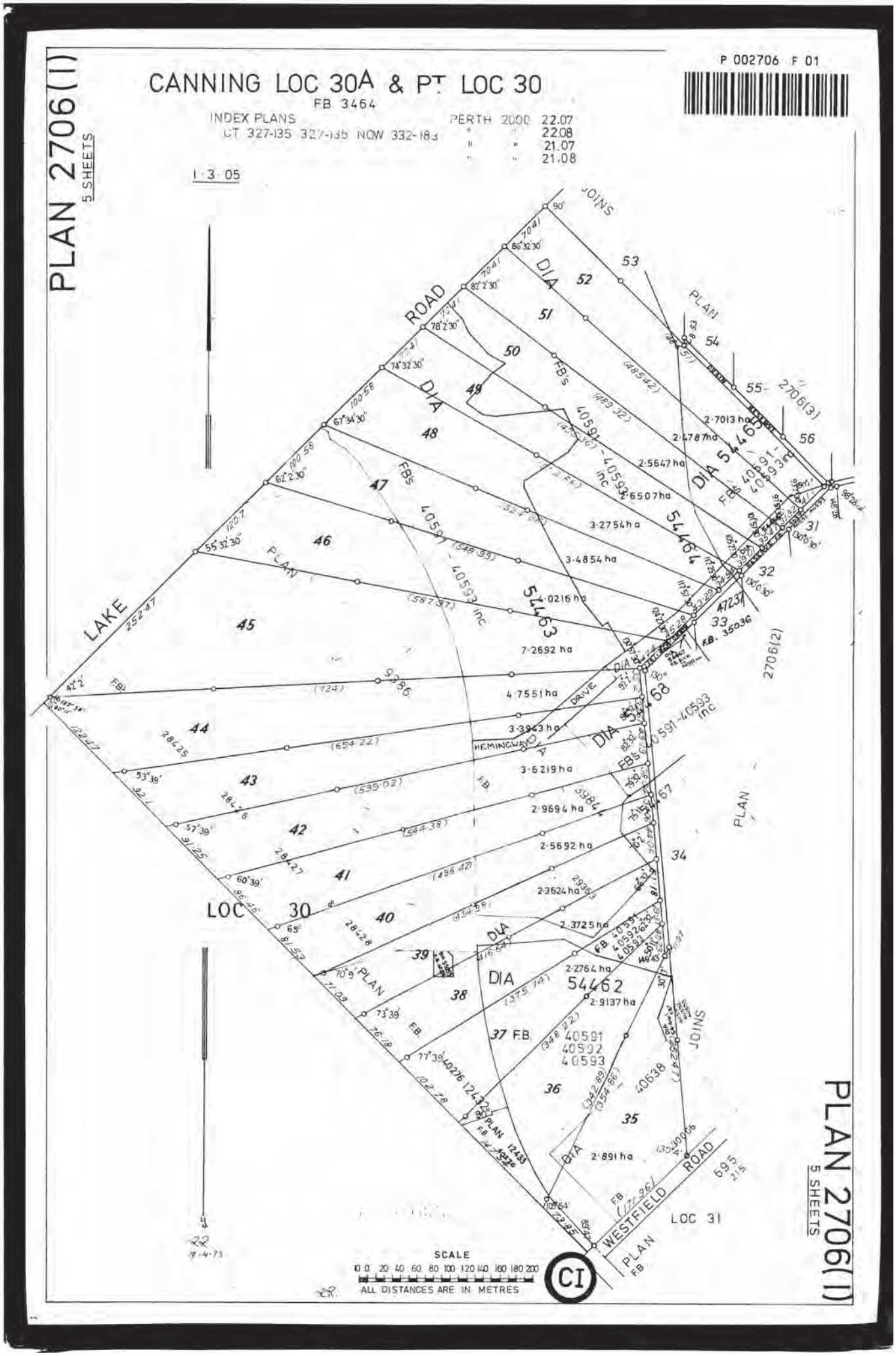
Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1008-712 (27/P2706).
PREVIOUS TITLE: 505-15.
PROPERTY STREET ADDRESS: 3 WESTFIELD RD, CAMILLO.
LOCAL GOVERNMENT AREA: CITY OF ARMADALE.



PLAN 2706(2
5 SHEETS

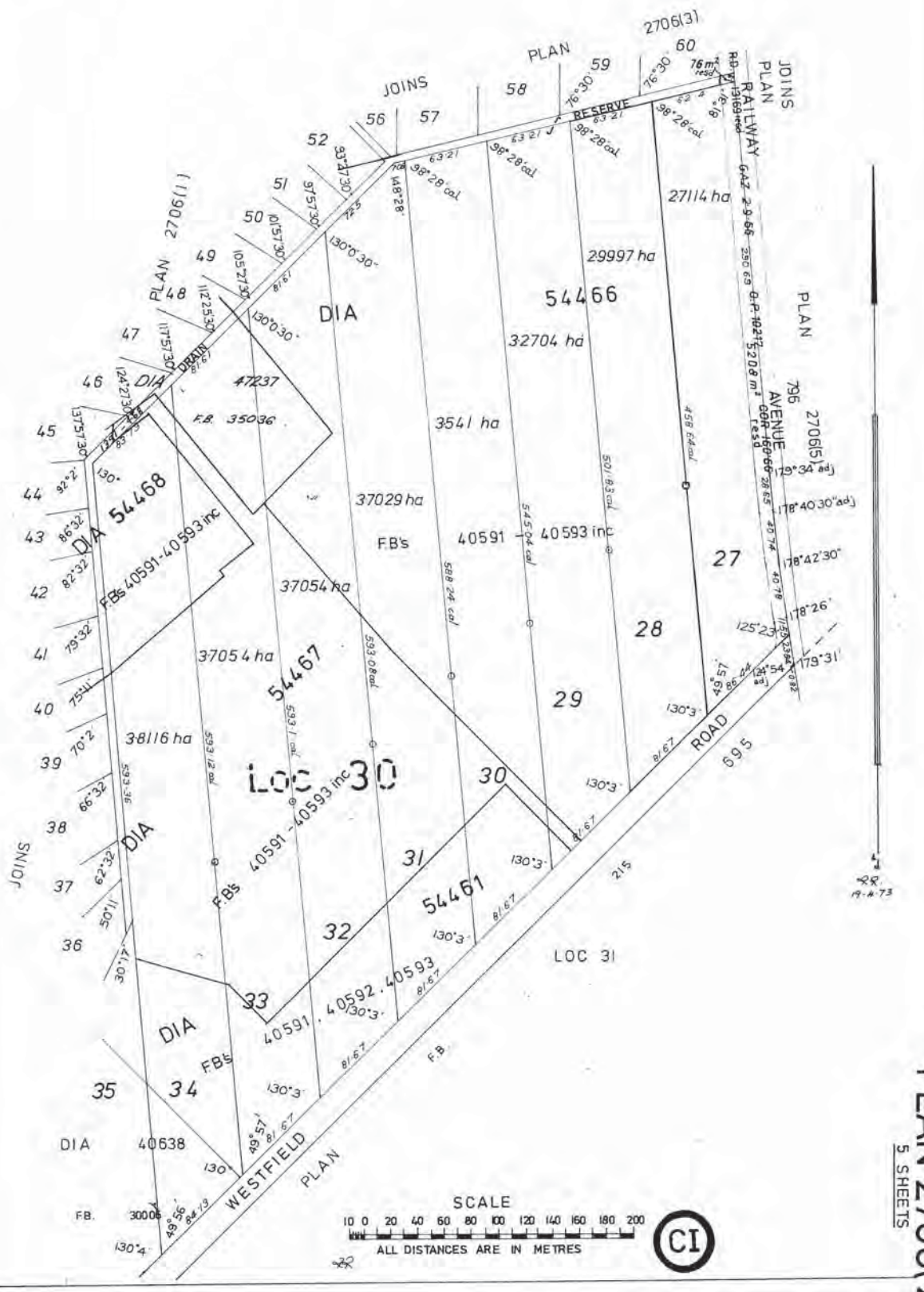
CANNING LOC 30A & PT LOC 30

FB 3464

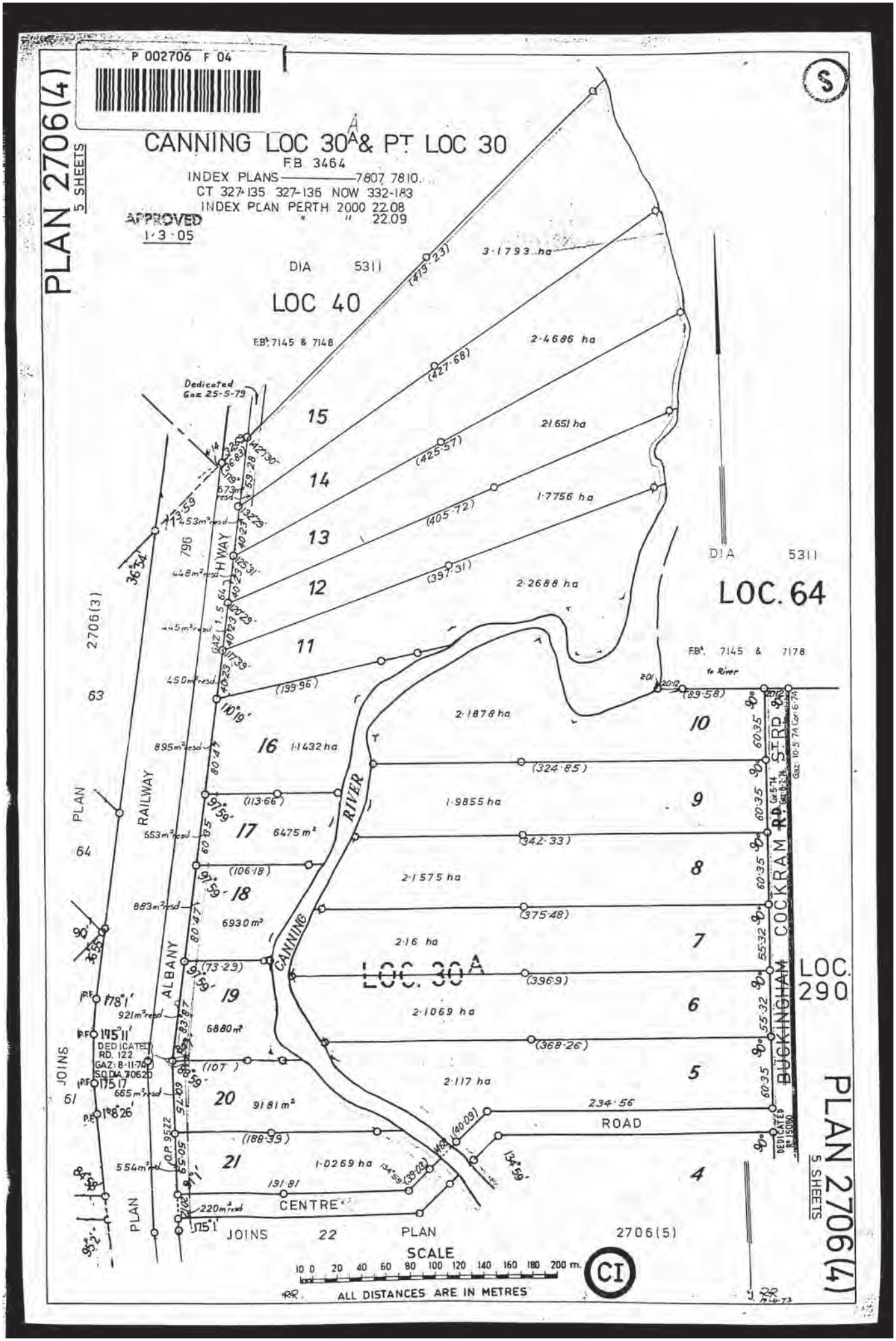
INDEX PLAN PERTH 2000 22.07
CT 327-135 327-136 NOW 332-183 " " 22.08

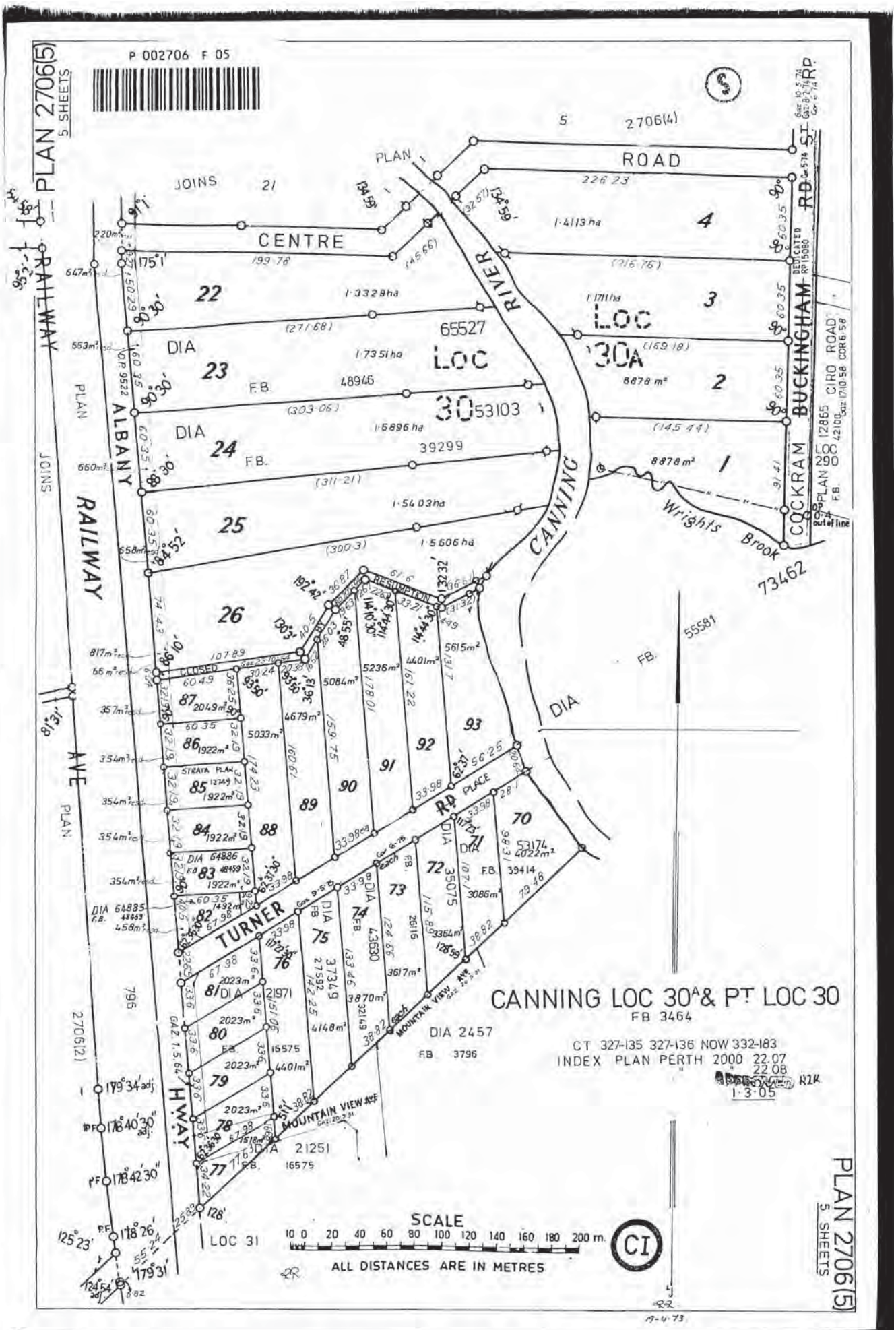
P 002706 F 02

1·3·05



PLAN 2706(2
5 SHEETS





WESTERN AUSTRALIA

REGISTER NUMBER	
60/P2706	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	12/8/2003

RECORD OF CERTIFICATE OF TITLE

VOLUME 1735 FOLIO 751

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 60 ON PLAN 2706

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WESTMINSTER PRESBYTERIAN CHURCH KELMSCOTT INC OF 6 LETSOM WAY, LANGFORD
(T D293378) REGISTERED 29 JULY 1986

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. THE LAND THE SUBJECT OF THIS CERTIFICATE OF TITLE EXCLUDES ALL PORTIONS OF THE LOT DESCRIBED ABOVE EXCEPT THAT PORTION SHOWN IN THE SKETCH OF THE SUPERSEDED PAPER VERSION OF THIS TITLE. VOL 1735 FOL 751.

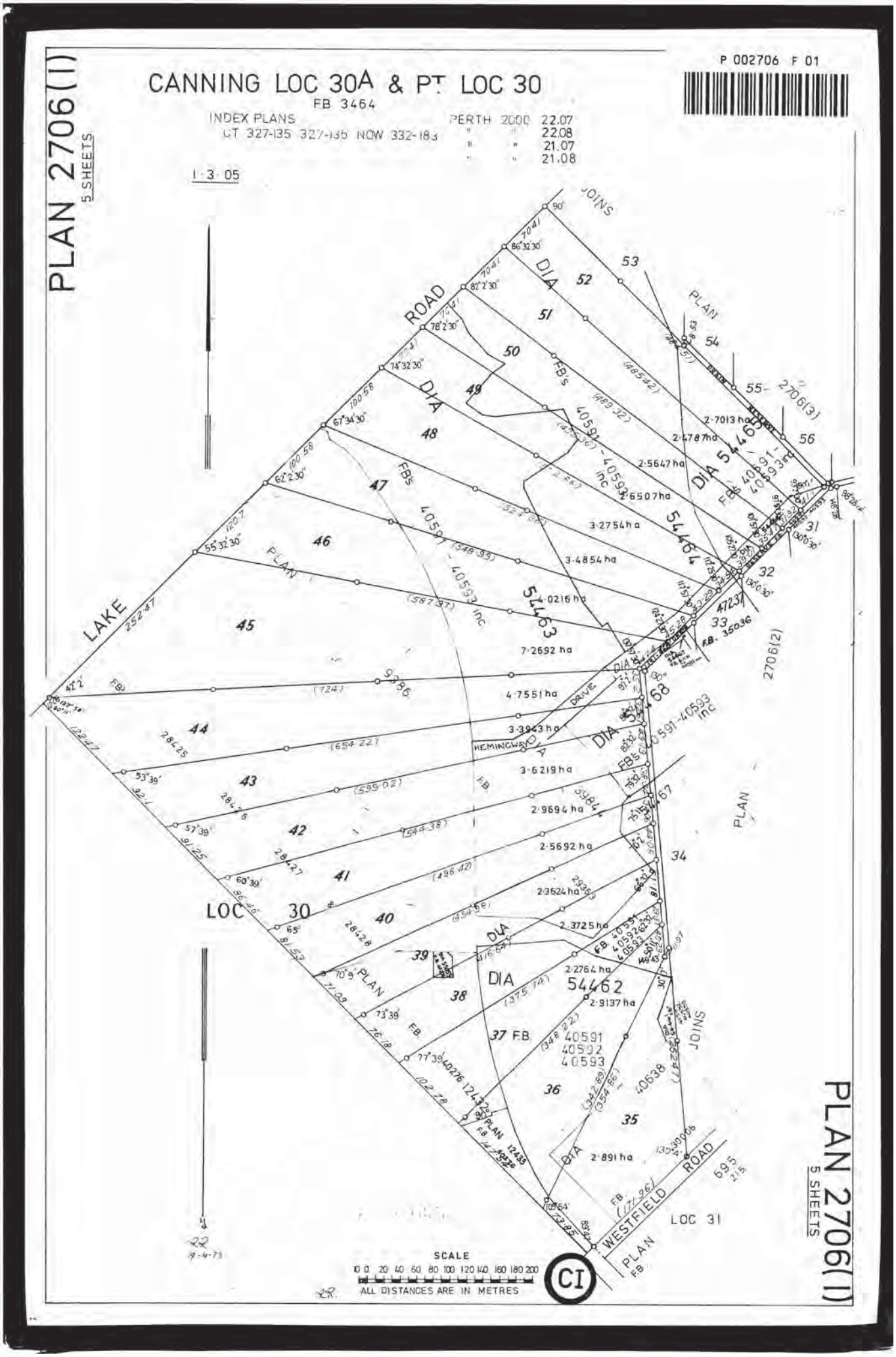
Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 1735-751 (60/P2706).
PREVIOUS TITLE: 393-111A.
PROPERTY STREET ADDRESS: LOT 60 CENTRE RD, CAMILLO.
LOCAL GOVERNMENT AREA: CITY OF ARMADALE.



PLAN 2706(2)
5 SHEETS

CANNING LOC 30A & PT LOC 30

FB 3464

INDEX PLAN PERTH 2000 22.07
CT 327-135 327-136 NOW 332-183 " " 22.08

P 002706 F 02

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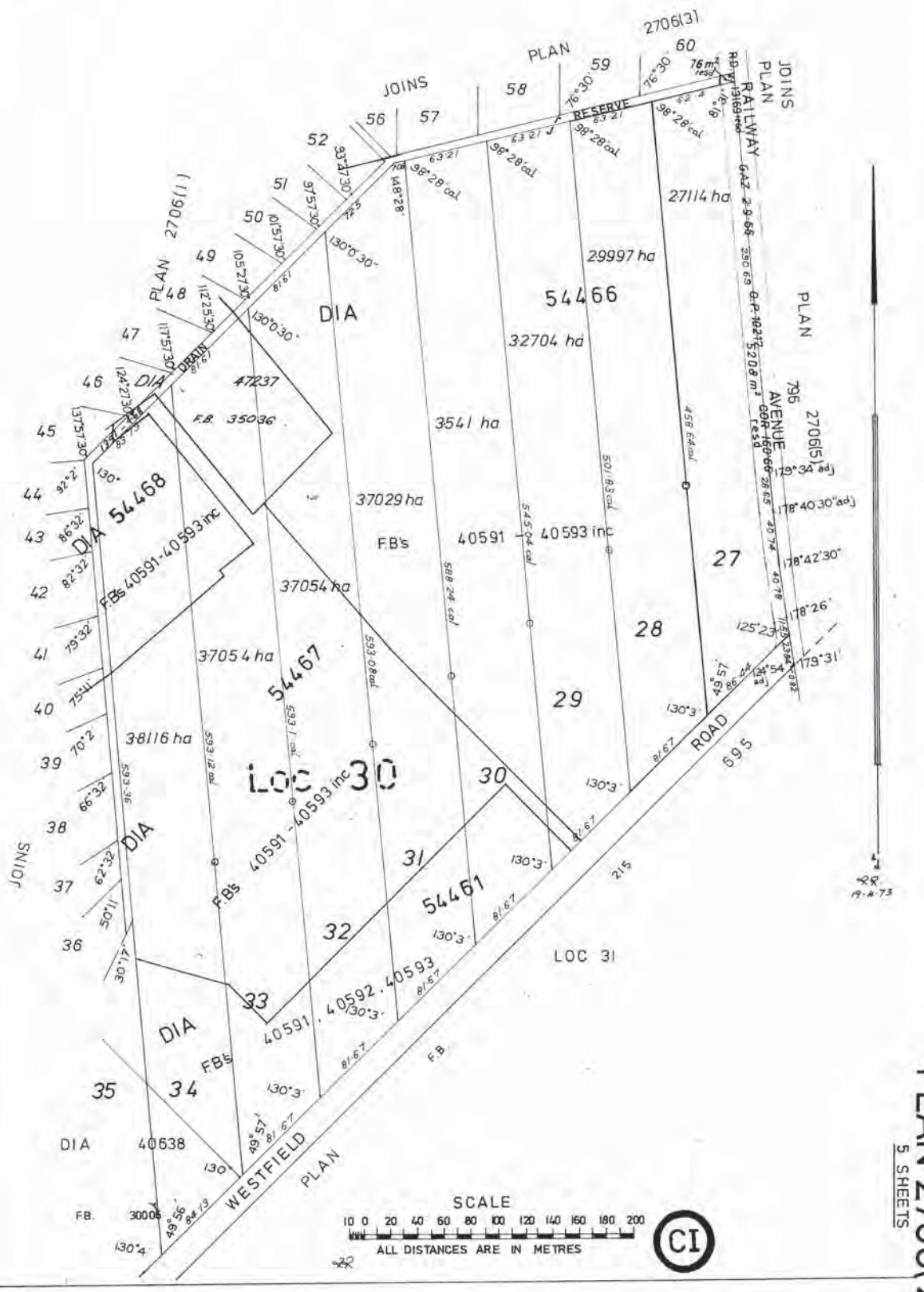
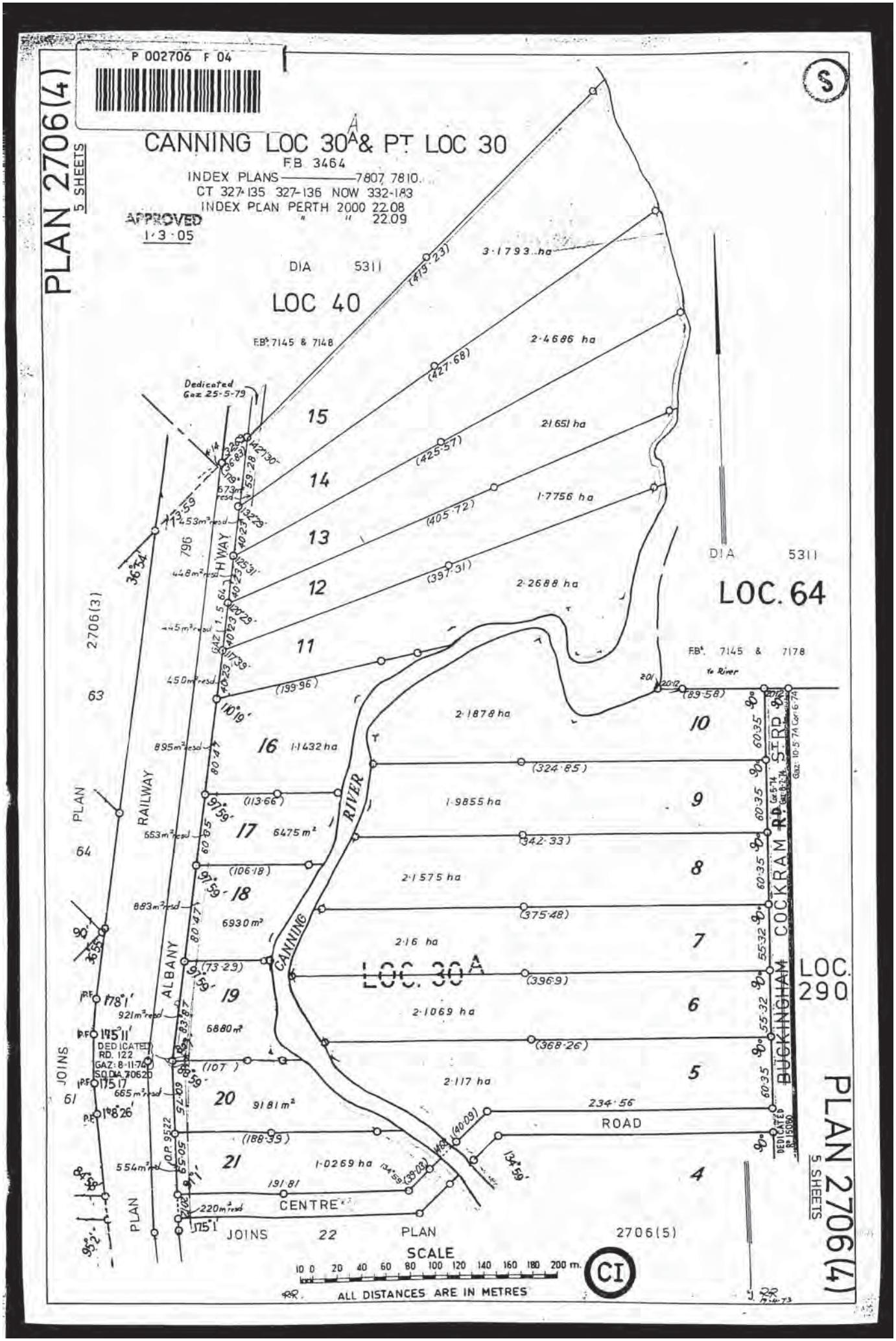
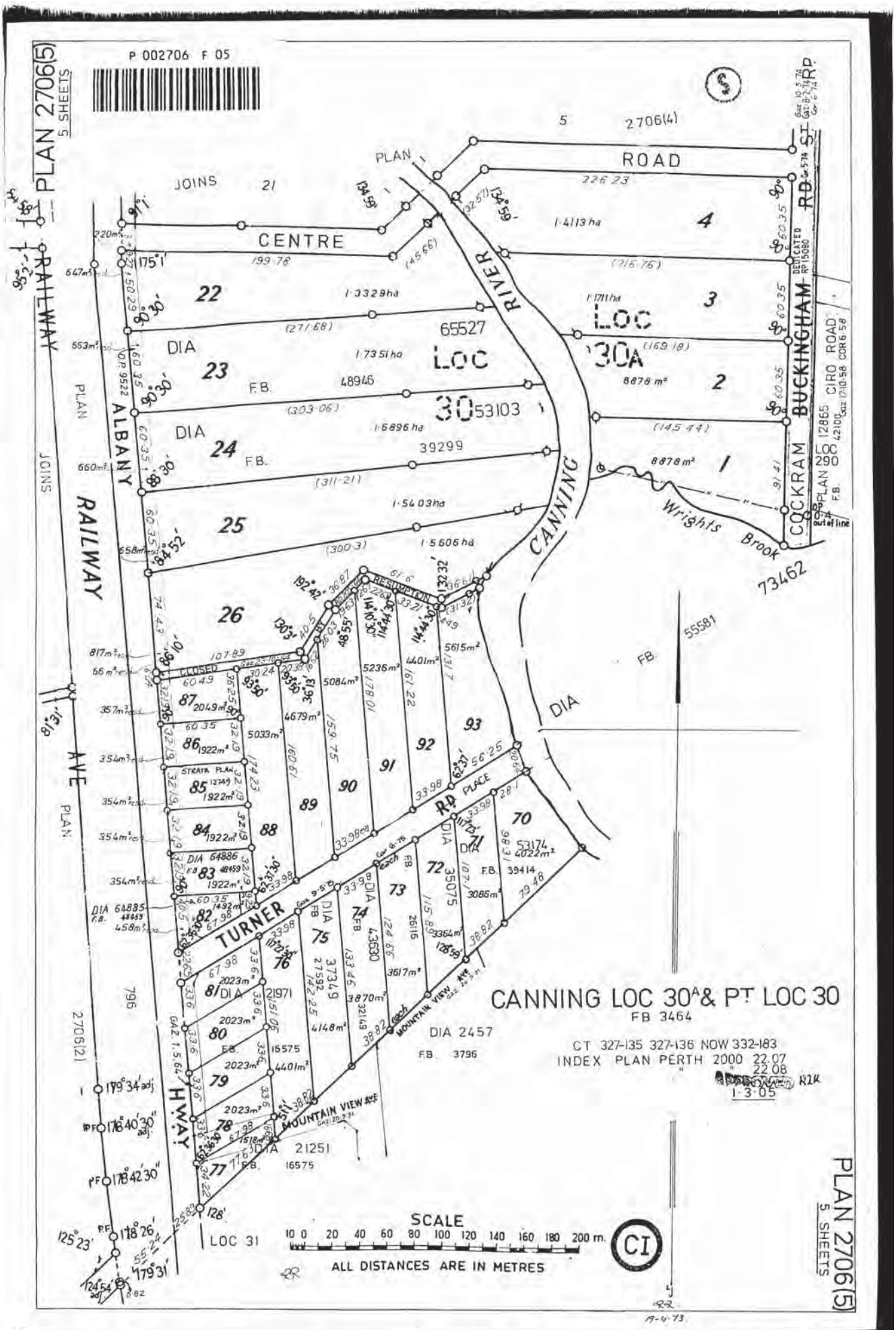


PLAN 2706(2)
5 SHEETS





APPENDIX B

Geotechnical Report prepared by Galt Geotechnics

Report on

GEOTECHNICAL STUDY
PROPOSED RESIDENTIAL SUBDIVISION
LOT 27 WESTFIELD ROAD, CAMILLO

Submitted to:
Property Edge WA Pty Ltd
10 Boronia Trail
CANNING VALE WA 6155

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6 014
T: +61 (8) 6272-0200
F: +61 (8) 9285-8444

J1401067 001 R Rev0

28 April 2014

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TABLES (WITHIN TEXT)

FIGURES

APPENDICES

1. INTRODUCTION

This report presents the outcomes of the geotechnical study for the proposed residential subdivision at Lot 27 Westfield Road, Camillo ("the site"). The location of the site relative to the surrounding area is shown on Figure 1, Site and Location Plan.

The investigation was requested by Mike Kelly of Property Edge WA Pty Ltd and authorised in a client authorisation form dated 7 April 2014.

2. SITE CONDITIONS AND PROPOSED DEVELOPMENT

The site is an elongated rectangle in plan and covers approximately 2.2 ha. From publicly available contour plans, the surface is flat at an elevation of about RL 21 m AHD over most of the site except for the southern end which is slightly raised, at an elevation of about RL 25 m AHD.

The site is densely grassed with a group of mature and young trees near the middle and along the eastern boundary. At the south end is an existing single storey residence with various sheds. There are several trees around the residence.

Railway Avenue along the eastern boundary is on an embankment, about 1.5 m high above the natural ground level. The residential area to the west of the site appears to be at natural ground level.

At the time of the fieldwork, the ground surface was hard. However, deep wheel ruts in the ground surface suggest that the area becomes soft and boggy during the rainy season.

We understand that, to tie into the adjacent Railway Avenue and avoid surface flooding, the area will be raised by about 1 m by the importation of sand fill.

The development is to comprise a number of two storey apartment units. We assume the buildings will be of masonry construction with slabs-on-ground and shallow footings.

3. PROJECT OBJECTIVES

The objectives of the study were to:

- assess subsurface soil and groundwater conditions across the site;
- provide recommendations on suitable footing systems for the proposed development;
- provide allowable bearing pressure and settlement estimates for shallow foundations;
- provide a site classification(s) in accordance with AS 2870-2011 "Residential Slabs and Footings";
- provide recommendations and geotechnical design parameters for earth retaining structures;
- recommend appropriate site preparation procedures including compaction criteria;
- assess the permeability of the soil at the site for potential stormwater disposal by infiltration; and
- provide a subgrade California bearing ratio (CBR) design value for pavement thickness design by others.

4. FIELDWORK

Fieldwork was carried out on 10 April 2014 and comprised:

- a site walk-over by a senior geotechnical engineer;
- cone penetration tests (CPTs) at 6 locations to depths of between 1.5 m and 6.0 m; and
- sampling with the CPT rig, using a 32 mm diameter sampler at depth of between 1.0 m and 2.0 m.

General

A geotechnical engineer from Galt located the test positions, observed the CPTs, collected samples for inspection and possible laboratory testing.

The test locations are shown on Figure 1, Site and Location Plan and details are summarised in Table 1, Summary of Tests. Photographs of the site are presented in Appendix A, Site Photographs.

Table 1: Summary of Tests

Test Names	Test Depth (m)	Thickness of Sand Cover (m)	Stratigraphy
CPT1	6.0	~1.0	Clayey SAND overlying hard clayey SAND/sandy CLAY. Minor sand lenses towards base
CPT2	6.0	-	Stiff CLAY to 1.5 m becoming hard clayey SAND
CPT3	6.0	-	Firm becoming stiff CLAY to 1.8 m overlying hard clayey SAND becoming sandy CLAY
CPT4	1.5R	-	Firm becoming hard CLAY
CPT4A	3.2R	-	Firm becoming hard CLAY to 1.2 m overlying hard clayey SAND
CPT5	6.0	-	Stiff becoming hard sandy CLAY to 1.8 m overlying lenses of clayey SAND and sandy CLAY
CPT6	2.5R	-	Stiff becoming firm sandy CLAY to 1.2 m overlying lenses of clayey SAND and sandy CLAY

Notes: 1. R – CPT refusal – possibly on cemented layer
2. No groundwater was encountered in the holes formed by the CPT.

Cone Penetration Tests

CPTs were undertaken using a 22 tonne truck-mounted CPT rig supplied and operated by Probedrill Pty Ltd. The results of the CPTs are provided in Appendix C, Cone Penetration Test Results along with a method of interpretation proposed by Robertson et al (1986).

Permeability Testing

No infiltration testing was undertaken at the site as an insufficient thickness of permeable sand is present on the site.

5. LABORATORY TESTING

Laboratory testing on soil samples was undertaken by Mining & Civil Geotest in their NATA accredited laboratory and comprised determination of:

- particle size distribution on 2 samples; and
- Atterberg limits and linear shrinkage on 2 samples.

Laboratory test results along with the test methods followed are included in Appendix C, Laboratory Test Results and are summarised in Table 2, Summary of Laboratory Test Results.

Table 2: Summary of Laboratory Test Results

Test Pit	Depth (m)	% Gravel	% Sand	% Fines	LL (%)	PI (%)	LS (%)
CPT02	1.0-2.0	0	88	12	SIC	NP	0.0
CPT05	1.0-1.5	26	46	28	47	32	13.0

LL: Liquid Limit PI: Plasticity Index LS: Linear Shrinkage
SIC: Slipped in cup NP: Non-Plastic

6. SITE CONDITIONS

6.1 Geology

The Armadale sheet of the 1:50,000 scale Environmental Geology series map indicates that the area is underlain by alluvium comprising sandy clay described as white-grey to brown, fine to coarse grained, sub-angular to rounded sand, clay of moderate plasticity, gravel and silt near scarp.

The findings of our investigation are generally in accordance with the geological mapping.

6.2 Subsurface Conditions

Based on the CPT data, we interpret that the site is underlain by the following strata:

- Clayey SAND/Sandy CLAY, typically stiff to hard, locally firm, moderate to high plasticity fines, extending from the ground surface to depths ranging from 1.5 m to 3.0 m; overlying
- Clayey/Silty SAND, very dense/hard, between 0.5 m and 1.5 m thick; extending to depths ranging from 2.0 m to 5.2 m overlying
- Clayey SAND/Sandy CLAY, very stiff and hard, extending to the maximum depth investigated of 6.0 m.

Note: 1. Soil descriptions inferred from Robertson et al interpretation and limited sampling.

2. A 1.0 m thick surface layer of sand (with clayey lenses) was encountered in CPT01 in the southern part of the site. The thickness of sand is expected to increase southwards towards Westfield Road.

3. Shallow refusal of CPT on cemented zones (or possibly roots/other obstructions) in CPT4 and CPT6.

6.3 Groundwater

The Perth Groundwater Atlas (2004) shows the groundwater level to be between RL 17 m and RL 18 m AHD. However, these groundwater contours were extrapolated from groundwater levels recorded in May 2003 following a prolonged dry period. Maximum historical groundwater levels are therefore likely to be at a higher level. As most of the site appears to be low-lying, we expect that water ponds on surface over much of the site in the wetter part of the year.

Groundwater was not encountered within any of the holes formed by the CPT (maximum depth of investigation was 6.0 m).

7. GEOTECHNICAL ASSESSMENT

7.1 Site Classification

The site classification is based on AS 2870-2011 "Residential Slabs and Footings" which defines the following site classes:

Table 3: Summary of Site Classification (AS 2780-1996)

Class	Description	Characteristic Surface Movement (y_s)
A	Most sand and rock sites with little or no ground movement from moisture change	Not defined (typically <5 mm)
S	Slightly reactive clay sites with only slight ground movement from moisture changes	0-20 mm
M	Moderately reactive clay or silt sites which can experience moderate ground movement from moisture changes	20-40 mm
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes	40-60 mm
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes	60-75 mm
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes	> 75 mm
P	Soft or unstable foundations such as soft clay or silt or loose sands, landslip, mine subsidence, collapsing soils and soils subject to erosion, reactive sites subject to abnormal moisture conditions, site underlain by uncontrolled fill, etc	Not defined

Based on our assessment, we consider the entire site (except the southern end) to be class 'P' in its current condition. This is due to:

- the presence of clay below the entire site and extensive evidence of clay-related surface movement on Railway Avenue and in the residential area to the west of the site (see Photographs 5 and 6 in Appendix A); and
- the likelihood of surface ponding, poor drainage and poor traffickability during the wet season

Development of this site (other than the higher-lying area to the south) in its current conditions is not recommended.

The site classification can be changed to a Class 'S' site classification by ensuring that there is a minimum thickness of 0.8 m of compacted inert granular material above the clayey soils.

This thickness of granular material includes any depth of *in situ* sand present. Any fill required to achieve this minimum thickness should be in accordance with Section 7.4 and comprise compacted sand (*in situ* or imported fill) above the expansive clayey layers.

The recommended minimum thickness of sand fill has been calculated to minimise the potential heave such that a Class S site classification is achieved. The finished site elevation may have to be raised depending on floodlines and surface drainage requirements. The assessment of such floodlines is outside the scope of this investigation.

The southern part (to the south of CPT01), may be classified as Class S due to the expected thickness of about 0.8 m of sand above the clay. This must be confirmed at the time of the bulk earthworks.

All foundations must be designed in accordance with AS 2780-2011, assuming the given site classification following subgrade preparation as detailed in Section 7.2.

Seasonal movements are highly likely not only from seasonal wetting and drying but also due to the presence of large mature trees throughout the area. We refer you to the CSIRO publication "Foundation Maintenance and Footing Performance: A Homeowner's Guide" (http://www.unitcare.com.au/pdfs/Foundation_maintenance_csiro.pdf). It contains useful information relevant to vegetation close to constructions on reactive clay sites. It is possible that site surface movements could potentially be worse than suggested by the site classification nominated due to the significant change in soil suctions over the year caused by rainfall (winter, saturated conditions) and dry weather combined with vegetation (summer, soil suctions will be larger, including suctions at depth from deeper tree roots).

As a guide, single trees may be considered to have a root influence zone in plan approximately equal to their height. A line of trees may be considered to have a root influence zone in plan equivalent to 1.5 times the height of the trees.

Where trees are removed, it will typically take one year for the soil to reach a state of moisture equilibrium with respect to the influence otherwise exerted by the trees on soil moisture content.

7.2 Site Preparation

The site preparation measures outlined below are aimed at improvement of the site in preparation for construction of buildings including on-ground slabs and shallow footings, retaining walls, culverts and pavement subgrades.

Recommended site preparation measures are as follows:

- strip vegetation from the site including grubbing out of tree roots and removal of rubbish;
- strip and stockpile topsoil from the site for potential re-use in non-structural applications (we consider a 100 mm strip should be adequate);
- compact the exposed soil with a minimum of 4 passes of a 10 tonne (minimum static mass) padfoot roller. Any soft zones must be excavated and replaced with approved fill material;
- Given the presence of moderate to high plasticity clays across the site (which hold water and soften significantly when exposed to water), traffickability of the site may be compromised during and following winter and any other times of high rainfall. For this reason, broad-acre site preparation involving trimming near clay level is recommended to be conducted in late summer. We would be pleased to provide further advice on this if required.
- Fill to build up levels using approved granular fill (refer to Section 7.4) to the required level. Fill must be placed and compacted in layers of no greater than 300 mm loose thickness.

We note that compaction of sand within 1 m of the groundwater level can be difficult. Further advice should be sought in this regard if such compaction is likely to be conducted when groundwater is within 1 m of the surface to be compacted. We recommend that site preparation occurs in summer, preferably late summer.

After compaction, verify that the required level of compaction has been achieved by testing to a minimum depth of 0.9 m below foundations:

- on each lift of fill at the rate of 1 test per 500 m^3;
- at 15 m centres along retaining wall footings; and
- at 15 m centres on pavement subgrades.

7.3 Compaction

In situ sand and granular fill must be compacted using suitable compaction equipment to achieve a dry density ratio (DDR) of at least 95% of maximum modified dry density (MMDD) as determined in accordance with AS 1289 5.2.1.

If sand is used as fill and a Perth sand penetrometer (PSP) is used for compaction control, we consider a blow count of 8 blows per 0.3 m penetration to correlate to a density of 95% MMDD. If difficulty arises in achieving the specified PSP blow count, then a calibration must be established between PSP blow count and the *in situ* density. This will allow confirmation of the blow count required to achieve a dry density ratio of at least 95%. We consider that the above will also be appropriate for PSP testing of the in-situ sand. **Note:** A PSP may only be used for compaction testing of sand (i.e. material with a maximum particle size of 2 mm and maximum fines content of 5%). Where gravelly or clayey fill is used, compaction testing must be done using a nuclear density gauge in accordance with AS 1289.5.8.1.

Over-excavation and replacement of loose materials may be required where the minimum density ratio cannot be achieved.

Fill must be placed in horizontal layers of not greater than 0.3 m loose thickness. Each layer must be compacted by suitable compaction equipment, and carefully controlled to ensure even compaction over the full area and depth of each layer.

Care will need to be taken when compacting in the vicinity of existing structures. This is particularly important if vibratory compaction is being carried out. Tynan (1973)[1] provides assistance with the selection of compaction equipment for use adjacent to structures.

We note that compaction within 1 m of the groundwater table is likely to be difficult. Difficulties may be experienced in places where water ponds on the clayey surface during the rainy season.

7.4 Approved Fill

Imported granular fill must comply with the material requirements as stated in AS 3798-2007, "Guidelines on Earthworks for Commercial and Residential Developments". Sand fill must comprise clean sand that is largely free of organic matter (<2% by weight) and have a fines content of less than 5%.

Where doubt exists about the excavation or use of any materials on site, a geotechnical engineer must be engaged to inspect and approve the use of potential fill materials.

7.5 Footings

Where footings are placed within compacted granular fill (minimum 0.8 m thick) as described in Section 7.2, an allowable bearing pressure of 100 kPa may be assumed for footings greater than 0.5 m wide.

The estimated settlement of such footings is estimated to be less than 10 mm. Most of this movement (~70%) is expected to occur during construction.

Note: In addition to the estimated maximum settlement of 10 mm, we note that movements of the order of 20 mm may be expected due to changes in the moisture of the underlying clay.

[1] Tynan (1973) Ground Vibration and Damage Effects on Buildings, Australia Road Research Board, Special Report No. 11.

7.6 Stormwater Disposal

As the *in situ* clayey soil has a relatively high fines content, it has a low permeability. Soakwells should therefore not be placed into this material.

Soakwells may be used where at least 1.2 m of sand is placed above the clay subgrade. For preliminary design purposes, a soil permeability (k) of 3 m/day may be used for soakwell design. This value should be confirmed by in-situ testing of the compacted sand fill following completion of the bulk earthworks.

Where possible, soakwells should not be placed within 3 m of footings (subject to local council regulations). Discharge from soakwells has been known to cause densification of loose sandy soils, leading to settlements of footings and slabs. Where soakwells are placed closer to footings, they must be carefully wrapped with geotextile to prevent migration of sand and fines into the soakwell.

7.7 In-situ Subgrade CBR

We consider that the in-situ subgrade clayey material has a soaked CBR of between 3% and 5% when compacted to a dry density ratio of 95% using Modified compactive effort.

Where there is at least 500 mm of compacted sand is present as per Section 7.2, a subgrade CBR of 12% may be assumed for pavement thickness design.

7.8 Retaining Walls

Retaining structures may be designed in accordance with AS 4678-2002 "Earth-Retaining Structures". For the design of retaining structures, the following parameters in Table 4 are appropriate.

Table 4: Recommended Retaining Wall Design Parameters

Soil Type	Bulk Density (t/m^3)	Angle of Internal Friction (deg.)	Wall Friction = 0°		Wall Friction = 0.5Φ	
			Coefficient of Active Earth Pressure, K_a	Coefficient of Passive Earth Pressure, K_p	Coefficient of Active Earth Pressure, K_a	Coefficient of Passive Earth Pressure, K_p
Dense or well compacted sand	18	36	0.26	3.9	0.22	6.5

Note:

1. Earth pressure coefficients are provided in this table for conditions of zero friction between the wall and the soil and with wall friction of 0.5Φ′. The retaining wall designer must make an independent assessment of the parameters appropriate to the construction method to be used, including alternative values of wall friction. A horizontal ground surface behind the wall has been assumed.

2. It is assumed that a suitable drainage layer and/or subsoil system is installed behind all walls such that the build-up of water pressure behind the walls is prevented.

Compaction plant can augment the lateral earth pressure acting on retaining walls. Hand operated compaction equipment is recommended within 2 m of any retaining walls to minimise compaction pressures.

It is important to note that some ground movement will occur behind any soil retaining system, including gravity retaining walls.

8. CLOSURE

We draw your attention to Appendix D of this report, Understanding Your Geotechnical Engineering Report. The information provided within is intended to inform you as to what your realistic expectations of this report should be. Guidance is also provided on how to minimise risks associated with groundworks for this project. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

GALT GEOTECHNICS PTY LTD

Rick Piovesan CPEng

Geotechnical Engineer

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Figures

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014
ABN: 73 292 586 155

Legend

- Site Boundary
- Cone Penetration Test

0 30 60 90 120 150
Meters

SCALE	1:2,000 (A3)
DRAWN	JW
DATE DRAWN	16/04/2014
CHECKED	RP
DATE CHECKED	25/04/2014
PROJECTION	GDA 1994 MGA Zone 50

Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Fax : +61 (0)8 9285 8444
Address: U2, 39 Flynn Street, Wembley, WA, 6014

CLIENT	**PROPERTY EDGE WA PTY LTD**
PROJECT	PROPOSED APARTMENT DEVELOPMENT
LOCATION	LOT 27 WESTFIELD ROAD CAMILLO
TITLE	SITE LOCATION AND SITE PLAN
Job No	P1401128
Fig No	FIGURE 1
Rev	**A**

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Appendix A: Site Photographs

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ABN: 73 292 586 155

Photograph 1: Looking south – CPT rig at CPT01 location

Photograph 2: Typical view of site – looking north along western boundary

Photograph 3: Looking north from southeast part

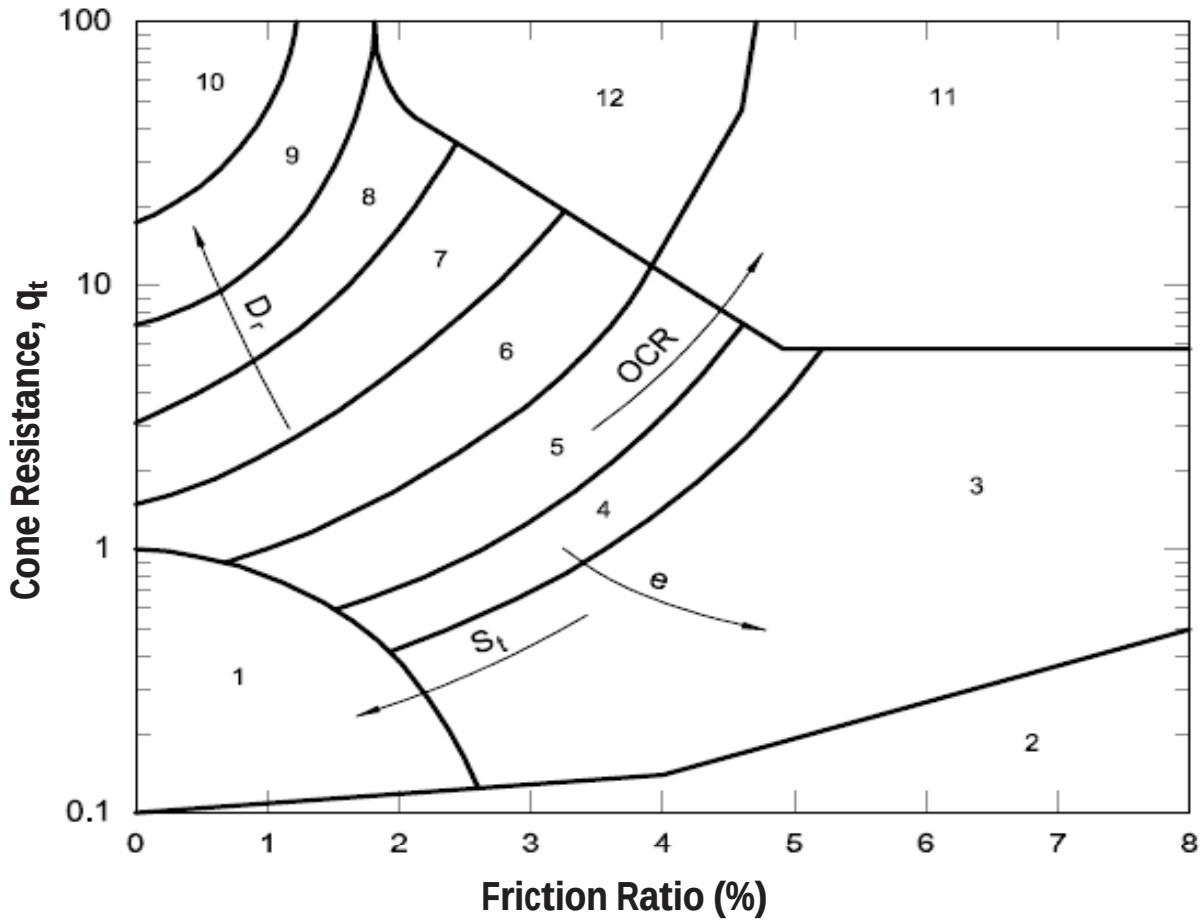
Photograph 4: Embankment along Railway Avenue (eastern boundary)

Photograph 5: Surface deflections on Railway Avenue

Photograph 6: Typical cracking in driveways in residential area west of site

Appendix B: Cone Penetration Test Data

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014
ABN: 73 292 586 155



DEFINITIONS

q_t : Cone tip resistance corrected for pore water pressure
S_t : Sensitivity
e : Void ratio
D_r : Relative density
OCR : Overconsolidation ratio
OC : Overconsolidated

SOIL BEHAVIOUR TYPE ZONES

1. Sensitive fine grained
2. Organic material
3. Clay
4. Silty clay to clay
5. Clayey silt to silty clay
6. Sandy silt to clayey silt
7. Silty sand to sandy silt
8. Sand to silty sand
9. Sand
10. Gravelly sand to sand
11. Very stiff fine grained material (OC/cemented)
12. Sand to clayey sand (OC/cemented)

NOTES

A. Some overlap in type zones is expected
B. Local correlations are preferred and may indicate soil type boundaries that are different from those shown above

Reference: Robertson, P.K., Campanella, R.G., Gillespie, D. and Grieg, J. (1986) "Use of Piezometer Cone Data". Proceedings of the ASCE Speciality Conference In Situ '86: Use of In Situ Tests in Geotechnical Engineering, Blacksburg, pp 1263-80, American Society of Civil Engineers (ASCE)

Galt GEOTECHNICS

CONE PENETRATION TESTING (CPT) SOIL TYPE INTERPRETATION

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Property Edge WA Pty Ltd

PROJECT: Lot 27 Westfield Road

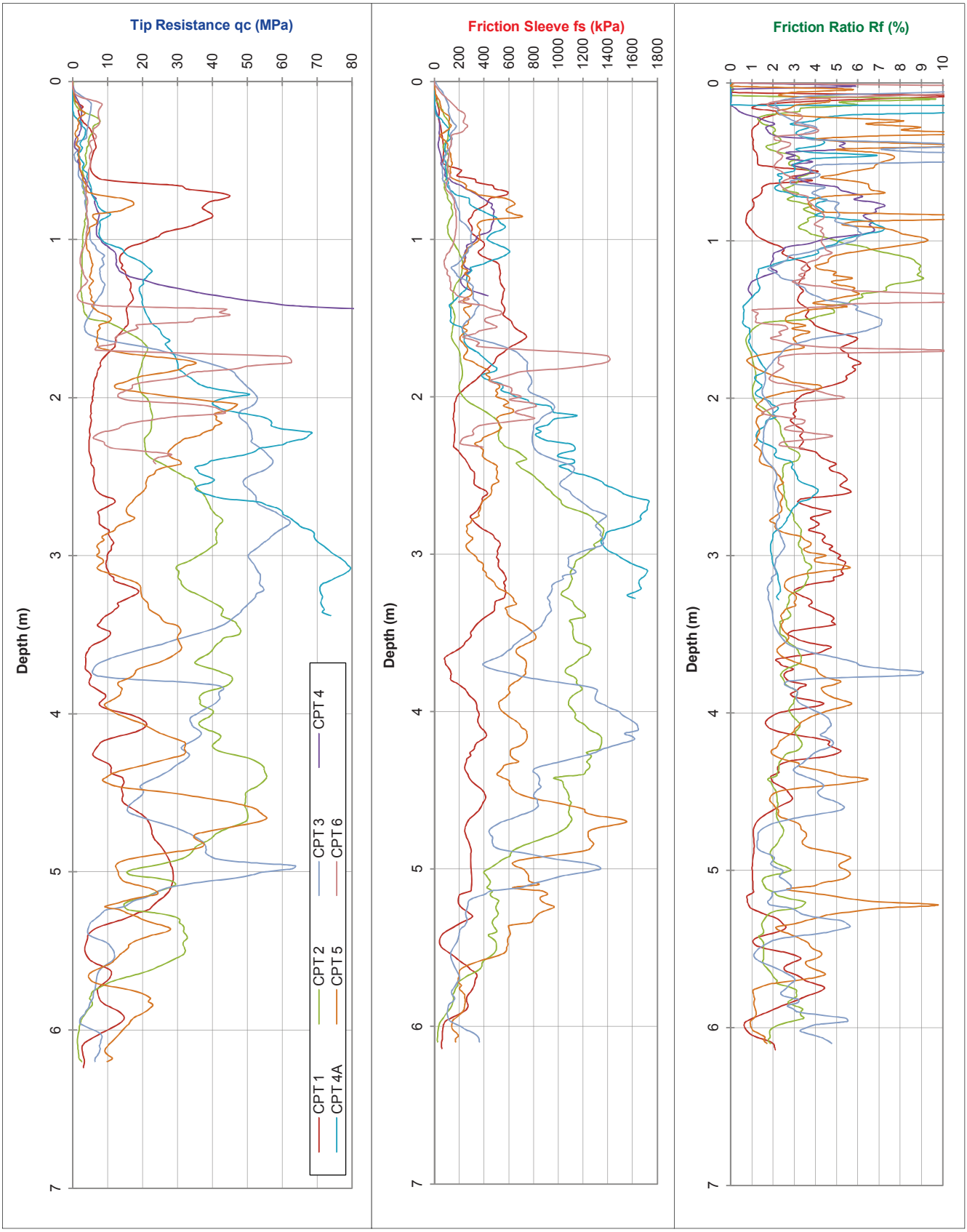
LOCATION: Camillo

Date: Thursday, 10 April 2014

Probe No.: All Data

Job Number: J1401067

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph. 9314 6611 Fax: 9314 6699

Water (m):

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File:

Dummy probe to (m):

Cone I.D. :

22 tonne truck mounted CPT Rig (Merc)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Property Edge WA Pty Ltd

PROJECT: Lot 27 Westfield Road

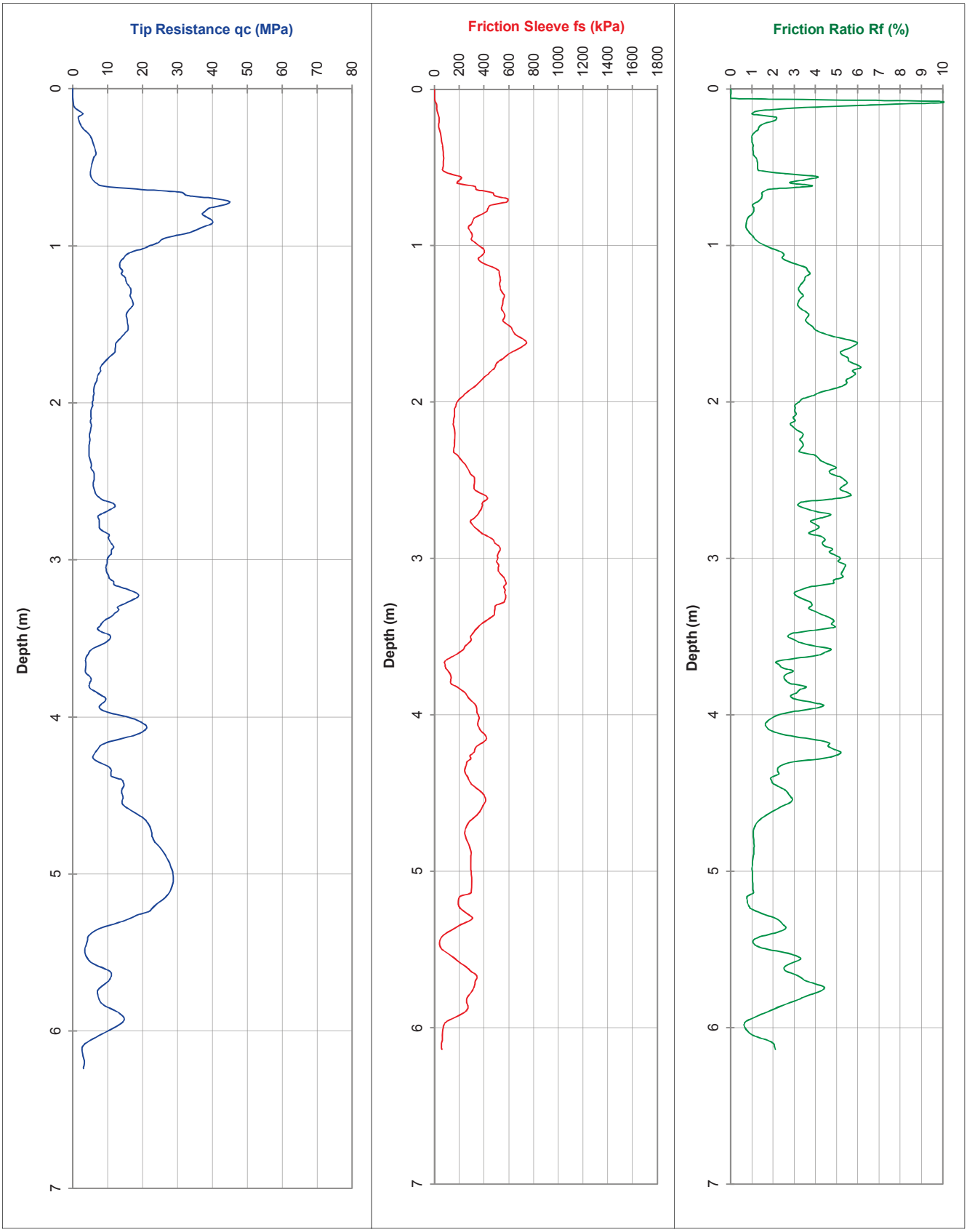
LOCATION: Camillo

Date: Thursday, 10 April 2014

Probe No.: CPT 1

Job Number: J1401067

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

Water (m): Dry to 5.6

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0341G

Dummy probe to (m):

Cone I.D. : ECF68GM

22 tonne truck mounted CPT Rig (Merc)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Property Edge WA Pty Ltd

PROJECT: Lot 27 Westfield Road

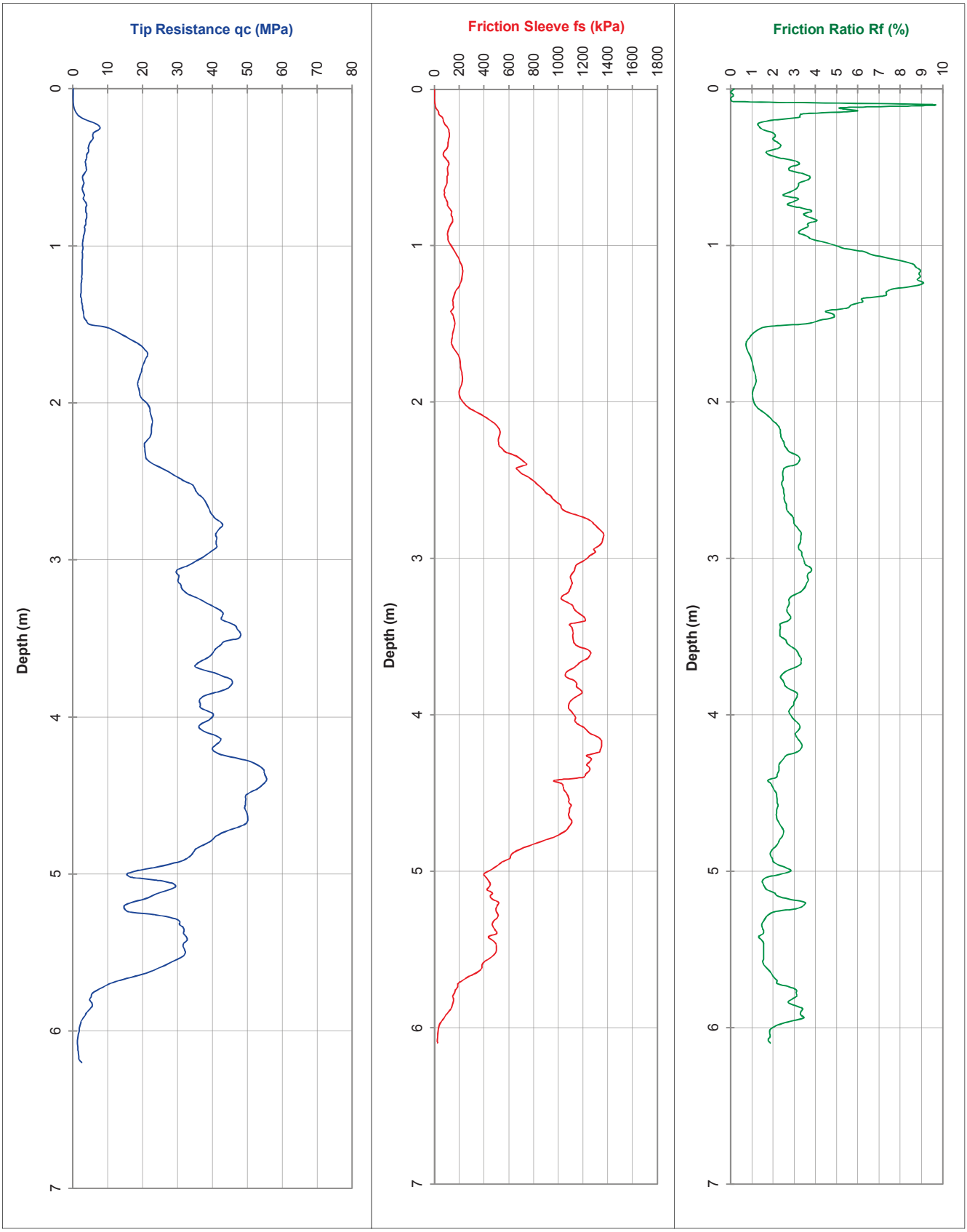
LOCATION: Camillo

Date: Thursday, 10 April 2014

Probe No.: CPT 2

Job Number: J1401067

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

Water (m): Dry to 5.1

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0342G

Soil Sample @ (m): 1.0-1.5, 1.5-2.0

Cone I.D. : E

22 tonne truck mounted CPT Rig (Merc)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Property Edge WA Pty Ltd

PROJECT: Lot 27 Westfield Road

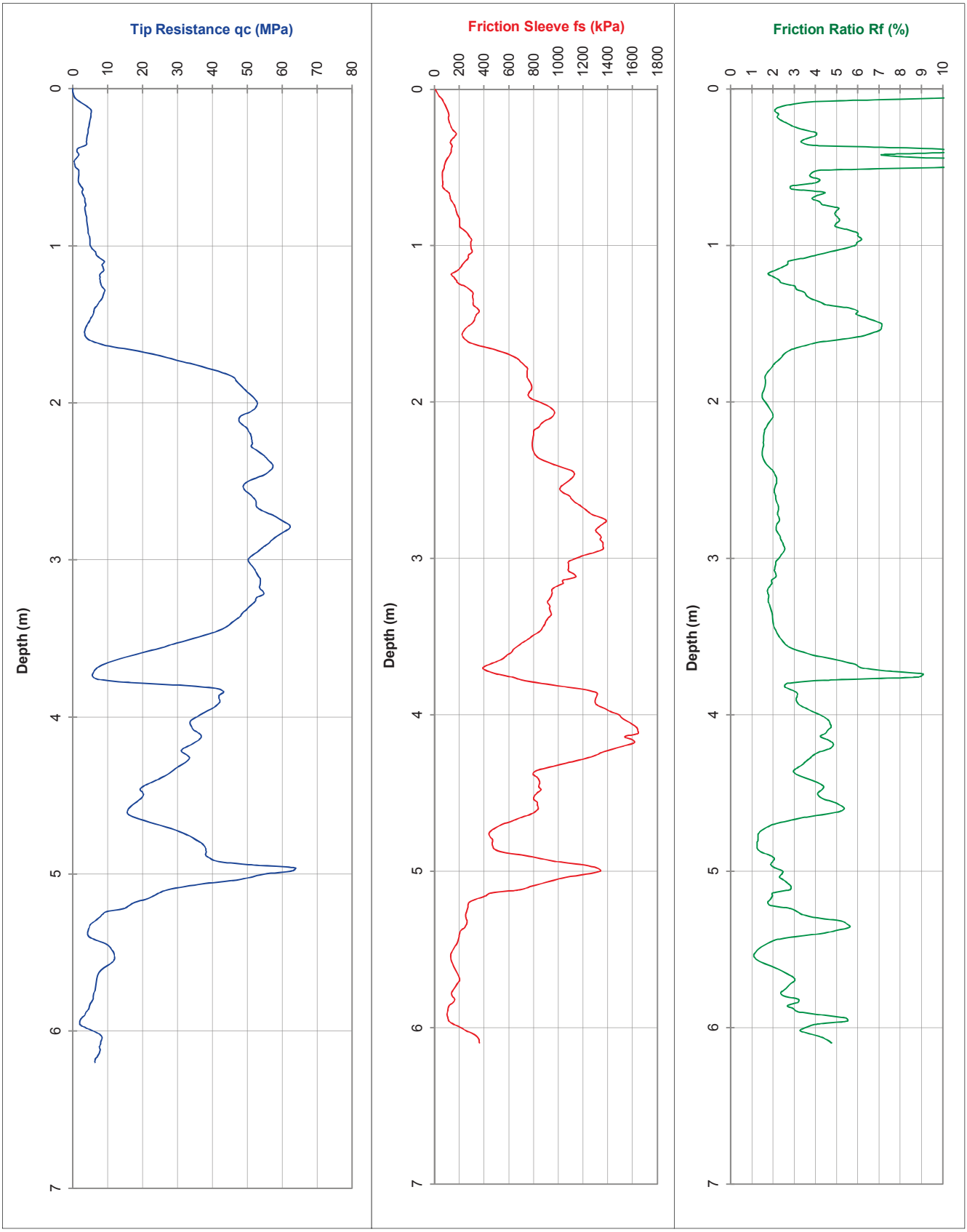
LOCATION: Camillo

Date: Thursday, 10 April 2014

Probe No.: CPT 3

Job Number: J1401067

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

Water (m): Dry to 5.2

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0339G

Dummy probe to (m):

Cone I.D. : ECF68GM

22 tonne truck mounted CPT Rig (Merc)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Property Edge WA Pty Ltd

PROJECT: Lot 27 Westfield Road

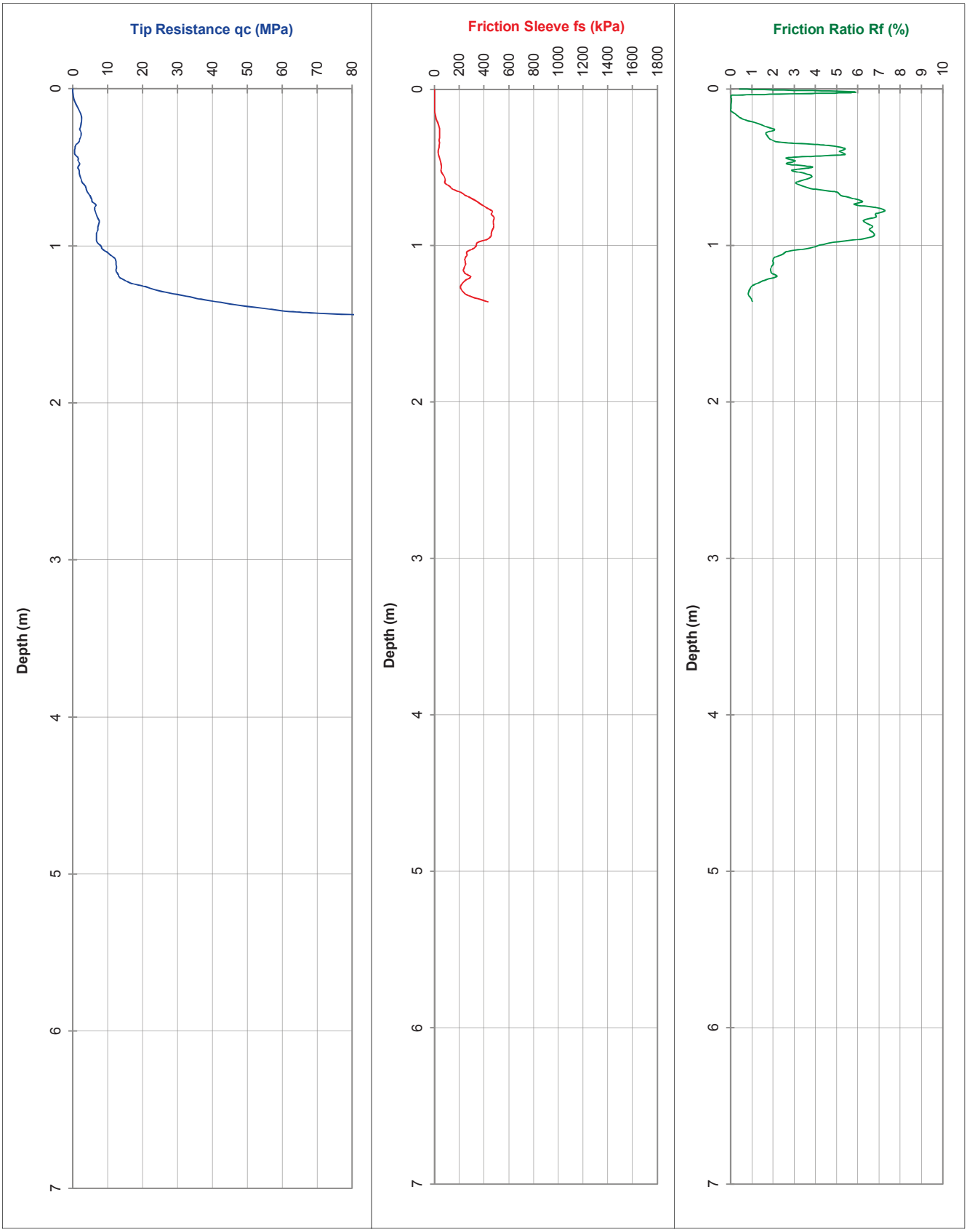
LOCATION: Camillo

Date: Thursday, 10 April 2014

Probe No.: CPT 4

Job Number: J1401067

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

Water (m):

Refusal: 100MPa

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0343G

Dummy probe to (m):

Cone I.D. : ECF68GM

22 tonne truck mounted CPT Rig (Merc)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Property Edge WA Pty Ltd

PROJECT: Lot 27 Westfield Road

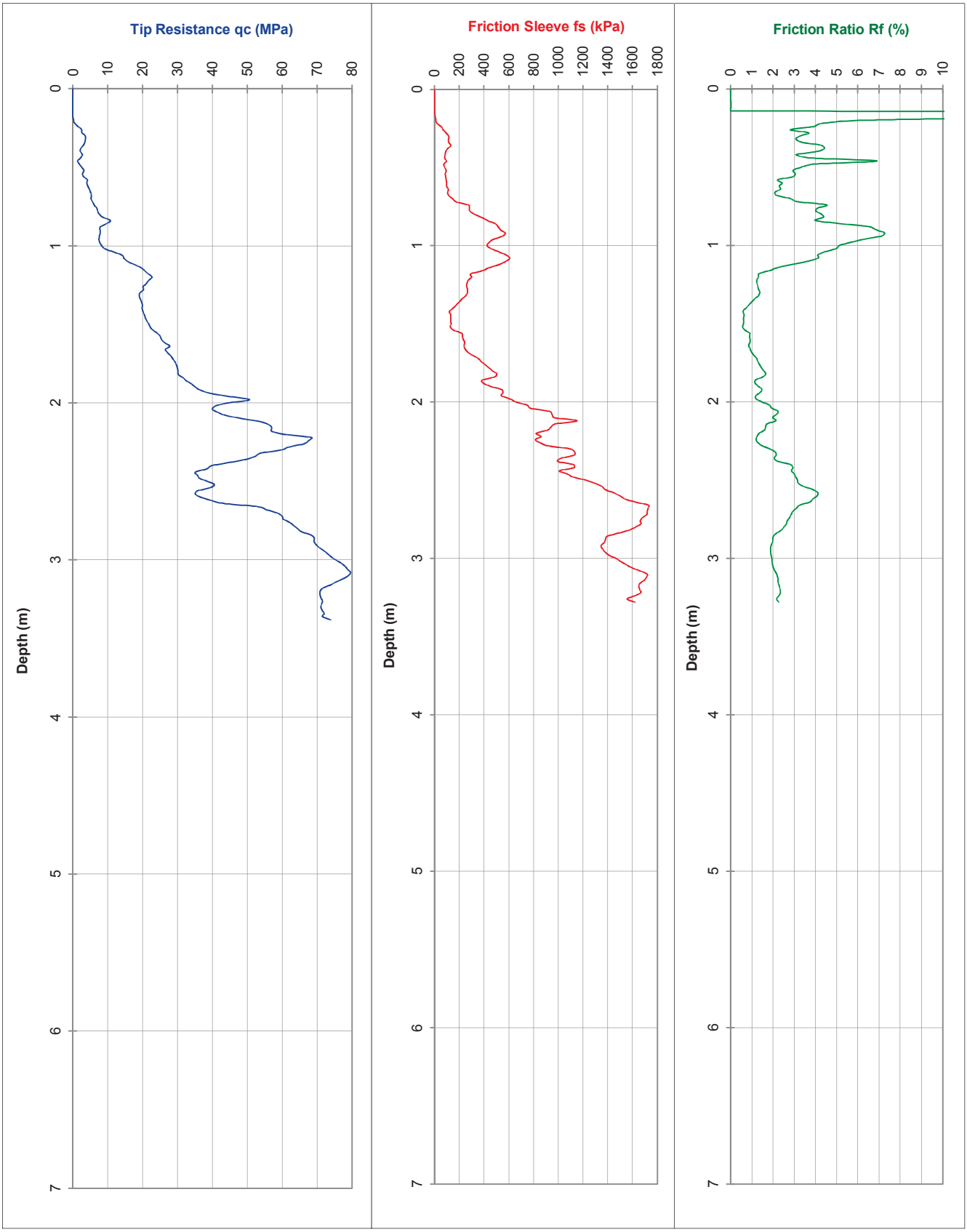
LOCATION: Camillo

Date: Thursday, 10 April 2014

Probe No.: CPT 4A

Job Number: J1401067

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

Water (m):

Refusal: Rod Friction

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0337G

Dummy probe to (m):

Cone I.D. : ECF68GM

22 tonne truck mounted CPT Rig (Merc)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Property Edge WA Pty Ltd

PROJECT: Lot 27 Westfield Road

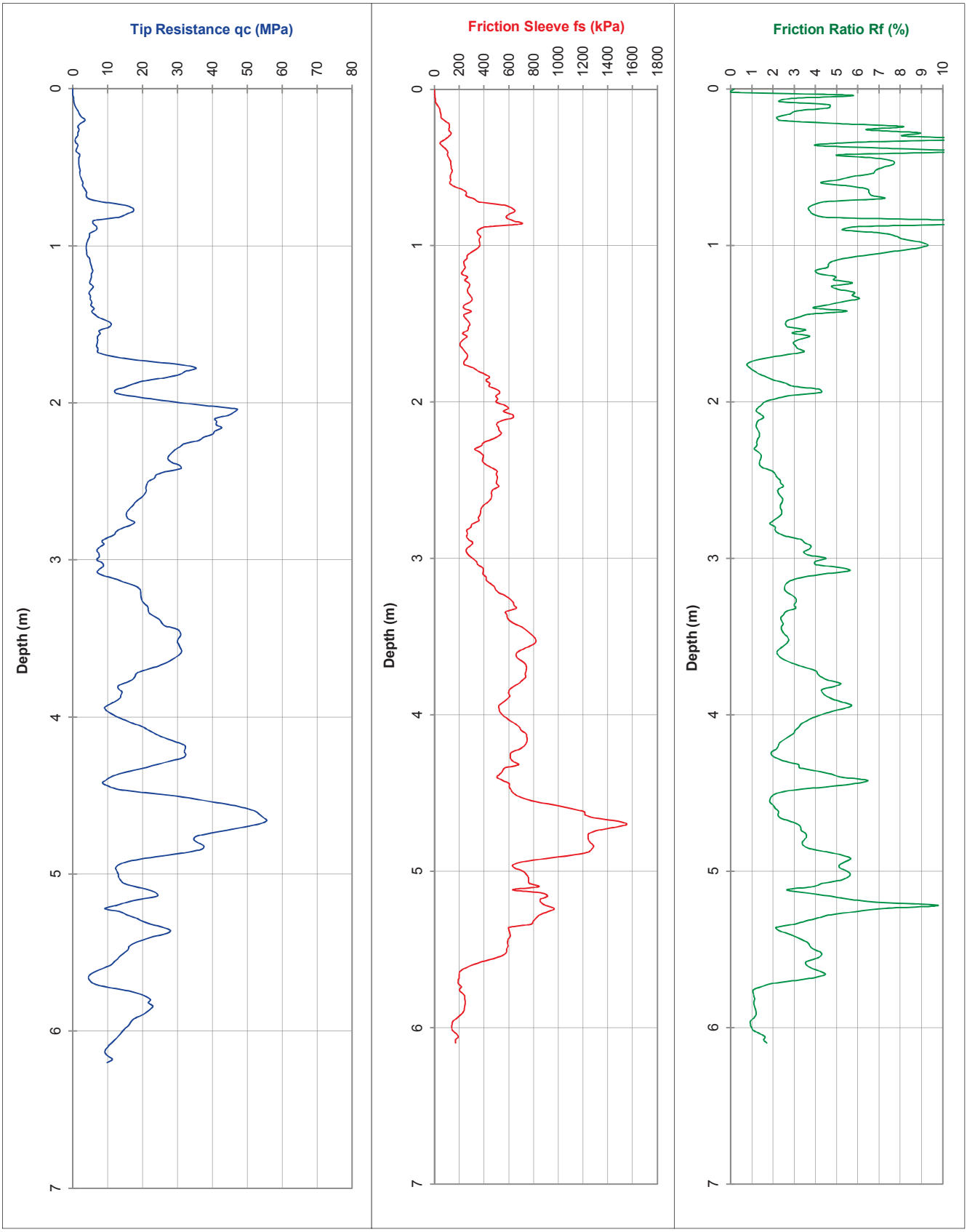
LOCATION: Camillo

Date: Thursday, 10 April 2014

Probe No.: CPT 5

Job Number: J1401067

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

Water (m): Dry to 6.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0338G

Soil Sample @ (m): 1.0-1.5

Cone I.D. : ECF68GM

22 tonne truck mounted CPT Rig (Merc)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: Property Edge WA Pty Ltd

PROJECT: Lot 27 Westfield Road

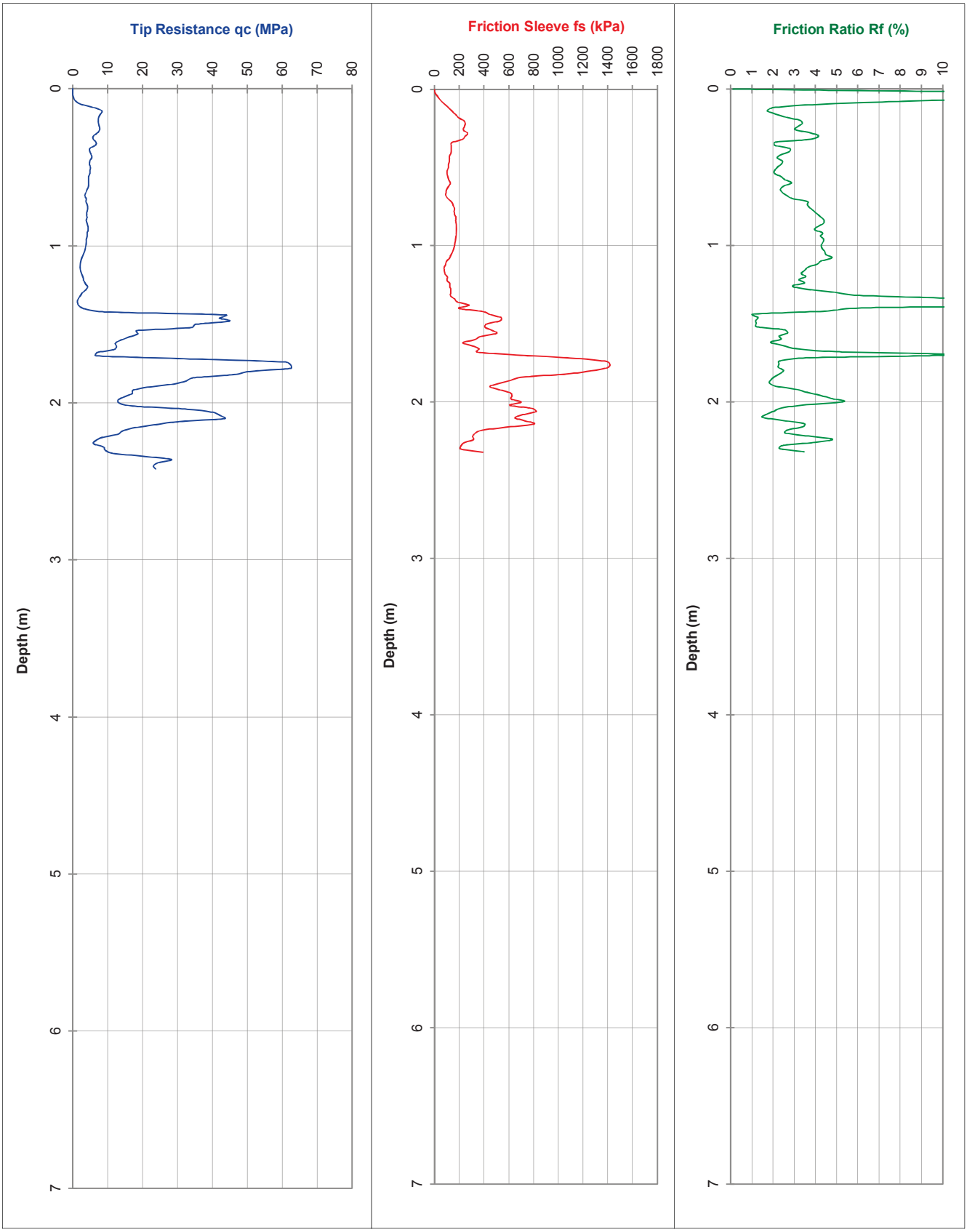
LOCATION: Camillo

Date: Thursday, 10 April 2014

Probe No.: CPT 6

Job Number: J1401067

Co-ordinates:



PROBEDRILL PTY LTD
GEOTECHNICAL SURVEY
Ph: 9314 6611 Fax: 9314 6699

Water (m): Dry to 2.0

Refusal: Inclination

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0340G

Dummy probe to (m):

Cone I.D. : ECF68GM

22 tonne truck mounted CPT Rig (Merc)

Appendix C: Laboratory Test Results

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2/39 Flynn St, WEMBLEY WA 6014
ABN: 73 292 586 155

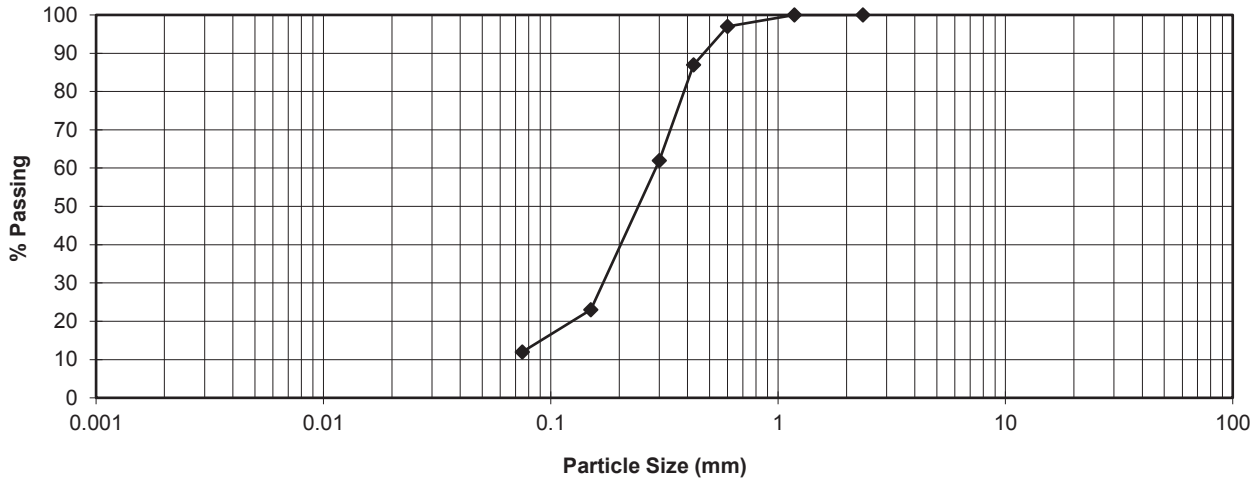
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: matt@mcgeotest.com.au

Job No:	60083
Report No:	60083-P14/1042
Sample No:	P14/1042
Issue Date:	23 April 2014

Client: Galt Geotechnics (J1401067)
Project: Residential Subdivision
Location: Lot 27 Westfield Street, Camillo

Sample ID: CPT02
Sample Depth: 1.0-2.0



SIEVE ANALYSIS AS 1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	97
0.425	87
0.300	62
0.150	23
0.075	12

Plasticity index tests
AS 1289

Liquid limit 3.1.1	SIC	%
Plastic limit 3.2.1	NP	%
Plasticity index 3.3.1	NP	%
Linear shrinkage 3.4.1	0.0	%

Cracked ☐
Curled ☐

Client Address: 2/39 Flynn Street, Wembley WA

Sampling Procedure: Tested as received

NATA WORLD RECOGNISED ACCREDITATION

Approved signature

Matthew van Herk
AS PSDPI May 2009

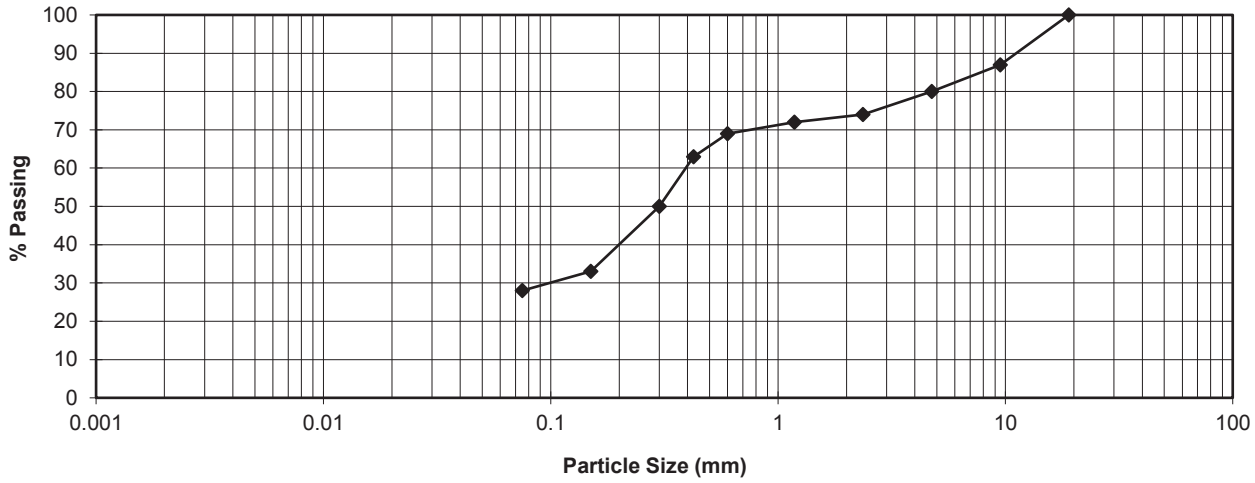
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: matt@mcgeotest.com.au

Job No:	60083
Report No:	60083-P14/1043
Sample No:	P14/1043
Issue Date:	23 April 2014

Client: Galt Geotechnics (J1401067)
Project: Residential Subdivision
Location: Lot 27 Westfield Street, Camillo

Sample ID: CPT05
Sample Depth: 1.0-1.5



SIEVE ANALYSIS AS 1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	87
4.75	80
2.36	74
1.18	72
0.600	69
0.425	63
0.300	50
0.150	33
0.075	28

Plasticity index tests
AS 1289

Liquid limit 3.1.1	47	%
Plastic limit 3.2.1	15	%
Plasticity index 3.3.1	32	%
Linear shrinkage 3.4.1	13.0	%

Cracked ☐
Curled ☐

Client Address: 2/39 Flynn Street, Wembley WA

Sampling Procedure: Tested as received

NATA WORLD RECOGNISED ACCREDITATION

Approved signature

Matthew van Herk
AS PSDPI May 2009

Appendix D: Understanding Your Geotechnical Engineering Report

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ABN: 73 292 586 155

UNDERSTANDING YOUR GEOTECHNICAL ENGINEERING REPORT

GALT FORM PMP11 Rev1

1. EXPECTATIONS OF A GEOTECHNICAL ENGINEERING REPORT

This document has been prepared to clarify what is and is not provided in your geotechnical report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with geotechnical conditions.

Geotechnical engineering is a less exact science than other engineering disciplines. We include this information to help you understand where our responsibilities as geotechnical engineers begin and end, to help the client recognise his responsibilities and risks. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of geotechnical problems and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following :

- The project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this geotechnical report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your geotechnical engineering report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the design team and by being able to review work produced by other members of the design team which relies on geotechnical information provided in our report.

3. GEOTECHNICAL ENGINEERING LOGS

Our reports often include logs of intrusive and non-intrusive geotechnical investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party as a consequence of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SUBSURFACE CONDITIONS

The geotechnical recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including as a result of anthropogenic events (such as construction on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

6. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use engineering judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from engineering judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

7. ENVIRONMENTAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not included. The investigation techniques used by us in developing our report differ from those for an environmental investigation. Our report was not prepared with environmental considerations in mind and it is the client's responsibility to satisfy himself that environmental considerations have been taken into account for the site. If you require guidance on how to proceed on evaluating environmental risk at the site, we can provide further information and contacts.

APPENDIX C

Traffic Impact Assessment prepared by KCTT

TRANSPORT IMPACT ASSESSMENT

Structure Plan for Lots 58 to 60 Centre Road and Lot 27 Westfield Road

May 2015,

Rev C

kctt

HISTORY AND STATUS OF THE DOCUMENT

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Rev A	13.05.2015	M Kleyweg	C Kleyweg	13.05.2015	Issued for Review
Rev B	22.05.2015	M Kleyweg	C Kleyweg	22.05.2015	Amended development structure for lot 60 Centre Road and all associated calculations; Executive summary added.
Rev C	25.05.2015	C Kleyweg	C Kleyweg	25.05.2015	Final revisions prior to submission

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1. Introduction

1.1 Executive Summary

The following dot points have been taken from our Conclusions in Section 3 – Transport Impact Assessment Checklist: -

- The focus of this report is a traffic analysis of the proposed development of Lot 27 Westfield Road, Camillo. The proposed development of this particular site comprises of 174 residential units.
- Although the proposed development will have a significant impact according to the WAPC guidelines criteria, it will not adversely impact the existing intersections or road networks.
- All internal access ways and crossovers / intersections have been designed to accommodate the necessary turning vehicles. KCTT have offered suggestions for improvement at intersections fronting gazetted roads with all kerb radii to be a minimum radius = 6 metres for standard 85th percentile vehicles and radius = 9 metres where turning movements for waste service vehicles are required. These improvements can be accommodated within the design, therefore we believe the development complies with all traffic and transport related requirements.
- The development has excellent connectivity to public transport with the majority of dwellings within an 800 metre radius of the Kelmscott Railway Station. The remainder of dwellings have excellent connectivity to existing bus services in Railway Avenue which offer direct connectivity to the Kelmscott Railway Station Bus / Rail Interchange.
- The subject site has excellent connectivity to major road networks in the south-east metropolitan corridor and therefore should not impact local residential streets.
- The subject site has strong connectivity with bicycle and pedestrian infrastructure which is noted as having good to high quality.
- The extension of Hemingway Drive to Railway Avenue will need to be designed to City of Armadale standards. We believe the intersection of Hemingway Drive and Railway Avenue should have a Give Way control in Hemingway Drive.
- The development is expected to have a traffic generation rate of 5.5 VPD/ dwelling (for dwellings larger than 110m2) and 4.5 VPD / dwelling (for dwellings smaller than 110m2). A high percentage of the remainder of the Structure Plan Area is within the walkable catchment as well.
- It is estimated that the full Structure Plan Area is likely to generate 1,873 vehicles per day and 300 vehicles per hour in the peak hour. The proposed development of Lot 27 Westfield Road, Camillo is expected to generate up to 837 vehicles per day and 139 vehicles per hour.
- Given that the Structure Plan Area features 9 main access points which provide connectivity to the surrounding road network, the pressure of accommodating access of the additional traffic volumes is spread with no one access / egress creating "congestion" issues.
- The extension of Hemingway Drive to intersect with Railway Avenue will alleviate additional traffic pressures from Westfield Road and Centre Road.
- SIDRA analysis was conducted for years 2017 (the estimated year of completion of the development) and 2027. The analysis provided in Appendix 4 showed that the existing network has sufficient capacity to cater for the proposed development.
- In conclusion, the proposed development of 174 residential units over Lot 27 Westfield Road, Camillo will not have an adverse impact on the surrounding road network. The proposed development satisfies all relevant criteria in relation to traffic and parking requirements. The radii on access/egress points on Westfield Road and Railway Avenue south will need to be redesigned to accommodate movement of a waste collection vehicle.

We believe the development proposal is robust and that all of the general traffic and transport requirements of a project of this nature can be accommodated to the City of Armadale's requirements.

1.2 Transport Impact Assessment Layout

KCTT have been requested to provide a Transport Impact Assessment for the proposed Structure Plan over Lots 58 to 60 Centre Road and Lot 27 Westfield Road. The purpose of this document is to provide detailed commentary and analysis on the potential traffic and transport impacts that the proposed development of the Structure Plan area may have on both the surrounding road and transportation networks. The scope of this report is to provide a detailed assessment of the following: -

Phase 1 – Transport Impact Assessment

- Collate all available traffic volumes from the City of Armadale and Main Roads WA within 400 metres of the subject site.
- Download all available public transportation information, bicycle routes and pedestrian pathways within a 400 metre radius of the subject site.
- Undertake a site visit and review any existing sight distance / road geometry issues which should be considered in the reporting.
- Collate all crash data for roadways and intersections within a 400 metre radius of the subject site.
- Collate the road hierarchy information, roadway and carriageway widths for all roads directly fronting the subject site.
- Estimate the subject sites' trip generation and trip attraction on the basis of the proposed land-use quantities and areas.
- Confirm parking requirements.
- Compare the "before development" and "post development" scenarios, and therefore determine the impact of the development on the surrounding road network.
- Complete the transport impact assessment checklist for developments.
- Provide colour graphics showing the following details overlaid on aerial imagery: -
    - Traffic Flow Diagram – up to 400m radius (preferred option only)
    - Existing and future Daily Traffic Flows (combined diagram)
    - AM / PM peak hour Traffic Flows (combined diagram)
- SIDRA Analysis for the following intersections: -
    - Westfield Road / Railway Avenue
    - Access 1 / Westfield Road
    - Access 2 / Railway Avenue
    - Access 3 / Railway Avenue

This Transport Impact Assessment is presented in the following logical sequence: -

- Section 1 – Introduction

This section provides a brief description on the role of this report in the Structure Planning process, the general layout of the report and a list of the guideline and reference documents used in its composition.

- Section 2 – Transport Impact Assessment

This section provides research and analysis of the key items required for submission of a Transport Impact Assessment for Structure Plans in accordance with the Transport Assessment Guidelines nominated above. In this section, KCTT have examined the following subject areas:

- Section 2.1 – Development Outline

In consultation with Seville Corporation, we will provide a brief description of the Structure Plan and its proposed land uses.

- Section 2.2 – Existing Situation and External Traffic Networks

This section provides a description of the existing land uses within the Structure Plan area and collates all available traffic data external to the subject site. The transportation networks are examined for a minimum 400 metre radius from the edge of the Structure Plan area.

- Section 2.3 – Traffic Modelling for the Proposed Structure Plan area

This section describes KCTT's 4-step model which is used to determine the future traffic generation / attraction to and from the proposed Structure Plan area.

- Section 2.4 – Vehicle Access and Parking Requirements

This section generically describes vehicle access and parking requirements for individual land uses within the Structure Plan area.

- Section 2.5 – Management of Traffic Attracted to the Structure Plan Area

This section provides:-

- Section 2.5.1 – Hours of Operation

This section describes the general operating times for the land uses as they are proposed in the yields for the development of the Structure Plan area. This information assists in determining the likely timing of the AM and PM peaks, and therefore the peak impact on the existing and surrounding transportation network. The peak vehicle generation is the key for determining intersection capacities within a road network.

- Section 2.5.2 – Public Transport Access

This section provides a summary of the existing public transportation services available within an 800 metre radius of the Structure Plan area.

- Section 2.5.3 – Pedestrian and Cyclist Access

This section provides a summary of the existing pedestrian and cyclist infrastructure available within an 800 metre radius of the Structure Plan area.

- Section 3 – Transport Impact Assessment Checklist

This section provides a concise, tabulated summary and review of the detailed information presented in Section 2 of this report. The intention of this checklist is to document the findings of this report, and / or any of the likely transportation / safety issues which should be considered as part of the submission. This checklist has been developed in accordance with the requirements of the Transport Assessment Guidelines for Developments: Structure Plans.

1.3 Notes Pertaining To This Report

The purpose of this document is to undertake the following analysis to support the proposed development of the subject landholdings. The traffic and transportation requirements discussed in this report are based on the land uses and yields nominated by Seville Corporation dated April, 2015.

1.4 Available Information and Technical Literature

This section provides a brief description of the inputs used in the compilation of this report:

- WAPC Transport Impact Assessment Guidelines – Volume 2 Structure Plans;
- WAPC Transport Impact Assessment Guidelines – Volume 5 (referenced for PM peak hour and traffic splits);
- RTA NSW Guide to Traffic Generating Developments Version 2.2 October 2002 (referenced to determine trip generation / attraction rates for various land uses);
- Guide to Traffic Management – Part 3: Traffic Studies and Analysis, Austroads, 2008 (referenced to discuss requirements for provision of car parking for various land use types, and how trip attraction / generation rates can be cross-checked in this report to provide a robust and consistent transportation model);
- Guide to Traffic Management – Part 11: Parking, Austroads, 2008 (referenced to discuss requirements for provision of car parking for various land use types, and how trip attraction / generation rates can be cross-checked in this report to provide a robust and consistent transportation model);
- Guide to Traffic Management – Part 12: Traffic Impacts of Developments, Austroads, 2008 (referenced to discuss requirements for provision of car parking for various land use types, and how trip attraction / generation rates can be cross-checked in this report to provide a robust and consistent transportation model);
- City of Armadale Local Planning Policy – Town Planning Scheme No 4.

2. Transport Impact Assessment

2.1 Structure Plan Outline

The subject site is an undeveloped site located in the edge of urban residential area Camillo.

Camillo is a south-eastern suburb of Perth, Western Australia. Its local government area is the City of Armadale and it was part of Kelmscott until 1978. Until mid-2008 it was named Westfield. Camillo is bound by Perth to Armadale railway line, Champion Drive, Westfield Road and Lake Road. The suburb is made up largely of residential households.

An indicative Structure Plan for Lots 58 to 60 Centre Road and Lot 27 Westfield Road has been utilised for the purpose of this analysis in order to identify the potential transportation issues. The development yields utilised in this report are as indicated by the conceptual plans provided by Seville Corporation.

The subject site is bound to the east by Railway Avenue, to the north by Centre Road, to the west by the John Wollaston Anglican Community School and residential development; and to the south by Westfield Road and the Kelmscott Town Centre.

Total Lot area is 7.95ha with an approximate developable area of 60% or 4.77ha. The proposed Structure Plan over the subject site proposes 381 units and more than 5 Communal Open Space once the full development is completed. The proposed residential density ranges from R15 to R40 therefore the proposed development will comprise of one or two storey multiple dwellings and minor internal movement network.

Table 1 - Quantities of Proposed Uses

Proposed Land Use	Units (less than 75m²)	Units (75m² to 110m²)	Communal Open Space	Individual Dwellings	Residential Units	Lot Area	Approximate Developable Area
Lot 58 Centre Road	n.a.	n.a.	t.b.c.	60	n/a	2.202ha	1.321ha
Lot 59 Centre Road	n.a.	n.a.	t.b.c.	57	n/a	2.115ha	1.269ha
Lot 60 Centre Road	60 units	n.a.	t.b.c	24	60	1.443ha	8,658m²
Lot 27 Westfield Road	130 units	44 units	1,979m²	n.a.	174	2.1906ha	13,143m²
Total	**n/a**	**n/a**	**n/a**	**141**	**234**	**7.95ha**	**4,77ha**
Lot 27 Westfield Road - Stage 1	48 units	2 units	255 + 264 = 519m²	n.a.	n.a.	n/a	n/a
Lot 27 Westfield Road - Stage 2	56 units	16 units	826m²	n.a.	n.a.	n/a	n/a
Lot 27 Westfield Road - Stage 3	26 units	26 units	264 + 370 = 634m²	n.a.	n.a.	n/a	n/a

Plans showing the proposed development have been provided in Appendix 1 of this report.

2.2 Existing Situation and External Traffic Networks

The existing road network surrounding and within the subject area includes Centre Road to the north, Railway Avenue to the east, Westfield Road to the south and Hemingway Drive in the middle. A plan showing the existing network and distribution of the existing traffic volumes is provided in Appendix 2.

Albany Highway is a two-way, four-lane divided road classified as an Urban Highway/Primary Distributor. Each lane is approximately 3.5 metres wide in the subject area (from Tonkin highway intersections to Davis / Fancote Road). Three bus lines (220, 241 and 249) run on Albany Highway in the vicinity of the proposed development. Albany Highway has a legal speed limit of 60km/h within the surroundings of this development and 70km/h from Harry Hunter Rehab Centre Access to Mountain View.

Railway Avenue is a two-way, two-lane undivided road classified as a Significant Urban Local Road/Distributer A. The road pavement is approximately 8.0 metres wide. There is one bus service that operates along this street in the vicinity of the subject site however currently there are no bus stops in Railway Avenue interfacing the proposed development. There is a 2.0m wide pedestrian footpath along the western side of the road reserve at Railway Avenue. Current legal speed limit of 70kph is imposed between the intersections with Corfield Road and Westfield Road while speed limit of 60km/h is imposed between the intersections with Westfield Road and Camillo Road.

Westfield Road is classified as a Significant Urban Local Road / Distributor A by Main Roads WA standards. In the vicinity of the subject site, Westfield Road is a two-way, two-lane undivided road, close to the intersections with Railway Avenue with a speed limit of 60kph. The trafficable lanes are approximately 3.5m wide. Bus service (Route No 245) operates along the street in the vicinity of the subject site. Pedestrian paths are provided on the north side of the road reservation. There is one access / egress point to / from the site from Westfield Road.

Hemingway Drive is a two-way, two-lane undivided road classified as an Urban Local Road / Access Road. Carriageway is approximately 7.0 metres wide. Legal speed limit on this road is 50kph. Pedestrian paths are provided on the south side of the road reservation. There are two access / egress points to / from the Structure Plan.

It is expected that there will be several new roads within the proposed subject area; however the exact location of these roads is yet to be determined.

The following existing traffic volume information has been sourced from MRWA.

Table 2 - Traffic Volumes for Roads Adjacent to the Subject Site

Road Name	Functional Classification / Road Hierarchy	Location of Traffic Count	Vehicles Per Day (VPD)	Vehicles per Peak Hour (VPH)	Heavy Vehicle %	Year	Legal Speed Limit
Westfield Road	Significant Urban Local Road / Distributor B	North of Champion Drive	5,745	AM 0800 - 431 PM 1600 - 539	6.2	May 2013	60kph
		West of Railway Avenue	3,752	AM 0745 - 260 PM 1715 - 389	n/a	July 2011	
Corfield Street	Significant Urban Local Road / Distributor A	North of Lake Road	14,289	AM 0800 – 839 PM 1630 – 1,303	6.4	Oct 2014	70kph
Camillo Road	Significant Urban Local Road / Distributor B	West of Third Avenue	2,234	AM 1100 – 141 PM 1600 – 228	n/a	April 2013	60kph
		South of Lake Road	3,338	AM 0730 – 307 PM 1445 – 278	n/a	Feb 2005	
Railway Avenue	Significant Urban Local Road / Distributor A	South of Lake Road	6,601	AM 0730 – 569 PM 1430 - 596	n/a	May 2006	60kph
		South of Lake Road	10,852	AM 0700 – 898 PM 1400 - 948	n/a	Feb 2015	

		South of Westfield Road	11,820	AM 0745 – 1,675 PM 1445 – 1,064	n/a	Jul 2011	
		South of Denny Avenue	9,853	AM 1000 – 756 PM 1630 - 824	n/a	Jan 2009	
Lake Road	Significant Urban Local Road / Distributor A	West of Corfield Street	5,131	AM 0730 – 520 PM 1500 - 449	n/a	May 2007	70kph
Tonkin Highway	Urban Highway / Primary Distributor	North of Albany Highway	28,545	AM 0715 – 2,223 PM 1645 – 2,591	12.8	Nov 2008	100kph
		At Bridge over Albany Highway	21,076	AM 0615 – 1,812 PM 1630 – 2,138	16.0	Oct 2014	
		At bridge over Corfield Street	24,636	AM 0630 – 2,034 PM 1630 – 2,408	15.8	Nov 2014	
		North of Champion Drive	25,661	AM 0700 – 2,160 PM 1615 – 2,523	12.8	Oct 2014	
Albany Highway	Urban Highway / Primary Distributor	South of Tonkin Highway	24,674	AM 0730 – 1,807 PM 1615 – 2,084	7.7	March 2014	70kph
		North of Denny Avenue	29,973	AM 0800 – 2,032 PM 1500 – 2,574	n/a	Jul 2011	
		North of Turner Place	23,693	AM 0745 – 1,739 PM 1530 – 1,942	8.1	Nov 2008	60kph

Formal peak hour data has been recorded and is shown in Table 2, above. An analysis of available traffic data within 2,000 metres of the proposed development suggests: -

- AM peak on Railway Parade occurs at 07:00h and peak hour traffic constitutes approximately 8.27% of total daily volumes;
- PM peak on Railway Parade occurs at 14:00h and the peak hour traffic constitutes approximately 8.73% of total daily traffic volumes.

2.2.1 Crash Data

The following table shows a collation of crash data from the Main Roads WA database for crashes and incidents for roads adjacent to the subject site between the 1st January 2009 and 31st December 2013.

Table 3 - Crash Data

Road Names	Road Hierarchy	Functional Classification	Speed Limit/s	Crash Statistics	
				Number and Type of Incident	Cause of Incidents
Westfield Road & Excalibur Circle	Significant Urban Local Road / Urban Local Road	Distributor B / Access Road	60kph / 50kph	Total of 4 incidents: • 1 Medical • 2 PDO Major • 1 PDO Minor	MR Nature: • 1 Rear End • 2 Sideswipe Same Direction • 1 Right Angle
Westfield Road &	Significant Urban Local	Distributor B / Distributor B	60kph / 60kph	Total of 3 incidents:	MR Nature: • 1 Rear End

Camillo Road	Road / Significant Urban Local Road			• 2 PDO Major • 1 PDO Minor	• 1 Head On • 1 Hit Object
Westfield Road & Railway Avenue	Significant Urban Local Road / Significant Urban Local Road	Distributor B / Distributor A	60kph / 60kph	Total of 9 incidents: • 1 Medical • 5 PDO Major • 3 PDO Minor	MR Nature: • 3 Rear End • 1 Sideswipe Same Direction • 1 Right Angle • 2 Right Turn Thru • 1 Hit Object • 1 Non Collision
Railway Avenue & Merrifield Avenue	Significant Urban Local Road / Urban Local Road	Distributor A / Access Road	60kph / 50kph	Total of 3 incidents: • 1 Hospital • 1 PDO Major • 1 PDO Minor	MR Nature: • 1 Rear End • 1 Right Angle • 1 Hit Object
Hemingway Drive from Camillo Road to Ivanhoe Way*	Urban Local Road	Access Road	50km/h	Total of 2 incidents: • 2 PDO major	• 1 involving animal • 1 involving parking
Denny Avenue from Railway Avenue to Albany Highway	Significant Urban Local Road	Distributor A	50km/h	Total of 168 incidents: • 8 hospital • 26 medical • 86 PDO major • 48 PDO minor	• 8 involving overtaking • 2 involving parking • 1 involving pedestrian • 6 entering/ leaving driveway • 151 unknown
Railway Avenue [2.93 to 5.59]	Significant Urban Local Road	Distributor A	60kph [2.93 to 4.30] 70kph [4.30 to 5.59]	Total of 98 incidents: • 10 Hospital • 18 Medical • 48 PDO Major • 22 PDO Minor	MR Nature: • 23 Rear End • 1 Head On • 2 Side Same Direction • 6 Right Angle • 48 Right Turn Thru • 4 Hit Pedestrian • 8 Hit Object • 2 Non Collision • 4 Other / Unknown
Westfield Road	Significant Urban Local Road	Distributor B	60kph	Total of 48 incidents: • 1 Fatal • 2 Hospital	MR Nature: • 9 Rear End • 6 Side Same Direction

				• 8 Medical • 23 PDO Major • 14 PDO Minor	• 14 Right Angle • 3 Right Turn Thru • 6 Hit Pedestrian • 7 Hit Object • 3 Other / Unknow
Cammillo Road	Significant Urban Local Road	Distributor B	60kph	Total of 24 incidents: • 2 Hospital • 3 Medical • 12 PDO Major • 7 PDO Minor	MR Nature: • 4 Rear End • 1 Head On • 3 Side Same Direction • 6 Right Angle • 1 Right Turn Thru • 8 Hit Object • 1 Non Collision

* Hemingway Drive not connected to Railway Avenue in periods of data collection.

The above table represents a comprehensive list of the local road environment and the total volume of crashes in the 5 years between 2009 and 2013.

KCTT have reviewed the likelihood of incidents in Denny Avenue from Railway Avenue to Albany Highway (SLK 0.00 to 0.18). The accident rate at this location is: -

- Killed and Serious Injury (KSI) Crashes (Fatality + Hospital) = 8 per every 5 years;
- All Crashes = 168 per every 5 years.

To compare the rate of incidents at this location with the metropolitan network average, Main Roads WA uses a criterion called Crash Rate / MVKT (million vehicle kilometres travelled).

Using an average daily throughput of approximately 5,000 VPD at this section and the zone of influence at this section is within 180 metres. The total VKT during the 5-year period is 5,000 VPD x 365 days x 5yrs x 0.18 kilometres = 1.6425 million kilometres over 5 years.

Therefore the crash rate is 168 incidents per 1.6425 million kilometres travelled or equivalent to an incident rate 102.28 crashes / MVKT. This rate of crashes is up higher than the network average of crashes / MVKT over the 5 year period.

The crash rate for KSI crashes is 8 incidents per 1.6425 million kilometres travelled, equating to a crash rate of 4.87 crashes / MVKT. This crash rate is higher than the network average over the 5 years.

The following table shows the Crash Density and Crash Rates on Metropolitan Local Roads as obtained from Main Roads WA on the 16th October 2014 by email request:

CRASH DENSITY AND CRASH RATE ON METROPOLITAN LOCAL ROADS NETWORK ONLY				
	ALL CRASHES		KSI CRASHES (FAT+HOS)	
	DENSITY ALL CRASHES/KM over 5 years	CRASH RATE/MVKT	DENSITY KSI CRASHES/KM over 5 years	CRASH RATE/MVKT
LOCAL - MIDBLOCK	3.62	1.17	0.18	0.06
LOCAL - ALL	7.69	2.54	0.37	0.12
NOTE: BASED ON 5-YEARS DATA FOR THE PERIOD 2009 TO 2013.				

2.3 Traffic Modelling for the Proposed Structure Plan

This section provides a detailed description of how traffic volumes are calculated for the proposed development. Our traffic model uses a 4-step approach for the estimation of transportation demand into and out of the area: -

- Step 1 - Confirm the size and quantum of the proposed land uses;
- Step 2 - Confirm how these land uses impact travel patterns and the generation / attraction of transportation trips;
- Step 3 - Confirm where the likely origins of travel external to the development are located and confirm the likely destinations for travel from the subject landholdings; and
- Step 4 - Distribute the traffic through the network.

The purpose of the Transport Impact Assessment is to determine the likely impact of the proposed development upon the local road network within an 800 metre radius of the Structure Plan Area.

2.3.1 Step 1 - Quantum of Proposed Land Uses

The Development Application proposes residential development on the subject site. Although the subject of the Development Application is Lot 27 Westfield Road all traffic calculations were conducted for the entire Structure Plan (Lots 58-60 Centre Road and Lot 27 Westfield Road).

The WAPC Transport Assessment Guidelines for Developments (Volume 5) offers the following vehicle trip generation rates for the land uses proposed within the development: -

- **Residential** - 0.8 vehicle trips per dwelling for the AM and PM peak hours. A 25% IN / 75% OUT split has been adopted for the AM peak and a 67% IN / 33% OUT split for the PM peak hour;

Given that the WAPC does not offer daily vehicle trip generation rates for the land uses proposed within the development, the following rates are provided in the NSW RTA Guide to Traffic Generating Developments:

- **Residential** (dwelling houses) - 9 vehicular trips per dwelling;

Given that WAPC Transport Assessment Guidelines offers daily trip generation rates for standard developments that are up to R20, the rate of 9VPD / dwelling can be considered highly conservative for a development of this type. The NSW RTA Guide to Traffic Generating Developments suggests developments of this type in Sydney tend to generate between 4 and 5 vehicular trips per dwelling. In Perth, the Department of Planning and Infrastructure conducted a series of studies in the late 1990's / early 2000's which showed that higher density dwellings tended to average closer to 5.5 vehicle movements per day. For the purposes of this report we will use 5.5 VPD and

4.5VPD for each proposed unit, depending of assumed number of dwellings. KCTT believes that this rate is suitable for this Local Structure Plan as it is located in metropolitan area with available public transport.

The following table outlines the traffic generation of the proposed development based on the above rates.

Table 4 - Traffic Generation of the Proposed Development

Proposed Land Use	Units	WAPC Transport Assessment Guidelines for Developments / NSW RTA Guide To Traffic Generating Developments Requirement	Total VPD	Total VPH (Peak)
Lot 58 Centre Road	60	5.5 vehicle trips per lot (daily traffic) 0.8 vehicle trips per lot (AM / PM Peak)	330 VPD	48 VPH
Lot 59 Centre Road	57		314 VPD	46 VPH
Lot 60 Centre Road (individual dwellings)	24		132 VPD	19 VPH
Lot 27 Westfield Road (units between 75m^2 and 125m^2)	44		242 VPD	35 VPH
Lot 60 Centre Road (residential units less than 75m^2)	60	4.5 vehicle trips per unit 0.8 vehicle trips per lot (AM / PM Peak)	270 VPD	48 VPH
Lot 27 Westfield Road (units less than 75m^2)	130		585 VPD	104 VPH
Total Lots 58-60 Centre Road	**207**	-	**1,046 VPD**	**161 VPH**
Total Lot 27 Westfield Road	**174**	-	**827 VPD**	**139 VPH**
Total	**381**		**1,873 VPD**	**300 VPH**

2.3.2 Step 2 - Trip Purposes

To understand the likely demand for alternative transportation modes (including public transportation trips; cyclist and pedestrian trips) and the impact of the vehicular traffic on the adjacent road network, it is important to understand why people are travelling into and out of the Structure Plan Area. These general trip purposes include employment, shopping, social, education and other general purposes. Each land usage will generate / attract a unique matrix of trip purposes. For example, the following table shows the likely percentage share for different trip purposes based on the residential land usage: -

Table 5 - Trip Purposes by Land Use

Land Use Type	Employment	Shopping	Education	Social / Recreational
Residential	40%	25%	17.5%	17.5%

2.3.3 Step 3 - Expected Origin / Destination

The expected origin / destination matrix is important to determine the likely route of vehicular and other travel. Table 6 (below) describes the expected trip purposes for trips generated by the proposed land use within the local area and the likely destinations.

This means that the all of the employment trips will be external to the proposed Structure Plan Area. The employment destinations are suggested by the City of Armadale for its residents and are shown in Table 6 below.

Table 6 - Table of Trip Purposes and Likely Destinations

Land Use Type	Trip Purpose	Likely Destination
Residential	• Employment	The economic profile in the City of Armadale shows that according to the latest census that 63.2% of the city's resident's travel outside the area for work while the remaining 24.1% both live and work within the area (Work location unknown for 12.7%) • Armadale (C) – 24.1% • Canning – 12.1% • Gosnells – 8.8% • Belmont – 5% • POW No Fixed Address – 4.8% • POW State/Territory Undefined – 4.3% • Perth (inner) – 4.3% • Cockburn – 4% • Perth (remainder) – 3.3% • Other – 29.3% http://profile.id.com.au/armadale/residents?WebID=140 We therefore believe that the following roads will be used for access / egress to the site: - • Centre Road; • Railway Avenue; • Albany Highway; • Westfield Road; • Hemingway Drive; • Denny Avenue; • Lake Road; • Corfield Street; • Tonkin Highway. Excluding work from home, there no other source of employment in this Structure Plan Area.
		Journey to work data: • Car as Driver - 65.6% • Did not go to work – 10.7% • Train – 7.2% • Car as Passenger – 5.7% • Worked at Home – 3.1% • Other – 7.7%
	• Shopping	• Westfield Shopping Town is located 2.2km to the south-west of the subject area • Kelmscott Plaza and Stargate Shopping Centre are located approximately 1.6km to the south of the subject area
	• Education	• Westfield Park Primary School is located approximately 0.4km to the west of the subject area. • Kelmscott Primary School is located approximately 2.7km

		to the south-east of the subject area. • Kelmscott Senior High School is located approximately 2.4km to the south of the subject area.
	• Social / Recreational	• Champion Lakes Recreation Park is located approximately 500m to the west of the subject area; • Westfield Heron Reserve is located approximately 300m to the west of the subject area; • Frye Park is located approximately 800m to the east of the subject area; • Lloyd Hughes Park is located approximately 1.4km to the west of the subject area

2.3.4 Step 4 - Destination Matrix and Distribution of Traffic / Transport

Land uses can be generally classified as trip generators and / or trip attractors. Given the nature of the development, the Structure Plan area will be classified as a trip generator. The Structure Plan area will be accessed via Railway Avenue, Westfield Road, Hemingway Drive and in future stages Centre Road. The subject site offers direct vehicular access via these roads. Railway Avenue provides connectivity to Albany Highway to the east via Denny Ave located to the south of the development. All proposed intersections will be designed to have full unrestricted movement of vehicles.

In summary, the site development scenario for Structure Plan for Lots 58 to 60 Centre Road and Lot 27 Westfield Road, is expected to generate approximately **1,873 vehicular movements per day** with a forecasted impact of around **300 vehicles per hour in the peak hour** after completion of all proposed stages of development.

Taking into consideration the breakdown for the typical residents' locations of work in the City of Armadale (refer the City of Armadale ID profile above), KCTT believe that the traffic from the first three stages of the Local Structure Plan will be distributed into the adjacent road network as follows: -

100% (1,873 VPD) from / to subject Structure Plan.

- Five access / egress on Railway Avenue – 200+249+200+290+289=1,228VPD;
    - 45% (553VPD) to / from north via Railway Avenue;
    - 55% (675VPD) to / from south via Railway Avenue;
- Access / egress on Centre Road – 284VPD
    - 60% (170VPD) to / from east via Centre Road;
        - 45% (76VPD) to / from north via Railway Avenue;
        - 55% (94VPD) to / from south via Railway Avenue;
    - 40% (114VPD) to / from west via Centre Road;
        - 40% (46VPD) to / from east via Lake Road;
        - 60% (68VPD) to / from west via Lake Road;
- South access / egress on Hemingway Drive – 114VPD;
    - 40% (46VPD) to / from west via Hemingway Drive;
    - 60% (68VPD) to / from east via Hemingway Drive;
- North access / egress on Hemingway Drive – 83 VPD;
    - 40% (33VPD) to / from west via Hemingway Drive;
    - 60% (50VPD) to / from east via Hemingway Drive;
- Access / egress on Westfield Road – 165VPD;

- 40% (66VPD) to / from west via Westfield Drive;
- 60% (99VPD) to / from east via Westfield Drive;

Given that lots 58-60 Centre Road are located approximately 400m north from the Lot 27 Westfield Road it is expected that large percentage of northbound trips will be accessing Albany Highway via Railway Avenue, Corfield Road and Tonkin Highway. A certain percentage of northbound travellers originating from Lot 27 Westfield Road will access Albany Highway via Denny Avenue effectively traveling southbound once they leave the development.

It is assumed that as different development stages are completed traffic volumes on Hemingway Drive will increase progressively. Residents of the northern edge dwellings are likely to utilise Centre Road for westbound travel.

Table 7 below considers the traffic generation from the proposed development of the lot development in Camillo and its impact upon the road network surrounding the Structure Plan Area. It should be noted that roads such as Railway Avenue, Denny Avenue and Corfield Street are likely to be used for most northbound, eastbound and southbound trips to and from the Structure Plan Area.

Table 7 - Forecasted Traffic Volumes on Existing Roads surrounding to the Structure Plan Area

Road Name	Functional Classification / Road Hierarchy	Location of Traffic Count	Vehicles Per Day (VPD)	Estimated traffic growth at the rate of 3% per annum - 2027 (VPD)	Traffic generated by the developme nt site (VPD)	Total VPD (2027)
Westfield Road	Significant Urban Local Road / Distributor B	North of Champion Drive	5,745 (May 2013)	8,191	51	8,317
		West of Railway Avenue	3,752 July 2011)	5,675	99	5,774
Corfield Street	Significant Urban Local Road / Distributor A	North of Lake Road	14,289 (Oct 2014)	21,613	755	22,275
Camillo Road	Significant Urban Local Road / Distributor B	South of Lake Road	3,338 (Feb 2005)	6,029	45	6,060
Railway Avenue	Significant Urban Local Road / Distributor A	South of Lake Road	6,601 (May 2006)	11,575	726	12,301
		South of Westfield Road	11,820 (Jul 2011)	17,879	885	18,764
		South of Denny Avenue	9,853 (Jan 2009)	15,811	187	15,942
Lake Road	Significant Urban Local Road / Distributor A	West of Corfield Street	5,131 (May 2007)	8,735	95	8,766
Tonkin Highway	Urban Highway / Primary Distributor	North of Albany Highway	28,545 (Nov 2008)	47,181	366	47,531
		At Bridge over	21,076	29,174	256	29,348

		Albany Highway	(Oct 2014)			
		At bridge over Corfield Street	24,636 (Nov 2014)	34,102	755	34,764
		North of Champion Drive	25,661 (Oct 2014)	35,521	710	36,233
Albany Highway	Urban Highway / Primary Distributor	South of Tonkin Highway	24,674 (March 2014)	34,155	523	34,579
		North of Denny Avenue	29,973 (Jul 2011)	45,337	523	45,761
		North of Turner Place	23,693 (Nov 2008)	39,161	523	39,585

Plans with the estimated vehicular traffic flow and distribution are shown in Appendix 2 (KC00341.000_S06 and KC00341.000_S07).

2.4 Vehicular Access and Parking Requirement

The Structure Plan area plan shows five access/egress points from Railway Avenue, two from Hemingway Drive and one access/egress point from Centre Road and Westfield Road each. Lot 27 Westfield Road is proposed to have two access/egress points from Railway Avenue and one access/egress point from Westfield Road and Hemingway Drive each.

The proposed development will have internal road network as well as a network of private access roads.

2.4.1 Service Vehicles

Waste collection will be performed internally therefore all new crossovers / intersections will be designed to cater for the movement of the waste vehicle. The role of KCTT in this project is to provide commentary on the concept layout plans if any of the kerb radii do not meet the requirements of the turning templates.

For Stage 1 development – the waste vehicle will enter the development via crossover on Westfield Road, collect waste from the designated area and exit the development in forward movement via southern crossover on Railway Parade. We have provided a note on Drawing S20, showing that the kerb radii in this location should be increased to Radius = 9 metres to allow for the safe access of the waste service vehicle.

For Stage 2 development – prior the construction of Stage 3, waste collection vehicle will access the development utilising northern crossover on Railway Avenue, collect waste, perform a three-point-turn internally to the development and exit the development in forward movement.

For Stage 2 and Stage 3 development – the vehicle will access the development via the northern crossover on Railway Avenue, collect waste from the designated areas and exit the development via Hemingway Drive crossover in forward movement.

In summary, the internal road layout is suitable for the safe access and egress of a waste service vehicle. The proposed kerb radii on all accessways should have a minimum kerb radius = 6 metres for standard 85th percentile

passenger vehicles and radius = 9 metres for waste service vehicles. The locations requiring this improvement are noted on our Appendix 3 plans on Plan S20 with the comment, "radius to be redesigned".

2.4.2 Vehicle Parking Requirements

The City of Armadale's Town Planning Scheme No 4 stipulates that parking provisions should be made in accordance with the W.A. Residential Design Codes for a grouped dwelling for portions of development zoned R40.

Clause C3.1 On-site Parking Provision of the Residential Design Codes provides guidance on the minimum requirements for parking provisions for developments of multiple dwellings with a coding of R30 or higher. When dwellings are within the following distances: 800m of a train station on a high frequency rail route, measured in a straight line from the pedestrian entry to the train station platform to any part of a lot; or 250m of a high frequency bus route, measured in a straight line from along any part of the route to any part of a lot, the following parking requirements should be considered applicable: -

- Parking for residents (dwelling area <75m^2) – 0.75 parking space per dwelling,
- Parking for residents (dwelling area 75m^2 < GFA < 110m^2) – 1 parking space per dwelling,
- Parking for residents (dwelling area 110m^2 < GFA) – 1.25 parking space per dwelling,
- Parking for visitors - 0.25 parking spaces per dwelling.

Table 4 below shows the minimum car parking requirements for the proposed development which have been calculated in accordance with Residential Design Codes.

Table 8 – Car Parking Requirements Using the Residential Design Codes

Land Use	Units	Parking Requirements	Total Parking bays
Lot 58 Centre Road	60 units (75m^2 to 110m^2)*	1 parking space per dwelling	60
Lot 59 Centre Road	57 units (75m^2 to 110m^2)*	1 parking space per dwelling	57
LOT 60 Centre Road	24 units (75m^2 to 110m^2)*	1 parking space per dwelling	24
	66 units (less than 75m^2)	0.75 parking space per dwelling	50
Lot 27 Westfield Road	130 units (less than 75m^2)	0.75 parking space per dwelling	98
	44 units (75m^2 to 110m^2)	1 parking space per dwelling	44
For all Lots	381 units	Parking for visitors - 0.25 parking spaces per dwelling	96
Total Parking Bays for Lot 27 Westfield Road	**174 units**	-	**186**
Total			**429**

*Note: areas of the units are assumed.

In accordance with the Residential Design Codes the number of required parking bays is 429 for the whole Structure Plan Area. Lot 27 Westfield Road has a requirement for a total of **186** parking bays (inclusive of visitors' parking).

2.4.3 Bicycle Parking

Due to the nature of the development being residential, it is assumed that provision for bicycle parking will not be necessary. All lots in the Structure Plan Area have a provision for storage space. It is assumed there will be sufficient space to store bikes in each premises.

2.4.4 ACROD Parking

Given there are no accessible units proposed within the development, there is no requirement for provision of ACROD parking.

2.5 Management of Traffic Attracted to the Structure Plan Area

SIDRA Intersection analysis (provided in Appendix 4) showed that the proposed development will have minimal impact on the surrounding road network.

There is no requirement for further upgrades of the existing intersections.

All proposed intersections are three-way intersections and can be configured as priority controlled intersections. The proposed intersection of Hemingway Drive and Railway Avenue can be configured as a sign controlled intersection.

2.6 Hours of Operation

The land usage within the Structure Plan Area is residential. It is likely that AM and PM peaks will coincide with journey to / from work times. As such, morning and afternoon peaks are likely to be around 08:00 to 09:00 and 15:30 to 16:30 respectively during work days.

It is therefore likely that the AM and PM Peak will coincide fully with the peak AM and PM hour period on Westfield Road and Corfield Street while current peak hour on Railway Road occurs outside of estimated peak hours for the proposed development.

2.7 Public Transport Access

Kelmscott Railway Station is the closest public transport hub to the proposed development. From the southern point of development, Kelmscott Railway Station is a 350m walk. From the northern lot of the development Kelmscott Railway Station is a 1.1km walk. Kelmscott Railway Station is on the Armadale line and provides access to Perth City. There is currently suitable pedestrian access from the proposed development to Kelmscott Railway Station.

Kelmscott Railway Station operates as a bus to rail transfer point. Bus routes operated from the Kelmscott Bus / Rail Interchange station include Routes 240, 241, 243, 244, 245, 249 and 252. Those bus routes operate as follows:-

- Bus Route No 240: Kelmscott Station to Clifton Hills Circular Service, with minimal 1 hour intervals on working days and 1 hour on weekends and no operation on Saturday, Sunday and Public holidays;
- Bus Route No 241: Kelmscott Station to Roleystone Circular Service, with minimal 30 minute intervals on working days, 1 hour intervals on Saturday and 2 hour interval on Sunday and Public holidays;
- Bus Route No 243: Kelmscott Station to Armadale Station, with minimal 45 minute intervals on working days, 2 hour intervals on Saturday and no operation on Sunday and Public holidays;
- Bus Route No 244: Kelmscott Station to Armadale Station, with 1 hour intervals on working days, 2 hour intervals on Saturday and no operation on Sunday and Public holidays;
- Bus Route No 245: Kelmscott Station to Armadale Station, with minimal 15 minute intervals on working days, with 1 hour intervals on Saturday and 2 hour interval on Sunday and Public holidays;

- Bus Route No 249: Armadale Station to Perth, with no intervals provided except bus Route No 249H Deviates via Armadale Kelmscott Hospital, with 30 minute intervals on working days, and no operation on weekends and Public holidays;
- Bus Route No 252: Kingsbury Drive / Jacaranda Avenue to Armadale Station, with minimal 75 minute intervals on working days and no operation on Saturday, Sunday and Public holidays;
- Bus Route No 220: Armadale Station to Perth (via Albany Highway), with minimal 20 minute intervals on working days, 1 hour intervals on Saturday and 2 hour intervals on Sunday and Public holidays;

Bus route 252 runs from Lake Road, onto Centre Road and down Railway Avenue directly in front of the proposed development and provides connection to Kelmscott train station. There are currently no stops out front of the proposed development along Railway Avenue. The closest current stop is situated in front of John Wollaston Anglican Community School.

Bus route 220 services Albany Highway and also runs down Railway Avenue directly in front of the proposed development.

In summary, the subject site offers excellent connectivity to public transport with the bulk of the development within the 800 metre walkable catchment of the Kelmscott Railway Station. For the smaller percentage of proposed dwelling outside of the 800 metre walkable catchments, there are regular bus services in Railway Parade connecting to the Kelmscott Bus / Rail Interchange.

2.8 Pedestrian and Cyclist Access

The main footpaths in the area are approximately 2.5m wide. These footpaths provide adequate mobility to and from some of the close attractions in the area.

The following is a list of the major cyclist infrastructure (Perth Bicycle Network) within an 800 metre radius of the subject site:

- Tonkin Highway is classified as PSP High Quality Shared Peth;
- Corfield Street (north side of the street), Lake Road (south side of the street), Cammillo Road, Westfield Road, Railway Avenue (wester side of the street), Centre Road, Merrifield Avenue, Third Avenue, Regina Road, O'Sullivan Drive, Lake View Terrace, Clifton Street are all classified as PBN "Other Shared Path (Shared by Pedestrian & Cyclists)" routes;
- O'Sullivan Drive, Westfield Road, Brookside Avenue, Clifton Street, Gilwell Avenue, Lucich Street, Page Road and Streich Avenue are all classified as PBN "Good Road Riding Environment" routes.

Bicycle lockers, shelters and parking spaces are provided in Kelmscott Station.

3. Transport Impact Assessment Checklist for a Structure Plan

The following is the summary / checklist for a Transport Impact Assessment as shown in the Department for Planning and Infrastructure's Transport Assessment Guidelines – Part 2: Structure Plans.

Item	Status	Comments / Proposals
Summary	Y	Total Lot area is 7.95ha with an approximate developable area of 60% or 4.77ha. The proposed Structure Plan comprises of approximately 381 residential units and 5 communal open spaces. The subject of the Development Application is Lot 27 Westfield Road, Camillo however the traffic impact was assessed for the whole of Structure Plan Area. According to the WAPC Guidelines the proposed development will have a large impact on the surrounding network generating 270 VPH (or 300 VPH for the whole Structure Plan Area).
Introduction / Background	Y	The subject area is currently vacant. The proposed residential development will vary in density from R15 to R40 with internal movement network. The development will front and have a direct access to Railway Avenue, Westfield Road, Centre Road and Hemingway Drive.
Structure Plan Proposal		
Regional Context	Y	The proposed Structure Plan fits within the general regional context. It is in accordance with the City of Armadale's Local Planning Strategy.
Proposed Land Uses	Y	The Structure Plan proposes a residential development on the subject site.
Table of Land Uses and Quantities	Y	Refer to Section 2.1 of this report for a summary of the quantities of the proposed uses.
Major Attractors / Generators	Y	The major trip generators will be Residential Use, with likely peaks from 08:00 to 09:00 and from 15:30 to 16:30 Mondays to Fridays.
Specific Issues	Y	KCTT have reviewed the design intent for the internal roads. We believe the internal road networks should be designed and built to cater for the shared environment. KCTT have reviewed the proposed internal intersections and crossovers and have provided commentary on minimum kerb radii such that each of the intersections is designed to accommodate for the movement of waste service vehicles and standard 85th percentile passenger vehicles.
Existing Situation		
Existing Land Uses Within The Structure Plan Area	Y	The existing land zoning is rural.
Existing Land Uses Within 800 metres of the Structure Plan Area	Y	Residential and rural land use, parks, commercial, education and recreation.
Existing Road	Y	The subject site bound to the east by Railway Avenue, to the north by

Network Within the Structure Plan Area		Centre Road, and to the south by Westfield Road. Existing road Hemingway Drive is to be extended through development to intersect with Railway Avenue.
Existing Pedestrian / Cyclist Network Within the Structure Plan Area	N	No pedestrian and cyclist network within the Structure Plan Area.
Existing Public Transport Services Within The Structure Plan Area	N	No public transport services within the Structure Plan Area, however public transport services are available immediately adjacent to the site and within walkable distances of the site.
Existing Road Network Within 2 km of Structure Plan Area	Y	Key traffic desire lines: – • Tonkin Highway; • Albany Highway; • Railway Avenue; • Westfield Road; • Lake Road; • Corfield Street. The subject site has excellent connectivity to major road networks in the south-east metropolitan corridor and therefore should not impact local residential streets.
Traffic Flows on Roads Within the Structure Plan Area (PM and/or AM Peak Hours)	Y	Refer to Section 2.2 for the existing traffic flows on the roads within the subject area.
Traffic Flows on Roads within 2 (or 5) km of Structure Plan Area (AM and/or PM Peak Hours)	Y	Refer to Section 2.2 for the existing traffic flows on the adjacent road network.
Existing Pedestrian / Cycle Networks Within 800 metres of the Structure Plan Area	Y	• Tonkin Highway is classified as PSP High Quality Shared Peth; • Corfield Street (north side of the street), Lake Road (south side of the street), Cammillo Road, Westfield Road, Railway Avenue (wester side of the street), Centre Road, Merrifield Avenue, Third Avenue, Regina Road, O'Sullivan Drive, Lake View Terrace, Clifton Street are all classified as PBN "Other Shared Path (Shared by Pedestrian & Cyclists)" routes; • O'Sullivan Drive, Westfield Road, Brookside Avenue, Clifton Street, Gilwell Avenue, Lucich Street, Page Road and Streich Avenue are all classified as PBN "Good Road Riding Environment" routes. Refer to KC00341.000_S02 PBN Plan in Appendix 2. The subject site has strong connectivity with bicycle and pedestrian

		infrastructure which is noted as having good to high quality.
Existing Public Transport Services Within 800 metres of the Structure Plan Area	Y	Refer to Section 2.5.2.
Proposed Internal Transport Networks		
Changes / Additions to Existing Road Network or Proposed Road Network	Y	Hemingway Drive will be extended to intersect with Railway Parade. The internal road network is proposed for the development of lots 58-60 Centre Road, however the exact layout of this network is to be determined. Lot 27 Westfield Road will have internal ROW access.
Road Reservation Widths	N	Hemingway Drive to match existing road reservation widths.
Road Cross-Sections and Speed Limits	N	All new gazetted roads to have 50kph speed environments. Road cross sections to be confirmed in detailed design phase of project. All internal road networks within "strata" type developments should be designed on the basis they are 20kph shared space environments.
Intersection Controls	Y	All the intersections should be designed to have full unrestricted movement of vehicles. Signage and linemarking control should be provided at the intersection of Hemingway Drive and Railway Avenue.
Pedestrian / Cycle Networks and Crossing Facilities	Y	The internal road layout network for the proposed development of Lot 27 Westfield Road will be designed as a shared network.
Public Transport Routes	N	No public transport routes proposed internally to the development.
Changes to External Transport Networks		
Road Network	Y	Hemingway Drive is proposed to be extended to intersect with Railway Avenue.
Intersection Controls	Y	Hemingway Drive / Railway Avenue to be configured with Give Way control in Hemingway Drive.
Pedestrian Cycle Networks and Crossing Facilities	Y	With the extension of Hemingway Drive a pedestrian path and a pedestrian crossing should be provided.
Public Transport Services	N	No changes proposed to the existing PT services.
Integration with Surrounding Area		
Trip Attractors / Generators Within 800 metres of the Structure Plan Area	Y	Residential (generator), parks, education, shops and recreation (attractor).

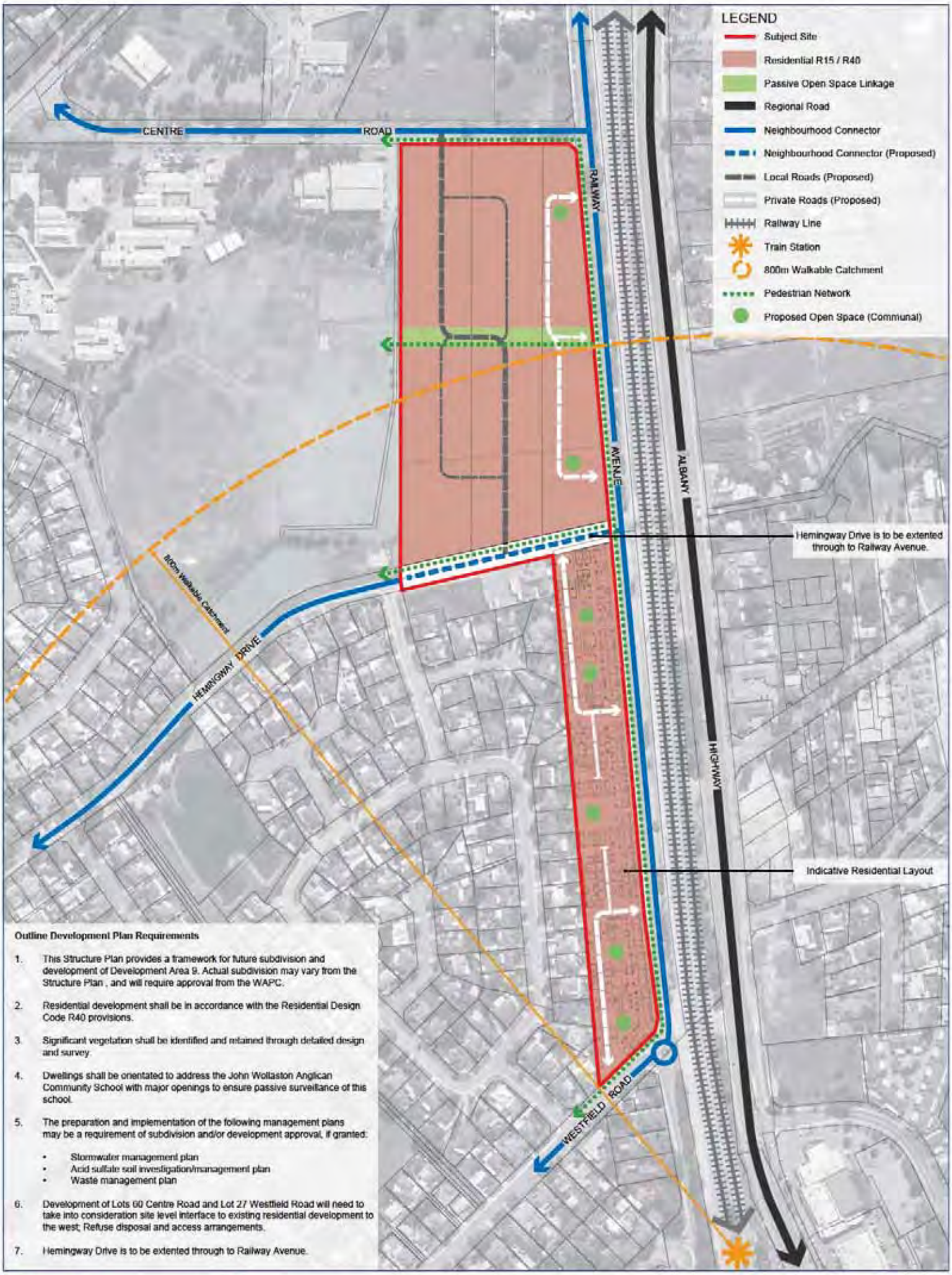
Proposed Changes to Land Uses Within 800 metres of the Structure Plan Area	N/A	N/A
Travel Desire Lines from the Structure Plan Area to Trip Attractors / Generators Within 800 metres of the Structure Plan Area	Y	Key desire lines: - • Tokin Highway; • Albany Highway; • Railway Avenue; • Westfield Road; • Lake Road; • Corfield Street; • Cammillo Road; • Centre Road; • Hemingway Drive.
Adequacy of External Transport Networks	Y	The existing external transport networks have sufficient capacity to cater for the proposed development.
Deficiencies in External Transport Networks	N/A	None identified
Remedial Measures to Address These Deficiencies	N/A	Not applicable.
Analysis of Internal Transport Networks		
Assessment Year(s) and Time Period(s)	Y	Year 2017 (as deemed year of completion) and year 2027.
Structure Plan Generated Traffic	Y	Refer to Table 4 - Section 2.3.
Extraneous (Through) Traffic	Y	Refer to Table 7 - Section 2.3.
Design Traffic Flows (i.e. Total Traffic)	Y	Refer to Section 2.3.
Road Cross-Sections	N	Not applicable to this development application.
Intersection Controls	Y	All the intersections should be designed to allow for unrestricted movement of vehicles to and from the Structure Plan Area. The intersections are sign or priority controlled.
Access Strategy	Y	Vehicular access / egress for the proposed Structure Plan Area will mainly be from Railway Avenue from five identified points. There is one access / egress point planned for both of Centre Street and Westfield Road and two access / egress points planned for Hemingway Drive. Lot 27 Westfield Road will have direct access from Railway Avenue, Westfield Road and Hemingway Drive.

Pedestrian / Cycle Networks	Y	Internal movement network is envisaged as a shared space for vehicles, cyclists and pedestrians. There are various access points to the abutting pedestrian and cycling network.
Safe Routes to Schools	Y	Appropriate pedestrian connections provided to the surrounding school.
Pedestrian Permeability and Efficiency	Y	The site is fully permeable and is promoting pedestrian movement.
Access to Public Transport	N/A	N/A
Analysis of External Transport Networks		
Extent of Analysis	Y	KCTT have undertaken a detailed review of road and transportation networks has been undertaken within an 800 metre radius of the Structure Plan Area.
Base Flows for Assessment Year(s)	Y	Refer to Sections 2.2 and 2.3
Total Traffic Flows	Y	Refer to Table 7 - Section 2.3.
Road Cross-Sections	N/A	Not applicable.
Intersection Layouts and Controls	Y	Consideration may be given by the City of Armadale to providing upgraded signage and linemarking at the intersection of Hemingway Drive and Railway Avenue as part of this Structure Plan application.
Pedestrian/Cycle Networks	Y	Refer to Section 2.8
Conclusions		
Conclusions	Y	• Although the proposed development will have a significant impact according to the WAPC guidelines criteria, it will not adversely impact the existing intersections or road networks. • All internal access ways and crossovers / intersections have been designed to accommodate the necessary turning vehicles. KCTT have offered suggestions for improvement at intersections fronting gazetted roads with all kerb radii to be a minimum radius = 6 metres for standard 85th percentile vehicles and radius = 9 metres where turning movements for waste service vehicles are required. These improvements can be accommodated within the design, therefore we believe the development complies with all traffic and transport related requirements. • The development has excellent connectivity to public transport with the majority of dwellings within an 800 metre radius of the Kelmscott Railway Station. The remainder of dwellings have excellent connectivity to existing bus services in Railway Avenue which offer direct connectivity to the Kelmscott Railway Station

		Bus / Rail Interchange. • The subject site has excellent connectivity to major road networks in the south-east metropolitan corridor and therefore should not impact local residential streets. • The subject site has strong connectivity with bicycle and pedestrian infrastructure which is noted as having good to high quality. • The extension of Hemingway Drive to Railway Avenue will need to be designed to City of Armadale standards. We believe the intersection of Hemingway Drive and Railway Avenue should have a Give Way control in Hemingway Drive.

Appendix 1

The layout of the proposed development



Outline Development Plan Requirements

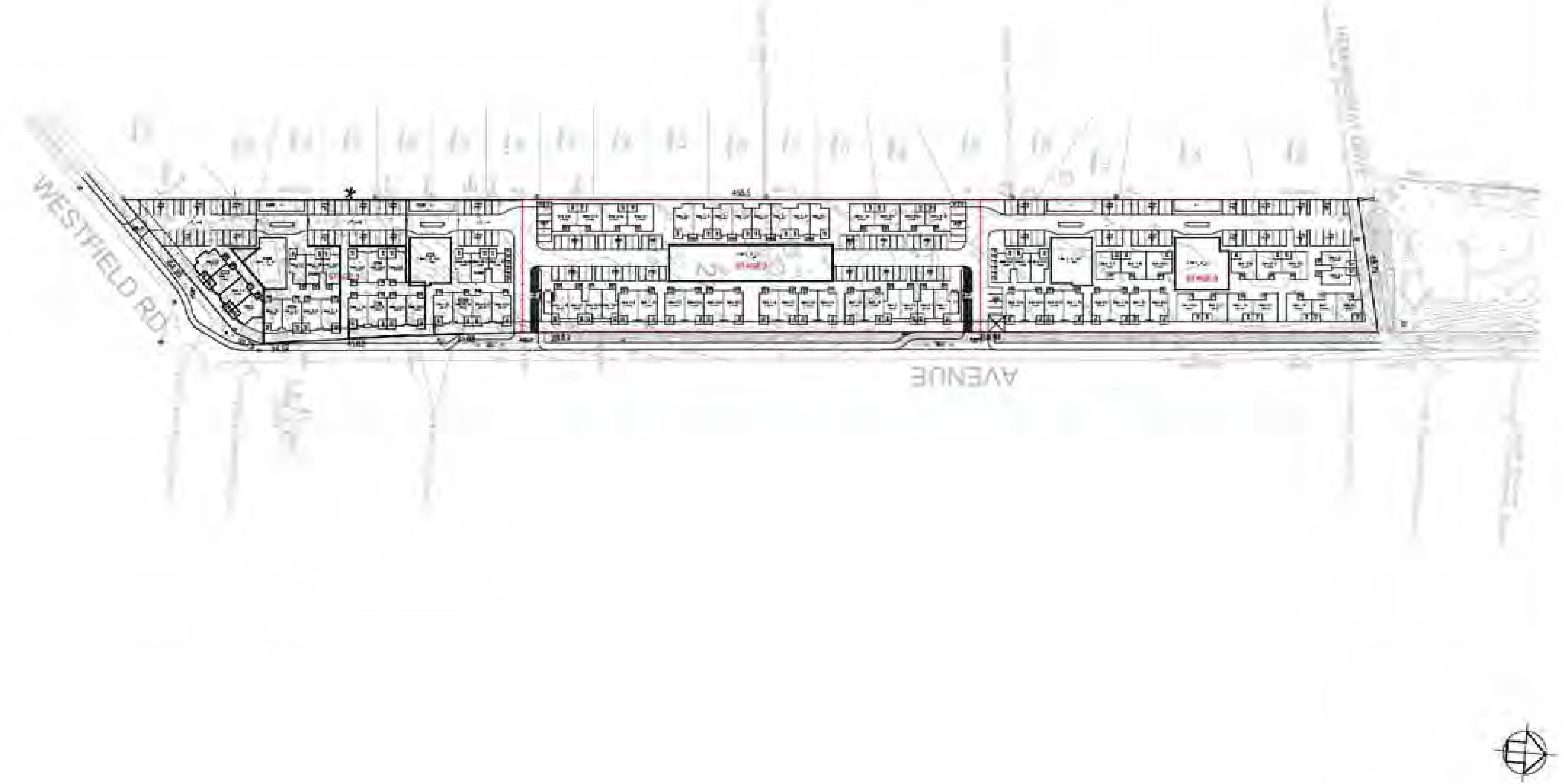
1. This Structure Plan provides a framework for future subdivision and development of Development Area 9. Actual subdivision may vary from the Structure Plan , and will require approval from the WAPC.
2. Residential development shall be in accordance with the Residential Design Code R40 provisions.
3. Significant vegetation shall be identified and retained through detailed design and survey.
4. Dwellings shall be orientated to address the John Wollaston Anglican Community School with major openings to ensure passive surveillance of this school.
5. The preparation and implementation of the following management plans may be a requirement of subdivision and/or development approval, if granted:
   - Stormwater management plan
   - Acid sulfate soil investigation/management plan
   - Waste management plan
6. Development of Lots 60 Centre Road and Lot 27 Westfield Road will need to take into consideration site level interface to existing residential development to the west; Refuse disposal and access arrangements.
7. Hemingway Drive is to be extented through to Railway Avenue.

Lots 58- 60 Centre Road & Lot 27 Westfield Road, Camillo
Structure Plan

RPS

PRELIMINARY FOR DISCUSSION PURPOSES ONLY

Scale 1:2000@A2 / 1:4000@A4 | Date November 2014 | Project No 123878-2-001b



PROJECT	RO OSED 50 (STA E 1), 72 (STA E 2) 52 (STA E 3) ULTI LE D ELLI S LOT 27 (3) EST IELD ROAD, CA ILLO
CLIENT	R R VALI

BROADVIEW DESIGN

DRAWING	OVERALL CO CE T LA	DATE AU 14	
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LOCATIO LA

DT TO SCALE

STAGE 1

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Units 3,4
Units 5,6
Units 7
Units 9,10
Units 11,12
Units 13,14
Units 15,16
Units 17,1
Units 1 ,20
Units 21,22
Units 23,24
Units 25,26
Units 27,2
Units 2 ,30
Units 31,32
Units 33,34
Units 35,36
Units 37,3
Units 3 ,40
Units 41,42
Units 43,44
Units 45,46
Units 47,4
Units 4 ,50

RO OSED 50 STA E 1, 72 STA E 2 52 STA E 3 ULTI LE D ELLI S
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BROADVIEW DESIGN

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LOCATIO LA

OT TO SCALE

Units 41,42 | Units 43,44 | Units 45,46 | Units 47,4

Units 13,14 | Units 15,16 | Units 17,1 | Units 1 ,20 | Units 1 ,20 | Units 17,1 | Units 15,16 | Units 13,14

Units 2 ,30 | Units 31,32 | Units 33,34 | Units 35,36

COVERED CARBAYS (5)

COVERED CARBAYS (6)

COVERED CARBAYS (3)

COVERED CARBAYS (4)

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COVERED CARBAYS (4)

COVERED CARBAYS (4)

COVERED CARBAYS (3)

C mm n O n S

A 20m²

STAGE 2

Units 3 ,40 | Units 37,3 | Units 35,36 | Units 33,34 | Units 31,32 | Units 2 ,30

Units 27,2 | Units 25,26 | Units 23,24 | Units 21,22

Units 1 ,20 | Units 17,1 | Units 15,16 | Units 13,14

Units 11,12 | Units ,10 | Units 7, | Units 5,6 | Units 3,4 | Units 1,2

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AVENUE

PROJECT: RO OSED 50 (STA E 1), 72 (STA E 2) 52 (STA E 3) ULTI LE D ELLI S
LOT 27 (3) EST IELD ROAD, CA ILLO

CLIENT R R VALI

BROADVIEW DESIGN
A.C.N. 115 187 805
SUITES, 18 HEARNS CRESCENT, ARDROSS 6153
Ph: 9316 0752 Fax: 9316 8153

DRAWING: STA E 2 00 OE T LA

REVISIONS:

DATE: AU 14

SCALE: 1200 (A1)

JOB REF: -

DWG: S 03

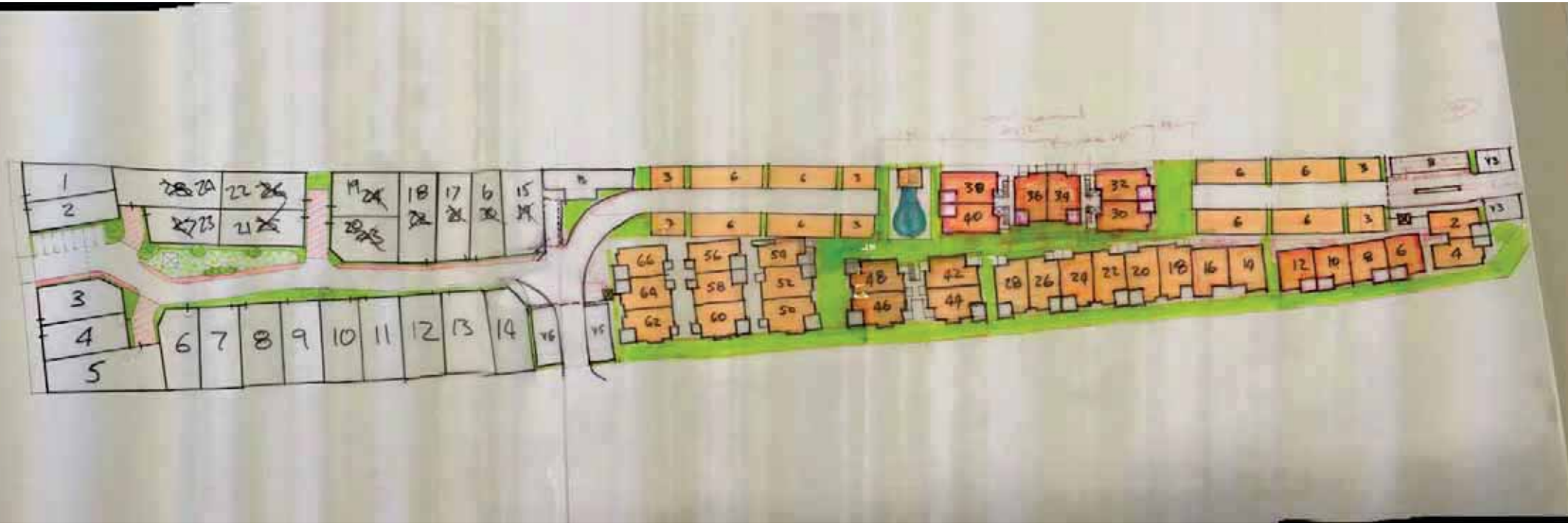
LOCATIO LA

DT TO SCALE

RO OSED 50 STA E 1, 72 STA E 2 52 STA E 3 ULTI LE D ELLI S
LOT 27 (3) EST IELD ROAD, CA ILO
R R VALI

BROADVIEW DESIGN

DRAWING STA E 3 00 E T LA AU 14
REVISIONS 1200 A1 5 04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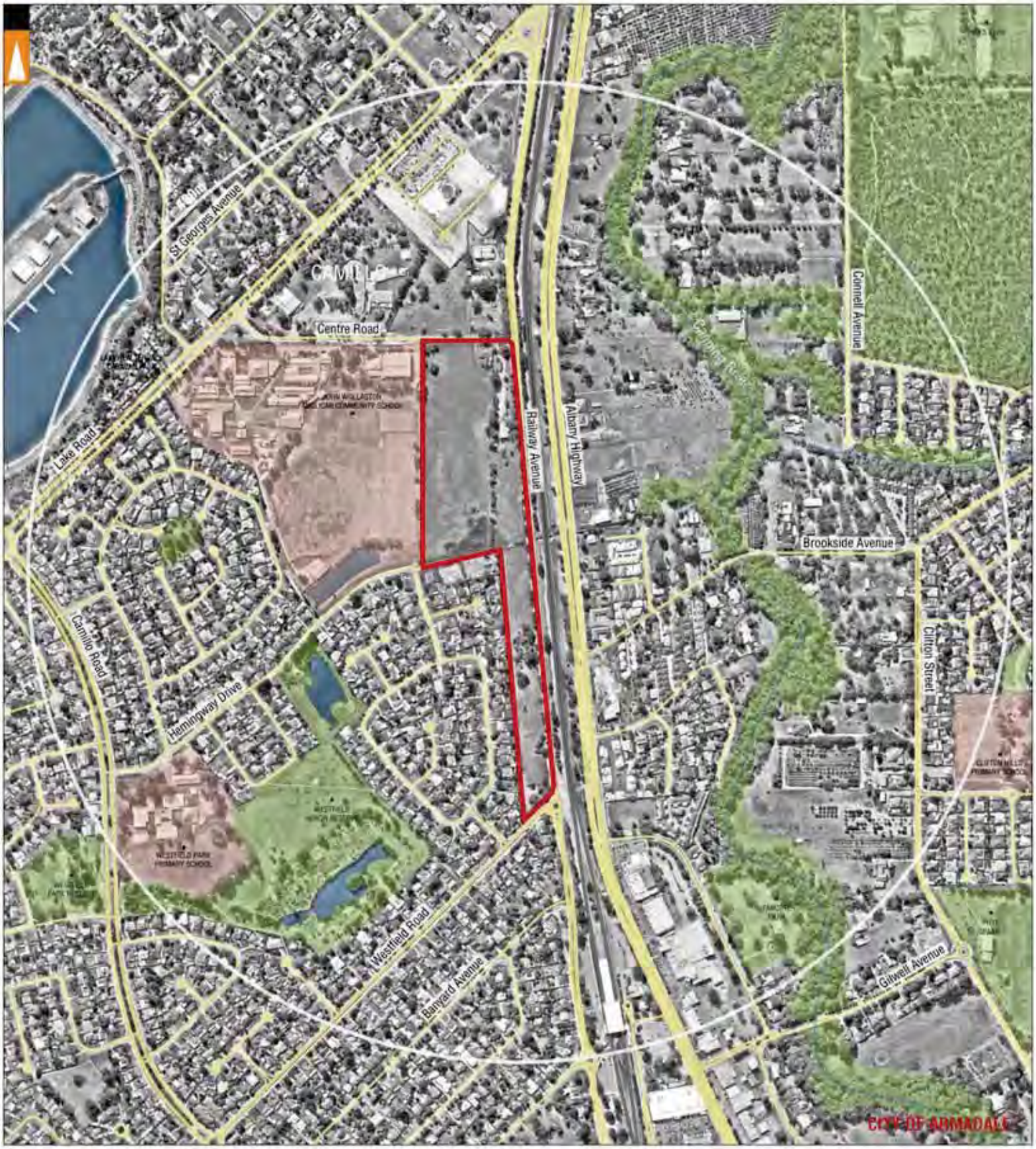
Appendix 2

Transport Planning and Traffic Plans



No	DATE	AMENDMENT
A	05-05-2015	ISSUED FOR REVIEW

PROJECT: Lots 58 to 60 Centre Road and Lot 27 Westfield Road, Camillo

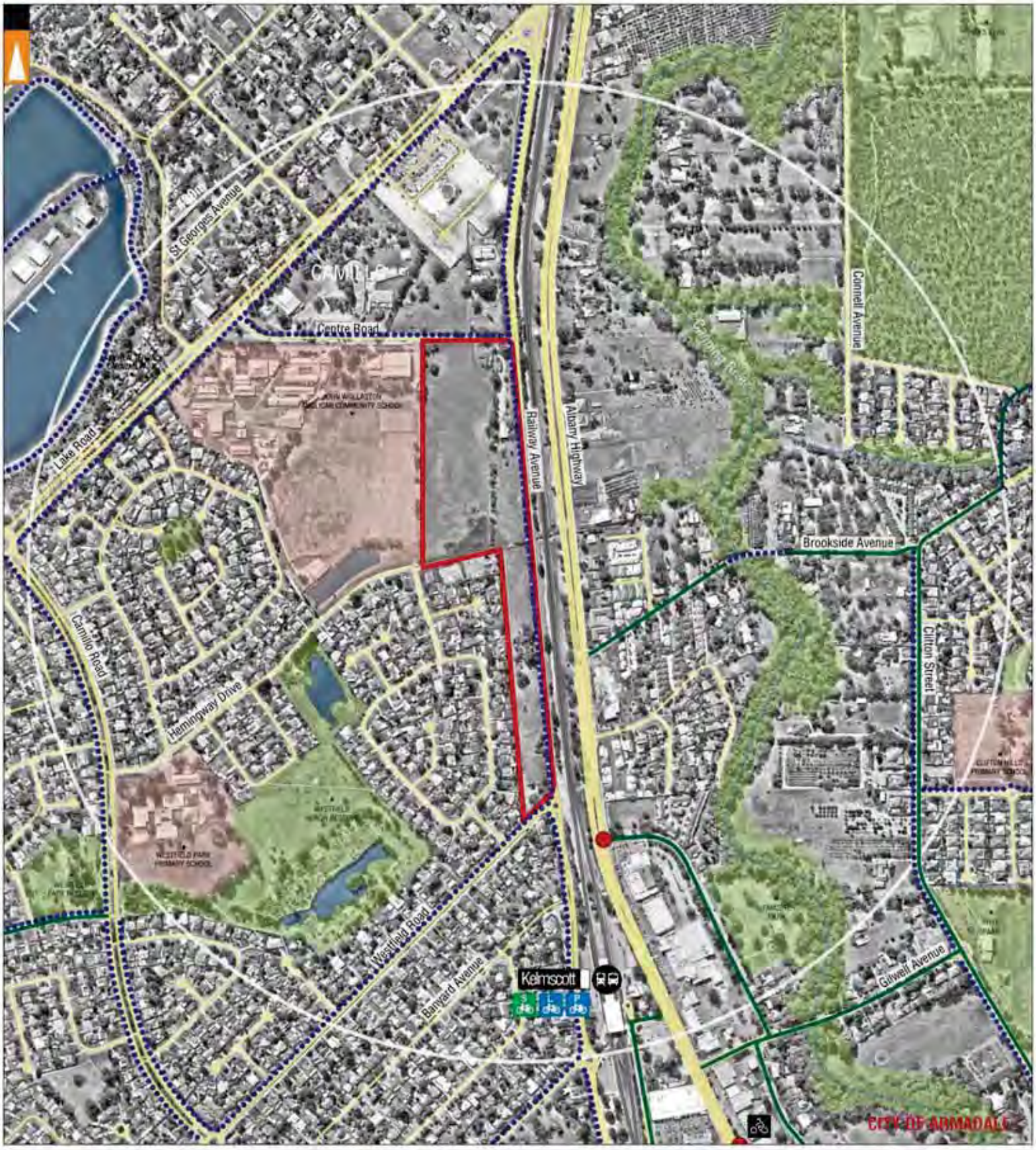
TITLE: Locality Plan - 400m Radius

DRAWING NUMBER: KC00341.000_S01

DRAWN BY: K.P.

Civil & Traffic Engineering Consultants
830B Beaufort Street Inglewood WA 6052

kctt



No	DATE	AMENDMENT
A	05-05-2015	ISSUED FOR REVIEW

PROJECT: Lots 58 to 60 Centre Road and Lot 27 Westfield Road, Camillo

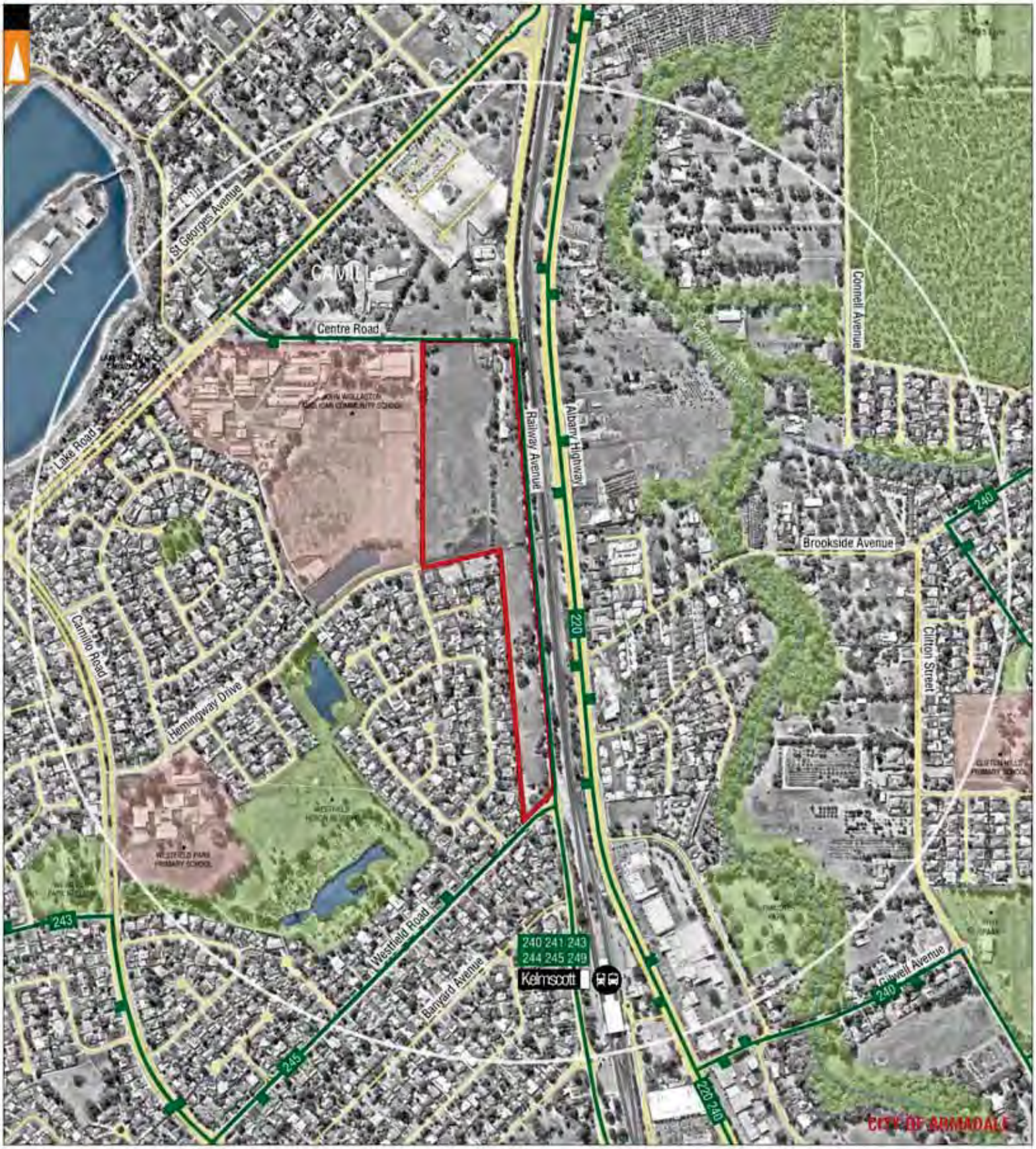
TITLE: Bicycle Network Plan - 400m Radius

DRAWING NUMBER: KC00341.000_S02

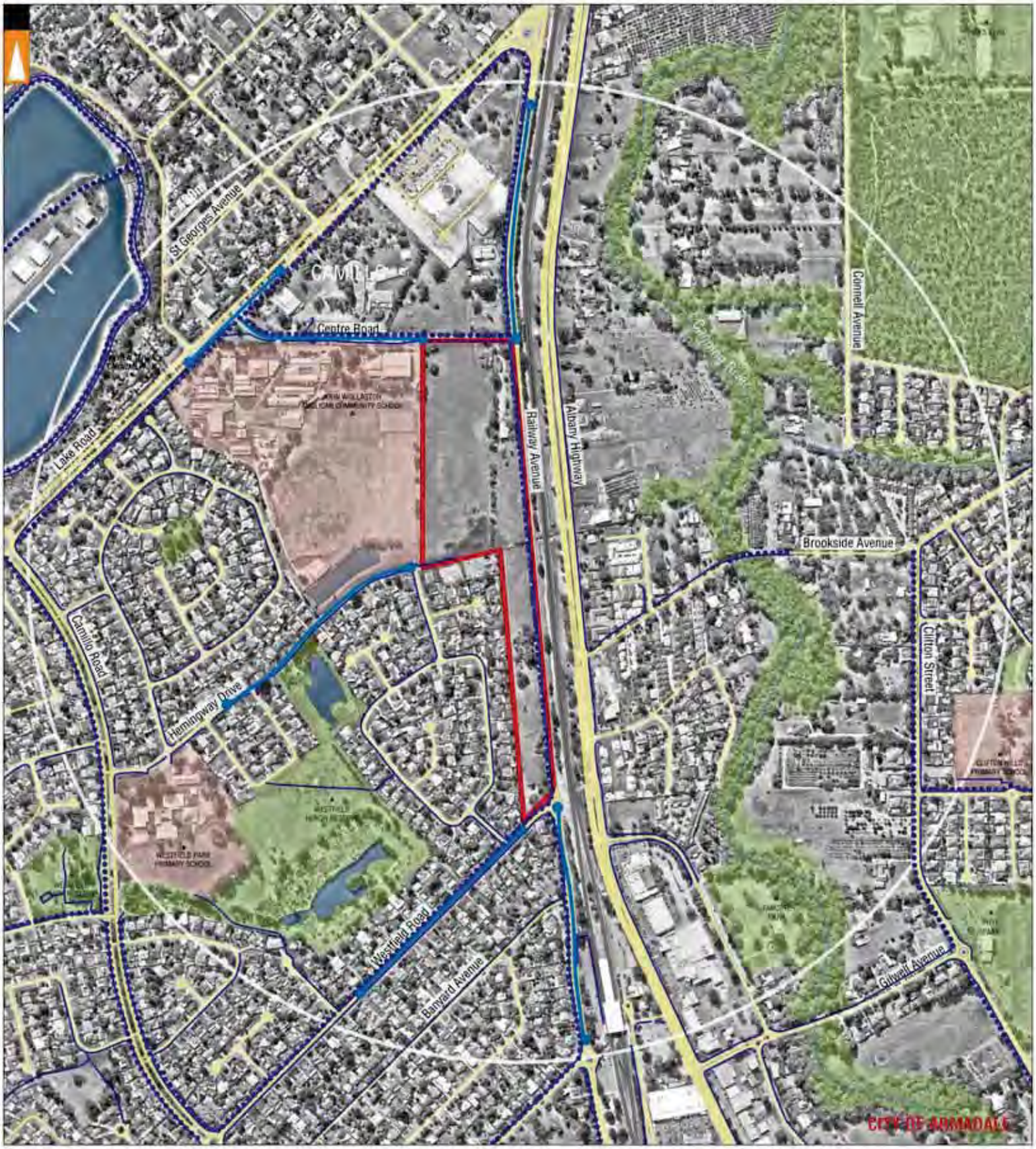
DRAWN BY: K.P.

Civil & Traffic Engineering Consultants
830B Beaufort Street Inglewood WA 6052

kctt



			PROJECT: Lots 58 to 60 Centre Road and Lot 27 Westfield Road, Camillo	DRAWN BY:	Civil & Traffic Engineering Consultants 83/8 Beaufort Street, Inglewood WA 6052
			TITLE: Public Transport Plan - 400m Radius	K.P.	kctt
A	05-05-2015	ISSUED FOR REVIEW	DRAWING NUMBER: KC00341.000_S03		
No	DATE	AMENDMENT			



No	DATE	AMENDMENT
A	05-05-2015	ISSUED FOR REVIEW

PROJECT: Lots 58 to 60 Centre Road and Lot 27 Westfield Road, Camillo

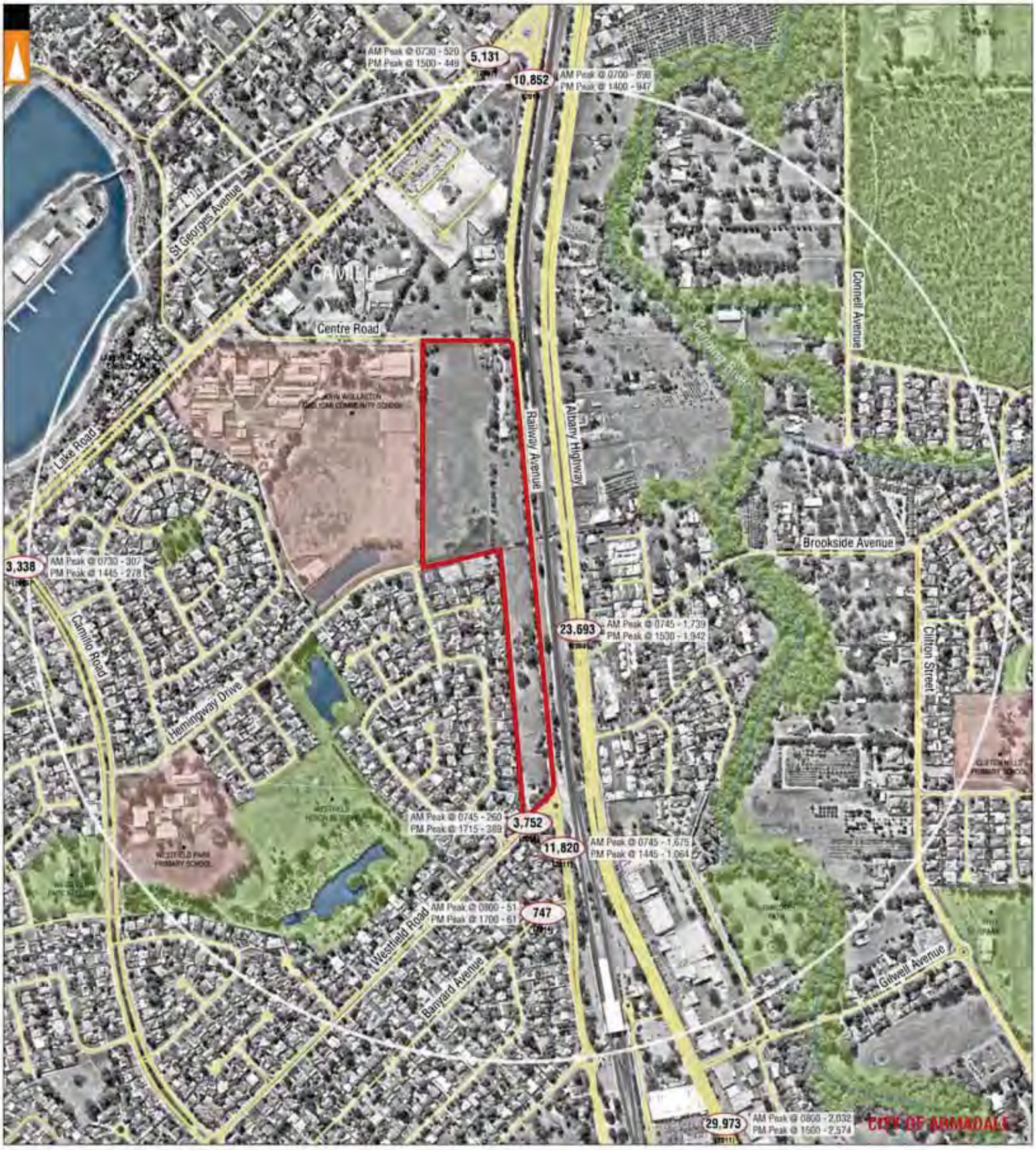
TITLE: Pedestrian Paths Plan - 400m Radius

DRAWING NUMBER: KC00341.000_S04

DRAWN BY: K.P.

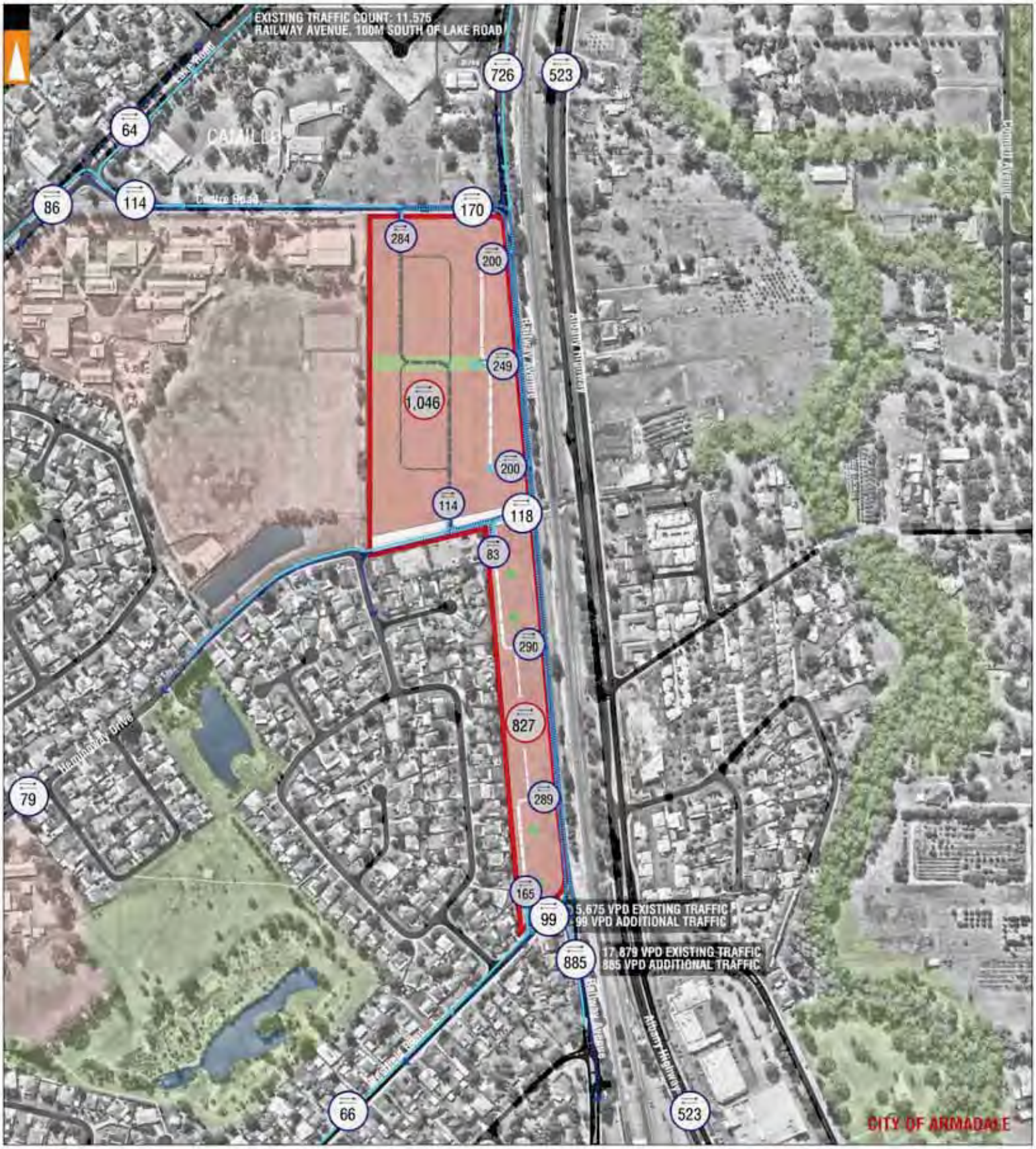
Civil & Traffic Engineering Consultants
830B Beaufort Street Inglewood WA 6052

kctt



LEGEND

			PROJECT: Lots 58 to 60 Centre Road and Lot 27 Westfield Road, Camillo	DRAWN BY:	Civil & Traffic Engineering Consultants 83/8 Beaufort Street Inglewood WA 6052
			TITLE: Existing Traffic Counts - 400m Radius	K.P.	kctt
A	05-05-2015	ISSUED FOR REVIEW	DRAWING NUMBER: KC00341.000_S05		
No	DATE	AMENDMENT			



No	DATE	AMENDMENT
B	21-05-2015	REVISED IN ACCORDANCE WITH THE COMMENTS RECEIVED FROM THE CLIENT
A	05-05-2015	ISSUED FOR REVIEW

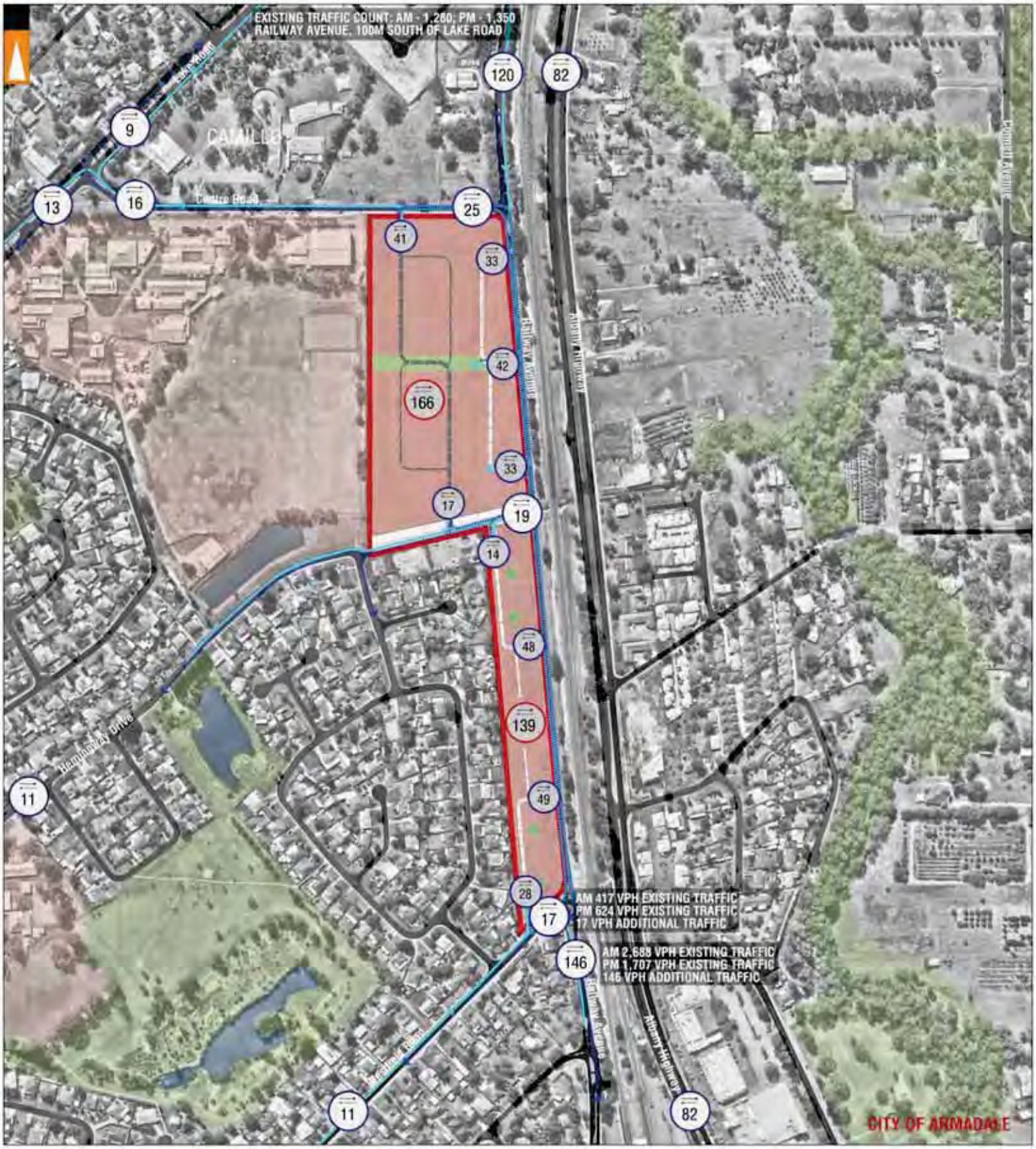
PROJECT: Lots 58 to 60 Centre Road and Lot 27 Westfield Road, Camillo

TITLE: Traffic Flow Diagram (2027)

DRAWING NUMBER: KC00341.000_S06

DRAWN BY: K.P.

Civil & Traffic Engineering Consultants
83(B Beaufort Street, Inglewood WA 6052
kctt



No	DATE	AMENDMENT
A	05-05-2015	ISSUED FOR REVIEW

PROJECT: Lots 58 to 60 Centre Road and Lot 27 Westfield Road, Camillo

TITLE: Traffic Flow Diagram - AM / PM Peak (2027)

DRAWING NUMBER: KC00341.000_S07

DRAWN BY: K.P.

Civil & Traffic Engineering Consultants
83(B Beaufort Street, Inglewood WA 6052

kctt

Appendix 3

Vehicle Turning Circle Plan

			PROJECT: Lot 27 Westfield Road, Cammillo	DRAWN BY:	Civil & Traffic Engineering Consultants 8308 Beaufort Street, Inglewood WA 6052
			TITLE: Vehicle Turning Circle - Service vehicle 8.8m	A.R.	
A	07-05-2015	ISSUED FOR REVIEW	DRAWING NUMBER: KC00341.000_S20		
NO	DATE	AMENDMENT			

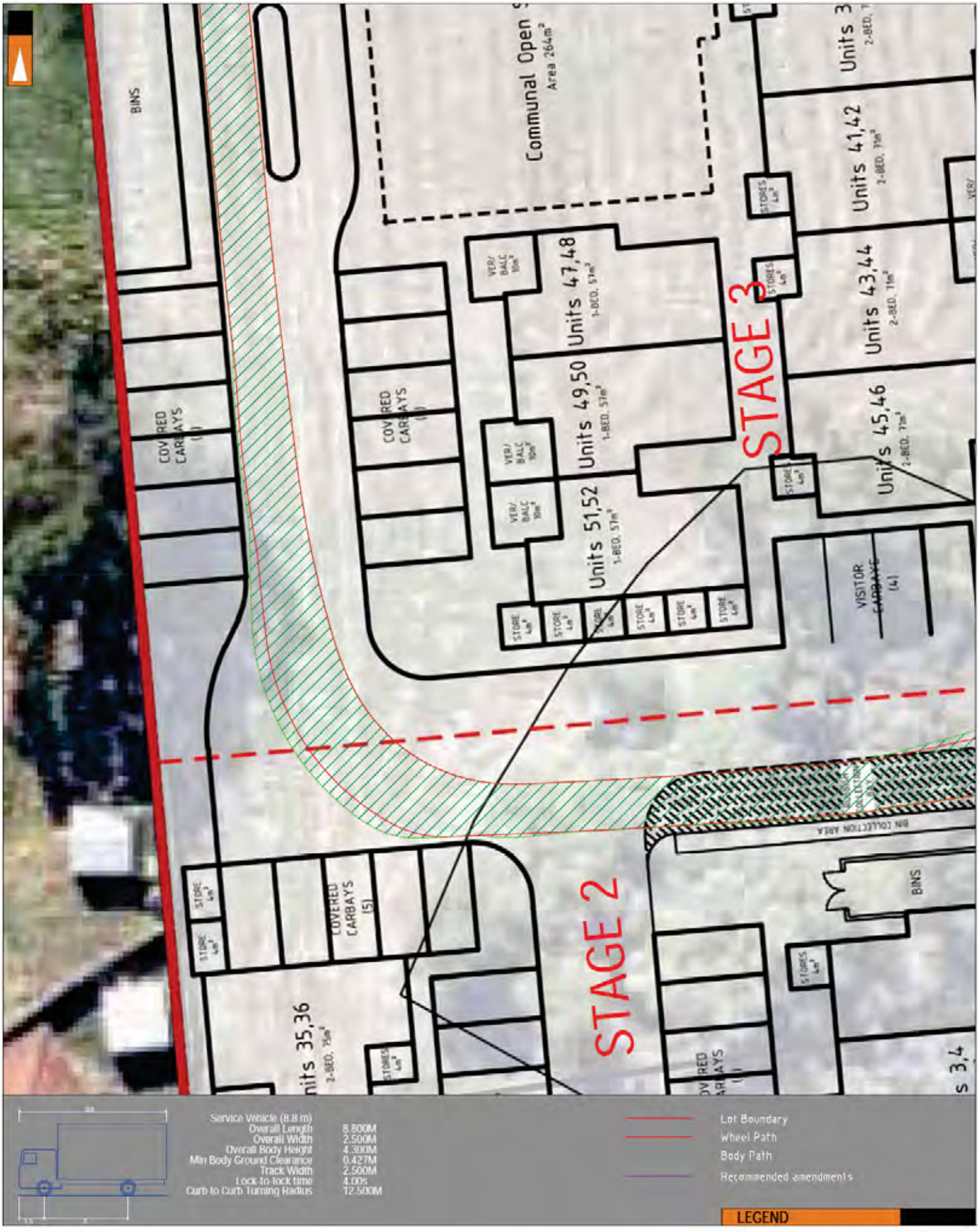
			PROJECT: Lot 27 Westfield Road, Cammillo	DRAWN BY: A.R.	Civil & Traffic Engineering Consultants 6308 Beaufort Street, Inglewood WA 6052 kctt
			TITLE: Vehicle Turning Circle - Service vehicle 8.8m		
A	07-05-2015	ISSUED FOR REVIEW	DRAWING NUMBER: KC00341.000_S21		
NO	DATE	AMENDMENT			

			PROJECT: Lot 27 Westfield Road, Cammillo	DRAWN BY:
			TITLE: Vehicle Turning Circle - Service vehicle 8.8m	A.R.
A	07-05-2015	ISSUED FOR REVIEW	DRAWING NUMBER: KC00341.000_S22	
NO	DATE	AMENDMENT		

Civil & Traffic Engineering Consultants
6308 Beaufort Street, Inglewood WA 6052
kctt

			PROJECT: Lot 27 Westfield Road, Cammillo	DRAWN BY:
			TITLE: Vehicle Turning Circle - Service vehicle 8.8m	A.R.
A	07-05-2015	ISSUED FOR REVIEW	DRAWING NUMBER: KC00341.000_S23	
NO	DATE	AMENDMENT		

Civil & Traffic Engineering Consultants
6308 Beaufort Street, Inglewood WA 6052
kctt



Service Vehicle (8.8 m)	
Overall Length	8.800M
Overall Width	2.500M
Overall Body Height	4.300M
Min Body Ground Clearance	0.427M
Track Width	2.500M
Lock-to-lock time	4.00s
Curb to Curb Turning Radius	12.500M

Lot Boundary
Wheel Path
Body Path
Recommended amendments

LEGEND

NO	DATE	AMENDMENT
A	07-05-2015	ISSUED FOR REVIEW

PROJECT:
Lot 27 Westfield Road, Cammillo

TITLE:
Vehicle Turning Circle - Service vehicle 8.8m

DRAWING NUMBER:
KC00341.000_S24

DRAWN BY:
A.R.

Civil & Traffic Engineering Consultants
6308 Beaufort Street, Inglewood WA 6052
kctt

Appendix 4

SIDRA Intersection Analysis
Rev A

Table of Contents

List of Figures

1. Introduction

This short report provides details on the SIDRA Analysis conducted to support the findings of the report KC00341.000_R01_Rev A. The intersection have been modelled in the AM and PM peak hours for 2017 and 2027.

The dimensions of the intersection elements have been scaled from the layout which was obtained by the Client and also from aerial imagery which was obtained through our commercial arrangement with Nearmaps. The aerial imagery which was utilised for this project is dated 24th April 2015. These images are suitable for use in concept drafting applications with a level of accuracy to within +/- 10 centimetres.

Base traffic data utilised for the modelling was obtained from the MRWA and the City of Armadale. The data was collected in February 2015 (Railway Avenue, south of Lake Road) and in July 2011 (Railway Avenue, south of Westfield Road and Westfield Road, west of Railway Avenue). These results were utilised for creating base SIDRA models.

The review of available traffic data has shown that AM Peak on Railway Avenue is occurring between 07:00-08:00 while the PM Peak occurs between 14:00-15:00 (CoA). Also, AM Peak on Westfield Road is occurring between 07:45-08:45 while the PM Peak occurs between 16:00-17:00 (MRWA). The estimated peak time for the proposed use is 08:00-09:00 for AM peak and 17:00-18:00 for PM peak.

SIDRA analysis was conducted for the peak hour of the proposed development. Volumes of passing traffic have been extracted from the reports provided by MRWA and City of Armadale (weekly volume by hour).

In accordance with the WAPC's stated AM and PM peak hour trip attraction / generation matrices quoted in Volume 5: Technical Guidelines, the expected total traffic generated by the development in the Peak hour is 28 VPH (Access 1), 49 VPH (Access 2), 48 VPH (Access 3), 14 VPH (Access 4). After a reduction of 20% of the total traffic generated by the development in the AM Peak hour occurs 22 VPH (Access 1), 39 VPH (Access 2), 38 VPH (Access 3), 11 VPH (Access 4). After a reduction of 40% of the total traffic generated by the development in the PM Peak hour occurs 17 VPH (Access 1), 29 VPH (Access 2), 29 VPH (Access 3), 8 VPH (Access 4). AM and PM Peak hour periods for the traffic generated by the development are likely to be between 8:00-9:00 and 17:00 to 18:00 during work days.

We believe the traffic attracted to and generated from the development would be distributed onto the adjacent road network as follows: -

100% (1,873 VPD) from / to subject Structure Plan.

- Five access / egress on Railway Avenue – 200+249+200+290+289=1,228VPD;
    - 45% (553VPD) to / from north via Railway Avenue;
    - 55% (675VPD) to / from south via Railway Avenue;
- Access / egress on Centre Road – 284VPD
    - 60% (170VPD) to / from east via Centre Road;
        - 45% (76VPD) to / from north via Railway Avenue;
        - 55% (94VPD) to / from south via Railway Avenue;
    - 40% (114VPD) to / from west via Centre Road;
        - 40% (46VPD) to / from east via Lake Road;
        - 60% (68VPD) to / from west via Lake Road;
- South access / egress on Hemingway Drive – 114VPD;
    - 40% (46VPD) to / from west via Hemingway Drive;
    - 60% (68VPD) to / from east via Hemingway Drive;

- North access / egress on Hemingway Drive – 83 VPD;
    - 40% (33VPD) to / from west via Hemingway Drive;
    - 60% (50VPD) to / from east via Hemingway Drive;
- Access / egress on Westfield Road – 165VPD;
    - 40% (66VPD) to / from west via Westfield Drive;
    - 60% (99VPD) to / from east via Westfield Drive;

The assumed split of the traffic attracted by the proposed development is: -

- **Residential** - A 25% IN / 75% OUT split has been adopted for the AM peak and a 67% IN / 33% OUT split for the PM peak hour;

Passing traffic volumes were projected using an average traffic growth rate of 3% per annum.

For purposes of this analysis we have assumed that the Intersection of Hemingway Drive / Railway Avenue (Model 6) will feature a full pedestrain crossing. This will provide the linkage of pedestrians flows from the development and potential new bus stop on Railway Avenue.

Summary of Results

SIDRA modelling has shown that the development will have minimal impact on the operation of the surrounding road network and namely the following intersections: -

- Intersection 1 – Westfield Road / Railway Avenue
- Intersection 2 – Access 1 / Westfield Road
- Intersection 3 – Access 2 / Railway Avenue
- Intersection 4 – Access 3 / Railway Avenue
- Intersection 5 – Access 4 / Hemingway Drive
- Intersection 6 – Hemingway Drive / Railway Avenue

The intersections were analysed in AM and PM peak with expected traffic volumes in 2017 (the estimated year of completion) and 2027.

Our findings through SIDRA Intersection analysis are that the existing road network has sufficient capacity to cater for the proposed development.

A summary of the results of the SIDRA analysis are shown on the following pages. For purposes of clarity we will provide network summaries below. A full SIDRA output report can be made available on request.

2. Network Analysis – Network 1

2.1.1 M01a 2017 AM Peak (1.1a , 1.2a ,1.3a ,1.4a ,1.5a ,1.6a)

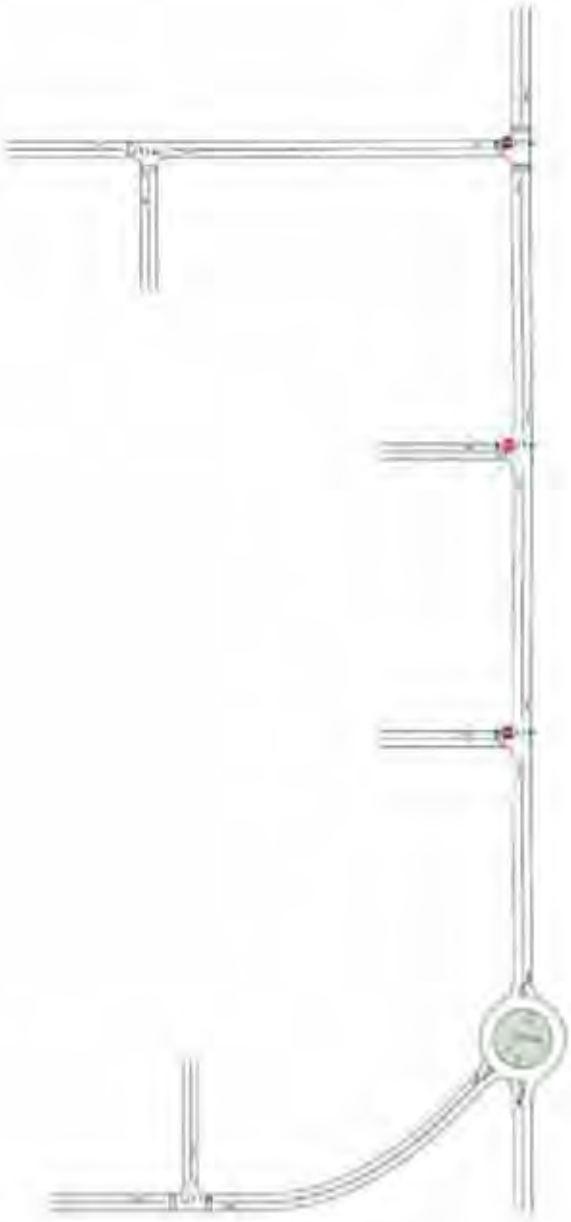


Figure 1- Network Layout - Network M01a+

SITES IN NETWORK	
Site ID	**Site Name**
1.1.a+	1.1.a+ Access 1 - Westfield Road 2017 - AM - WD
1.1.a+	1.1.a+ Westfield Road - Railway Avenue 2017 - AM - WD
1.1 a+	1.1 a+ Access 2 and Railway Avenue 2017 - AM - WD
1.1 a+	1.1 a+ Access 3 and Railway Avenue 2017 - AM - WD
1.1 a+	1.1 a+ Hemingway Road and Railway Avenue 2017 - AM - WD

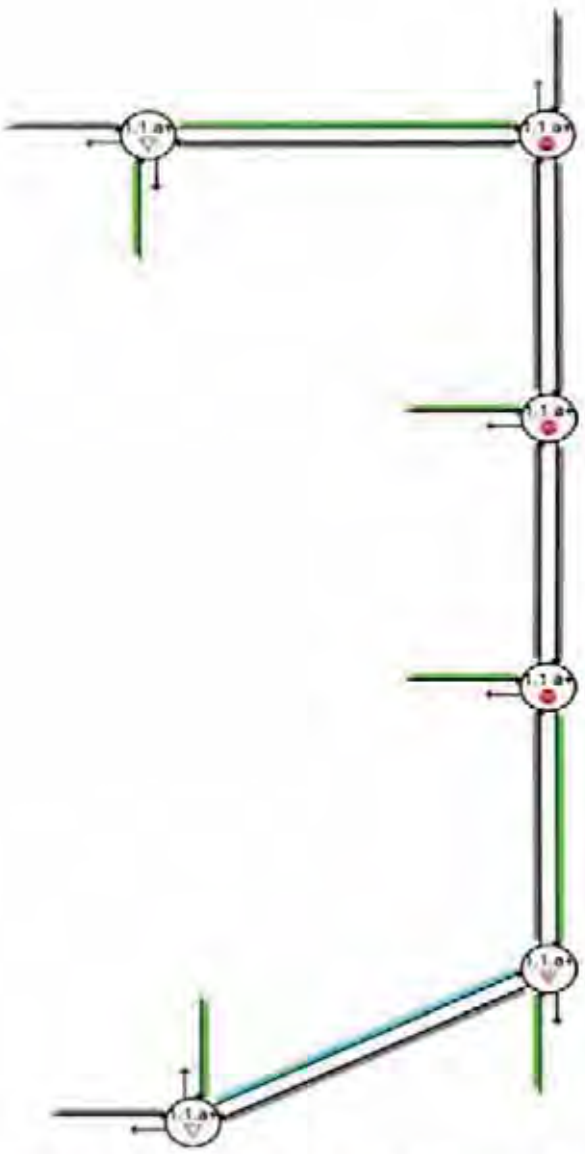


Figure 2 – Level of Service – Network 1 - 2017 AM with development

2.1.2 M01p 2017 PM Peak (1.1p , 1.2p ,1.3p ,1.4p ,1.5p ,1.6p)

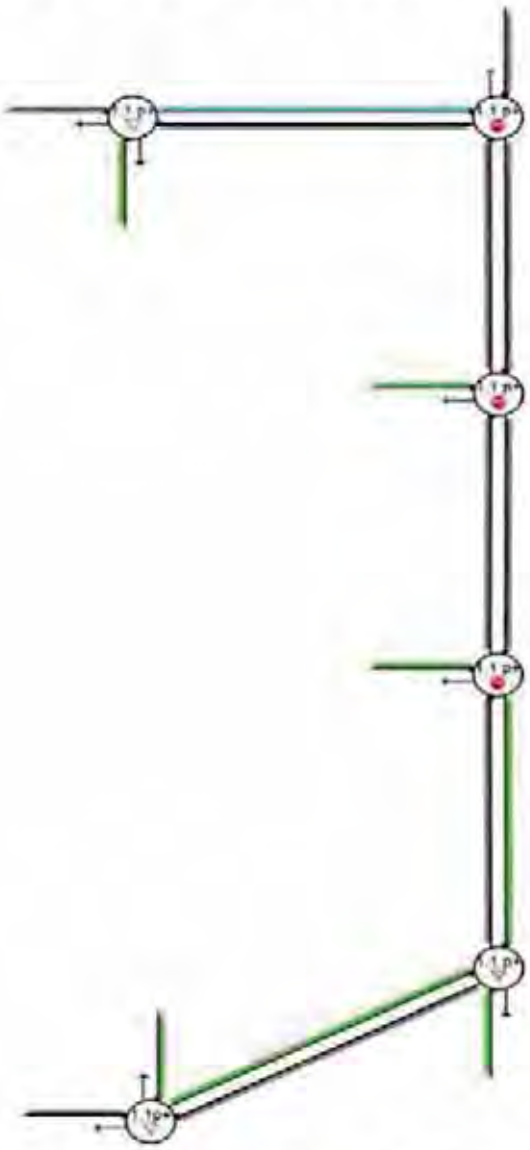


Figure 3 - Level of Service – Network 1 - 2017 PM with development

2.1.3 M01a 2027 AM Peak (2.1a , 2.2a ,2.3a ,2.4a ,2.5a ,2.6a)

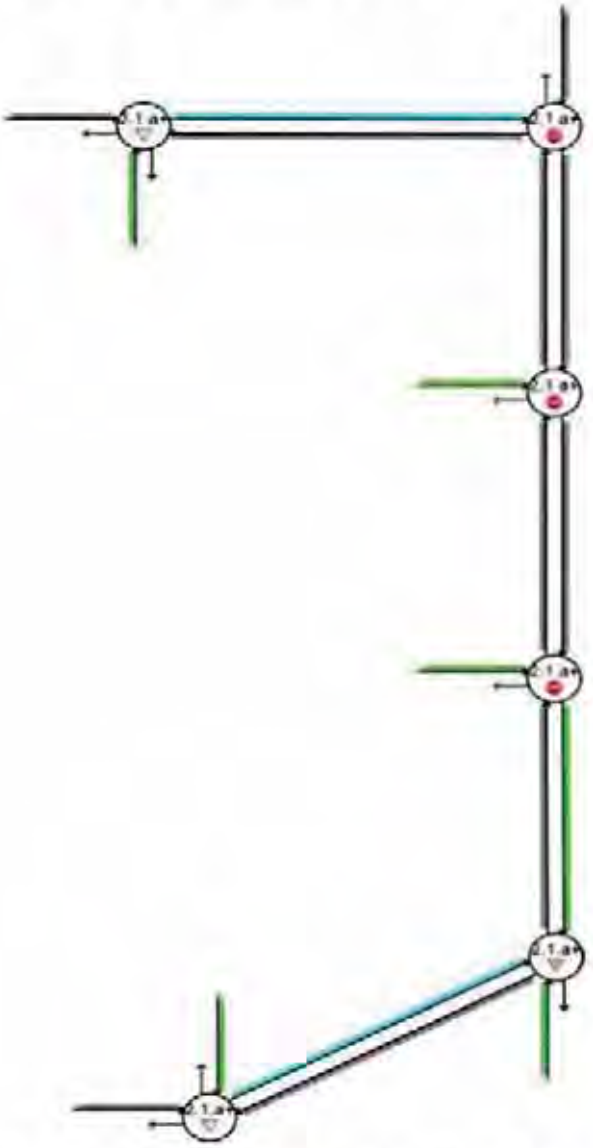


Figure 4 - Level of Service – Network 1 - 2027 AM with development

2.1.4 M01p 2027 PM Peak (2.1p , 2.2p ,2.3p ,2.4p ,2.5p ,2.6p)

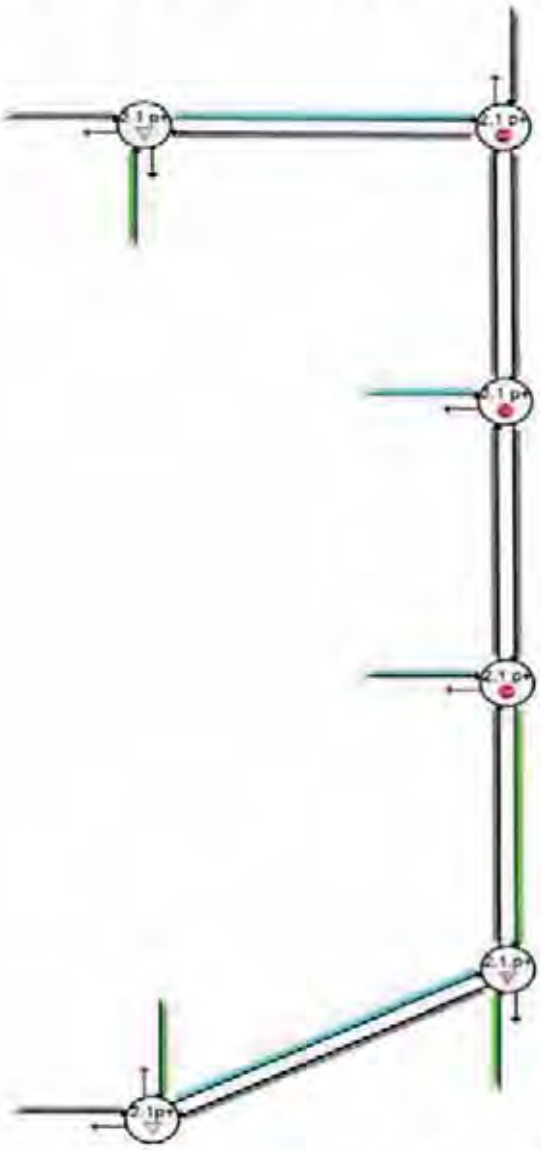
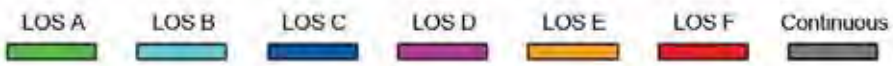


Figure 5 - Level of Service – Network 1 - 2027 PM with development



APPENDIX D

Local Water Management Strategy prepared by Civil Technology

Local Water Management Strategy

Development Area 9; City of Armadale TPS4

For Seville Corporation Pty Ltd

4 August 2015

CIVIL TECHNOLOGY

Contents

Abbreviations/Glossary

AHD	Australian Height Datum
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
BGL	Below Ground Level
BoM	Bureau of Meteorology
City	City of Armadale
c	coefficient of run-off
DN	Nominal Diameter
HGL	Hydraulic Grade Line
HL	Hydraulic Level in m AHD
IFD	Frequency-Duration design rainfall intensity co-efficient
$^{33}I_{10}$	Rainfall intensity in mm/hour, for an ARI 10 year storm event of 33 minutes duration
Lot 27	Lot 27 Westfield Road, Camillo
Lot 58	Lot 58 Centre Road, Camillo
Lot 59	Lot 59 Centre Road, Camillo
Lot 60	Lot 60 Centre Road, Camillo
LWMS	Local Water Management Strategy
l/s	Litres per sec
m	metres
mm/hr	millimetres per hour
NGL	Natural Ground Level
ODP	The open discharge pit located east of Railway Avenue's intersection with Hemingway Drive, where the Water Corporation's Rising Main and the City's DN1500RC discharge into.
Q	Peak flow occurring at catchment t_c, in l/s
RC	Reinforced Concrete pipe

RCBC	Reinforced Concrete Box Culvert
Rising Main	Water Corporation's DN525 Steel Drainage Rising Main
RL	Reduced Level
Seville	Seville Corporation Pty Ltd
TPS 4	The City of Armadale's Town Planning Scheme No 4
t_c	Time of concentration in minutes
TWL	Top Water Level
WCWMD	Water Corporation's Westfield Main Drain 61201

1. Introduction

1.1 Authority

Civil Technology has been engaged by Seville to prepare a LWMS for the proposed development of:

- Lot 27 Westfield Road, Camillo (Lot 27), and
- Lot 60 Centre Road, Camillo (Lot 60).

These existing super lots are contained within a Structure Plan, prepared by RPS Australia East Pty Ltd, over Development Area 9 of the City's TPS 4. Lots 58 & 59 Centre Road, Camillo, owned by others, also fall within the Structure Plan area. Collectively, these 4 lots will be referred to in this LWMS as either the "site" or the "Structure Plan" depending on context.

Refer to Figure 1 for the location and extent of the Structure Plan area.

Following a review by the City of the Structure Plan lodged in December 2014, by way of a letter dated 20 April 2015 (Ref: SP/DA/9) the City specifically requested that a LWMS be prepared. Refer to Appendix 3; Correspondence 1.

1.2 Site Bounds

The Structure Plan covers an infill area between Camillo and Kelmscott, bounded by Railway Avenue and an active rail reserve to the east, which are adjacent to, and parallel with Albany Highway, as it passes through Kelmscott. To the north is Centre Road, and Westfield Road forms the southern bound. Urban development abuts the western boundary and southern boundary of Lot 27. John Wallaston Anglican Community School abuts the western boundary of Lot 58.

2. Proposed Development

The Structure Plan area is coded under TPS 4 Residential R15/40 and falls with Development Area 9. The ultimate development of the Structure Plan area would most likely consist of Grouped and/or Multiple Dwellings in accordance with the R40 Code, consistent with Seville's proposal for Lots 27 and 60, refer Figures 2 & 3 respectively for the preliminary layouts for the development of Lots 27 & 60.

3. Design Principles and Constraints

The guiding design principles within this LWMS are, as part of the development of the Structure Plan area recognition of:

- The context of the Structure Plan's position within the WCWMD catchment, which is a pumped system discharging stormwater through:
  - Ā firstly, a DN750RC culvert under Railway Avenue;
  - Ā secondly, a 1200RCBC under the existing railway line;
  - Ā thirdly, a DN900RC culvert under Albany Highway; and

- Ā thereafter, an open drain which reports to the Canning River.
- The fact that the Structure Plan area is an infill development bounded by developed land;
- The existing clay subgrade soils comprising the land from and the response to imposed subsoil infiltrated water loading;
- Sustainable best practice in urban water sensitive design;
- Maintenance of appropriate structural integrity in any development that will occur close to the boundary of existing developed areas; and,
- Proper public utility and amenity in the proposed stormwater infrastructure and related earthworks.

Calculations contained in this LWMS with respect to stormwater generation for the whole of the Structure Plan area will be based on an extrapolation of the known proposed layout for Lot 27; namely the densest likely development. This approach will allow a conservative calculation of equivalent impermeable area applicable to development of the whole of the Structure Plan area.

4.0 Pre-Development Conditions

4.0.1 Site Geotechnical Investigation

Galt Geotechnics investigated the ground conditions of Lots 27 & 60 in April and September 2014, respectively. Both of these existing lots comprised soft clays and were accorded P Classifications under AS2970.

Galt Geotechnics has stated the clayey subgrade found on these lots has low permeability.

Galt Geotechnics reports were lodged with the City via email on Thursday, 25 June 2015, and should be referred to for detail.

Whilst no detailed geotechnical investigation has been undertaken by Galt for Lots 58 & 59, it will be taken that for the purposes of preparation of this LWMS, that the worst case requirement stipulated by Galt that 1200mm of compacted inert granular fill is needed to be placed above the clayey soils will be assumed to be required for Lots 58 & 59 until such future geotechnical investigation recommends otherwise.

4.0.2 Acid Sulphate Soils

Galt Geotechnics has alluded to the possibility of being present on Lots 27 & 60, refer lodged report. Further opinion sought by the author of this report from Ms Gina Pemberton, of Ace Environmental a locally based acid sulphate soils expert, informs that acid sulphate soils would likely only be present in excavations conducted at a depth of more than 3m BGL in the subject location.

4.0.3 Site Morphology

The site in general grades from both north and south towards the centrally located Hemingway Drive forming localised depressions due to existing development levels at the boundaries of this site. The site's NGLs and averaged grades are shown in Table 1:

Table 1

Lot	Highest Level (RL m AHD)	Lowest Level (RL m AHD)	Calculated Average Grade
27	26	21	1.1%
60	24	21	0.9%
59	24	21	0.9%
58	24	21	0.8%

4.0.4 Existing Uses

The Structure Plan area has been mostly cleared of natural vegetation and is likely to have at some earlier stage had rural usage; as such the land is currently primarily comprised of grassed open paddock.

Existing buildings:

- Lots 58 & 59, together, have a single residence on them.
- Lot 60 has a church; and
- Lot 27 had a single residence, now demolished.

Refer Figure 4 for an aerial view of the site.

Through the centre of the Structure Plan area is an unconstructed portion of Hemingway Drive. Part of Lot 60 will be given up by Seville as a widening for Hemingway Drive road reserve and to provide for its ultimate connection to Railway Avenue. The remaining portion of Hemingway Drive road reserve will be required to be given up by the owners of Lots 58 & 59 Centre Road at the time of development of these lots.

4.1 Drainage Infrastructure

4.1.1 Historical

In earlier times, there was an agricultural type drainage pathway dividing what is now the Structure Plan area. This drain was located along the alignment of what Hemingway Drive, within a Drain Reserve; refer Figures 5 & 6. Surface water flows off the agricultural area (which appears to been a natural lowland similar in size to Wright Lake located to the north of Lake Road), would have flowed towards this drain, thus making agricultural use of what would otherwise been a dampland possible. This drain flowed eastwards towards the Canning River, prior to being made redundant by:

- the residential development occurring to the west (which incorporated the construction of the Water Corporation's WCWMD aa a replacement drainage system for the dampland); and,
- being severed by construction of roads and rail line.

As such, neither the agricultural drain or the reserve now exist.

4.1.2 Water Corporation's Drainage Infrastructure

The site is located within, and at the eastern boundary of, the WCWMD catchment, refer Figure 7. Within this catchment the Water Corporation has three interconnected compensating basins:

- Hemingway North Drainage Basin TWL 18.6m AHD;

- Hemingway South Drainage Basin TWL 18.6m AHD; and
- Merlin Drainage Basin TWL 20.70m AHD.

Refer to Figure 8 for their relationship to the site.

The Water Corporation has, as part of the existing development to the west of the Structure Plan area installed a DN525 Steel Drainage Rising Main (Rising Main) along the Hemingway Drive reserve alignment, where the drainage reserve once existed; discharging to the existing ODP; refer Figure 4.

In accordance with information supplied to the author of this report by the Water Corporation, the Hemingway South Drainage Basin is equipped with two Flygt submersible drainage pumps with a combined duty of 320 l/sec @ 4.3m head under normal operation; refer Figures 9 & 10. These pumps discharge pump stormwater via a DN525 steel rising main, located in Hemingway Drive, into the ODP, refer Figure 4.

From the ODP, stormwater is conveyed under the rail line through a 1200 x 1200 RCBC and then under Albany Highway via a DN 900 RC pipe ultimately flowing eastwards towards the Canning River.

Importantly, prior to stormwater entering the Canning River it is conveyed by a 250m vegetated open drainage channel allowing, to some degree, nutrient stripping.

4.1.3 City of Armadale Drainage Infrastructure

The residential development area located to the southwest of the Structure Plan area is presently serviced by City's reticulated subsoil/street drainage, which ultimately discharges into the WCWMD's interconnected Hemingway North and South Basins.

The area to the south of the Structure Plan area and south of Westfield Road, is presently serviced by the City's reticulated subsoil/street drainage system, which at the downstream extent comprises a DN1500RC piped drain that discharges into the ODP i.e. at the same point as the Water Corporation's WCWMD system, at an invert level of RL 20.04m AHD; refer Figure 11.

Pre-development capacity of DN1500 Main Drain in Railway Avenue

A review of the peak stormwater flow rate that is likely to be carried within the City's DN1500RC drain located in Railway Avenue has been undertaken. The hydraulic analysis has been based on:

- An adequate local reticulated drainage system being connected to the DN1500RC;
- The sub catchments as depicted in Figure 11;
- Run-off allowances likely from lots, verges, roads, open areas, and the existing carpark improvements located in the rail reserve area.
- Calculated sub catchment areas the flow from which reports to the DN1500RC, based on impermeable area types as shown in Table 2 below
- An ARI of 1 in 10 years; ARR rational method; BoM IFD; and,
- That the street gully intake system linked to the piped drain system is limited to the 1 in 10 year event.

Table 2

	Impermeable Area Types		
	Lots (m^2)[1]	**Roads/Paths (m^2)[1]**	**Verge/POS (m^2)[1]**
Run-off Coefficient	0.35	0.9	0.3
Subcatchment			
A	5466	597	616
B	9110	597	616
C	9110	995	1026
D	5466	597	616
E	9981	1379	1526
F	67414	6062	5078
G	7150	1249	1574
H	7440	3621	4787
I	800	1707	2440
J	17938	3137	5103
J1		1700	2064
K	6528	3508	5936
L		546	48
M		1049	2396
N		752	1717
O		4554	10396

[1]The areas stated above have been obtained by measurements taken off the City's website; via link to the GIS "Online Mapping" system.

The calculations of the likely flow rate in the City's DN 1500 RC drain pipe for the predevelopment scenario are presented in Excel format as Analysis 1; Appendix 2.

These calculations show that for the predevelopment situation:

a) During an ARI 5 year event, the estimated peak flow in the City's DN1500RC pipe is 1380 l/s;
b) The optimum discharge capacity of a DN1500RC pipe at the existing grade of 1:289 is 5127 l/s.
c) The depth of flow in the DN1500 during the 1 in 10 year event is estimated to be 540mm. That is, in the opinion of the author, the DN1500RC is manifestly oversized and there is a large extent of redundancy in this pipe; and
d) The level of the water flow's free surface at the ODP is RL 20.58m AHD; given the invert of this pipe being at RL 20.04m AHD.

The analysis has allowed for the upgrading of DN150 and DN225 pipes which are currently located at the uppermost extents of the catchment, refer Figure 11, which in the author's opinion are somewhat undersized. Consequently, should the upstream pipes be upgraded, the calculation remains relevant and presently conservative.

The analysis has been carried through to the DN900RC under Albany Highway, the smallest downstream pipe. Over and above the flow generated the existing extent of urban development discharging into the DN1500RC, the DN900RC also receives 320 l/s of flow from the Water Corporation's basin pumps and about 90 l/s of flow from the Railway Avenue portion of road north of the ODP to give an estimated cumulative total flow in the DN900RC of 1710 l/s. The flow capacity

of a DN900RC pipe at the existing grade of 1:130 is 1955 l/s. The depth of flow in the DN900RC is estimated to be 662mm which, expressed as a percentage, equates to 87% of its capacity of a full flow at grade and without surcharge head. Again, as with the DN1500RC, there is redundancy in the DN900RC culvert under Albany Highway. It should also be noted that the calculations are reasonably conservative in as much that the calculation assumes that both the Water Corporation's basin pumps are in full operation and pumping 320 l/s, at the time of peak flow in the DN1500 pipe of 22 minutes.

4.3 Surface Water Quality

No creeks or open drains traverse the Structure Plan area and no public roads shed runoff into the area. Present land uses appear to be mainly redundant broad acre farm land. As mentioned above there are existing buildings. Together with associated hardstand areas, these comprise hard surfaces of about 1500m^2 in area which appear to discharge stormwater onto the grassland area.

Stormwater run-off quality therefore can only be that of a typical grassland area. No stock (from which excreted fecal matter would add nutrients to surface water) appears to be present on the site. Therefore, present nutrient loads would likely be low.

4.4 Groundwater

The Water Corporation's Hemingway North and South Drainage Basins with TWLs of RL 18.70m AHD to the west, and the Canning River a short distance to the east suppress, and control, ground water levels in the WCWMD catchment area. The existing lowest NGLs within the Structure Plan area are in the vicinity of RL 21m AHD.

The City's reticulated drainage in the existing urban development immediately west of Lot 27 has subsoil drainage, which again suppress ground water levels to below RL 21m AHD.

Galt Geotechnics test pitted 6 holes within Lot 60. In four of these holes groundwater was not observed and in two holes ground water was observed at 0.7-0.8m BGL, however this water was perched above a laterite stratum at which excavator refusal was experienced. It is worth noting that Galt Geotechnic's field investigations were conducted on 21 August 2014, i.e. at the completion of winter that year.

5.0 Water Corporation's Pre-development Run-off Allowance.

The Water Corporation's mandate within the WCWMD catchment boundary is to reduce the likelihood of damage to property through flooding by providing:

1. Suitably sized drainage basins;
2. Suitably sized and maintained drainage pumps and rising main; and
3. Stormwater inflow management, including development control of stormwater run-off to its drainage basins.

Items 1 and 2 have no nexus with proposed development within the Structure Plan. However it is within the power of the Water Corporation to restrict the quantum of run-off from the development in accordance with Item 3 above to meet the pre-development level. As such, the Water Corporation has limited the surface water run-off from the Structure Plan area to its drainage basins, by stipulating that run-off from the fully developed Structure Plan area to that of an equivalent run-

off that might be expected from a pre-developed area; with a run-off coefficient of 20% during an ARI 10 year storm event. Refer Water Corporation's email in the attached Correspondence 2; Appendix 3.

6.0 Post Development

6.1 General

Galt Geotechnics recommends that to alter the AS 2970 classification of the site from P to S, it would be required to place a minimum thickness of 800mm of compacted inert granular fill above the clayey soils (in Lot 27) and minimum thickness of 1200mm of compacted inert granular fill above the clayey soils (in Lot 60).

One consequence of the recommendation for the placement 800mm to 1200mm of granular fill means that excavation of soil for the purposes of installing piped drainage and other underground utility services for the development of the site are likely to occur within the imported sand fill condition rather than within the existing clay condition. As such, it is highly unlikely that acid sulphate soil conditions to be encountered during service trenching operations.

The engineers for Lots 27 and 60, McDowell Affleck, also recommend that the clay substratum be contoured with imported clay for the purposes of directing infiltrated water to subsoil drainage.

6.2 Groundwater

The proposed earthworks, entailing subgrade clay recontouring, imported granular fill to between 0.8-1.2m above the NGL and subsoil drains being located at the current clay stratum level will not vary peak groundwater levels from conditions existent.

By way of further explanation, the impermeable subgrade layer, identified by Galt Geotechnics as primarily high in clay sized particle content, will be re-contoured as part of the proposed earthworks, which will direct infiltrated water from the imported granular fill, to subsoil drainage which will prevent subsurface groundwater ponding between the existing clay fraction and the sand fill fraction and prevent ground water level rise. The subsoil drainage flow will ultimately report to the Water Corporation's Hemingway Drive basins, through proposed drainage works. Refer Figure 12.

It should be noted there will be, during storm events, a substantial time separation, and thus attenuation, between the surface water generation and subsoil water arriving at the Water Corporation existing drainage basins located in Hemingway Drive. Thus there is minimal consequence to the rate of stormwater flow that is permitted by the Water Corporation to discharge into those basins.

6.2.1 Soil Infiltrated Stormwater Management

Specifically for Lot 27, in order to retain the required inert imported granular height, there will be a retaining wall constructed on the western boundary which abuts several small residential sized neighbouring lots. It is therefore important to ensure that infiltrated water from the development is not impounded by the retaining wall structure. As such, along the retained heel of the retaining wall, there will be subsoil drainage installed as relief against impounding, using a slotted PVC pipe at a minimum DN150 size for ease of long term maintenance. The DN150 pipe would be embedded in an engineered filter; details of which would be provided at the detailed engineering stage.

Subsoil water run-off from the Structure Plan area will report to the Water Corporation's Hemingway Drive basins, facilities which will provide settling for particulate matter carried by the piped drainage system.

Adopting Galt Geotechnic's assumed infiltration rate through the granular fill fraction of 3m/day and allowing an assumed minimum 15m distance between compensating basins located centrally to the long axis of each existing lot as a development site (i.e. within common property open space areas) and the subsoil drainage at the heel of the western retaining walls, infiltrated water would not report to the Water Corporation's Hemingway Drive compensating basins, as an attenuated hydrograph, until at least 5 days after the associated storm had passed.

6.3 Water Sustainability

6.3.1 Water Conservation

The owners of Lot 27 and Lot 60, as developers of a unit site development, are in a position to optimise the utility of water coupled with future unit occupants' amenity, particularly in the design of uniform landscaping. Further, through the selection of water efficient water appliances to the proposed units, which should include water saving shower heads, taps and toilets and perhaps pressure reduction at the meter, reticulated potable water delivery pressure allowing, thus reducing potable water usage.

Grassed and landscaped areas will be designed and installed with water conservative native species, mixed with paved, shaded (treed and shade clothed) areas and by the supply of drip irrigation to garden bed areas. Guidance for these initiatives is presented below.

Internal water usage

Indicative comparative house water usages for appliances, complied by the Domestic Water Use Study (Water Corporation, 2003) are tabulated in Table 3 below.

Table 3

No	Appliance	Type of Appliance	Assumption	Water Consumption (kL/year)	Water Saving (kL/year)
1	Shower Head	Conventional shower head	One 7.5 minute shower per person per day	99	_
		AAA rated shower head		77	22
2	Flushing	Conventional single flush toilet	Three flushes per person per day	48	_
		Dual flush toilet		31	18
3	Washing Machine	Conventional top loader	One load per household per day	53	_
		AAAA rated front loader		15	38
4	Taps	Conventional	16% of all water used in the home is used via taps	32	_
		Water Saving		16	16
Total		Conventional Devices		232	_
		Water Saving Devices		138	94

External water usage

The average home in Perth uses 707 l/day or 260 kl/year on gardens, equating to 56% of lot water consumption (Water Corporation, 2003). To reduce this average consumption the Water Corporation's Waterwise Display Village programme recommends water saving techniques such as:

- Soils can be improved with soil conditioner to a minimum depth of 150mm where turf is to be planted and a minimum depth of 300mm for garden beds.
- Irrigation systems shall be designed and installed according to best water efficient practices. The controller must be able to irrigate different zones with different irrigation rates. Emitters must disperse coarse droplets or be subterranean.
- The adoption of xeriscaped communal gardens where garden beds are landscaped using water wise plants, which are local native species from similar climates.
- Turf species should be a genotype endorsed by the UWA Turf Industries Research Steering Committee (e.g. Couch grass Cynodon dactylon).
- Garden beds are to be mulched to 75mm.

Using water saving techniques such as those detailed above could reduce reticulated water usage by between 40% and 50% i.e. a decrease in consumption from 260 kl/year/average home to 115 kl/year/average home. Whilst these figures relate to the average home, it is not suggested that water savings of a similar magnitude could be achieved in a unit development but the water saving techniques listed should nonetheless be used where appropriate to reduce reliance on the reticulated water network as much as possible.

6.4 Surface Water Quality Management

It is proposed that surface water quality will have pass through three levels of treatment prior to reaching the Canning River:

- Compensating basins located within public or private open space (common property) areas and soak wells will be incorporated into the drainage systems of the development so as to retain first flush stormwater run-off on site;
- The WCWMD Hemingway North Basin acts as a sediment settlement basin prior to entering the Hemingway South Basin where final pump out occurs, and only in the highest stormwater events;
- Pumped stormwater discharge from the WCWMD Hemingway South Basin flows through approximately 250m of open drain prior to entering the Canning River.

The passive treatments referred to above lower the sediment and nutrient loading of stormwater run-off from site entering the Canning River.

Surface applied nutrient load agents such as the use of fertilisers need to be controlled by the education of residents. Further, an appropriate selection of open area and compensating basin vegetation by the developers' landscapers will further assist in the take up of nutrients before stormwater exits the site. The Structure Plan area will, in all likelihood, predominantly become a unit site development whereby there will be ample opportunity for the strata body corporate to engage in a routine of appropriate education of residents as to the proper use of fertilisers.

6.5 Waste Water Management

As an infill urban development, the Structure Plan area is surrounded by, and connected with, reticulated sewer, refer Figure 13. Accordingly, residential dwellings within the development will be connected to the sewer as a requirement of the City's Development Approval.

7.0 Water Corporation's Limitation to Stormwater Runoff

7.1 Pre-Development Stormwater Run-off Limits

Without loss of generality and in consideration of the small, long, thin catchments that will be generated by a staged development of each superlot located within the Structure Plan area, the time of concentration (t_c) for Lot 27 in the Pre-Development state has been applied to determine a common ARI 10 year event storm intensity (I_{10}) for each existing superlot. The calculated t_c, in accordance the Kinetic Wave Equation (ARR), is 33 mins.

The BoM rainfall IFD data for Camillo, indicates an $^{33}I_{10}$ of 44mm/hr; refer Figure 14. Using the ARR Rational Method with a run-off coefficient of 0.2 (20%) the pre-development peak flow (Q) for each super lot's catchment is limited to the results set out in Table 4 below:

Table 4

	Lot 27	Lot 58	Lot 59	Lot 60	Total
Land Area A(Ha)	2.2	2.2	2.1	1.4	7.9
Water Corporation's Limit to Peak Flow Q (l/s)[1]	54	54	51	34	193

[1] Q = 2.78xcIA

Q = Peak flow in l/s

c= coefficient of run-off (required by the Water Corporation to be 0.2).

I= $^{33}I_{10}$ which is 44mm/hr

A= lot area in Ha

8.0 Water Management Strategy Options

The key to any strategy adopted for adequate stormwater management within the Structure Plan area is to manage the stormwater run-off hydrographs so that, neither Water Corporation's nor the City's receiving infrastructure's capacities are exceeded, at the risk levels applicable to ARIs, so that flooding does not result.

The flow rates and surplus receiving capacities of existing infrastructure have been outlined in Section 4.1 above.

In this LWMS, options will be analysed in the context that the only preliminary lot layout that exists is for Lot 27 and a conservative approach will be adopted by using this reasonably advanced layout as being a reasonable base model for the likely development form that will occur in the balance of the Structure Plan area. As such, options analysed in this LWMS demonstrate generic solutions as to

viability only and that final development layouts and site levels will eventually dictate the final solution to water management for the Structure Plan area.

Base Option 1: This option is available to the whole of the Structure Plan area and is centred around the use of discrete stormwater compensating basins being located on each development site, either within public open space areas (for green title type subdivision) or within private open space common property areas (for strata title type subdivision). Through soakwells and compensating basins located within each super lot as they are developed, the stormwater run-off hydrograph will by attenuated so as to achieve a run-off equivalent to 20% pre-development rate, the attenuated flow being directed to the WCWMR drainage basins. The compensated stormwater flows will report, either directly or indirectly, to the existing WCWMD drainage basins.

It has already been established that subsoil drainage is a necessary requirement for the Structure Plan area. Subsoil drainage invert levels, located just above the clay subgrade, taken together with the likely final height of the clay fraction compared to existing discharge points, dictate that flow from this form of drainage can only report to the WCWMD drainage basins unless a small pump system is used to send the subsoil drain water to the ODP in lieu of the Water Corporations basin located to the west (which is not recommended due to cost issues). It has also been demonstrated that this flow will not affect the run-off limitation imposed by the Water Corporation, due to attenuation being created by the time lag in which subsoils water pass slowly but steadily through the imported fill fraction. Refer Figure 12 for a schematic representation of the proposed subsoil drainage routes.

Option 2: Due to existing elevation constraints, this option is likely to be viably engaged only in the the case of development of existing Lots 27 & 60. This option consists of, in lieu of directing compensated stormwater flow from Lots 27 and 60 westward towards the WCWMD basins, directing the compensated flow eastward straight to the City's drainage system located in Railway Avenue.

As has been mentioned above under Base Option 1 above, subsoil drainage water must report to, either directly or indirectly, to the existing WCWMD drainage basins unless a pumps system is used.

8.1 Options Analyses

8.1.1 Post Development Parameters and Assumptions

To date, only Lot 27 has had a preliminary development layout drawn up with any degree of development footprint detail. Since Lot 27 takes full advantage of its zoning in terms of allowable dwelling units per land area, Lot 27 is deemed by the author to be a conservative layout in terms of determination of a suitable stormwater run-off co-efficient to apply to the whole of the Structure Plan area.

The equivalent impervious area parameters for Lot 27 are shown in Table 5 below:

Table 5

Surface Type	Run-off Coefficient	Area (Ha)	Equivalent Impervious Area (Ha)

Covered Car park	0.95	0.224	0.213
Unit Roof	0.95	0.606	0.576
Footpath	0.85	0.445	0.378
Asphalt minus covered car park	0.90	0.471	0.424
Grassed area minus basin	0.30	0.455	0.126
Totals		2.200	1.73

Accordingly, on the basis of the above figures, the ratio of post-development equivalent impervious area to the area for Lot 27 is 0.78 (1.73/2.2). This ratio can then be applied to each individual super lot area in the Structure Plan to provide estimated equivalent impermeable areas as are shown in Table 6 below:

Table 6

	Lot 27	Lot 58	Lot 59	Lot 60	Total
Land Area (Ha)	2.2	2.2	2.1	1.4	7.9
Equivalent Impervious Area (Ha)	1.7	1.7	1.6	1.1	6.1

8.1.2 Base Option 1: *By way of soakage wells and compensating basins located within each development site, attenuate the stormwater run-off hydrograph so as to achieve a run-off of 20% pre-development reporting to the WCWMD drainage basins;*

Again, only Lot 27 is analysed as it is deemed conservative for application to the other lots within the Structure Plan area. A cascading compensating basin model has been developed that determines compensating basin sizes for the purposes of restricting off-site run-off to within the Water Corporation's run-off flow rate limitations as detailed in Table 4 above. Specifically for Lot 27, this has been estimated to be 54 l/s. The modelling undertaken has determined that to limit off-site run-off flows to 54 l/s, three compensating basins of total volume 413m^3 would be required, corresponding to a total basin area of 880m^2 or 4% of Lot 27's total area.

By extension, each lot would be required to make available compensating basin areas as shown in Table 7 below:

Table 7

Lot	Land Area (Ha)	Total Basin Area (m^2)
Lot 27	2.2	880
Lot 58	2.2	880
Lot 59	2.1	840
Lot 60	1.4	560

The compensating basin areas are based on dry 900mm deep basins with 1:6 side slopes. These figures were developed on the basis of having 3 cascading basins roughly equally separated per super lot located in grassed open space areas.

At detailed engineering stage, the exact compensation basin requirements would need to be determined within the space available within the respective development design layouts.

This option is effectively the only option for Lots 58 and 59 Centre Road.

8.1.3 Option 2: *Discharge compensated stormwater run-off directly to the City's drainage system in Railway Avenue.*

A flow-to-flow confluence of the City's DN1500RC and the compensated stormwater from Lot 27 via a piped connection to the City's DN1500RC or direct to the ODP, a downstream HL of 20.58m AHD is available, refer above in Section 4.1.2. This represents the downstream level of flow contained in the DN1500RC pipe at peak flow for the 1 in 10 year event, based on the calculated t_c across the catchment allowing for flow time across surfaces and through the piped system).

Assuming the minimum proposed level in Lot 27 is RL 22m AHD and allowing for a compensating basin freeboard depth of 300mm, an upstream HL of RL 21.7m AHD is available. Given a pipe length of say 40m (i.e. taken from a downstream compensating basin located in Lot 27 across to the DN1500 or the ODP), the available HGL for that pipe would be about 1:35.

Using the Colebrook White pipe flow formula, with a roughness coefficient of 0.6mm being applied (i.e. typical for a RC pipe), Table 8 below sets out the flow capacities for various pipe sizes at various HGL's as specified in the table.

Table 8

Diameter (mm)	Full Pipe Flow @ 1:35 (l/s)
225	90
300	185
375	340
Diameter (mm)	**Full Pipe Flow @ 1:100 (l/s)**
225	54
300	115
375	195
Diameter (mm)	**Full Pipe Flow @ 1:200 (l/s)**
225	36
300	77
375	140

Table 8 above demonstrates is that there is a multitude of possible pipe connection options that can be considered at detailed engineering design stage. One option available to employ is to construct a DN225 installed at 1:100 allowing for a discharge of 54 l/s. Such a flow would result in the ARI 5 year event being adequately managed if compensating basins of the size determined in Base Option 1 were constructed.

In reality there are several options for piping across Railway Avenue to the ODP:

- Directional drill from Lot 27 and 60 to the ODP, or the City's DN1500RC; or
- With the permission of the Water Corporation discharge into the existing DN750RC via a connection on the western side of Railway Avenue.

It must be noted that for the ARI 10 year event, the cascading basins have t_c of 145 minutes. At that t_c, the flow in the DN1500RC will be only 288 l/s with a resultant depth of flow of 379mm.

Simply put, there is abundant redundant flow capacity within the City's DN1500RC pipe located in Railway Avenue by which a connection from Lot 27 (at a conservative RL 20.58m AHD or above) can take advantage.

Unfortunately, the elevation of the redundant capacity in within the City's DN1500RC pipe located in Railway Avenue would be too high for use for the drainage of the lower extents of Lots 58 and 59.

8.2 Recommended Action

In respect of the development of Lots 58 and 59, a series of small compensating basins should be provided (located within open space areas set aside within those lots) for the purposes of flow rate attenuation and nutrient stripping. Connection of overflow from these basins and subsoil drainage can be made the Water Corporation's basins located in Hemingway Drive provided that the peak flow rate is, by way of the compensating basins, attenuated down to a peak flow rate of 54 l/sec for the Lot 58 area and to 51 l/sec for the Lot 59 area. Due to the level of Lots 58 and 59 and their proximity to the Water Corporation's basins located in Hemingway Drive, connection to those basins would not be difficult.

In respect of Lots 27 & 60, a series of small compensating basins should be provided (located within open space areas set aside within the development of those lots) for the purposes of flow rate attenuation and nutrient stripping. Connection of overflow from these basins can be made to either the Water Corporation's basins located in Hemingway Drive or to the City's DN1500RC pipe or the ODP located within the adjacent Railway Avenue reserve. Due to an abundance of spare flow capacity in the City's DN1500RC pipe located in Railway Avenue, directing stormwater flows from Lot 27 & 60 to that drain system is likely to be the better option as it is a short, more direct discharge route. Further, the abundant spare flow capacity in the DN1500 RC pipe and the ODP will enable reduction the volume of compensation required to be set up within the development of Lots 27 and 60. Due to level constraints, subsoil drainage should be directly or indirectly connected to the WCWMD drainage basins or otherwise securely pumped to the City's DN1500RC or the ODP. Due to low peak (but steady) flow rates that can be expected to pass through the subsoil system, an indirect connection to the Water Corporation's basins can be made by way of a simple connection into the City's local street drainage system located on Hemingway Drive at the intersection of Ivanhoe Way.

9.0 Conclusions

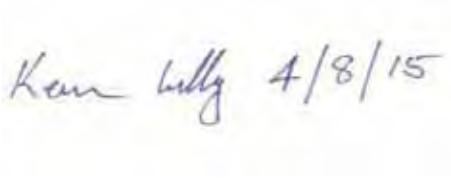
It has been demonstrated by way of an analysis of existing infrastructure using credible and conservative data analysis as set out in this LWMS that there will be no negative impact on existing private and public assets (including water infrastructure) and the receiving environment as a result for residential development of the Structure Plan area to a density at the R40 code provided that the detailed drainage design incorporated into the proposed development adopts the limitations imposed by the Water Corporation, adopts the recommended actions stated above and engages the urban drainage design principles contained in the ARR.

Further, pre-development groundwater conditions will be maintained unaltered as a consequence of the proposed development due to:

- the fact that there will be no change to existing drainage infrastructure, both of Water Corporation and of the City, which currently control groundwater levels;
- the earthworks for the development will direct localised infiltrated groundwater to proposed subsoil drains above the contoured clay substratum, which will report to the Water Corporation's compensating basins.

It follows that this LWMS should be adopted by the City so as to form part of or, at least, guide the Structure Plan.

This LWMS has been prepared by:



Kevin Lilly
BE (Hons) MIEAust

This LWMS has been reviewed and approved for issue by:

Ian McKellar
Project Manager

10.0 Appendix 1

List of Figures

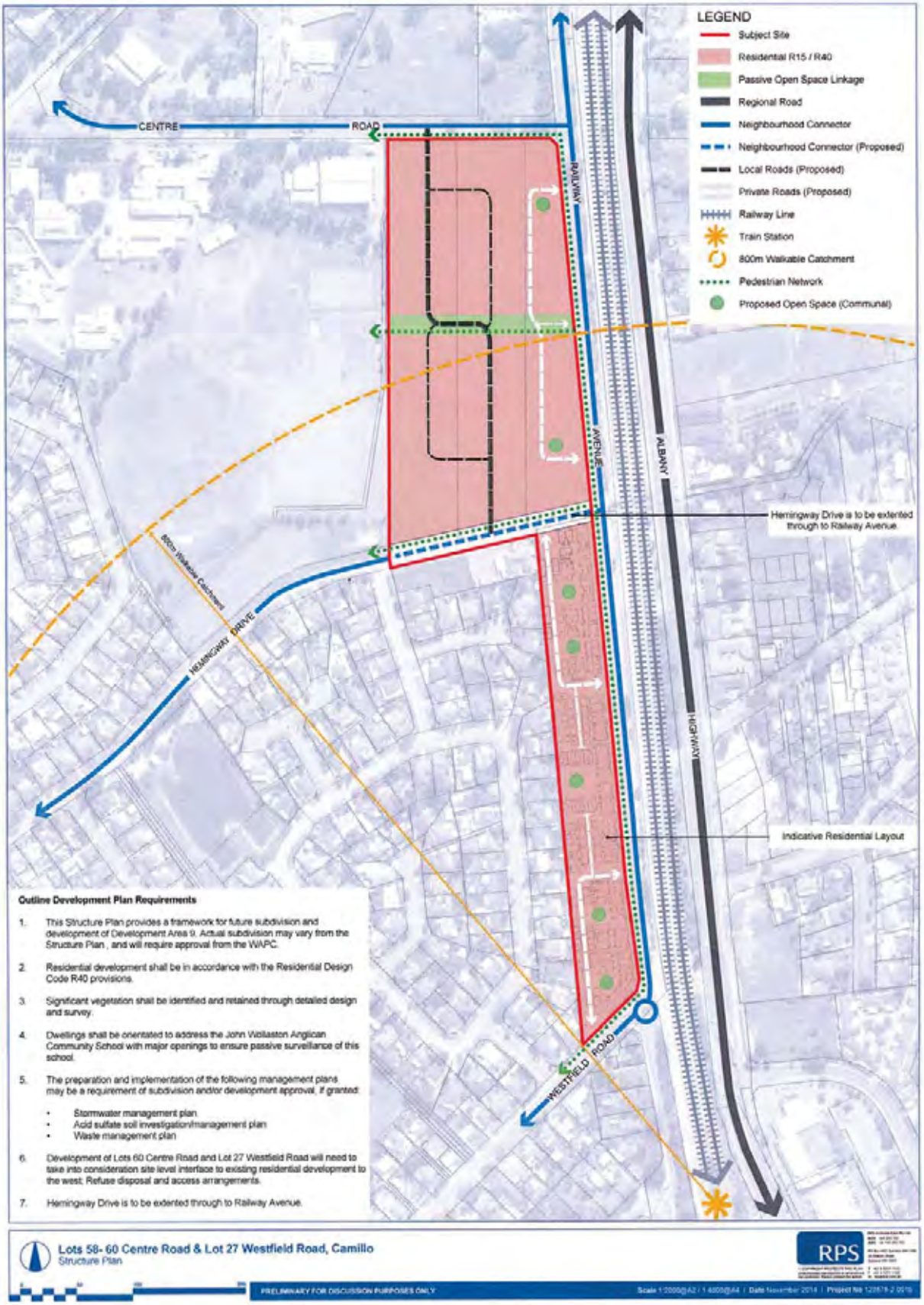

LEGEND
Subject Site
Residential R15 / R40
Passive Open Space Linkage
Regional Road
Neighbourhood Connector
Neighbourhood Connector (Proposed)
Local Roads (Proposed)
Private Roads (Proposed)
Railway Line
Train Station
800m Walkable Catchment
Pedestrian Network
Proposed Open Space (Communal)
CENTRE ROAD
RAILWAY AVENUE
ALBANY HIGHWAY
HEMINGWAY DRIVE
800m Walkable Catchment
WESTFIELD ROAD
Hemingway Drive is to be extented through to Railway Avenue
Indicative Residential Layout
Outline Development Plan Requirements
1. This Structure Plan provides a framework for future subdivision and development of Development Area 9. Actual subdivision may vary from the Structure Plan , and will require approval from the WAPC.
2. Residential development shall be in accordance with the Residential Design Code R40 provisions.
3. Significant vegetation shall be identified and retained through detailed design and survey.
4. Dwellings shall be orientated to address the John Wollaston Anglican Community School with major openings to ensure passive surveillance of this school.
5. The preparation and implementation of the following management plans may be a requirement of subdivision and/or development approval, if granted:
• Stormwater management plan
• Acid sulfate soil investigation/management plan
• Waste management plan
6. Development of Lots 60 Centre Road and Lot 27 Westfield Road will need to take into consideration site level interface to existing residential development to the west; Refuse disposal and access arrangements.
7. Hemingway Drive is to be extented through to Railway Avenue.
Lots 58- 60 Centre Road & Lot 27 Westfield Road, Camillo
Structure Plan
RPS
PRELIMINARY FOR DISCUSSION PURPOSES ONLY

Figure 1

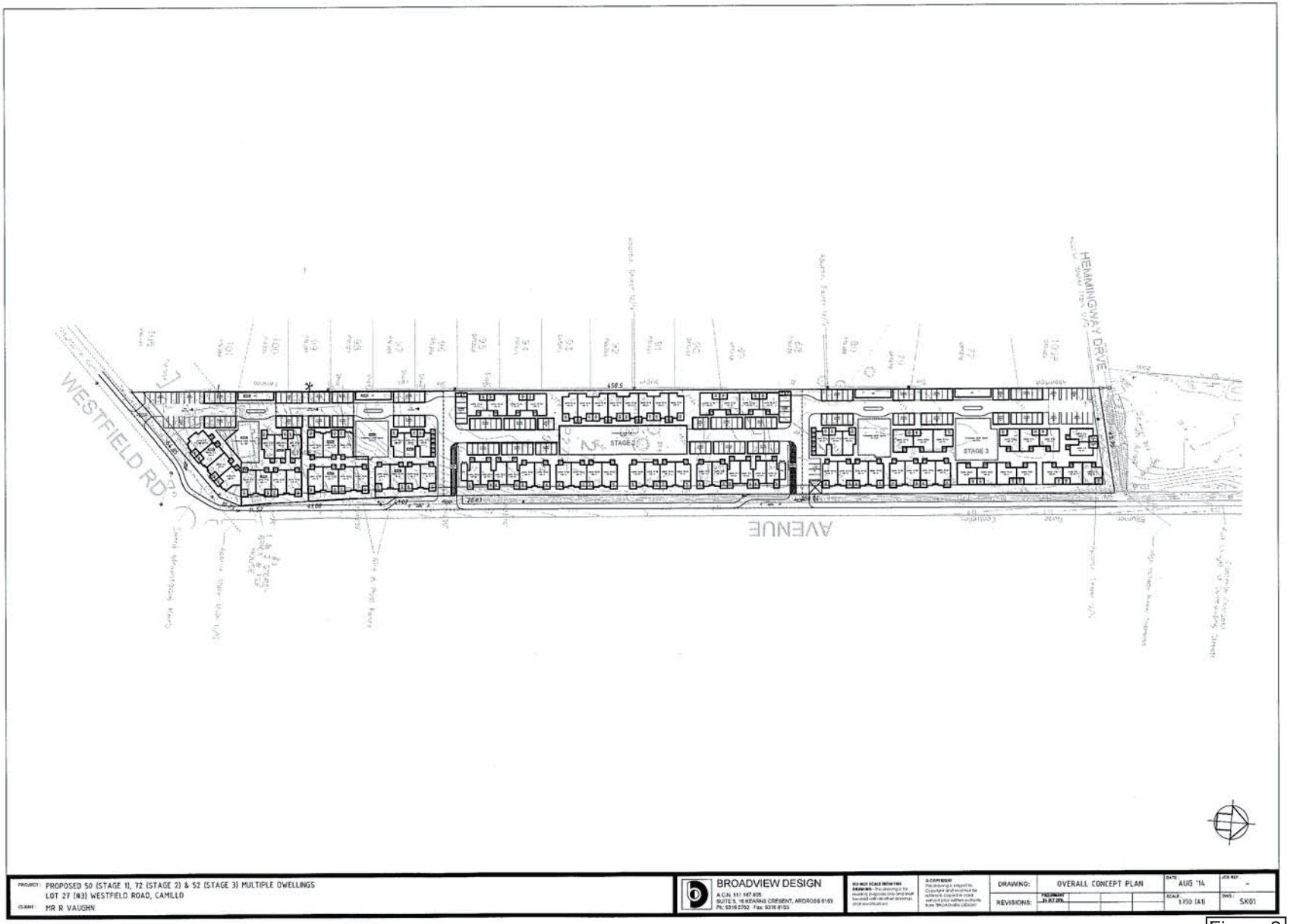
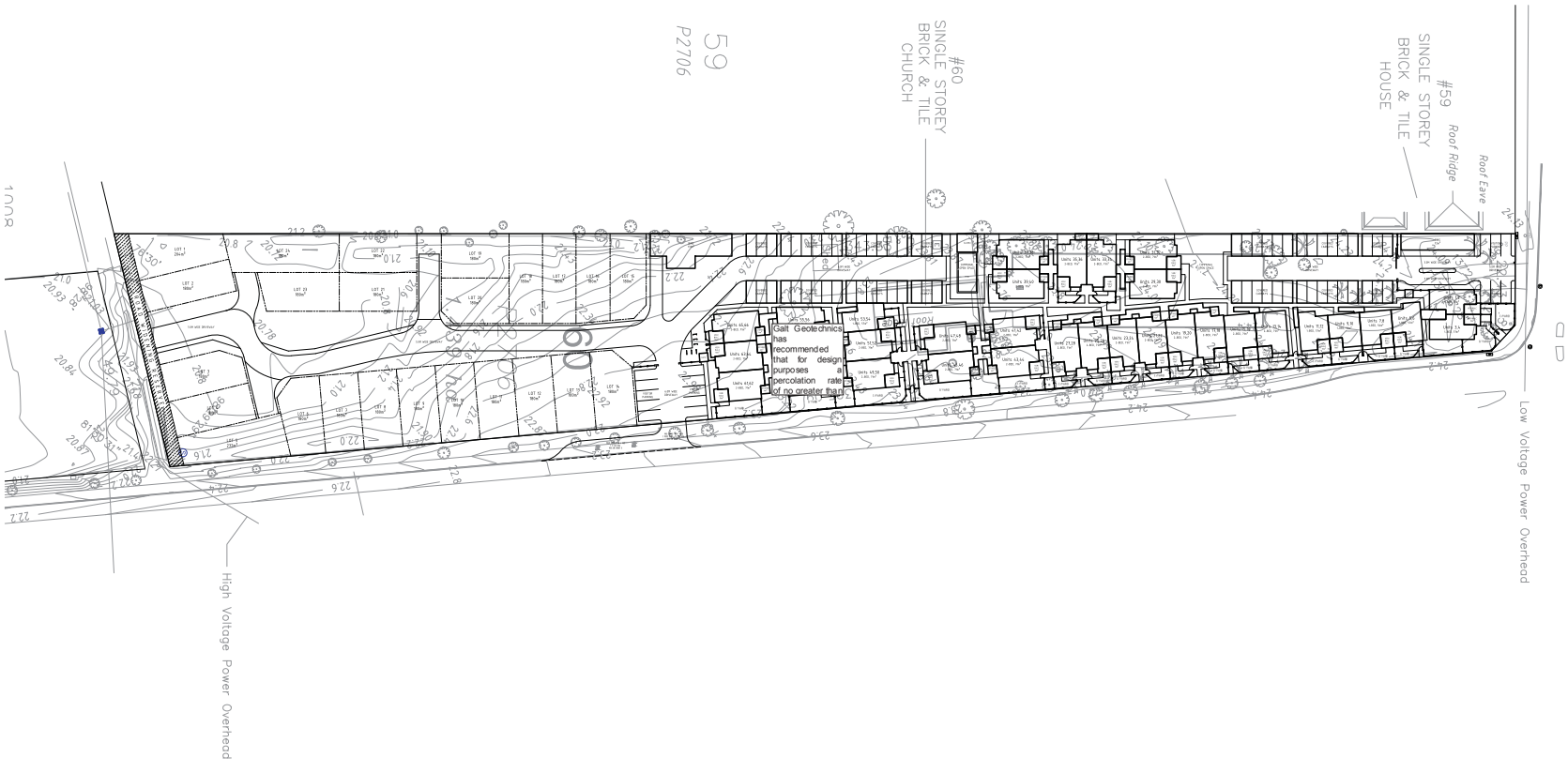

WESTFIELD RD
HEMMINGWAY DRIVE
AVENUE
STAGE 2
STAGE 3
PROJECT: PROPOSED 50 (STAGE 1), 72 (STAGE 2) & 52 (STAGE 3) MULTIPLE DWELLINGS
LOT 27 (#3) WESTFIELD ROAD, CAMILLO
CLIENT: MR R VAUGHN
BROADVIEW DESIGN
A.C.N. 111 167 805
SUITE 5, 16 KEARNS CRESCENT, ARDROSS 6153
Ph: 9316 0752 Fax: 9316 9159
DRAWING: OVERALL CONCEPT PLAN
DATE: AUG '14
JOB REF: -
REVISIONS:
SCALE: 1:150 (A1)
DWG: SK01

Figure 2



PROJECT: PROPOSED 24 GROUPED & 66 MULTIPLE DWELLINGS
LOT 60 (#60) CENTRE ROAD, CAMILLO
CLIENT: MR R VAUGHN

BROADVIEW DESIGN
A.C.N. 111 187 805
SUITE 5, 16 KEARNS CRESENT, ARDROSS 6153
Ph: 9316 0752 Fax: 9316 8153

DRAWING: SITE PLAN
DATE: MAR '15
JOB REF: -
SCALE: 1:500 (A
REVISIONS:
PRELIMINARY

Figure 3

LOCAL AUTHORITY: *City of Armadale*

THE TITLE BOUNDARIES AS SHOWN HEREON WERE NOT MARKED AT THE TIME OF SURVEY AND HAVE BEEN DETERMINED BY PLAN DIMENSIONS ONLY, POSITIONED OVER EVIDENCE OF OCCUPATION. IT SHOULD BE NOTED THAT UNDERGROUND SERVICES ARE SHOWN BUT NEED TO BE VERIFIED BY THE RELEVANT AUTHORITY PRIOR TO ANY DEMOLITION, EXCAVATION OR CONSTRUCTION, AND THE CERTIFICATE OF TITLE SHOULD BE CHECKED FOR EASEMENTS AND ENCUMBRANCES. THEREFORE, NO RESPONSIBILITY IS TAKEN FOR BOUNDARY POSITIONS AND SERVICE LOCATIONS.

LEGEND

ELECTRICITY		GAS / DRAINAGE / COMMS / GENERAL		STORMWATER	VEGETATION	WATER
E ELECTRICAL PIT	POWER POLE	GAS MARKER	CLOTHES HOIST	SEPTIC TANK	BUSH EDGE	BORE
GUY (ANCHOR) WIRE	POWER POLE w. LIGHT	GAS VALVE	POST BOX	SEWER IO (VENT)	PALM TREE	HYDRANT
LIGHT POLE	POWER TRANSFORMER	GULLY TRAP	SURVEY MARK (TBM)	SEWER MANHOLE (SQUARE/ROUND)	SHRUB	METER
POWER DOME	STAY POLE	TELECOM PIT	TRAFFIC SIGN		TREE	STOP VALVE
						TAP

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WEB: www.ausurv.com.au
25 DAVEY STREET
MANDURAH, W.A. 6210
EMAIL: mandurah@ausurv.com.au

CLIENT	PROPERTY EDGE
TITLE	FEATURE SURVEY OF LOTS 27 & 60 ON PLAN 2706 #3 WESTFIELD ROAD & 60 CENTRE ROAD, CAMILLO
SCALE	1:1750 @ A2 (0 20 40 60 80 100 metres)
CONTOUR INTERVAL	0.2m
REVISION NO.	A
SURVEYED	MK 30/7/2014
DRAWN	MK 5/8/2014
APPROVED	MC 11/8/2014
HORIZONTAL DATUM	PCG94
VERTICAL DATUM	AHD (ISSM)
JOB NUMBER	14-1097

Figure 4

GATE COPY OF ORIGINAL NOT TO SCALE Mon Oct 27 16:19:04 2014 JOB 45975879

Landgate
www.landgate.wa.gov.au

Figure 5


Structure plan area
Dampland extent
Agricultural drain
Canning River
N

Figure 6

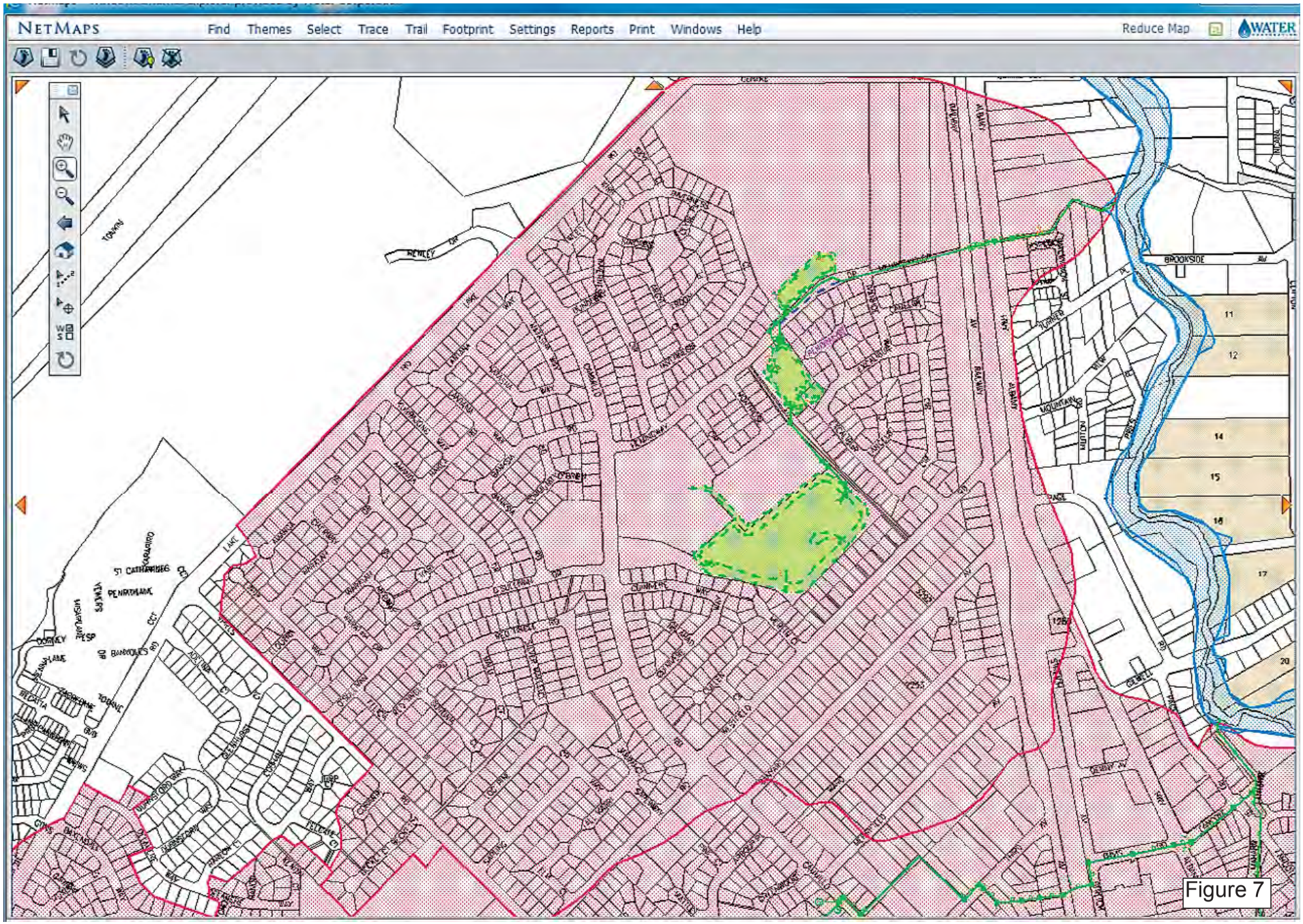
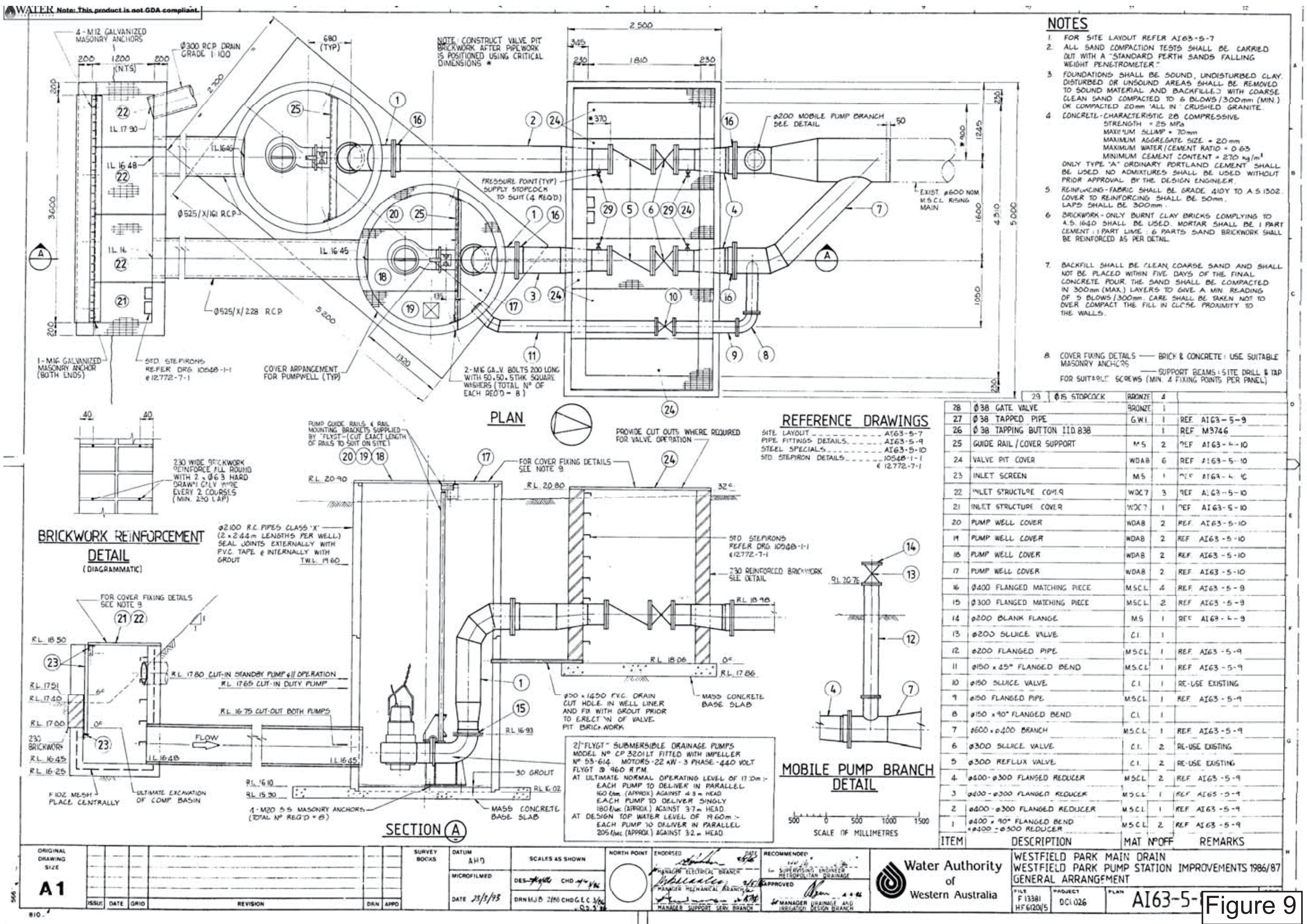

NETMAPS
Find
Themes
Select
Trace
Trail
Footprint
Settings
Reports
Print
Windows
Help
Reduce Map
WATER

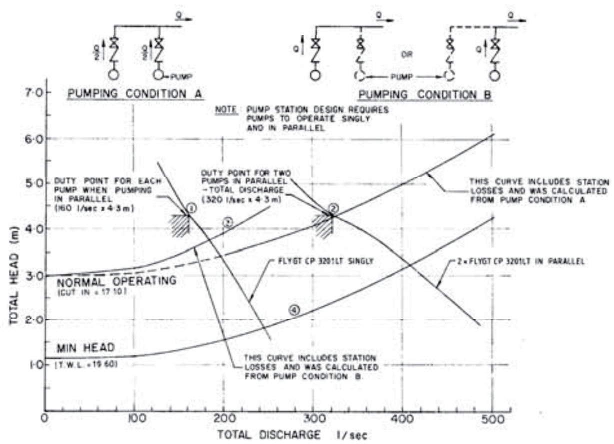
Figure 7

Screen bg34/22.07 UNKNOWN Date Printed: 15/06/15 16:50:24 Coordinate System: MGA94 Zone 50 Height Datum: AHD

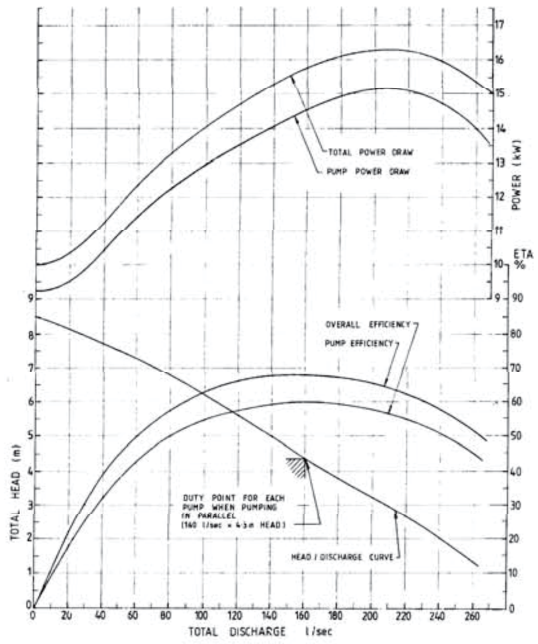

WATER Note: This product is not GDA compliant.
NOTES
1. FOR SITE LAYOUT REFER AI63-5-7
2. ALL SAND COMPACTION TESTS SHALL BE CARRIED OUT WITH A "STANDARD PERTH SANDS FALLING WEIGHT PENETROMETER."
3. FOUNDATIONS SHALL BE SOUND, UNDISTURBED CLAY. DISTURBED OR UNSOUND AREAS SHALL BE REMOVED TO SOUND MATERIAL AND BACKFILLED WITH COARSE CLEAN SAND COMPACTED TO 6 BLOWS/300mm (MIN.) OR COMPACTED 20mm 'ALL IN' CRUSHED GRANITE.
4. CONCRETE - CHARACTERISTIC 28 COMPRESSIVE STRENGTH = 25 MPa MAXIMUM SLUMP = 70mm MAXIMUM AGGREGATE SIZE = 20mm MAXIMUM WATER/CEMENT RATIO = 0.63 MINIMUM CEMENT CONTENT = 270 kg/m³ ONLY TYPE "A" ORDINARY PORTLAND CEMENT SHALL BE USED. NO ADMIXTURES SHALL BE USED WITHOUT PRIOR APPROVAL BY THE DESIGN ENGINEER.
5. REINFORCING - FABRIC SHALL BE GRADE 410Y TO A.S.1302. COVER TO REINFORCING SHALL BE 50mm. LAPS SHALL BE 300mm.
6. BRICKWORK - ONLY BURNT CLAY BRICKS COMPLYING TO A.S.1640 SHALL BE USED. MORTAR SHALL BE 1 PART CEMENT : 1 PART LIME : 6 PARTS SAND. BRICKWORK SHALL BE REINFORCED AS PER DETAIL.
7. BACKFILL SHALL BE CLEAN COARSE SAND AND SHALL NOT BE PLACED WITHIN FIVE DAYS OF THE FINAL CONCRETE POUR. THE SAND SHALL BE COMPACTED IN 300mm (MAX.) LAYERS TO GIVE A MIN. READING OF 5 BLOWS/300mm. CARE SHALL BE TAKEN NOT TO OVER COMPACT THE FILL IN CLOSE PROXIMITY TO THE WALLS.
8. COVER FIXING DETAILS — BRICK & CONCRETE: USE SUITABLE MASONRY ANCHORS — SUPPORT BEAMS: SITE DRILL & TAP FOR SUITABLE SCREWS (MIN. 4 FIXING POINTS PER PANEL)
PLAN
SECTION A
BRICKWORK REINFORCEMENT DETAIL (DIAGRAMMATIC)
MOBILE PUMP BRANCH DETAIL
REFERENCE DRAWINGS
SITE LAYOUT AI63-5-7
PIPE FITTINGS DETAILS AI63-5-9
STEEL SPECIALS AI63-5-10
STD. STEPIRON DETAILS 10548-1-1 & 12772-7-1
2/"FLYGT" SUBMERSIBLE DRAINAGE PUMPS MODEL Nº CP 3201LT FITTED WITH IMPELLER Nº 53-614. MOTORS - 22 kW - 3 PHASE - 440 VOLT FLYGT @ 960 R.P.M.
AT ULTIMATE NORMAL OPERATING LEVEL OF 17.0m:- EACH PUMP TO DELIVER IN PARALLEL 160 l/sec (APPROX) AGAINST 4.3m HEAD EACH PUMP TO DELIVER SINGLY 180 l/sec (APPROX) AGAINST 3.7m HEAD.
AT DESIGN TOP WATER LEVEL OF 19.60m:- EACH PUMP TO DELIVER IN PARALLEL 205 l/sec (APPROX) AGAINST 3.2m HEAD
ITEM | DESCRIPTION | MAT | Nº OFF | REMARKS
29 | Ø15 STOPCOCK | BRONZE | 4 |
28 | Ø38 GATE VALVE | BRONZE | 1 |
27 | Ø38 TAPPED PIPE | G.W.I. | 1 | REF. AI63-5-9
26 | Ø38 TAPPING BUTTON IID 838 | | 1 | REF. M3746
25 | GUIDE RAIL / COVER SUPPORT | M.S. | 2 | REF. AI63-5-10
24 | VALVE PIT COVER | WDAB | 6 | REF. AI63-5-10
23 | INLET SCREEN | M.S. | 1 | REF. AI63-5-10
22 | INLET STRUCTURE COVER | WDC7 | 3 | REF. AI63-5-10
21 | INLET STRUCTURE COVER | WDC7 | 1 | REF. AI63-5-10
20 | PUMP WELL COVER | WDAB | 2 | REF. AI63-5-10
19 | PUMP WELL COVER | WDAB | 2 | REF. AI63-5-10
18 | PUMP WELL COVER | WDAB | 2 | REF. AI63-5-10
17 | PUMP WELL COVER | WDAB | 2 | REF. AI63-5-10
16 | Ø400 FLANGED MATCHING PIECE | M.S.C.L. | 4 | REF. AI63-5-9
15 | Ø300 FLANGED MATCHING PIECE | M.S.C.L. | 2 | REF. AI63-5-9
14 | Ø200 BLANK FLANGE | M.S. | 1 | REF. AI63-5-9
13 | Ø200 SLUICE VALVE | C.I. | 1 |
12 | Ø200 FLANGED PIPE | M.S.C.L. | 1 | REF. AI63-5-9
11 | Ø150 x 45° FLANGED BEND | M.S.C.L. | 1 | REF. AI63-5-9
10 | Ø150 SLUICE VALVE | C.I. | 1 | RE-USE EXISTING
9 | Ø150 FLANGED PIPE | M.S.C.L. | 1 | REF. AI63-5-9
8 | Ø150 x 90° FLANGED BEND | C.I. | 1 |
7 | Ø600 x Ø400 BRANCH | M.S.C.L. | 1 | REF. AI63-5-9
6 | Ø300 SLUICE VALVE | C.I. | 2 | RE-USE EXISTING
5 | Ø300 REFLUX VALVE | C.I. | 2 | RE-USE EXISTING
4 | Ø400 - Ø300 FLANGED REDUCER | M.S.C.L. | 2 | REF. AI63-5-9
3 | Ø400 - Ø300 FLANGED REDUCER | M.S.C.L. | 1 | REF. AI63-5-9
2 | Ø400 - Ø300 FLANGED REDUCER | M.S.C.L. | 1 | REF. AI63-5-9
1 | Ø400 x 90° FLANGED BEND x Ø400 - Ø300 REDUCER | M.S.C.L. | 2 | REF. AI63-5-9
Water Authority of Western Australia
WESTFIELD PARK MAIN DRAIN
WESTFIELD PARK PUMP STATION IMPROVEMENTS 1986/87
GENERAL ARRANGEMENT
FILE F13381 HF6120/5
PROJECT DC1026
PLAN AI63-5-
A1
SCALES AS SHOWN
DATUM AHD
Figure 9

WATER Note: This product is not GDA compliant.

AI63-5-11



RISING MAIN CHARACTERISTIC CURVE AND DUTY POINTS

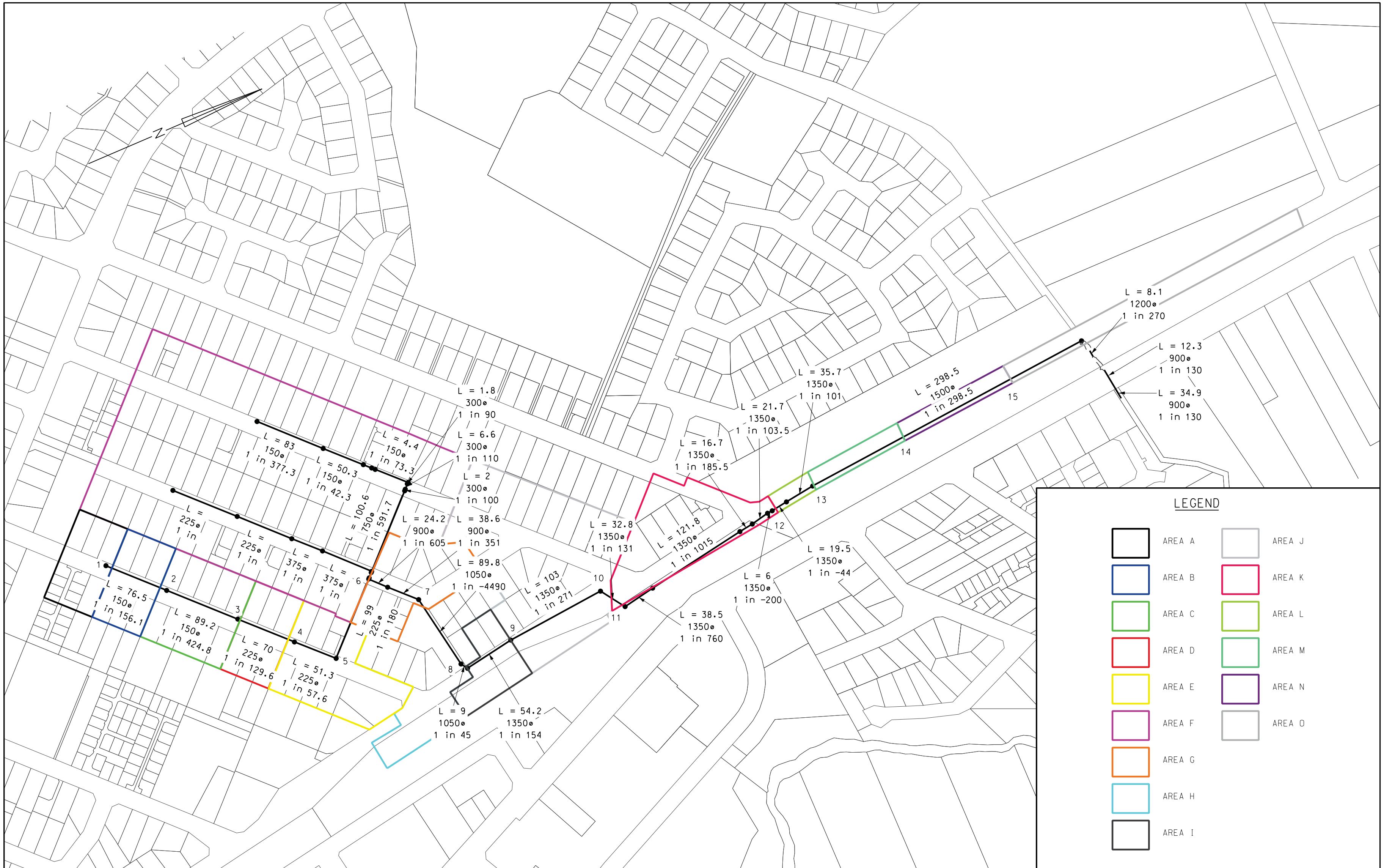


PUMP PERFORMANCE CURVE

TYPE - FLYGT CP 3201LT
IMPELLOR N° 53-614 PART N° 384 40 01
MOTOR - 22 kW AT 440 VOLTS - 940 R.P.M.

ORIGINAL DRAWING SIZE A1	SURVEY BOOKS	DATUM A.H.D.	SCALES AS SHOWN	NORTH POINT	RECOMMENDED / APPROVED	Water Authority of Western Australia	WESTFIELD PARK MAIN DRAIN WESTFIELD PARK PUMP STATION IMPROVEMENTS 1986/87 SYSTEM CURVES AND CHARACTERISTICS
ISSUE DATE GRID REVISION DRN APPD		MICROFILMED DATE 28/5/85	DES CHD DRN		SUPERVISING ENGINEER METROPOLITAN DRAINAGE; MANAGER DRAINAGE AND IRRIGATION DESIGN BRANCH		FILE F13381 61201/5 PROJECT D01 026 PLAN AI63-5-11 ISSUE

Figure 10



No.	DATE	BY	DESCRIPTION

AMENDMENTS

SCALE:
40m 0 40m 80m 120m
A1 PAGE - SCALE 1 : 2000
A3 PAGE - SCALE 1 : 40000

DRAWN: D.CLUBB
CHECKED:
APPROVED:

DESIGNED BY:
CIVIL TECHNOLOGY
CONSULTING CIVIL
AND STRUCTURAL ENGINEERS
15 CHARLES STREET
SOUTH PERTH W.A. 6151
PH: (08) 9367 2533
FAX:(08) 9367 8046
W.A.P.C. No.:

DN 1500 FLOW ANALYSIS
CATCHMENT PLAN - PIPE DETAILS

FILE NAME: 833-SK-003.DGN
DATE: 30/07/15
DRAWING No.: 833-SK-003
AMDT No.:

Figure 11

833-SK-003.dgn 6/08/2015 11:19:40 AM ChrisE

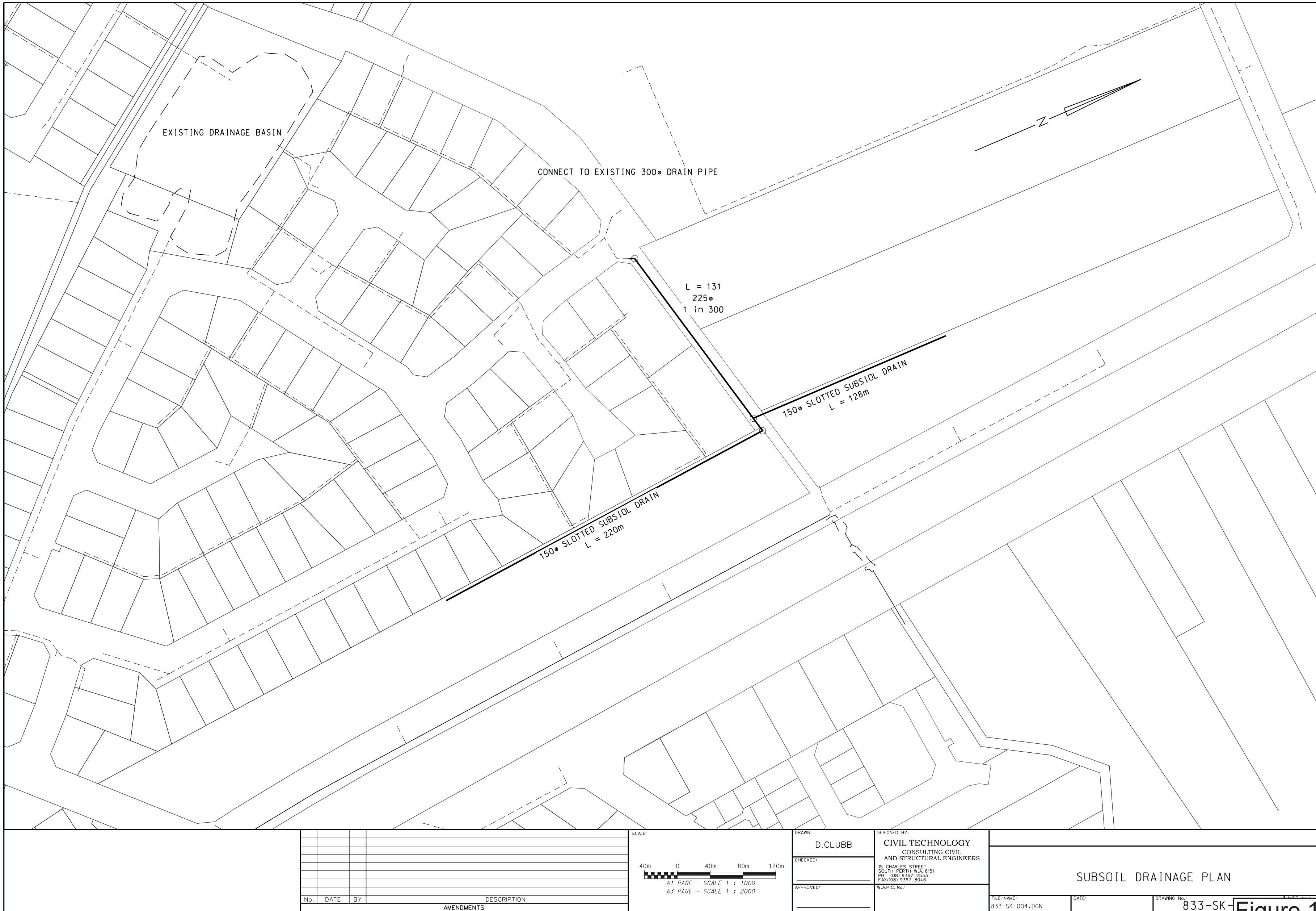


Figure 12

833-SK-004.dgn 6/08/2015 10:24:42 AM ChrisE

Screen bg34/22.07 UNKNOWN Date Printed: 15/06/15 16:38:57 Coordinate System: MGA94 Zone 50 Height Datum: AHD

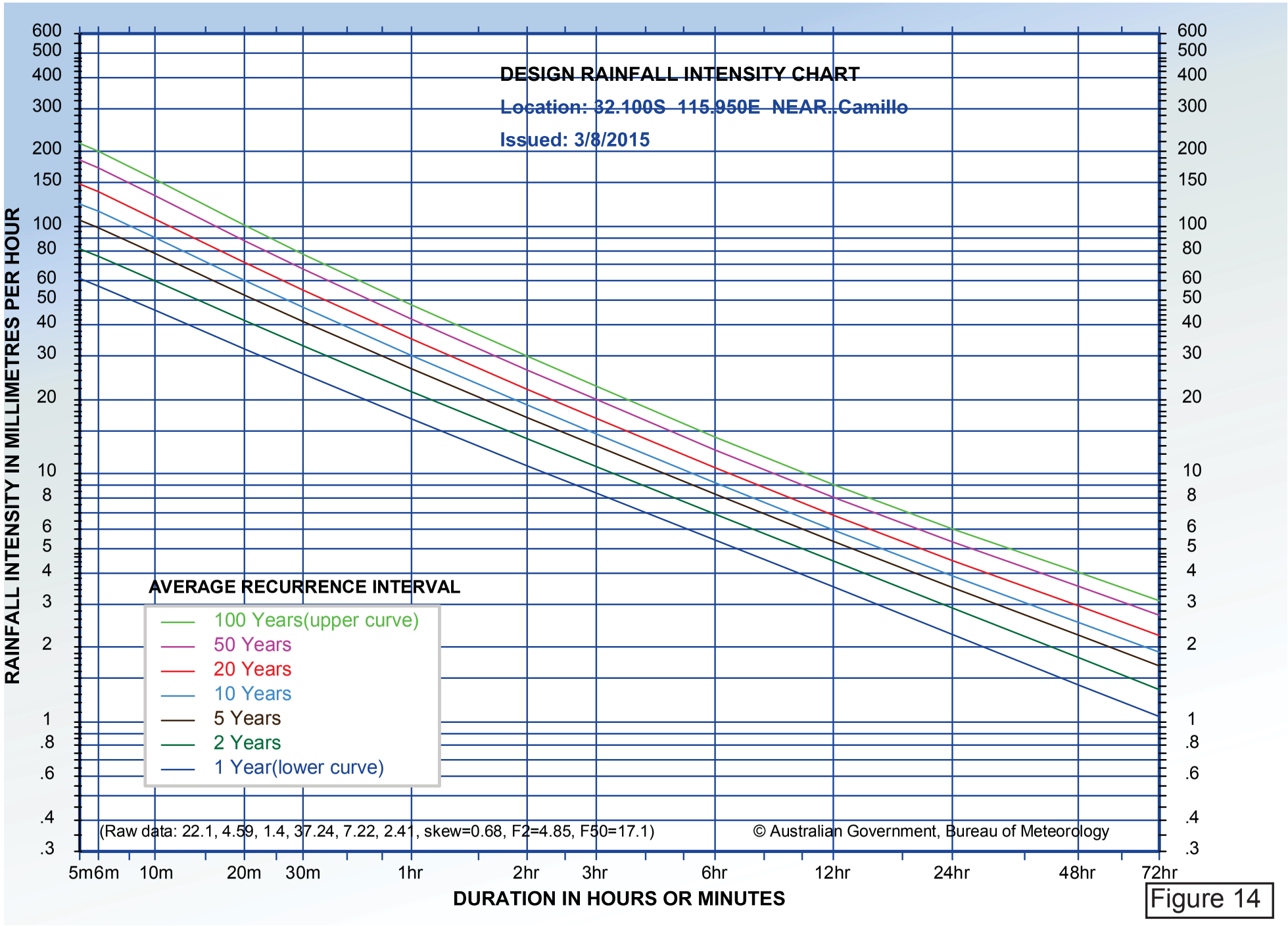
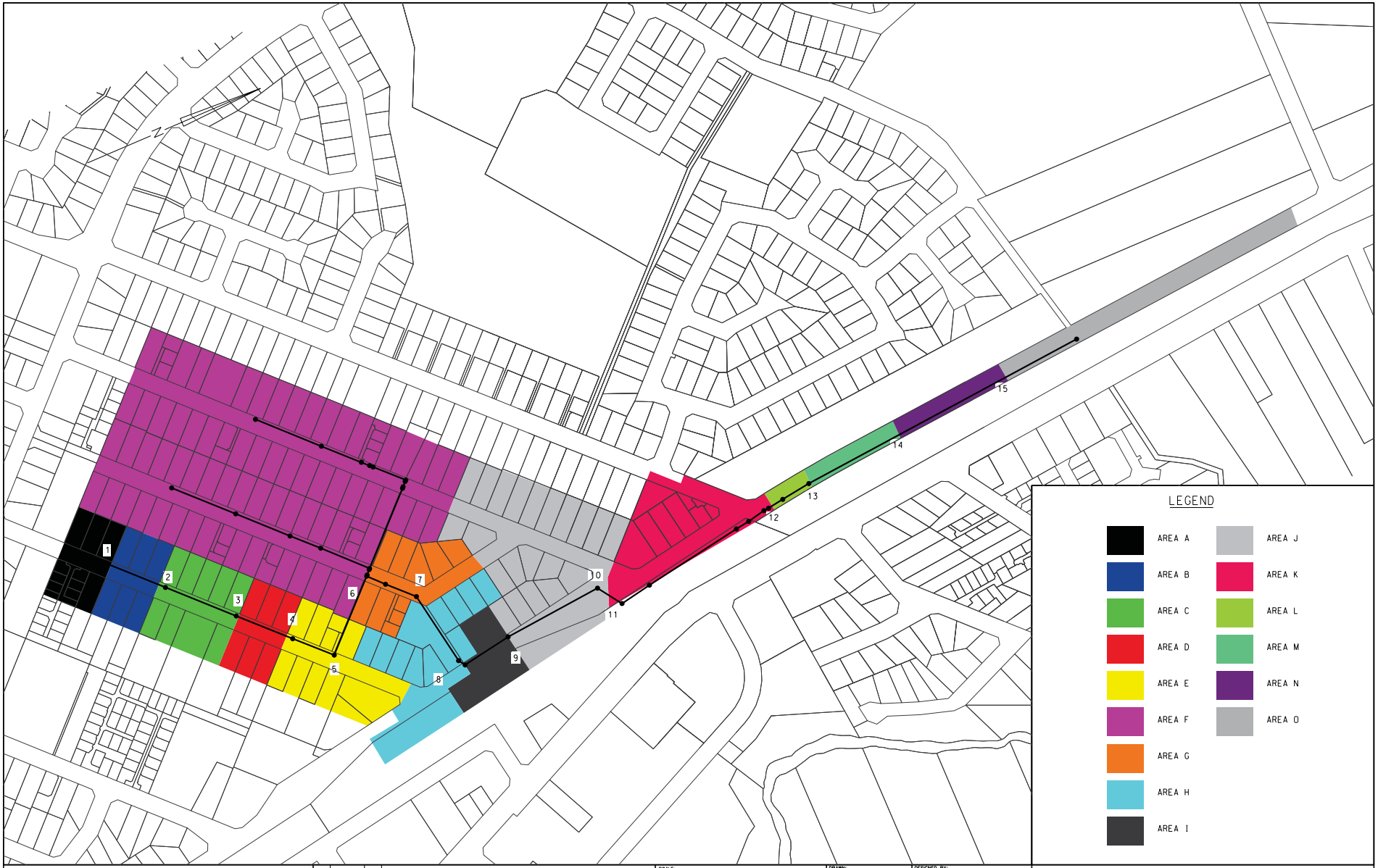

DESIGN RAINFALL INTENSITY CHART
Location: 32.100S 115.950E NEAR..Camillo
Issued: 3/8/2015
RAINFALL INTENSITY IN MILLIMETRES PER HOUR
600
500
400
300
200
150
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
.8
.6
.4
.3
AVERAGE RECURRENCE INTERVAL
100 Years(upper curve)
50 Years
20 Years
10 Years
5 Years
2 Years
1 Year(lower curve)
(Raw data: 22.1, 4.59, 1.4, 37.24, 7.22, 2.41, skew=0.68, F2=4.85, F50=17.1)
© Australian Government, Bureau of Meteorology
5m
6m
10m
20m
30m
1hr
2hr
3hr
6hr
12hr
24hr
48hr
72hr
DURATION IN HOURS OR MINUTES

Figure 14



No.	DATE	BY	DESCRIPTION
AMENDMENTS			

SCALE:
40m 0 40m 80m 120m
A1 PAGE - SCALE 1 : 2000
A3 PAGE - SCALE 1 : 40000

DRAWN: D.CLUBB
CHECKED:
APPROVED:

DESIGNED BY:
CIVIL TECHNOLOGY
CONSULTING CIVIL AND STRUCTURAL ENGINEERS
15 CHARLES STREET
SOUTH PERTH W.A. 6151
PH: (08) 9367 2533
FAX:(08) 9367 8046
W.A.P.C. No.:

DN 1500 FLOW ANALYSIS
CATCHMENT PLAN

FILE NAME: 833-SK-002.DGN
DATE: 30/07/15
DRAWING No.: 833-SK

Figure 15

833-SK-002.dgn 6/08/2015 11:23:31 AM ChrisE

11.0 Appendix 2

List of Analyses

Analysis 1	Capacity of City's DN1500RC pipe in Railway Avenue Pre-development
Analysis 2	Cascading Basins Modelling - Lot 27

	Incremental		0		0		0		0		6528		0		17938		800		7440		7150		67414		9981		5466		9110		9110		5466	
	Total coefficient		4554		752		1049		546		3508		1700		3137		1707		3621		1249		6062		1379		597		995		597		597	
	Total		10396		1717		2396		1248		5936		2064		5103		2440		4787		1574		5078		1526		616		1026		616		616	
	Lots		0.35		0.35		0.35		0.35		0.35		0.35		0.35		0.35		0.35		0.35		0.35		0.35		0.35		0.35		0.35		0.35	
	Roads/footpaths/carparks		0.90		0.90		0.90		0.90		0.90		0.90		0.90		0.90		0.90		0.90		0.90		0.90		0.90		0.90		0.90		0.90	
	Verges/POS		0.30		0.30		0.30		0.30		0.30		0.30		0.30		0.30		0.30		0.30		0.30		0.30		0.30		0.30		0.30		0.30	
	Incremental		7217		1192		1663		866		7223		2149		10633		2548		7299		4099		30574		5192		2635		4392		3911		2635	
	Total coefficient		48%		48%		48%		48%		45%		57%		41%		52%		46%		41%		39%		40%		39%		39%		38%		39%	
	Total		94228		87010		85818		84156		83290		76067		73918		63285		60737		53438		49339		18765		13573		10938		6546		2635	
	Inlet/Overhead		21.89		20.02		17.60		16.49		13.40		12.82		11.00		9.98		9.09		8.58		8.06		7.81		7.54		6.98		6.00		6.00	
	Flow Time		2.85		1.87		2.42		1.11		3.09		0.58		1.82		1.02		0.89		0.51		0.52		0.25		0.27		0.56		0.98			
	Time of Conc		24.74		21.89		20.02		17.60		16.49		13.40		12.82		11.00		9.98		9.09		8.58		8.06		7.81		7.54		6.98		6.00	
	Recurrance Interval (yrs)		10		10		10		10		10		10		10		10		10		10		10		10		10		10		10		10	
	Design Intensity		53		57		60		65		68		77		79		86		90		95		97		101		102		104		108		115	
	Cummulative		1390		1384		1442		1528		1572		1620		1614		1504		1521		1405		1336		524		385		315		196		84	
	Base		320	Pressure main																														
	Total		1710		1384		1442		1528		1572		1620		1614		1504		1521		1405		1336		524		385		315		196		84	
	Pipe size selected (mm)				1524		1524		1524		1372		1372		1372		1372		1372		1054		914											
	Surface slope (1 : x)		68		225		225		1445		29		341		137		1030		903		489		157		-990		257		233		297		191	
	Selected Pipe Grade (1:x)				289		289		289		69.3		442		131		271		154		449		418		180		57.6		130		425		156	
	Hydraulic Grade if full (1: x)		170		3962		3652		3252		1754		1653		1664		1917		1875		538		278		45		32		14		37		201	
	Flow if full at selected grade @ 0 head		1955		5127		5127		5127		7911		3133		5754		4001		5307		1539		1090		262		285		105		58		96	
	Flow Depth (mm)																						914		457		381		305		305		221	
	Flow at that depth (lit/sec)		1709		1379		1432		1522		1553		1617		1607		1504		1519		1404		1336		524		385		315		196		84	
	Velocity (m/s)		2.94		0.64		0.68		0.73		0.83		1.10		0.94		0.95		0.89		1.83		2.04		3.19		3.38		4.32		2.68		1.30	
	Sum Pressure Coeff - Ku																																	
	Pit Losses (m)																																	
	Pipe Losses (m)																																	
	HGL Upstream																																	
	HGL Downstream																																	
	Finished level	22.20		22.40		22.89		23.23		23.30		25.20		25.80		26.04		26.14		26.20		26.40		26.80		26.70		26.90		27.20		27.50		27.90	
	Design DS obvert US	20.96		21.59		21.97		22.23		22.60		23.40		23.86		24.11		24.49		24.84		25.06		25.21		25.76		26.65		27.19		27.40		27.40	
	Fall between pits		0.10		0.38		0.26		0.37		0.80		0.46		0.25		0.38		0.35		0.22		0.15		0.55		0.89		0.54		0.21			
	Design Pit US invert	20.06		20.09		20.47		20.73		21.25		22.04		22.51		22.76		23.14		23.80		24.16		24.76		25.38		26.35		26.89		27.10		27.10	
	Max cover available (m)	1.24		0.81		0.92		0.99		0.70		1.80		1.94		1.93		1.65		1.36		1.34		1.59		0.94		0.25		0.01		0.10		0.50	
	Chainage (m)	0.0		13.5		123.5		199.5		305.5		360.7		565.4		598.2		701.2		755.4		853.2		916.0		1015.0		1066.3		1136.3		1225.5		1302.0	

1. Formula for pipes flowing part full is Manning with n = .011
2. Formula for pipes flowing full and under head is Colebrook - White with K = 0.6

Net % runoff from catchment 41.8%

1) BUS = Bubble-up type outlet structure
2) M9 = Manhole 9
3) S16a = Side Entry Pit 16a
4) G5 = Gully 5

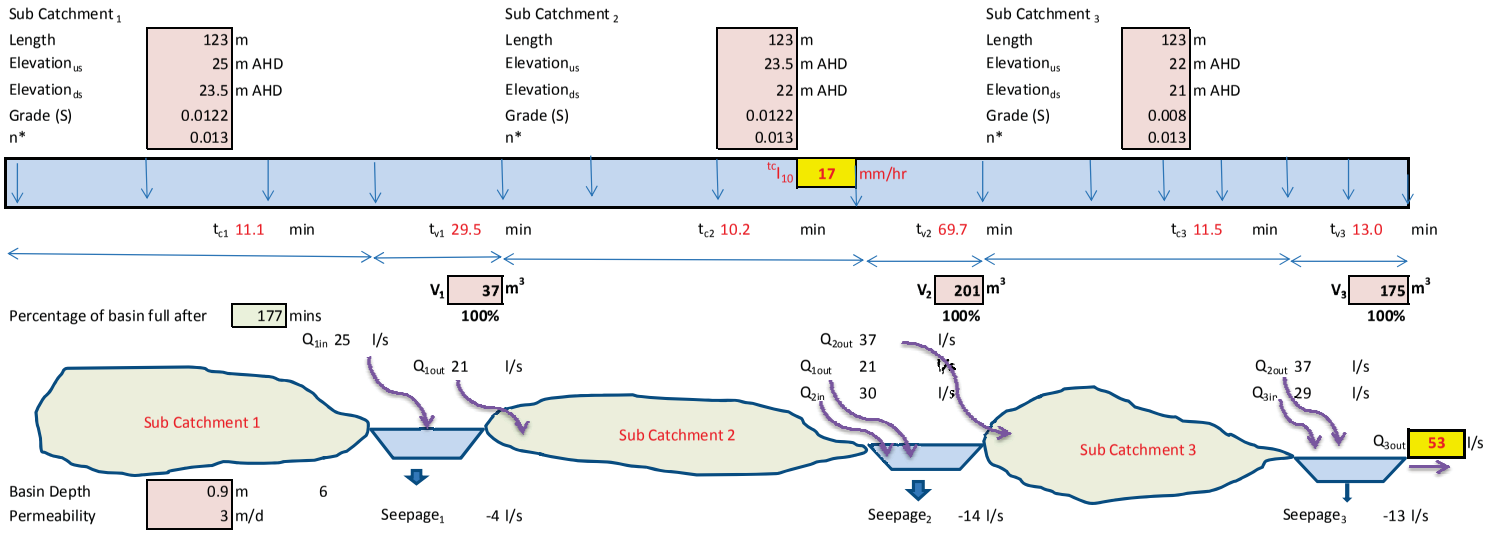
Reference	Job No 833
Designed	Ian McKellar
Checked	Ian McKellar
Approved	
Date	26th July 2015

Civil Technology
15 Charles Street
South Perth WA 6151
Telephone (08) 9367 2533
Facsimile (08) 9367 8046

EXISTING DN 1500 DRAIN
ANALYSIS DATA
RAILWAY AVE CAMILLO
CITY OF ARMADALE

STORM EVENT	a	b	c	d	e	f	g
1	2.815066814	-6.19E-01	-1.43E-02	7.47E-03	-1.09E-03	-9.31E-05	9.38E-06
2	3.068716049	-6.27E-01	-1.43E-02	6.68E-03	-7.56E-04	4.81E-05	-2.69E-05
5	3.281610012	-6.45E-01	-1.24E-02	5.83E-03	-5.50E-04	2.32E-04	-6.20E-05
10	3.403781414	-6.56E-01	-1.06E-02	5.19E-03	-5.32E-04	3.54E-04	-8.03E-05
20	3.557574272	-6.65E-01	-1.00E-02	4.44E-03	-2.82E-04	4.89E-04	-1.11E-04
50	3.743318558	-6.77E-01	-8.78E-03	3.61E-03	-7.12E-05	6.40E-04	-1.43E-04
100	3.875274181	-6.85E-01	-7.92E-03	2.99E-03	5.07E-05	7.50E-04	-1.63E-04
10	3.403781414	-6.56E-01	-1.06E-02	5.19E-03	-5.32E-04	3.54E-04	-8.03E-05

Analysis 1



C		Area (Ha)			Area (Ha)			Area (Ha)		Water Corporation Allowance
0.90	Roads	0.1428	21%	Roads	0.19		Roads	0.19		54 l/s
0.95	Roofs	0.2515	38%	Roofs	0.24		Roofs	0.24		
0.85	Footpath Paved	0.135	20%	Footpath Paved	0.17		Footpath Paved	0.17		
0.30	Soft Landscape/Gras	0.1378	21%	Soft Landscape/Grass	0.18		Soft Landscape/Gra	0.18		
1.00	Basin 1	0.012	11 msq	Basin 2	0.040	20 msq	Basin 3	0.036	19 msq	
	Sub Catchment1	0.667		Sub Catchment 2	0.780		Sub Catchment 3	0.780		Total Area 2.2 Ha
	Imp Area (A_{1i})	0.53		Imp Area (A_{2i})	0.63		Imp Area (A_{3i})	0.62		

ARI 10 years

	t_c	145.0 mins	Sum of t_c	145.0 mins		84.069 l/s	
	tcI_{10}	16.78 mm/hr				53	
Aggregate Times		40.6 mins		120.5 mins			145.0 mins

A_h	121.0		A_h	400.0		A_h	361.0
h	0.9		h	1.7		h	1.6
$A_{(h-d)}$	0.04		$A_{(h-d)}$	84.64		$A_{(h-d)}$	67.24

Analysis 2

12.0 Appendix 3

Correspondence

Correspondence 1	City's letter Ref: SP/DA/9 Structure Plan 20 April 2015
Correspondence 2	Water Corporation's email re Structure Plan area run-off limitation

CITY OF Armadale

7 Orchard Avenue Armadale
Western Australia 6112
Locked Bag 2 Armadale
Western Australia 6992
T (08) 9399 0111
F (08) 9399 0184
info@armadale.wa.gov.au
www.armadale.wa.gov.au
ABN [illegible]

Our Ref: SP/DA/9
Enquiries: A J VanderPlas

20 April 2015

RPS Australia East Pty Ltd
PO Box 749
BUSSELTON WA 6280

Attention: Mr Matthew Young

Dear Sir,

PROPOSED STRUCTURE PLAN – FURTHER DRAINAGE AND TRAFFIC INFORMATION REQUIRED
LOTS 58, 59 AND 60 CENTRE ROAD AND LOT 27 WESTFIELD ROAD, CAMILLO

The City refers to your Structure Plan application for Lots 58, 59 and 60 Centre Road and Lot 27 Westfield Road, Camillo (the 'precinct') and to various recent emails and phone discussions with yourself and the landowner regarding the proposal. As you are aware, the City's Planning Services have sought and obtained advice from the City's Technical Services regarding information requirements necessary for Structure Plan assessment.

While the City has consistently advised that the planning matters for this site are capable of progression (especially in light of the site's current Residential R15/40 zoning), it has previously advised you that matters such as drainage and traffic management will have a greater impact on the site and the outcomes of the Structure Plan. The landowner has previously been advised of this, as early as 14 May 2014 during a meeting with the City's Executive Director Development Services Mr Ian MacRae, and the City's Executive Manager Planning Services Mr Paul Sanders.

In providing referral comments to Planning Services, the City's Technical Services have advised that they are unable to assess the Structure Plan in the absence of drainage information. This is because a Structure Plan is generally accompanied by a Local Water Management Strategy (LWMS), a requirement that is specified in the Western Australian Planning Commission's *Structure Plan Preparation Guidelines*, *Planning Bulletin 92 Urban Water Management* and *Better Urban Water Management* publications.

The City's Technical Services have advised that a LWMS is required in accordance with the above planning framework. This LWMS is to be prepared by a suitably qualified hydrologist/drainage engineer to inform the assessment of this structure plan (i.e. prior to any advertising). It is noted that preparation of an LWMS generally requires a period of groundwater monitoring, which will significantly delay the assessment timeframes of this Structure Plan.

The City's Technical Services have also advised that a Traffic Impact Assessment is also required to be prepared by a suitable qualified traffic engineer as part of the assessment of this structure plan (i.e. prior to any advertising) The Traffic Impact Assessment is to include the City's current data (traffic counts), available from Technical Services and an assessment of traffic safety and circulation.

Given the above advice, and the apparent absence of any engineering input into the Structure Plan, the City's Planning Services are reluctant to progress this Structure Plan to public advertising.

However, prior to determining its course of action, the City wishes to give RPS Australia East Pty Ltd the opportunity to respond to the City's issues outlined above. In particular, the City wishes to confirm whether RPS Australia East Pty Ltd has any information from suitably qualified engineering consultants to inform the Structure Plan design, and to address the above issues.

While the City wishes to see planning and development of this precinct progress, it must ensure that planning and development progresses in a manner that addresses traffic and drainage issues of this site, and does not determinately affect future development or existing development on adjoining land.

We trust that this correspondence clarifies the City's position. However, should you have questions in relation to the above, please contact the City's A/Manager Statutory Planning Mr Paul Rosser on (08) 9399 0139 or Strategic Planning Officer Mr Alex VanderPlas on (08) 9399 0892.

Yours sincerely

G WINDASS
A/EXECUTIVE MANAGER PLANNING SERVICES

From: Wayne Smith [mailto:Wayne.Smith@watercorporation.com.au]
Sent: Tuesday, 23 June 2015 8:48 AM
To: Ian McKellar
Cc: Kevin Lilly (kevin@civiltech.com.au)
Subject: Lot 27 & 60 Hemingway Drive

Hi Ian

I received an e-mail from our drainage engineer in relation to your query, details are below.

- The development may connect to the LA drain in Railway Av, but this should be discussed with the LA.
- If it was not feasible to connect to the LA drain, the WC would consider a limited connection into the existing open section of the drain in Railway Av, upstream of the Perth Armadale railway for Lot 27. Similarly a limited connection can be considered to the Hemingway Drive north Compensating Basin for Lot 60.
- If a connection is to be given to the WC main drain (either direct or via LA drain), the additional runoff (up to a 10 year ARI event) from the development will be required to be compensated on-site and outflow throttled. For this purpose, a runoff co-efficient of 20% can be considered as the pre-development condition (even though no runoff from these lots are currently discharged into the MD).
- Please note that the LA may require a higher level of compensation.

If you have any queries let me know and I will follow up.

Regards

Wayne Smith
Land Servicing Consultant
Water Corporation
Development Services Branch
T: (08) 9420 3369 | **F:** (08) 9420 3193
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