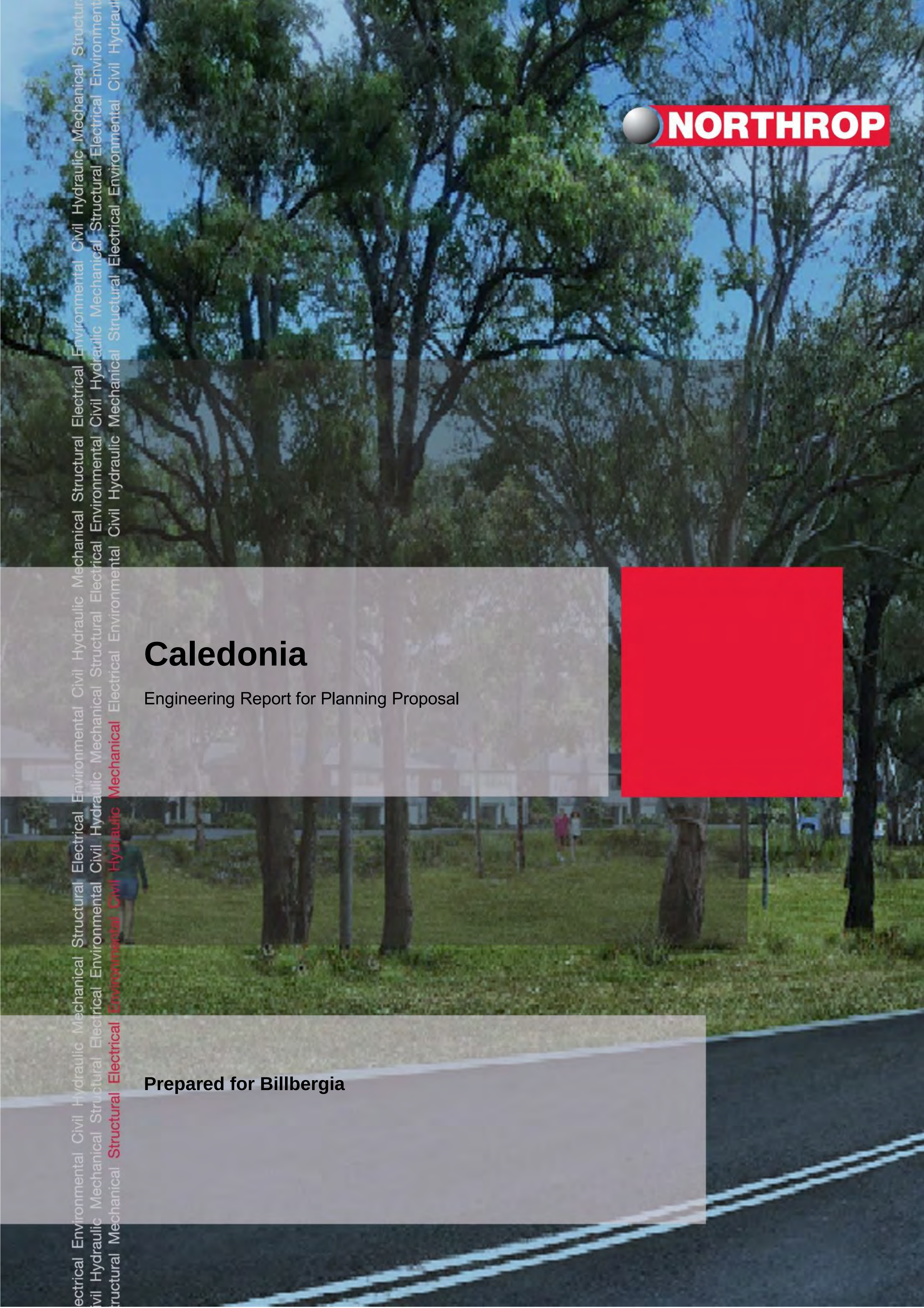

NORTHROP

Caledonia

Engineering Report for Planning Proposal

Prepared for Billbergia

CONTENTS

1. INTRODUCTION

Northrop has been commissioned by Billbergia, on behalf of land owners of the lots that comprise the proposed Caledonia subdivision in Ingleburn. The scope of Northrop's engagement is to provide engineering concepts, advice and costings to inform a Concept Master Plan for the site. Engineering services for this project comprise:

- Stormwater, drainage and flooding
- Power and telecommunications
- Water and sewer
- Roads and Traffic

The site comprises existing lots which support a very low density scale of residential development on land characterised by a rural to semi-rural use.

Billbergia is one landowner, and on behalf of themselves and others, they are preparing a Planning Proposal to achieve rezoning of the land for residential purposes.

The site is located in Ingleburn and bounded by three local roads, Mercedes Road, Bensley Road and Oxley Road (Figure 1).

Figure 1: Site location (Google Earth)

The site is 17.5 Ha in area. It slopes down to a low point on Bensley Road. While most of the site has been cleared of tree and scrub vegetation, scattered trees are present on site, particularly in the east and north. Minor earth levelling has occurred in the past to form level pads for houses. Several driveways and fences are present on and around the boundary of the site. There is no stormwater drainage on the site. Maximum slopes are 4%. Soils on the site appeared to be of medium texture and free draining. The features of the site are shown in Figure 2.

Figure 2: Site analysis and features

2. PROPOSED DEVELOPMENT

The Concept Master Plan for the development is shown in Figure 3.

Figure 3: Concept Master Plan

Achieving this development layout will require earthworks, road construction and associated drainage. Servicing of the subdivision will also be required with power, telecommunications, water, sewer and gas. This report provides high level concepts for this infrastructure.

3. STORMWATER MANAGEMENT

3.1. Catchment context

The site forms the upper extent of a small catchment draining direct to Georges River. The western boundary of the site is the subcatchments divide. The drainage line commences at two points where drainage from the site is piped under Bensley Road. The concentrated flow from these pipes then join and flow in an unnamed creek into the Georges River (Figure 4).

The unnamed creek appears to be in very good condition with a dense coverage of native vegetation and no apparent erosion. It is important to protect this creek from impacts of upstream development.

Figure 4: Site drainage into unnamed creek (Google Earth)

3.2. Flooding

The lowest point of the site is at approx. RL 47m. The level at the nearby Georges River reach is RL 75m. The Georges River at base flows is at approx. RL 10m. Therefore, the site is considered to be well above the level of flooding in the Georges River. In addition, there is no development downstream of the development that can be affected by flooding of the unnamed creek. As such, it is concluded that flooding is not a constraint on the development.

3.3. Council requirements

The *Cambelltown (Sustainable City) Development Control Plan 2014* contains provisions for new development in the LGA. The relevant ones are as follows:

- Sustainable Building Design,
- Water Cycle Management,
- Stormwater
- Water Demand Management

Specific requirements are listed and described as follows:

- **Rain water tanks** with reuse is encouraged on all new buildings. For roof areas up to 200m^2, 3,000L rain tanks are required to meet BASIX, For roofs 201-1,000m^2, 5,000L rain tanks are required. The rain tanks would ideally be plumbed into houses for toilet fushing and outdoor irrigation.

- **Water Cycle Management Plan (WCMP)** – a comprehensive WCMP shall be prepared and submitted as part of a Development Application. This report provides a Water Cycle Management Strategy that can form the basis of this more deailed plan.

- **Stormwater** shall be designed to convey minor and major flows and public safety is required in all Stormwater infrastructure and drainage features.

- **Water quality measures** are to be located off-line to creek paths. A **treatment train** approach to water management is required.

- **On-site Detention (OSD)** is not typically required for developments in the LGA except where the capacity of any downstream drainage can be exceeded as a result of development. Protection of the unnamed creek is paramount and so we interpret this requirements as pertaining to the unnamed creek. It only has capacity to cater for flows from the existing land use and development density in its catchment. By increasing the development density, there is potential to create erosive flows which would threaten its values. In discussions with Council's Engineer Cathy Kinsey, the sensitivity of receiving waters would be a key consideration of Council. Cathy advised that in such a circumstance that Council would be likely to impose a stringent requirement, i.e. to achieve a Stream Erosion Index value of 1 (this is described later).

3.4. Water Cycle Management Strategy (WCMS)

A concept Water Cycle Management Stratregy is presented in Appendix 1.

The urban water cycle is described as all the interconnected elements of rainfall, drainage, infiltration, water and sewer supply and water quality treatment. A WCMS is a way to balance these component parts holistically in order to derive a good development, community and environmental outcome.

The strategy that we have developed is driven laregely by the need to achieve a Stream Erosion Index (SEI) of 1. The Stream Erosion Index risk assessment procedure relies on calculating the increase in the relative frequency of flows from the site greater than the “stream forming flow”. The stream forming flow is defined as 50% of the 2-year ARI flow rate estimated for the catchment under natural flow conditions. Achieving a value at or below 1 is considered to represent an appropriate means of ensuring the impacts of site hydrology are mitigated such that the downstream watercourse remains stable.

It is very challenging to achieve an SEI of 1 for a newly proposed development. It requires a combination of water detention measures to throttle flow rates, and water retention measures to create “losses’ where water is diverted from the site drainage, e.g. infiltration, reuse. It also requires a treatment train approach where water is incrementally managed in the urban water cycle. The treatment train approach that we have adopted as our WCMS is described in Table 1.

Table 1: Water Cycle Management Strategy shown as a Treatment Train

Treatment Train hierarchy	**WCM element**	**Function**
Source Controls, or On lot measures	Rain tanks, overflowing to 10m^2 infiltration trenches$^\#$	Detention* Retention
Conveyance Controls, or streetscape measures	Bioswales	Retention Treatment
End of pipe controls	Gross Pollutant Traps (2 required) Biobasin – HydroCon exfiltration system (unlined), and with extended detention	Traetment Detention Retention

$^\#$infiltration trenches not on smallest lots, i.e. 225m^2 area
*detention effect discounted in the hydraulic modelling

The biobasin that has been proposed is similar to several systems that have been designed and built in NSW and the ACT. They are known as Stormwater Exfiltration Measures where Stormwater is both detained and treated in a combined underground/above-ground basin. They function with the following sequence:

- Flow first enters Gross Pollutant Traps where coarse sediment and debris is filtered (two are proposed in easily accessible locations for ease of maintenance).
- Flow then enters a HydroCon pipe network. These are ‘leaky” pipes with a permeable wall which is impregnated with zeolite. Fine sediment, Phosphorus and Heavy Metals are retained in the HydroCon pipe and walls.
- The treated water then enters a sand matrix where further filtering can occur. The sand supports a bacterial population to provide biological treatment of the water.
- This basin leaks to groundwater.
- When flows exceed the capacity of the basin to leak, it will fill with water under the ground surface.
- When flows exceed the 2-year ARI event, flow will surcharge onto the top of the basin. The top of the basin will be designed as an open space landscaped area. Water will pond to 300mm depth. After a storm finishes, water percolates back down into the underground basin. Thus it is predominantly a dry system.
- During this process, the flow that exits the basin will achieve the SEI 1 rate.

Figure 5 shows an example of a HydroCon Exfiltration system in Western Sydney. Details on the design and the sizing of its elements are provided in Appendix 2.

Figure 5: Schematic representation of HydrCon Exfiltration System for Stormwater treatment, detention and retention. Note the storage tank (background) is not proposed at Caledonia..

Performance of WCMS

The proposed Stormwater/Water Cycle Management Strategy has been developed using the proprietary models DRAINS and MUSIC which are standard in the Stormwater industry. The modelling undertaken reports on three different but relkated aspects of stormwater, i.e.

- Water quantity
- Water quality
- Stream Erosion Index

<u>Water quantity</u>

Results are presented in Table 2 to differentiate the hydraulic behaviour between the pre-development and post-development conditions with on-site detention and retention measures in place. It shows that flow rates downstream of the development will be virtually unchanged as a result of the development of the site.

Results of the predeveloped DRAINS model are present in Table 2.

Table 2 – Hydrologic/Hydraulic Modelling Results of Subject Site

Design ARI	**Pre-Development Peak Flows (m^3/s)**	**Post-Development Peak Flows from Basin (m^3/s)**
1	0.7	0.62
2	1.45	1.33
5	1.57	1.51
10	2.82	2.37
20	3.5	3.37
50	4.63	4.33
100	5.19	5.10

Note the results overestimate the post-development peak flows as no rainwater tanks were able to be inputted into the model at a lot based level, despite their inclusion in the stormwater management plan. The rainwater tanks will allow the retention of a greater amount of rainfall post-development, therefore reducing the peak flow.

Water quality

The MUSIC software package was used to assess the extent of pollutant discharged from the site. The effectiveness of the proposed "treatment train" has been assessed based on modelling of two separate scenarios, as follows:

- Existing conditions
- Post development conditions with treatment measures.

The results of the MUSIC model of the site are presented in Table 3.

Table 3 – MUSIC modelling Results of Subject Site Under Pre-developed and Post-developed Condition, Including the Percent Reduction of Each Contaminant

	Pre	**Post**	**% Reduction**	**Post (inc. Infiltration Losses)**	**% Reduction**
Flow (ML/yr)	**204**	136	33.33%	**176.87**	**13.30%**
Total Suspended Solids (kg/yr)	**29800**	4790.00	83.93%	**5237**	**82.43%**
Total Phosphorus (kg/yr)	**61.7**	19.3	68.72%	**23.3**	**62.27%**
Total Nitrogen (kg/yr)	**448**	147	67.19%	**196**	**56.35%**
Gross Pollutants (kg/yr)	**4540**	65.6	98.56%	**65.6**	**98.56%**

The results in Table 3 show that the implementation of the proposed treatment devices within the treatment train can effectively capture and remove a sufficient amount of pollutants from the site. The results also demonstrate that the proposed treatment train can effectively reduce the total volume of pollutant discharged from the site under proposed conditions to ensure they do not exceed volumes generated that under predeveloped conditions.

Stream Erosion Index

MUSIC was used to determine the Stream Erosion Index, as seen in Table 4. Both pre- and post development scenarios yielded values very close to the ideal SEI value of 1, well below the best practice index range of 2-5.0. This indicates that downstream waterways would not be at risk of erosion due to increased rate or frequency of flows from the development.

Table 4 - MUSIC Modelling Results for Stream Erosion Index (SEI) under Proposed Development Conditions

	Moderately Cohesive Soils (25% of 2yr Peak)	**Cohesive Soils (50% of 2yr Peak)**
Pre-Dev	36.3	30.1
Post-Dev	39.3	31.5
SEI	**1.08**	**1.05**

Summary

The modelling results have demonstrated that the above treatment devices are effective at reducing total pollutant loads, peaks flows and total volume of flows generated across the proposed site in accordance with Council's requirements.

Overall, Northrop are generally satisfied that stormwater runoff generated across the proposed residential subdivision can be appropriately managed. We are of the opinion that the proposed stormwater management strategy can effectively manage stormwater runoff to ensure that under proposed conditions, the residential subdivision will not result in an increase in pollutants or stormwater flows and result in any detrimental impacts to receiving waterways or downstream infrastructure.

Detailed analysis and investigations will be undertaken at future stages of detailed design so as to confirm and precisely detail the relevant hydraulic analysis and calculations.

WCMS Costs

Table 5 presents estimates of costs for Stormwater infrastructure based on our professional experience.

Table 5 – Stormwater infrastructure cost estimates

	Unit	**Cost**	**Quantity**	**$ Total**
Pit and pipe network	m	$ 420.00	2210	$ 928,200
Hydrocon System	m	$ 500.00	280	$ 140,000
Underground Tank OSD	m^3	$ 410.00	3000	$ 1,230,000
Above Ground OSD	m^3	$ 115.00	8000	$ 920,000
RWT & Infiltration System	unit	$ 9,600.00	241	$ 2,313,600
			Total	**$ 5,531,800**

4. ROADS AND TRAFFIC ANALYSIS

4.1. Traffic analysis

Positive Traffic has assessed traffic conditions, access arrangements, parking deamnds and matters for consideration in future development proposals for the Caledonia site. The full report by Positive Traffic is included as Appendix C.

In summary, Positive Traffic completed intersection counts at three intersections, as shown in Figure 6.

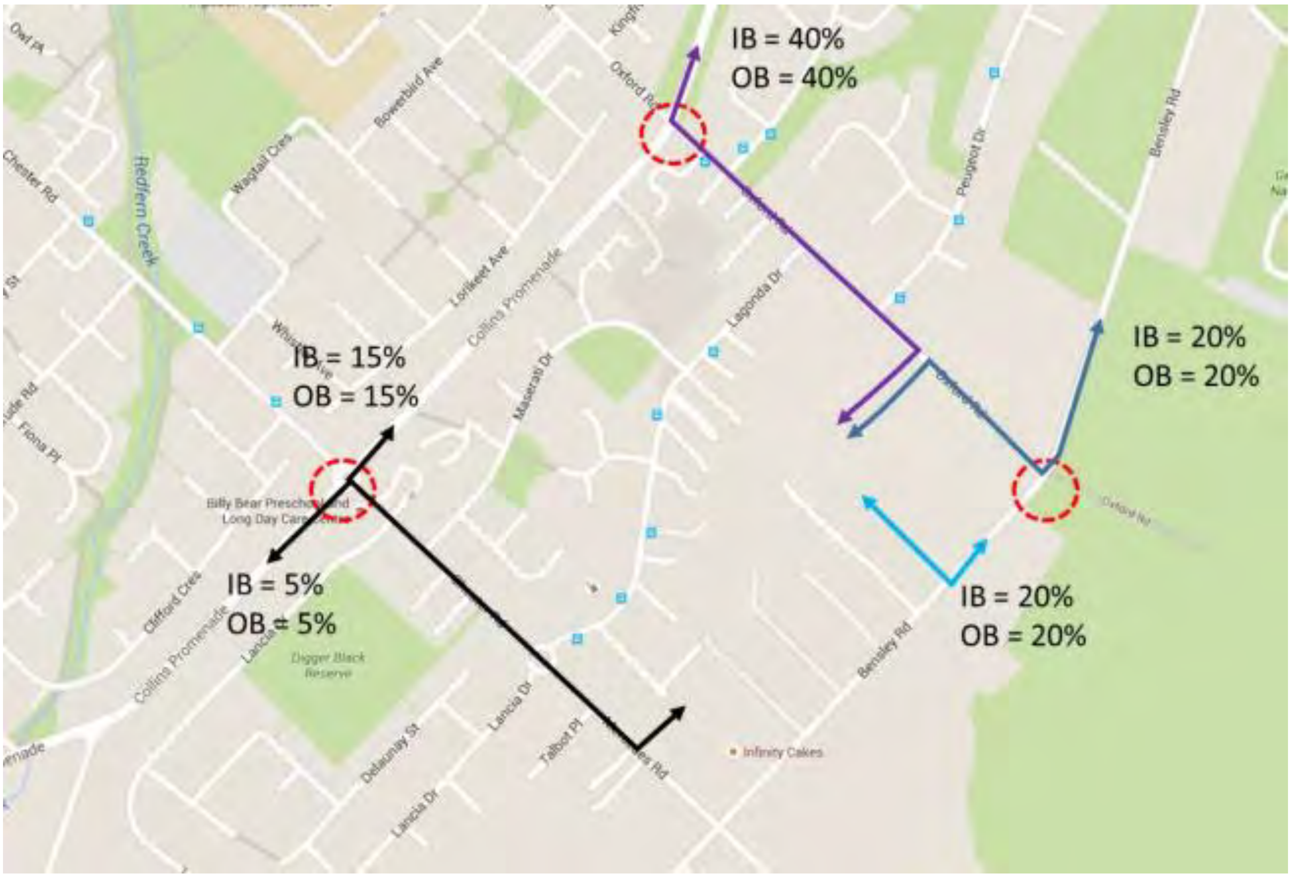

Figure 6: Analysis of intersection counts

The assessment by Positive Traffic has found the following:

- The traffic impacts of the development would be minimal with future traffic flows on surrounding roads within acceptable limits
- Intersections immediately surrounding the development site would continue to operate at levels of service to that which currently occurs
- The internal road network has been designed to facilitate a future bus route if deemed viable with all proposed residential lots within 400m of the internal bus route.

Overall the traffic impacts of the proposal are considered acceptable.

4.2. Roads

The internal roads in the development have been tested against Council's DCP requirements for road widths and the AMCORD criteria for stagger. Comments made into the network have been incorporated into the road network layout as proposed.

Costing of road infrastructure for the development is based on the assumption of a varying road reserve, some with road and footpath plus kerb and gutter. There is 3.6km of internal roads at a rate of 1,333 per metre. The total cost of roads is estimated at $4,800,000.

5. ELECTRICITY AND TELECOMMUNICATIONS SERVICING

A concept electrical infrastructure drawing is shown in Appendix 4. The detailed report from which the following information is summarized is in Appendix 5.

5.1. Maximum Power Demand Calculations

As shown in Table 6, the anticipated maximum demand is approximately 2,343 Amps with an additional 234 Amps for future allowance. Therefore, the maximum demand including the spare capacity is 2674 Amps in total. The proposed development maximum demand is based on AS/NZS 3000:2007.

Table 6: Maximum Power Demand

Edge Lands, Ingleburn				
	Blocks	**VA**	**KVA**	**TOTAL Amps**
241 residences	241	7000	1687	2,343
Future allowance				234 (10%)

5.2. Substations

Five substations are required to feed this development. These kiosks will provide power to pillars which in turn will supply houses.

The substation will have four distributors dedicated to provide power to pillars which will be connected in series and/or parallel configuration supplying up to 4 houses. The substations need to be located strategically to optimize the cost-effective solution while keeping in mind the sensitivity towards the aesthetics of such pieces of equipment.

5.3. Preliminary Electrical Cost Estimates

Referring to the preliminary details provided by Endeavour energy, we have assessed the cost of the substation to as shown in Table 7.:

Table 7: Substation costs

Substation Preliminary Budget Estimate		
Detail	**Costs**	**Total**
5 x Pad Mount Kiosk Substations	$200,000	$1,000,000
Pillars (89 @ $3,500)	$311,500	$311,500
HV Cabling (approximately 500m)	$1,000/m	$ 500,000
LV Cabling (approximately 4300m)	$500/m	$2,150,000
Low voltage Pillars x 90	$3,000	$ 270,000
Additional HV costs due to the substation location being unknown (50m)-	$1500/m	$ 60,000
TOTAL		**4,291,500**
Excludes Street lights and Street lighting reticulation		

5.4. Telecommunications servicing

The site will require a NBN fibre network. A formal application has been lodged on NBN co website. Investigations were done over the phone with Telstra and NBN. The costs in Table 8 were derived based on the costs provided on the fact sheet provided by NBN. Currently, Ingleburn is not NBN fibre-ready and will require backhaul, possibly from Campbelltown CBD. The total costs for bringing NBN into site are as follows:

Table 8: NBN costs

Description			
	Blocks	**Costs/house**	**Total Costs**
Cost of NBN per development (Includes for Back haul, Construction and Deployment Contribution (SDU))	241	$1,500	361,500
TOTAL			**361,500**

6. WATER, SEWER & GAS SERVICING

6.1. Existing infrastructure

The location of Sydney water infrastructure adjoining the Caledonia site is shown in Figure 7. In summary, Sydney Water water mains are located on each of the surrounding roads. Sewer is located in the existing developed subdivision to the north.

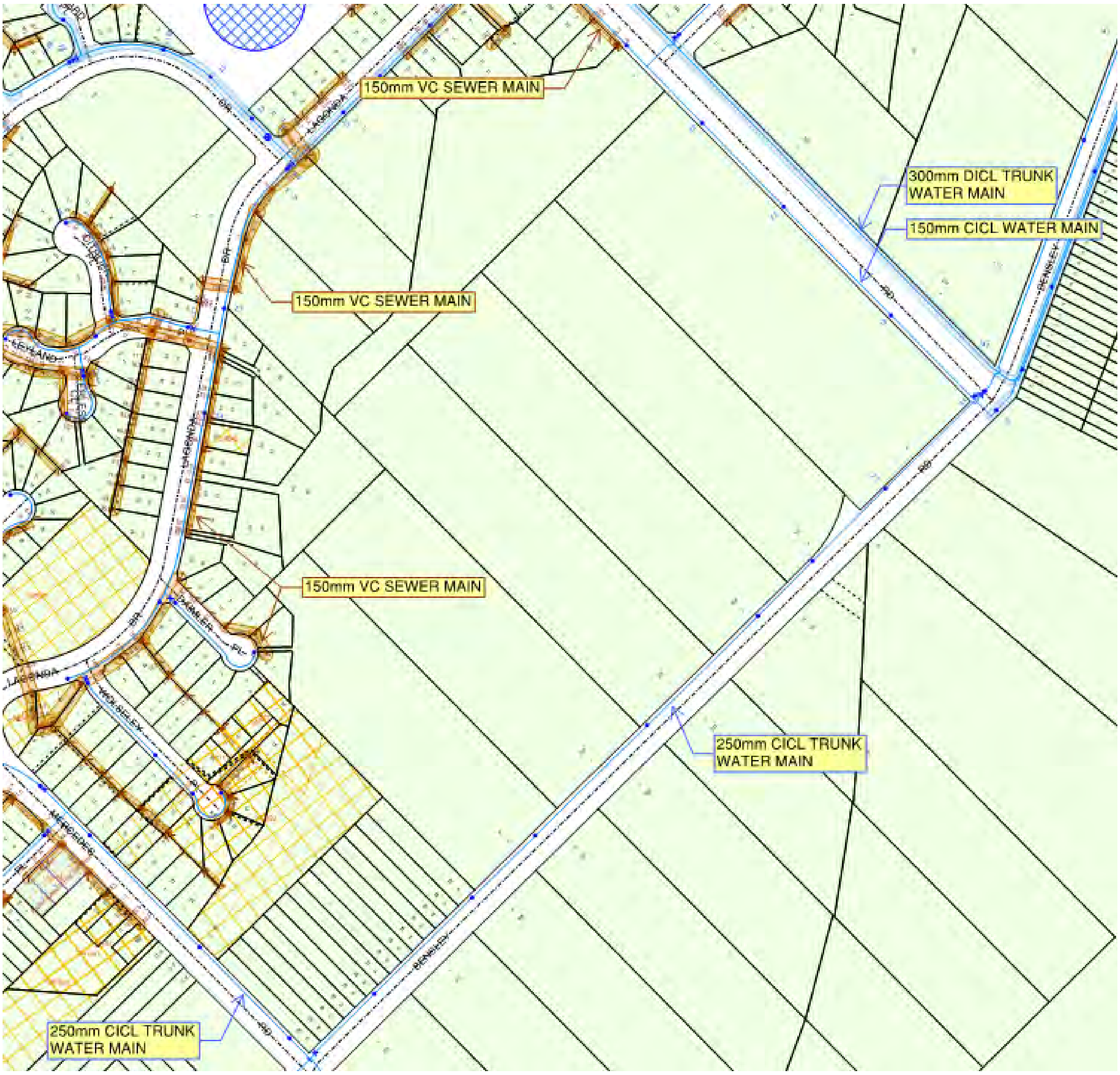

Figure 7: Sydney Water Hydra plot showing water and sewer infrastructure (Source: Sydney Water)

Jemena gas infrasture is shown in Figure 8. Gas mains are present to the north of the Caledonia site.

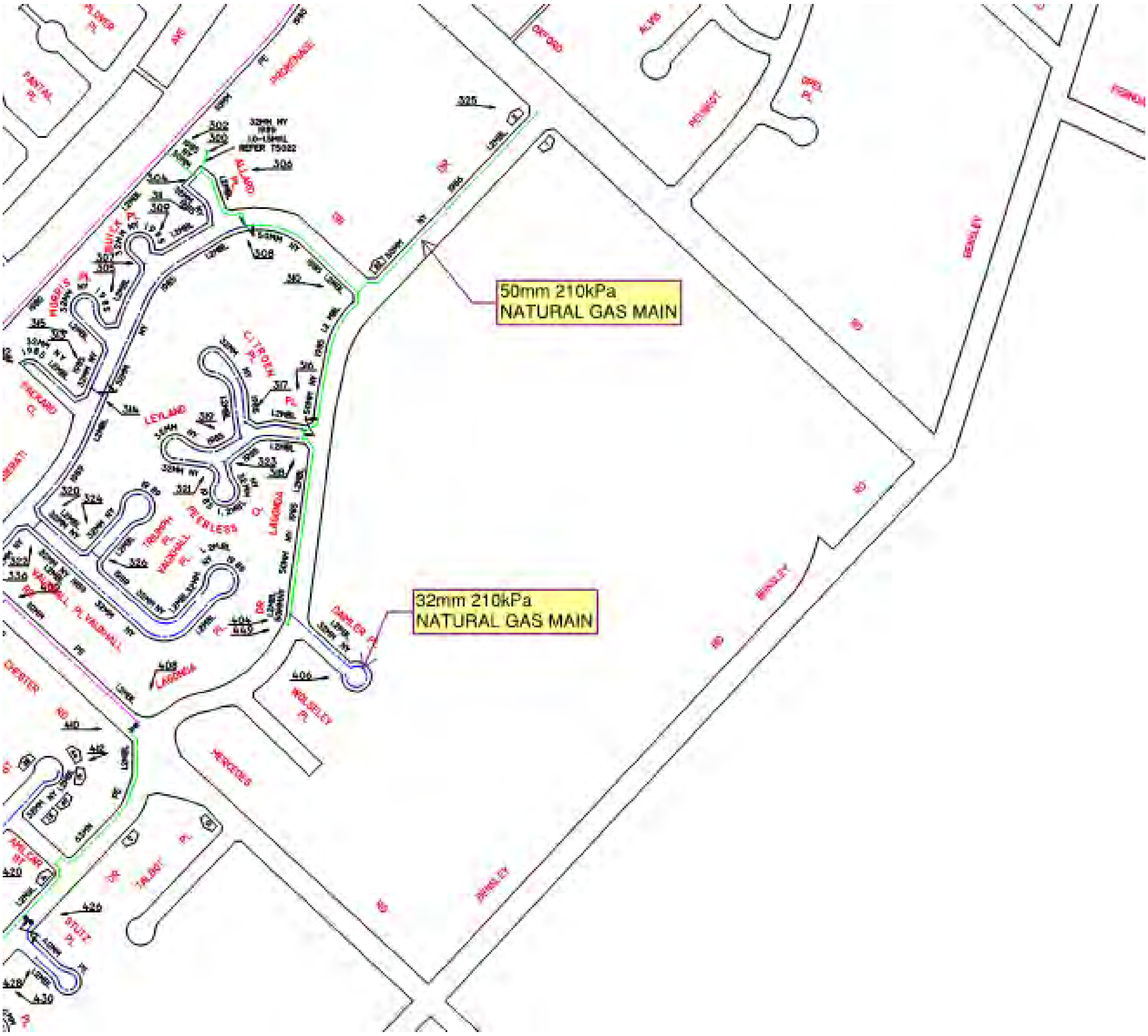

Figure 8: Jemena infrastructure (Source: Jemena)

6.2. Proposed connecting infrastructure

It will be necessary to connect the proposed services at Caledonia to existing infrastructure in the adjoining area. A sewer servicing strategy is shown in Appendix 6. Essentially, gravity sewer will drain to a common low point on Bensley Road. A pump station is required at this location. From there, sewage will be pumped in a rising main to the sewer pipe on Oxford Road to the immediate north of the Caledonia site. As each lot will be a Torrens title, the sewer pump station will be owned and maintained by Sydney Water.

Water will be connected into the Caledonia site at various points along the surrounding roads. These mains appear to have adequate size to provide supply to the Caledonia development withoiut the need for augmentation.

Water and sewer servicing requirements will be confirmed post DA following submission of the Section 73 Application to Sydney Water.

Costings

The costs in Tables 9 and 10 have been estimated from our experience on other projects:

Table 9: Sewer infrastructure costs

SEWER	**Unit**	**Cost**	**Quantity**	**$ Total**
Pump Station	Station	$180,000	1	$180,000
Rising Main	m	$ 1,200	550	$660,000
Connection to existing Sydney Water Main	Connection	$ 25,000	1	$25,000
Gravity Sewer	m	$ 600	2,500	$1,500,000
			Total	**$ 2,365,000**

Table 10: Water infrastructure costs

WATER SUPPLY	**Unit**	**Cost**	**Quantity**	**$ Total**
Rising Main	m	$ 500	2,500	$1,250,000
Connection to existing Sydney Water Main	Connection	$ 20,000	4	$ 80,000
			Total	**$ 1,330,000**

These cost estimate exclude:

- Sydney Water contributions

- Authority applications and associated developer fees and charges

- Rock excavation

.

7. SUMMARY AND CONCLUSIONS

This report presents concepts for infrastructure at the Caledonia site in support of a rezoning to achieve a 241 lot residential subdivision. Engineering investigations and concepts have been developed for each of the following:

- Stormwater/Water Cycle Management
- Traffic
- Electricity and Telecommunications
- Water and Sewer

The results indicate that it is feasible to service the proposed development and also achieve compliance with regulator and authority requirements.

The costs of infrastructure are summarized in Table 11.

Table 11: Infrastructure costs for Caledonia subdivision

Infrastructure		
Stormwater / Water Cycle Management Strategy		$5,531,800
Roads		$4,800,000
Electricity		$4,291,500
NBN		$ 361,500
Water supply		$1,330,000
Sewer		$2,365,000
TOTAL		**$18,679,800**

APPENDIX 1
Water Cycle Management Strategy

FOR PLANNING PROPOSAL

VERIFIER:
JOB MANAGER:
DESIGNED: C. PALADA
DRAWN: R. ESTRADA

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
1	ISSUED FOR PLANNING PROPOSAL	CP		CP	08.12.15
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CLIENT

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PROJECT
EDGELANDS PLANNING

DRAWING TITLE
PLANNING CIVIL DESIGN

STORMWATER CONCEPT PLAN

JOB NUMBER
151459

DRAWING NUMBER
SK3.01

REVISION
1

DRAWING SHEET SIZE = A1

APPENDIX 2

Water Cycle Management/Stormwater Calculations Report

Proposed Caledonia Residential Subdivision

Stormwater/Water Cycle Management Strategy

Background Report

Prepared for Billbergia

8th December 2015

Reference: 151459

Table of Contents

1. Introduction

This report forms an Appendix to a main Engineering Report prepared by Northrop Consulting Engineers (Northrop). It describes and provides calculations and design for a Stormwater Concept basded on a Concept Master Plan for a Planning Proposal to Cambelltown City Council DCP (Council).

This report specifies the stormwater management strategy developed for managing stormwater runoff from the proposed development, as per Council's specifications and requirements.

2. Existing Site Description

This site is located in Ingleburn and bounded by Mercedes Road, Bensley Road and Oxley Road (Refer to Figure 1).

Figure 1 – Locality Plan and Site Extents

The site is irregular in shape and covers an area of approximately 17.5ha. The site is enclosed by Oxford Road along its northern boundary, Bensley Road along its eastern boundary, Mercedes Road along its southern boundary and large private lots around its remaining western boundaries. The proposed Georges River Parkway will also run across the north eastern corner of the site.

Currently, the site supports a very low level of residential development. A majority of the site is undeveloped cleared land. Scattered trees and shrubs are present on the eastern and northern extents of the site. Access to the site is currently provided by driveway entrances off Bensley Road. The site currently has an impervious area of approximately 5% due to the existing dwellings and associated infrastructure located by a survey.

Based on survey undertaken across the site and topographic photographs, the site slopes up to 4% down to a low point on Bensley Road. The existing site forms part of the upper catchment of the Georges River.

2.1. Proposed Development

The proposed development will involve the construction of a subdivision comprising of 241 lots. Existing dwellings and heritage land have been incorporated into the design and will be retained. A park is also proposed on the western edge of the development. The development can be split into approximately 10 catchments based on both land use and topography (Refer to **Figure 2**).

A stormwater management strategy has been developed for the entire site to manage the quantity and quality of stormwater runoff. The strategy has been developed to Council's guidelines. To achieve Council's requirements, the strategy incorporates the use of gross pollutant traps, rainwater tanks, infiltration trenches, HyrdroCon pipes and underground and aboveground on-site detention tanks. Details of the proposed stormwater strategy and of each of the proposed treatment devices are discussed in Sections 3 and 4.

Figure 2: Sub-Catchment Plan of Subject Site Under Post-developed Conditions

3. Concept Stormwater Management Plan

The Stormwater Management Strategy has been developed in accordance with *Cambelltown (Sustainable City) Development Control Plan 2014*).

The two main objectives are to:

- Prevent erosion in the downstream waterways, namely Georges River, by maintaining an appropriate post-development Stream Erosion Index.

- Appropriately manage gross pollutants and nutrient discharge from the site to minimise the impact on ecological heath of receiving waterways and ensure total pollutant volumes generated under proposed conditions do not exceed best practice total volumes.

3.1. Stormwater Quantity Management

The strategy that we have developed is driven largely by the need to achieve a Stream Erosion Index (SEI) of 1. The Stream Erosion Index risk assessment procedure relies on calculating the increase in the relative frequency of flows from the site greater than the “stream forming flow”. The stream forming flow is defined as 50% of the 2-year ARI flow rate estimated for the catchment under natural flow conditions. Achieving a value at or below 1 is considered to represent an appropriate means of ensuring the impacts of site hydrology are mitigated such that the downstream watercourse remains stable.

It is very challenging to achieve an SEI of 1 for a newly proposed development. It requires a combination of water detention measures to throttle flow rates, and water retention measures to create “losses’ where water is diverted from the site drainage, e.g. infiltration, reuse.

It also requires a treatment train approach where water is incrementally managed in the urban water cycle. This has been incorporated into the MUSIC analysis, **Section 3.2.1.**

The DRAINS software package has also been used to model the overall hydrologic and hydraulic characteristics of stormwater runoff and flow across the site. The model has been prepared to assess the 1, 2, 5, 10, 20, 50 and 100 year ARI storm event.

3.1.1. Hydrology/Hydraulic Assessment

One model has been developed to establish the impacts of the proposed development on peak discharge rates across the site. The model includes both the pre-development and post-development conditions, as shown in **Figure 3**. As some of the subcatchments feed into one another before reaching the OSD, they are combined in a DRAINS model.

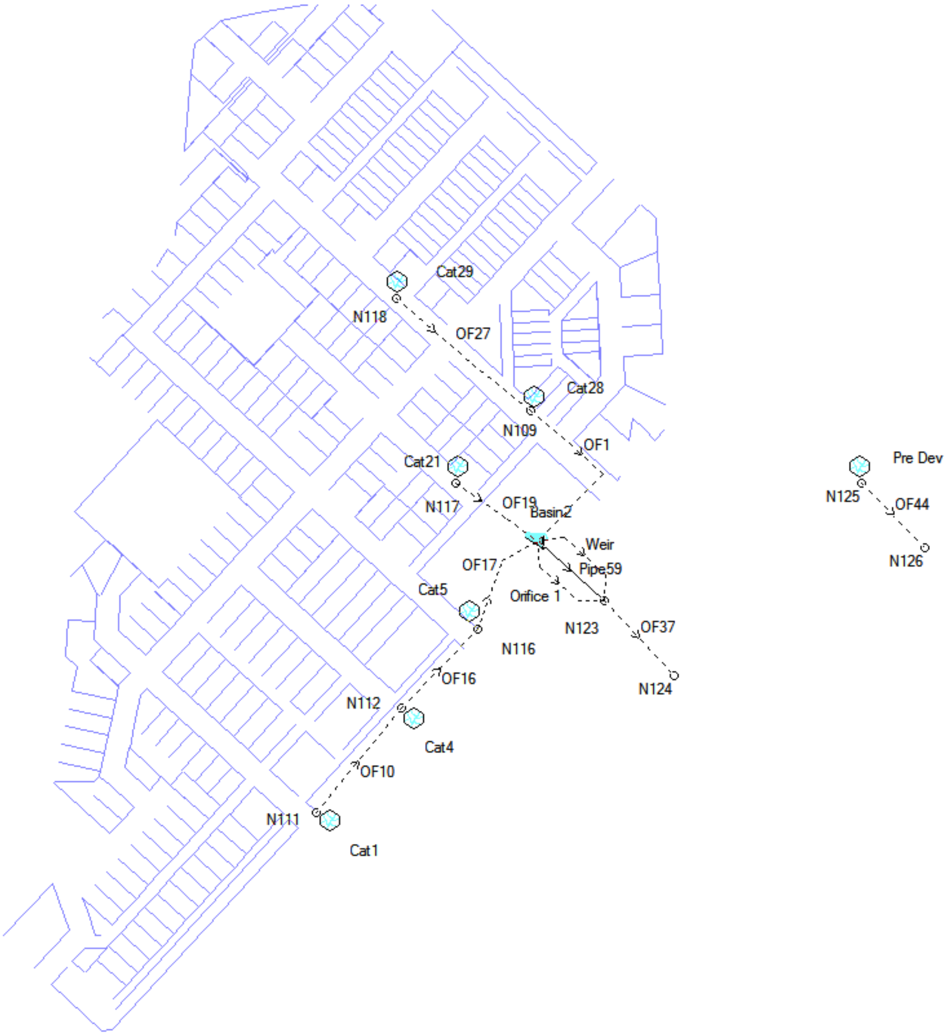

Figure 3: DRAINS Model of Both Predevelopment and Post development Catchments

The modelling input parameters adopted for the model are as described:

- ILSAX Hydrologic routing method
- Soil Type 3
- Antecedent Moisture Conditions 3
- Paved Area Depression Storage 1 mm
- Supplementary Area Depression Storage 3 mm
- Grassed Area Depression Storage 5 mm
- IFD Data obtained from the Bureau of Meteorology for Inglewood
- Time of concentration has been determined for each catchment based on catchment parameters of area, roughness and flow path

The results are presented to differentiate the hydraulic behaviour between the pre-development and post-development conditions with on-site detention and retention measures in place. The results overestimate the post-development peak flows as no rainwater tanks were able to be inputted into the model at a lot based level, despite their inclusion in the stormwater management plan. The rainwater tanks will allow the retention of a greater amount of rainfall post-development, therefore reducing the peak flow.

The results of the predeveloped DRAINS model are present in **Table 1**.

Design ARI	Pre-Development Peak Flows (m^3/s)	Post-Development Peak Flows from Basin (m^3/s)
1	0.7	0.62
2	1.45	1.33
5	1.57	1.51
10	2.82	2.37
20	3.5	3.37
50	4.63	4.33
100	5.19	5.10

Table 1 – Hydrologic/Hydraulic Modelling Results of Subject Site

3.1.2. On-Site Detention Details

To manage stormwater quantity discharge across the site and achieve the results in **Table 1**, the OSD basin has been designed as a combination of underground and aboveground storage with minor and major event outlet configurations as follows:

- Basin Total Storage Volume: 4900m^3;
  - Underground storage volume: 3000m^3;
  - Above ground volume: 1900m^3;
- Basin Base Area: 2115m^2;
- Basin Top of Bank Area: 2635m^2;
- Maximum above ground ponding depth (100yr): 0.81m;
- Underground storage depth: 1.5m;
- Minor Event Outlet Configuration:
  - 2x375mm pipes at basin invert;
  - 2x375mm (1.3m from underground tank invert);
  - 1x225mm (1.4m from underground tank invert);
- Overflow Weir:
  - Width: 7.5m;
  - Height: 0.5m.

The underground OSD will fill with water first and overflow in 2 year ARI rain events into the substrate and aboveground OSD via Hydrocon filter pipes. When the water dissipates in the underground storage after time, the water held aboveground and in the soil will then be able to infiltrate back into underground tank. This arrangement will allow for the recreational use of the basin area since as it will predominately be a dry system.

3.2. Stormwater Quality Management

3.2.1. MUSIC Modelling

The MUSIC software package was used to assess the extent of pollutant discharged from the site. The effectiveness of the proposed "treatment train" has been assessed based on modelling of two separate scenarios, as follows:

- Existing conditions; and
- Post development conditions with treatment measures.

A MUSIC model has been developed to model the total pollutant volumes discharged from the site under existing conditions. The following input parameters have been adopted in this model:

- Pluvio Rainfall data from the NSW Bureau of Meteorology Sydney rainfall station (Station Number 066062, 1959-1960)
- Pollutant Event Mean Concentrations (EMC) for rural residential from the draft NSW Music Modelling guidelines
- Default Rainfall-Runoff Parameters from MUSIC

The following treatment measures have been proposed and incorporated into the MUSIC model, which are described further in **Section 3.2.3**.

- Gross Pollutant Traps
- Rainwater Tanks
- Infiltration Trenches
- HydroCon Pipes

A screen shot of the MUSIC model is shown in **Figure 4**.

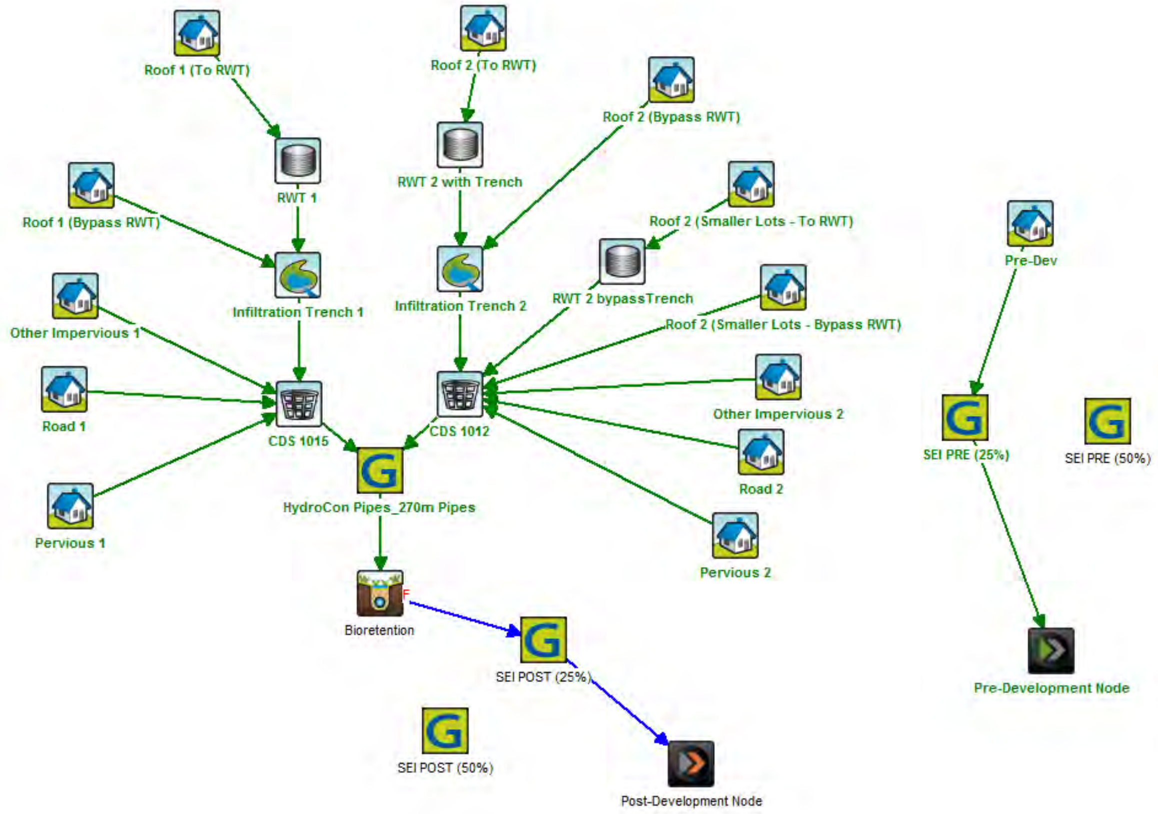

Figure 4 – MUSIC screenshot of Modelling Results of Site under Proposed Development Conditions with Treatment

The results of the MUSIC model of the site are presented in **Table 2**.

	Pre	Post	% Reduction	Post (inc. Infiltration Losses)	% Reduction
Flow (ML/yr)	**204**	136	33.33%	**176.87**	**13.30%**
Total Suspended Solids (kg/yr)	**29800.00**	4790.00	83.93%	**5236.97**	**82.43%**
Total Phosphorus (kg/yr)	**61.7**	19.3	68.72%	**23.28**	**62.27%**
Total Nitrogen (kg/yr)	**448**	147	67.19%	**195.54**	**56.35%**
Gross Pollutants (kg/yr)	**4540.00**	65.6	98.56%	**65.6**	**98.56%**

Table 2 – MUSIC modelling Results of Subject Site Under Pre-developed and Post-developed Condition, Including the Percent Reduction of Each Contaminant

The results in **Table 2** show that the implementation of the proposed treatment devices within the treatment train can effectively capture and remove a sufficient amount of pollutants from the site. The results also demonstrate that the proposed treatment train can effectively reduce the total volume of pollutant discharged from the site under proposed conditions to ensure they do not exceed volumes generated that under predeveloped conditions.

MUSIC was also used to determine the Stream Erosion Index, as seen in **Table 3**. The process of calculating SEI was following using the process outlines in the Draft MUSIC modelling guidelines for NSW. Both scenarios yielded values very close to the ideal SEI value of 1, well below the best practice ratio of 2-5.0. This indicates that downstream waterways would not be at risk of erosion due to increased size or frequency of flows from the development.

	Moderately Cohesive Soils (25% of 2yr Peak)	Cohesive Soils (50% of 2yr Peak)
Pre-Dev	36.3	30.1
Post-Dev	39.3	31.5
SEI	1.08	1.05

Table 3 - MUSIC Modelling Results for Stream Erosion Index (SEI) under Proposed Development Conditions

3.2.2. Proposed Stormwater Treatment Train

In order to achieve the reduction targets present in **Section 3.2.1**, the following treatment devices are required as part of the treatment train:

- Gross Pollutant Traps (GPT)

  The GPT units will be used to capture litter and coarse sediment prior to runoff entering the centralized detention system. The GPT's have been sized based on contributory catchment area with the following assumed capture rates:

TSS	70%
TN	0%
TP	30%
Litter	98%

- Rainwater Tanks

2 kL rainwater tanks are proposed to be installed on all residential lots in the proposed sub-division to reduce runoff volume, maximise non-potable supply/re-use and minimise peak flows for frequent storm events.

The rainwater tank reuse values modelled in the MUSIC model were based on the values provided in the NSW MUSIC Modelling Guidelines, assuming 1-2 occupants per dwelling. The water reuse external (irrigation) and internal (toilet flushing and laundry) demand are outlined below:

- Daily External Demand: 0.5 kL/lot/day
- Daily Internal Demand: 0.15 kL/lot/day

- Infiltration Trenches

10m^2 Infiltration trenches are proposed for all lots excluding the 225m^2 sized lots. The trenches will receive overflows from their accompanied rainwater tanks in the event when tanks become full and have no remaining retention capacity.

- HydroCon Pipes

HydroCon pipes are semi-permeable concrete pipes that filter water. They have an impermeable base that collects larger particulates. When the pipes are filled to capacity the porous upper edge filters water as it flows through the pipe and into spaces in the surrounding porous media. This allows water to be pretreated before it enters the porous media of the aboveground OSD.

A Hydrocon filter system is proposed at the base of the OSD basin:

- Hydrocon Pipe Length: 270m;
- Filter Area: 1025m^2;
- Filter Depth: 0.6m;

4. Stormwater Drainage Strategy

Stormwater generated across the site will be captured and conveyed through the site via an underground stormwater pit and pipe network located underneath the proposed communal road. The stormwater network will collect stormwater generated across the majority of the site.

Rainwater tanks will be used to retain stormwater for household purposes on site. Stormwater captured into the underground stormwater pipes system will pass through gross pollutant traps to remove gross pollutants, coarse sediment and associated nutrients from the stormwater. They will be positioned before the OSD tanks and be accessible for maintenance. Infiltration trenches will also be used to remove substrate from stormwater runoff.

The stormwater will then enter the underground OSD tank and Hydrocon system, where stormwater will be temporarily stored and discharged in a controlled manner into the river on the eastern edge of the site. In larger events, the water will surcharge into the aboveground basin by infiltrating through the HydroCon pipes. The water will be treated to a higher level by the HydroCon pipes. When dry, the basin will also have the added benefit of being a recreational area.

Detailed analysis and investigations will be undertaken at future stages of detailed design so as to confirm and precisely detail the relevant hydraulic analysis and calculations.

5. Conclusion

A stormwater management strategy has been developed in accordance with *Cambelltown (Sustainable City) Development Control Plan 2014.* The stormwater management strategy will include the implementation of gross pollutant traps, rainwater tanks, infiltration trenches, HydroCon pipes and an underground and aboveground OSD.

Concept modelling on the effectiveness of the above stormwater treatment devices on the management of stormwater across the site has been undertaken using the DRAINS and MUSIC software package. The modelling results have demonstrated that the above treatment devices are effective at reducing total pollutant loads, peaks flows and total volume of flows generated across the proposed site in accordance with Council's requirements.

Overall, Northrop are generally satisfied that stormwater runoff generated across the proposed residential subdivision can be appropriately managed. We are of the opinion that the proposed stormwater management strategy can effectively manage stormwater runoff to ensure that under proposed conditions, the residential subdivision will not result in an increase in pollutants or stormwater flows and result in any detrimental impacts to receiving waterways or downstream infrastructure.

APPENDIX 3

Traffic Analysis Report

Caledonia Planning Proposal Ingleburn

Traffic and Access Assessment Report

Prepared for: Billbergia

December 2015

Report No: PT15044r01_Final

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1. Introduction

This report has been prepared on behalf of Billbergia Pty Ltd to present findings of a traffic and access assessment of the proposed residential sub division known as Caledonia in Ingleburn to provide 241 residential development lots.

The study has assessed existing traffic conditions, access arrangements, potential traffic impacts and includes a design assessment of the road network for compliance with relevant Council policies.

The remainder of the report is set out as follows:

- Section 2 summarises the adopted data collection strategies
- Section 3 describes the existing traffic conditions; and
- Section 4 summarises the proposed development
- Section 5 analyses potential traffic impacts of the proposal; and
- Section 6 presents findings of this assessment.

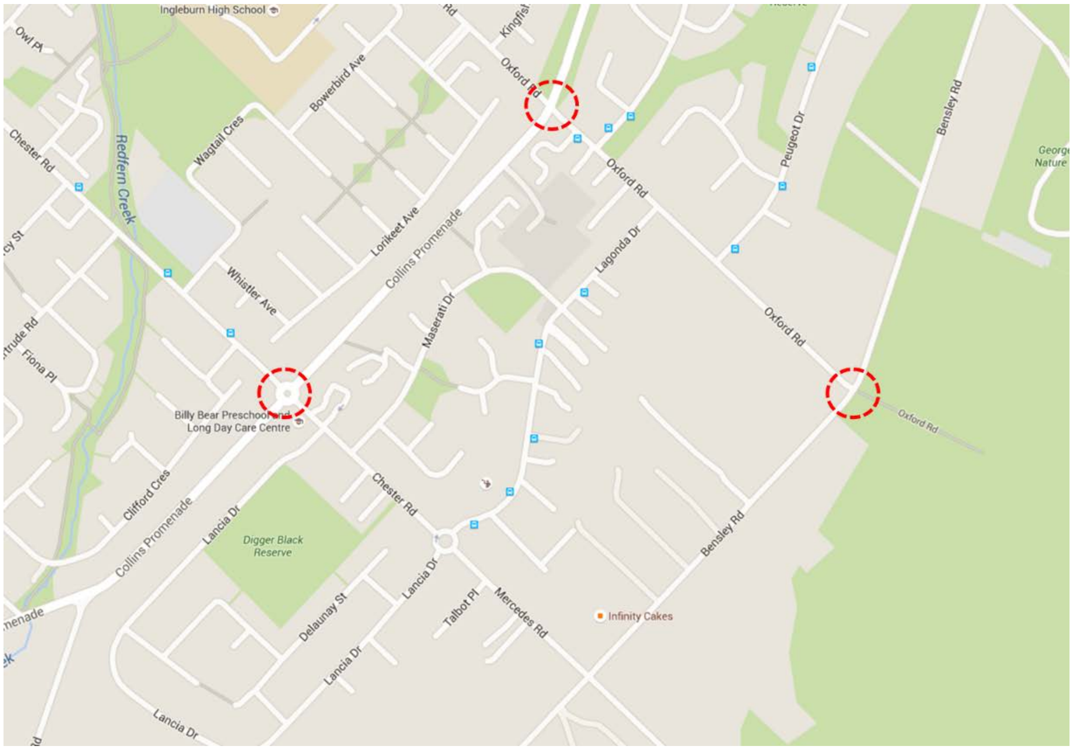
2. Data Collection Strategy

Following a site inspection of the location and surrounding road network, the following presents a summary of data collection strategy to inform this report.

2.1 Intersection Counts

The intersections which were identified for morning and afternoon peak hour intersection counts are shown in **Figure 1** below.

Figure 1 – Intersection Count Locations



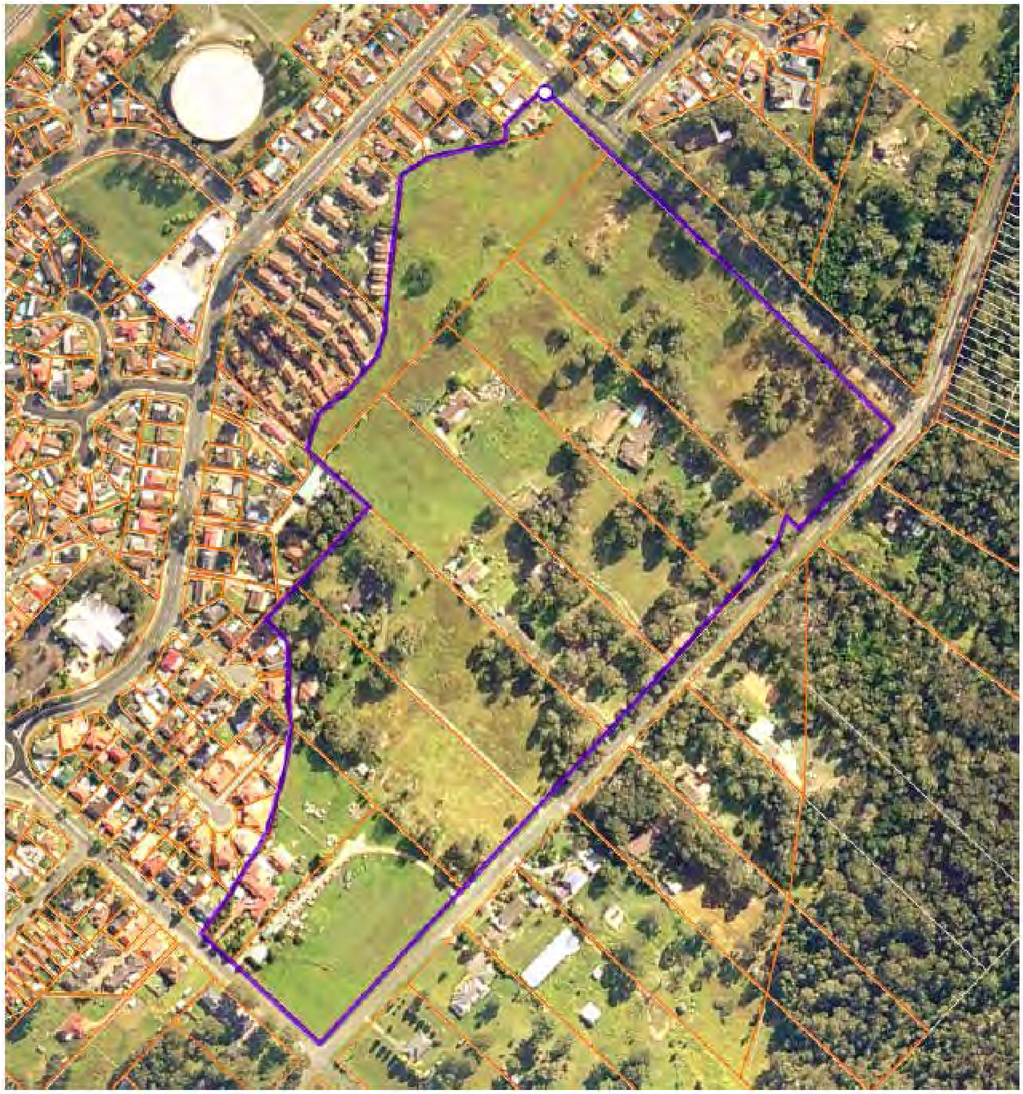
The identified count locations would provide a measure of existing intersection operating conditions and capacity and would more than likely be used by traffic generated by the planning proposal.

3. Existing Traffic / Parking Conditions

3.1 Site Location

The location of the development site is shown in **Figure 2**.

Figure 2 - Site Location



Source: Google maps

The land is bounded by Oxford Road in the north, Bensley Road in the east, Mercedes Road in the south and existing residential dwellings in the west. The site consists of a small number of rural residential dwellings on large blocks.

3.2 Classification Criteria

It is usual to classify roads according to a road hierarchy in order to determine their functional role within the road network. Changes to traffic flows on the roads can then be assessed within the context of the road hierarchy. Roads are classified according to the role they fulfil and the volume of traffic they should appropriately carry. The RTA has set down the following guidelines for the functional classification of roads.

- Arterial Road – typically a main road carrying over 15,000 vehicles per day and fulfilling a role as a major inter-regional link (over 1,500 vehicles per hour)
- Sub-arterial Road – defined as secondary inter-regional links, typically carrying volumes between 5,000 and 20,000 vehicles per day (500 to 2,000 vehicles per hour)
- Collector Road – provides a link between local roads and regional roads, typically carrying between 2,000 and 10,000 vehicles per day (250 to 1,000 vehicles per hour). At volumes greater than 5,000 vehicles per day, residential amenity begins to decline noticeably.
- Local Road – provides access to individual allotments, carrying low volumes, typically less than 2,000 vehicles per day (250 vehicles per hour).

3.3 Existing Road Network

<u>Oxford Road</u> – is a local street connecting Collins Promenade (a major north / south collector road) in the west with Bensley Road in the east. The street has a posted speed limit of 50km/hr and generally includes a single travel lane in each direction with unrestricted parallel parking on either side of the street. The intersection of Oxford Road / Collins Promenade is controlled by traffic signals whereas the intersection of Oxford Road / Bensley Road is a priority controlled intersection.

<u>Bensley Road</u> – is a local rural residential road forming a cul-de-sac at its southern end and connecting Harold Street (Collins Promenade) in the north via a dual land roundabout. Across the frontage of the development site the road includes an 80km/hr speed zone with a single lane of travel in each direction and unformed shoulders. Properties which front Bensley Road consist of rural residential properties.\

<u>Mercedes Road / Chester Road</u> - is a local street linking Bensley Road in the east with Collins Promenade in the west. The intersection of Chester Road / Collins Promenade is controlled by a single lane roundabout whereas the intersection of Mercedes Road / Bensley Road is a priority controlled intersection. The street includes a single lane of travel in each direction and generally unformed shoulders across the frontage of the development site. The posted speed limit of 50km/hr.

3.4 Existing Traffic Flows

As stated above, intersection counts were undertaken at three (3) locations. Copies of the intersection counts can be found in **Appendix A** of this report. The peak flows by direction in each street at each intersection are summarised below for a weekday and Saturday conditions.

Table 1 - Summary of Weekday Peak Period Volumes in vicinity of site (veh/hr)

		AM		PM	
Road	Location	NB/EB	SB/WB	NB/EB	SB/WB
Oxford Road	East of Collins Promenade	98	286	232	160
Oxford Road	West of Collins Promenade	183	301	157	149
Collins Promenade	South of Oxford Road	694	512	474	852
Harold Street	North of Oxford Road	723	471	481	923
Oxford Road	West of Bensley Road	39	25	51	47
Bensley Road	South of Oxford Road	45	39	43	54
Bensley Road	North of Oxford Road	73	53	84	91
Mercedes Road	East of Collins Promenade	100	238	243	184
Chester Road	West of Collins Promenade	128	172	223	193
Collins Promenade	South of Chester Road	646	625	511	880
Collins Promenade	North of Chester Road	616	501	430	828

*West of College Road South

From **Table 1** it can be seen that existing flows on surrounding roads are in generally in line with their classification.

3.5 Existing Conditions Intersection Analysis

All intersections surveyed have been analysed using the Sidra Intersection analysis program. Sidra Intersection determines the average delay that vehicles encounter, the degree of saturation of the intersection, and the level of service. The degree of saturation is the ratio of the arrival rate of vehicles to the capacity of the approach. Sidra Intersection provides analysis of the operating conditions which can be compared to the performance criteria set out in **Table 2.**

Table 2 – Level of Service Criteria

Level of Service	Average Delay per Vehicle (secs/veh)	Signals & Roundabouts	Give Way & Stop Signs
A	less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays & spare capacity	Acceptable delays & Spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays Roundabouts require other control mode	At capacity, requires other control mode
F	> 70	Extra capacity required	Extreme delay, traffic signals or other major treatment required

Adapted from RTA Guide to Traffic Generating Developments, 2002.

For roundabouts and priority intersections, the reported average delay is for the individual movement with the highest average delay per vehicle. At signalised intersections, the reported average delay is over all movements.

The existing weekday and weekend day intersection operating conditions are presented in **Table 3**. Average delay is expressed in seconds per vehicle.

Table 3 – Existing Weekday Intersection Operating Conditions

		Morning Peak		Evening Peak	
Intersection	**Control**	**Av Delay**	**LOS**	**Av Delay**	**LOS**
Oxford Road / Collins Promenade	Signals	32.3	C	24.1	B
Oxford Road / Bensley Road	Give Way	5.8	A	5.9	A
Chester Road / Collins Promenade	Roundabout	12.6	A	15.5	B

Avg Delay (sec/veh) is over all movements at signals, and for worst movement at priority and roundabouts

From **Table 3**, it can be seen that all intersections in the vicinity of the development site currently operate at a satisfactory level of service with adequate spare capacity for increased demands.

4. The Proposed Development

The key elements of the proposed development in terms of yield, traffic and access matters are presented below:

1. The development would yield at total of 241 residential development lots.
2. Construction of an internal road network which would include one (1) intersection connection with Mercedes Road, four (4) intersection connections to Bensley Road and two (2) intersection connections to Oxford Road.
3. An internal road network which would facilitate a bus service with all residential lots within a 400m walking distance to the service.
4. Internal road widths which comply with Liverpool Council's DCP for Residential Development.

For the area as a whole, the current plan would achieve the following total lot yield:

225m^2 lots -	84
300m^2 lots	116
450m^2 lots	24
600m^2 lots	17
Total	241 lots

Plans of the proposed sub division can be found in **Appendix B** of this report.

5. Traffic and Access Assessment

The following presents an analysis of potential future traffic impacts of the proposed development.

5.1 Traffic Generation

Whilst the development includes a range of residential lot types, for the purpose of assessing future traffic impacts, all residential lots have been assumed to function as single dwelling houses as defined in the RTA Guide to Traffic Generating Developments.

Therefore, at a potential peak hour rate specified by the guide of 0.85 trips per dwelling, the proposed 241 lots have the potential to generate 205 peak hour vehicle trips two way. 80% of these trips (164) would travel outbound in the AM peak and 20% (41) would travel inbound. The reverse would occur in the PM peak.

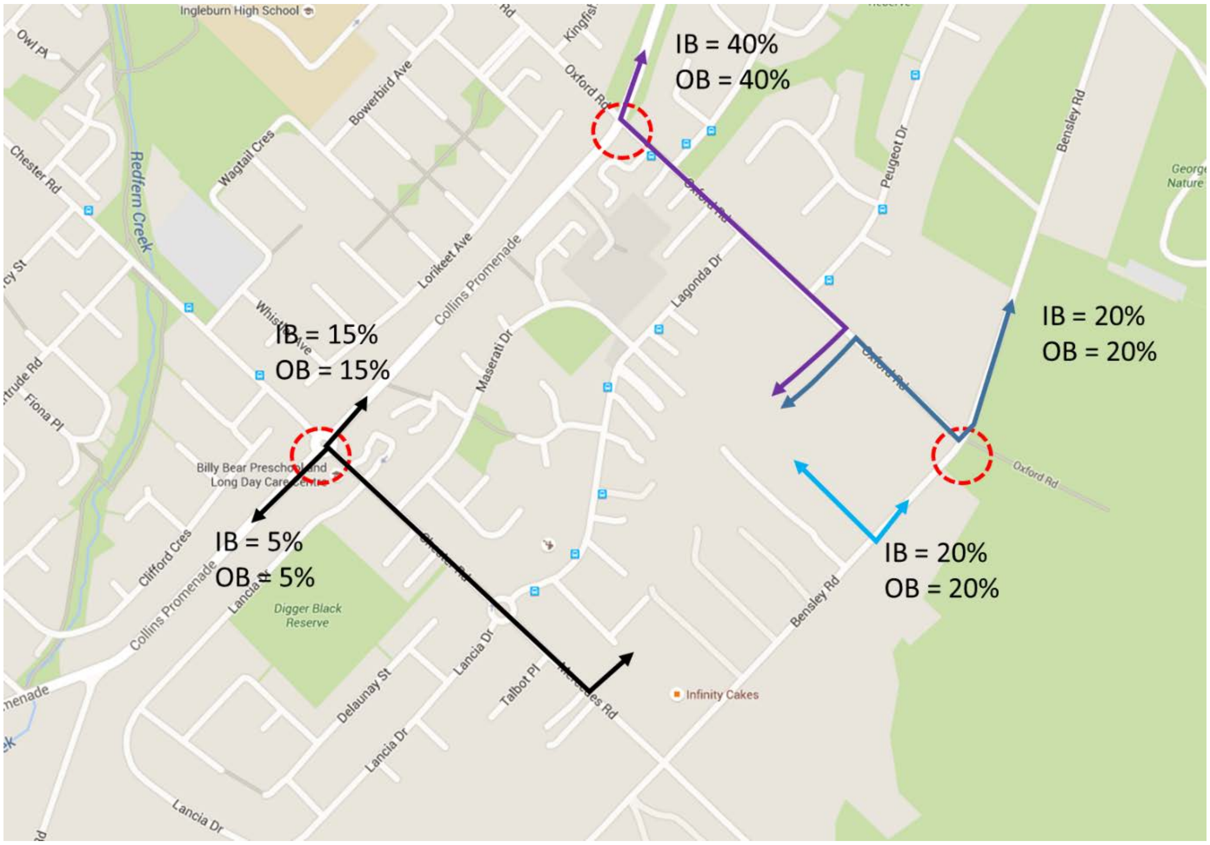
5.2 Trip Distribution

The potential routes of travel of new residents of the sub division have been developed considering both the proposed access connections to existing surrounding roads and existing traffic flows by direction.

Collins Promenade included a 3:2 proportion of traffic flows northbound / southbound respectively with the reverse occurring in the PM peak. Bensley Road included an approximate 50 / 50 split of northbound / southbound traffic flows in both peak periods.

Bensley Road would provide a direct access north and would be attractive for residents of the sub division.

Based on the above, the following trips distribution has been adopted which shows the percentage of the total inbound / outbound trips by direction.



5.3 Future Traffic Flows

The traffic generated by the proposal has been added to the surrounding road network as per the adopted trip distribution detailed above. The resulting future traffic flows are presented below.

Table 4 – Future Weekday Peak Period Volumes in vicinity of site (veh/hr)

		AM		PM	
Road	Location	NB/EB	SB/WB	NB/EB	SB/WB
Oxford Road	East of Collins Promenade	164	302	248	226
Oxford Road	West of Collins Promenade	183	301	157	149
Collins Promenade	South of Oxford Road	694	512	474	852
Harold Street	North of Oxford Road	799	487	497	999
Oxford Road	West of Bensley Road	47	58	84	55
Bensley Road	South of Oxford Road	78	47	51	87
Bensley Road	North of Oxford Road	139	65	100	157
Mercedes Road	East of Collins Promenade	133	246	251	217
Chester Road	West of Collins Promenade	128	172	223	193
Collins Promenade	South of Chester Road	648	633	519	882
Collins Promenade	North of Chester Road	641	507	436	853

*West of College Road South

From **Table 4** it can be seen that traffic flows in the future on the surrounding road network would remain in line with their respective classification.

5.4 Future Intersection Operation

The future traffic flows on the surrounding road network have been assessed in SIDRA. The resulting future intersection operation is presented below.

Table 5 – Future Weekday Intersection Operating Conditions

		Morning Peak		Evening Peak	
Intersection	**Control**	**Av Delay**	**LOS**	**Av Delay**	**LOS**
Oxford Road / Collins Promenade	Signals	39.0	C	27.6	B
Oxford Road / Bensley Road	Give Way	5.9	A	6.2	A
Chester Road / Collins Promenade	Roundabout	12.5	A	15.8	B

Avg Delay (sec/veh) is over all movements at signals, and for worst movement at priority and roundabouts

From **Table 5** it can be seen that at full development of the sub division, all intersections surveyed would continue to operate at satisfactory levels of service.

Overall the potential traffic impacts of the development are considered satisfactory.

6. Summary of Findings

This report has reviewed the potential traffic impacts of the 241 lot residential development known as Caledonia in Ingleburn. The findings of this review are presented below:

1. The traffic impacts of the development would be minimal with future traffic flows on surrounding roads within acceptable limits.
2. Intersections surrounding the development would continue to operate at levels of service to that which currently occurs.
3. The internal road network has been designed to facilitate a future bus route if deemed viable with all proposed residential lots within 400m of the internal bus route.

Overall the traffic impacts of the proposal are considered acceptable.

7. Appendix A – Intersection / Parking Counts

Oxford Rd & Bensley Rd

To

Dean Brodie

at **Positive Traffic**

your results for

Ingleburn - Oxford Rd Counts

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Reliable, Original & Authentic Results

Ph.88196847, Fax 88196849, Mob.0418-239019

Client : Positive Traffic
Job No/Name : 5803 Ingleburn Oxford Rd Counts
Day/Date : Thursday 15th October 2015

All Vehicles	NORTH		WEST		SOUTH		
	Bensley Rd		*Oxford Rd*		*Bensley Rd*		
Time Per	R	T	L	R	L	T	TOTAL
0600 - 0615	3	2	5	1	2	4	**17**
0615 - 0630	1	4	8	0	0	4	**17**
0630 - 0645	2	3	6	0	1	1	**13**
0645 - 0700	0	5	3	1	1	4	**14**
0700 - 0715	3	4	8	1	1	2	**19**
0715 - 0730	2	8	7	0	0	5	**22**
0730 - 0745	4	5	7	0	1	7	**24**
0745 - 0800	1	2	8	1	0	5	**17**
0800 - 0815	1	9	15	0	2	8	**35**
0815 - 0830	7	9	7	2	4	7	**36**
0830 - 0845	3	11	7	0	1	12	**34**
0845 - 0900	6	7	7	1	1	10	**32**
Period End	**33**	**69**	**88**	**7**	**14**	**69**	**280**

All Vehicles	NORTH		WEST		SOUTH		
	Bensley Rd		*Oxford Rd*		*Bensley Rd*		
Time Per	R	T	L	R	L	T	TOTAL
1500 - 1515	6	7	3	0	1	7	**24**
1515 - 1530	9	8	4	1	2	8	**32**
1530 - 1545	10	12	4	2	1	10	**39**
1545 - 1600	10	13	4	2	0	12	**41**
1600 - 1615	3	11	7	1	2	6	**30**
1615 - 1630	6	15	4	0	1	4	**30**
1630 - 1645	9	8	8	1	0	11	**37**
1645 - 1700	9	11	8	1	2	6	**37**
1700 - 1715	6	12	18	0	1	4	**41**
1715 - 1730	14	12	12	1	1	11	**51**
1730 - 1745	12	15	9	2	2	16	**56**
1745 - 1800	10	8	3	1	1	6	**29**
Period End	**104**	**132**	**84**	**12**	**14**	**101**	**447**

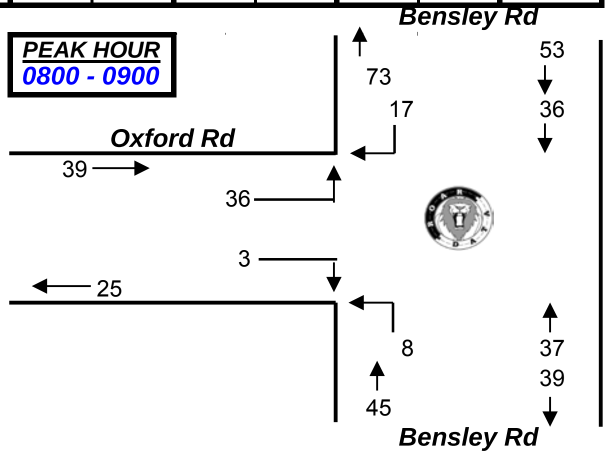
	NORTH		WEST		SOUTH		
	Bensley Rd		*Oxford Rd*		*Bensley Rd*		
Peak Per	R	T	L	R	L	T	TOTAL
0600 - 0700	6	14	22	2	4	13	**61**
0615 - 0715	6	16	25	2	3	11	**63**
0630 - 0730	7	20	24	2	3	12	**68**
0645 - 0745	9	22	25	2	3	18	**79**
0700 - 0800	10	19	30	2	2	19	**82**
0715 - 0815	8	24	37	1	3	25	**98**
0730 - 0830	13	25	37	3	7	27	**112**
0745 - 0845	12	31	37	3	7	32	**122**
0800 - 0900	17	36	36	3	8	37	**137**

PEAK HR	**17**	**36**	**36**	**3**	**8**	**37**	**137**

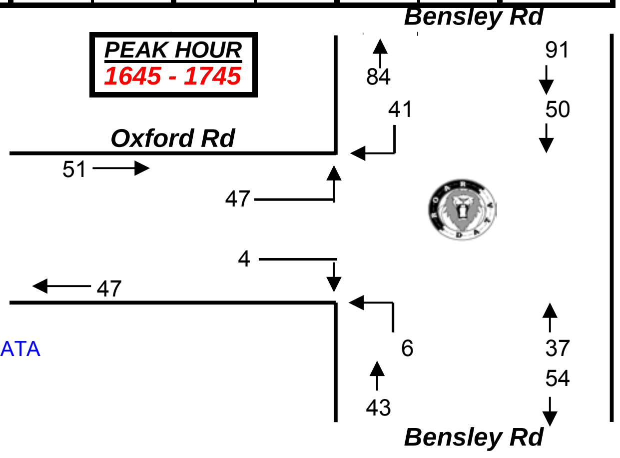
	NORTH		WEST		SOUTH		
	Bensley Rd		*Oxford Rd*		*Bensley Rd*		
Peak Per	R	T	L	R	L	T	TOTAL
1500 - 1600	35	40	15	5	4	37	**136**
1515 - 1615	32	44	19	6	5	36	**142**
1530 - 1630	29	51	19	5	4	32	**140**
1545 - 1645	28	47	23	4	3	33	**138**
1600 - 1700	27	45	27	3	5	27	**134**
1615 - 1715	30	46	38	2	4	25	**145**
1630 - 1730	38	43	46	3	4	32	**166**
1645 - 1745	41	50	47	4	6	37	**185**
1700 - 1800	42	47	42	4	5	37	**177**

PEAK HR	**41**	**50**	**47**	**4**	**6**	**37**	**185**

PEAK HOUR
0800 - 0900



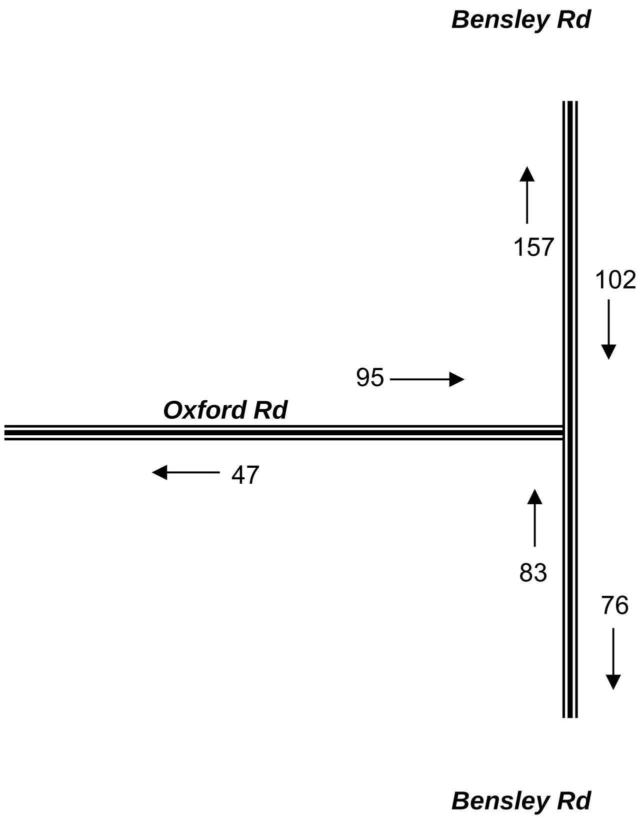
PEAK HOUR
1645 - 1745



N

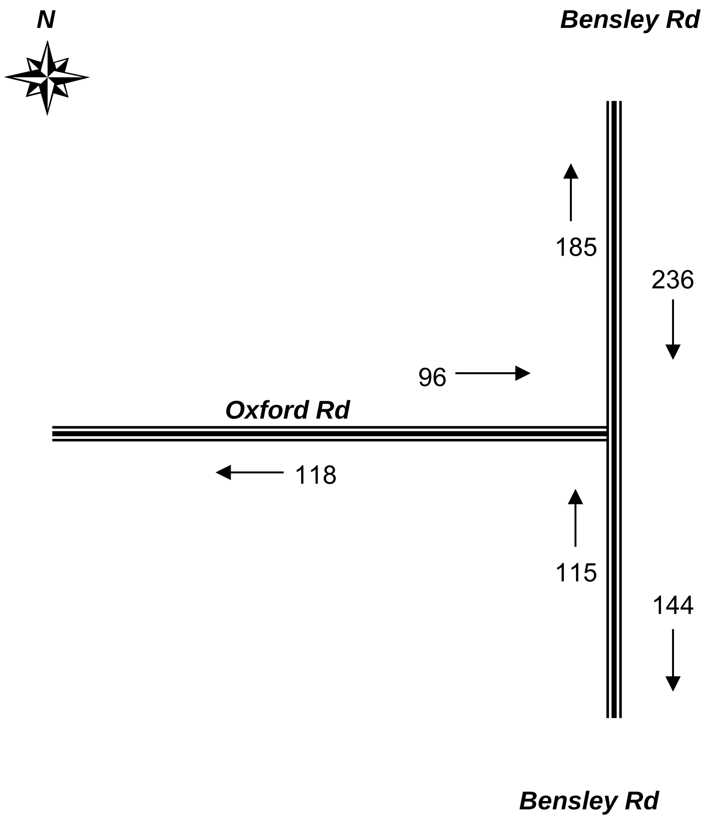
TOTAL VOLUMES FOR PERIOD COUNTED

AM



N

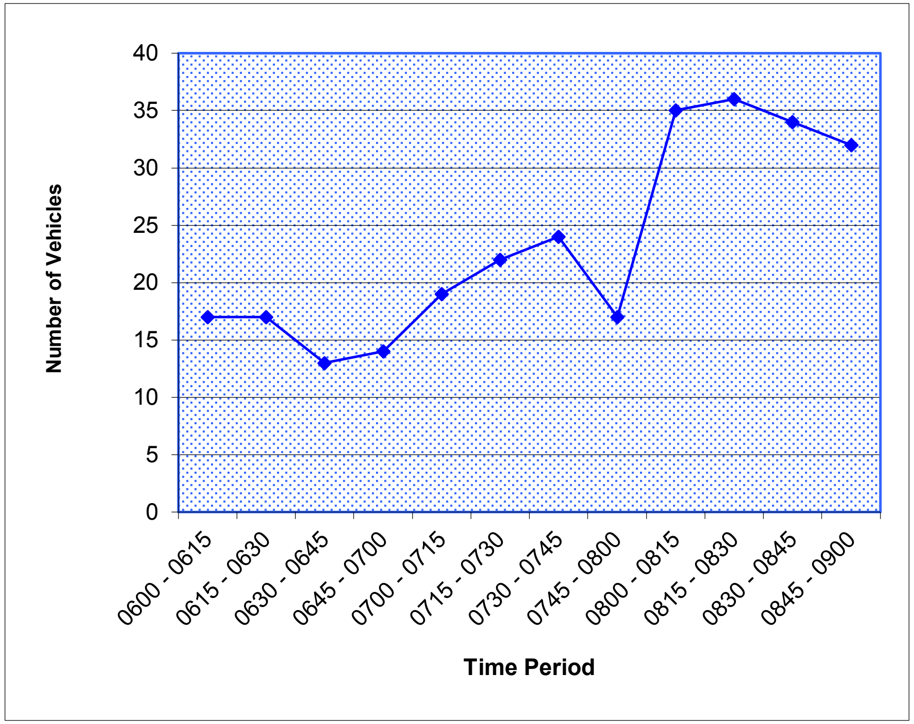
PM



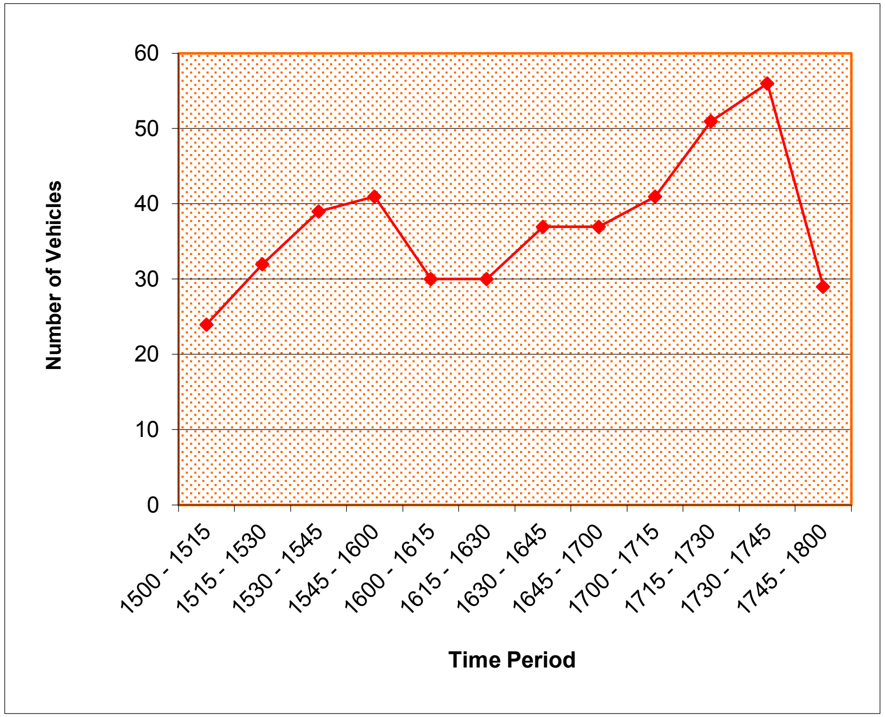
Client	: Positive Traffic
Job No/Name	: 5803 Ingleburn Oxford Rd Counts
Day/Date	: Thursday 15th October 2015

Oxford Rd & Bensley Rd

AM



PM



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Client	: Positive Traffic
Job No/Name	: 5803 Ingleburn Oxford Rd Counts
Day/Date	: Thursday 15th October 2015

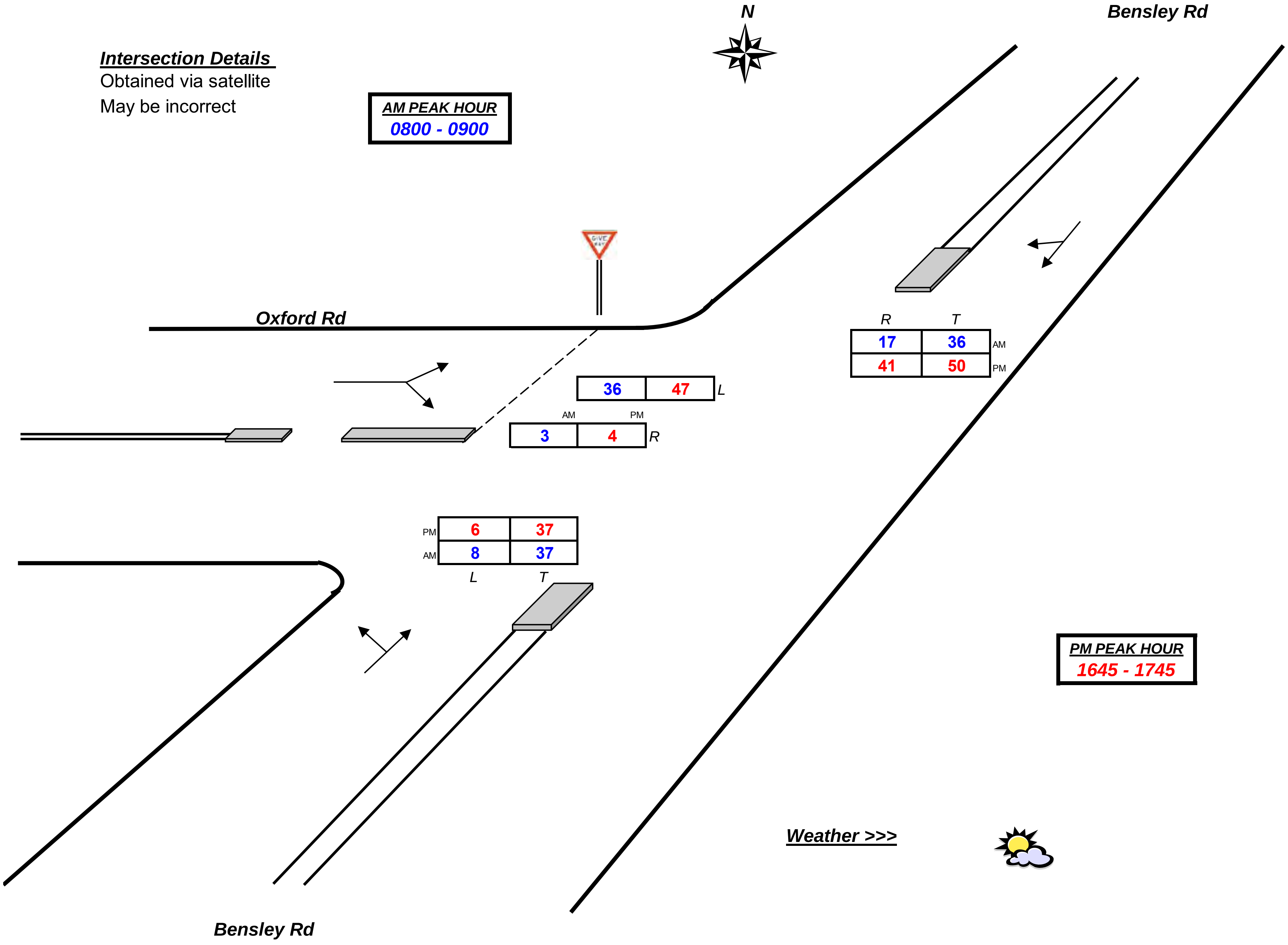
Intersection Details

Obtained via satellite

May be incorrect

AM PEAK HOUR

0800 - 0900



PM PEAK HOUR

1645 - 1745

Weather >>>

Chester Rd Rd & Collins Prm

To

Dean Brodie

at ***Positive Traffic***

your results for

Ingleburn - Oxford Rd Counts

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Reliable, Original & Authentic Results

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Client : Positive Traffic
Job No/Name : 5803 Ingleburn Oxford Rd Counts
Day/Date : Thursday 15th October 2015

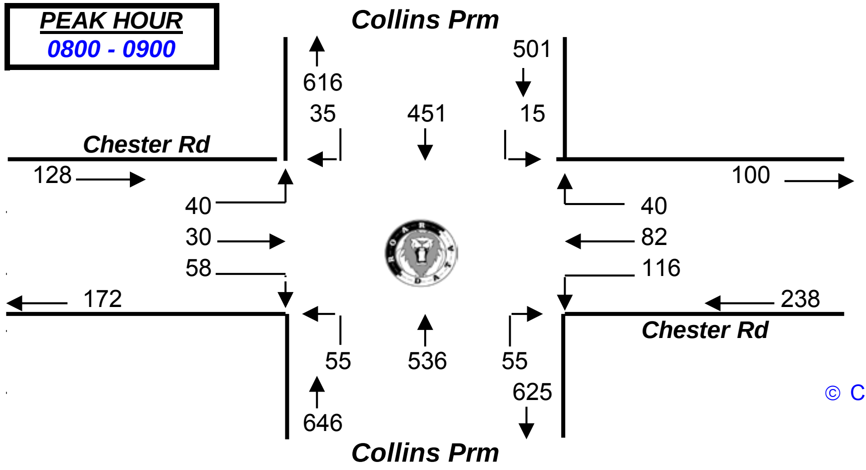
All Vehicles	NORTH			WEST			SOUTH			EAST			
	Collins Prm			*Chester Rd*			*Collins Prm*			*Chester Rd*			
Time Per	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**TOT**
0600 - 0615	3	16	0	6	4	4	2	83	6	10	6	8	**148**
0615 - 0630	5	37	0	7	8	0	5	106	4	16	6	12	**206**
0630 - 0645	1	54	3	3	6	4	1	109	2	11	10	11	**215**
0645 - 0700	2	53	8	11	6	5	8	108	9	14	13	14	**251**
0700 - 0715	3	40	6	16	11	7	7	111	2	11	25	8	**247**
0715 - 0730	3	52	3	5	9	6	11	116	12	16	22	12	**267**
0730 - 0745	5	64	10	15	15	8	15	113	4	15	26	7	**297**
0745 - 0800	5	62	3	9	10	7	15	155	4	18	18	17	**323**
0800 - 0815	3	71	3	12	9	6	17	122	10	27	18	12	**310**
0815 - 0830	6	116	13	6	11	16	14	142	7	31	16	11	**389**
0830 - 0845	2	131	3	15	6	21	13	145	20	34	23	8	**421**
0845 - 0900	4	133	16	7	4	15	11	127	18	24	25	9	**393**
Period End	**42**	**829**	**68**	**112**	**99**	**99**	**119**	**1437**	**98**	**227**	**208**	**129**	**3467**

All Vehicles	NORTH			WEST			SOUTH			EAST			
	Collins Prm			*Chester Rd*			*Collins Prm*			*Chester Rd*			
Time Per	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**TOT**
1500 - 1515	8	162	13	14	20	27	12	99	37	22	15	7	**436**
1515 - 1530	15	170	9	8	20	14	9	113	35	18	13	7	**431**
1530 - 1545	9	165	12	7	10	9	11	95	22	20	9	7	**376**
1545 - 1600	5	139	10	12	26	8	14	104	19	23	16	5	**381**
1600 - 1615	12	172	15	6	12	22	9	107	20	17	9	7	**408**
1615 - 1630	7	170	11	12	10	20	12	96	26	18	11	5	**398**
1630 - 1645	10	171	6	8	17	19	7	90	23	28	12	6	**397**
1645 - 1700	11	160	13	12	19	24	12	94	21	20	12	7	**405**
1700 - 1715	8	151	13	11	24	19	19	100	30	27	20	3	**425**
1715 - 1730	12	163	21	18	21	22	14	100	23	21	17	5	**437**
1730 - 1745	19	175	17	13	30	18	8	76	26	22	20	7	**431**
1745 - 1800	12	225	12	9	21	17	16	82	17	20	16	6	**453**
Period End	**128**	**2023**	**152**	**130**	**230**	**219**	**143**	**1156**	**299**	**256**	**170**	**72**	**4978**

	NORTH			WEST			SOUTH			EAST			
	Collins Prm			*Chester Rd*			*Collins Prm*			*Chester Rd*			
Peak Time	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**TOT**
0600 - 0700	11	160	11	27	24	13	16	406	21	51	35	45	**820**
0615 - 0715	11	184	17	37	31	16	21	434	17	52	54	45	**919**
0630 - 0730	9	199	20	35	32	22	27	444	25	52	70	45	**980**
0645 - 0745	13	209	27	47	41	26	41	448	27	56	86	41	**1062**
0700 - 0800	16	218	22	45	45	28	48	495	22	60	91	44	**1134**
0715 - 0815	16	249	19	41	43	27	58	506	30	76	84	48	**1197**
0730 - 0830	19	313	29	42	45	37	61	532	25	91	78	47	**1319**
0745 - 0845	16	380	22	42	36	50	59	564	41	110	75	48	**1443**
0800 - 0900	15	451	35	40	30	58	55	536	55	116	82	40	**1513**
PEAK HOUR	**15**	**451**	**35**	**40**	**30**	**58**	**55**	**536**	**55**	**116**	**82**	**40**	**1513**

	NORTH			WEST			SOUTH			EAST			
	Collins Prm			*Chester Rd*			*Collins Prm*			*Chester Rd*			
Peak Time	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**L**	**T**	**R**	**TOT**
1500 - 1600	37	636	44	41	76	58	46	411	113	83	53	26	**1624**
1515 - 1615	41	646	46	33	68	53	43	419	96	78	47	26	**1596**
1530 - 1630	33	646	48	37	58	59	46	402	87	78	45	24	**1563**
1545 - 1645	34	652	42	38	65	69	42	397	88	86	48	23	**1584**
1600 - 1700	40	673	45	38	58	85	40	387	90	83	44	25	**1608**
1615 - 1715	36	652	43	43	70	82	50	380	100	93	55	21	**1625**
1630 - 1730	41	645	53	49	81	84	52	384	97	96	61	21	**1664**
1645 - 1745	50	649	64	54	94	83	53	370	100	90	69	22	**1698**
1700 - 1800	51	714	63	51	96	76	57	358	96	90	73	21	**1746**
PEAK HOUR	**51**	**714**	**63**	**51**	**96**	**76**	**57**	**358**	**96**	**90**	**73**	**21**	**1746**

PEAK HOUR
0800 - 0900



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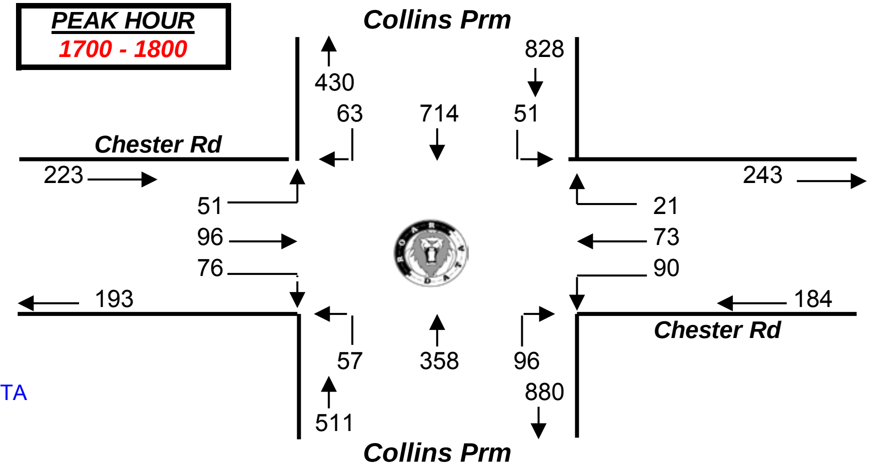
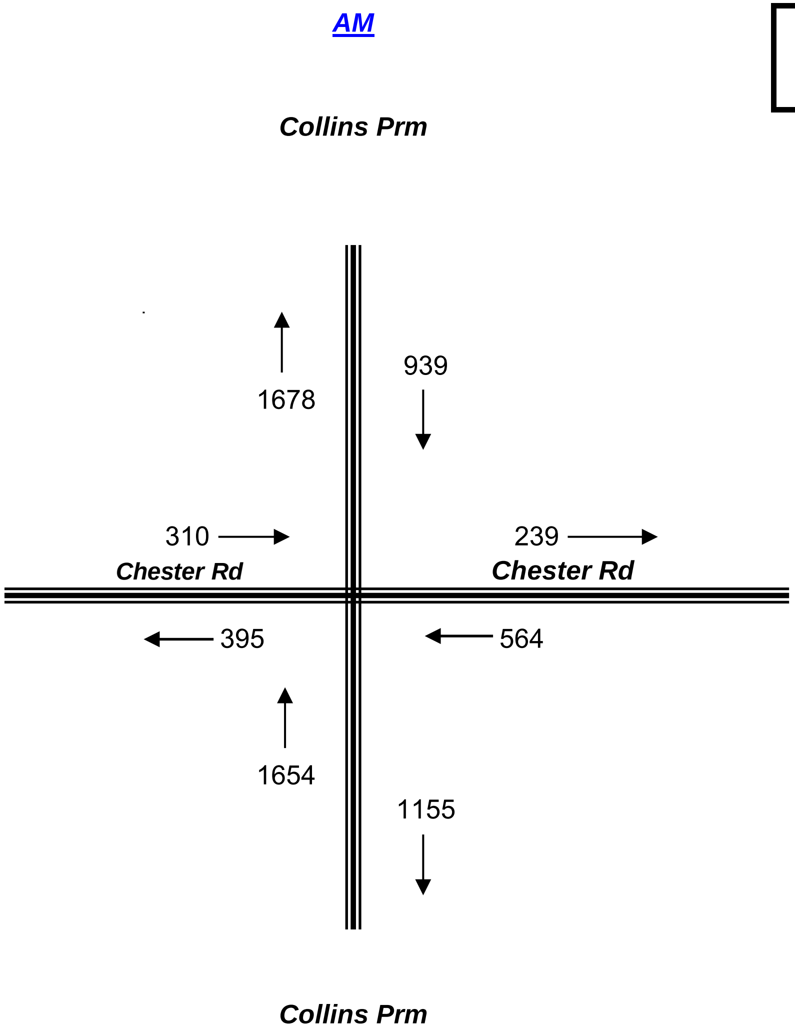
PEAK HOUR
1700 - 1800

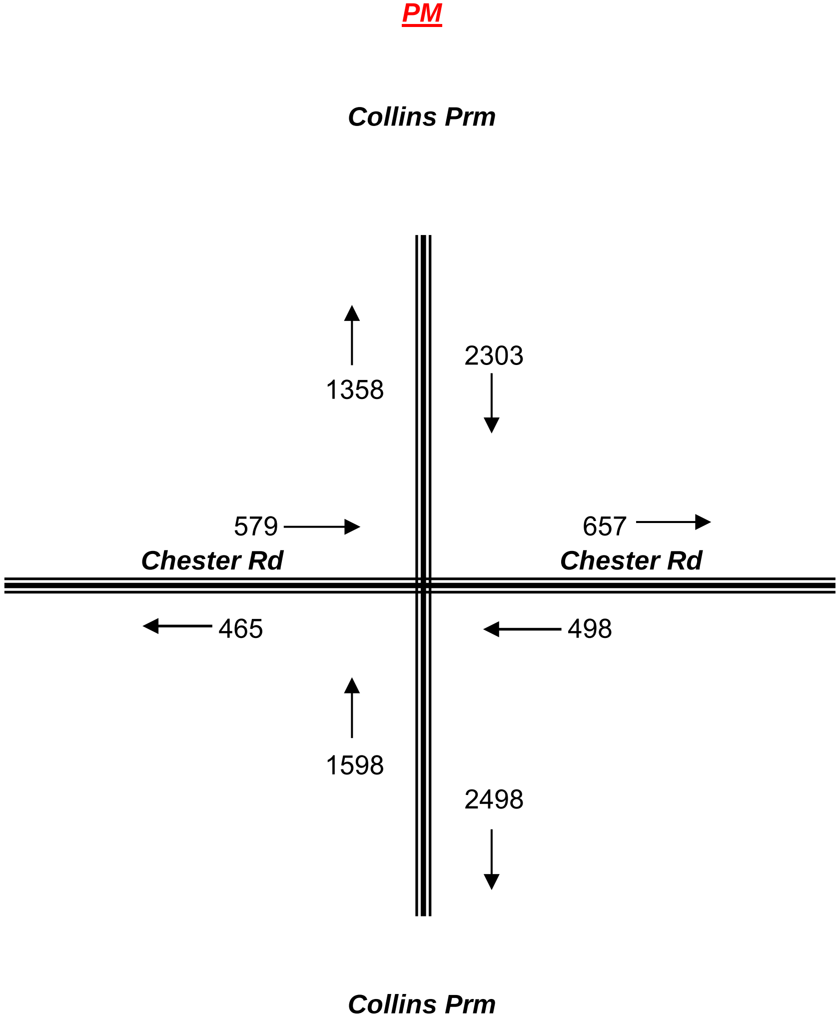


Client : Positive Traffic
Job No/Name : 5803 Ingleburn Oxford Rd Counts
Day/Date : Thursday 15th October 2015

TOTAL VOLUMES FOR COUNT PERIOD

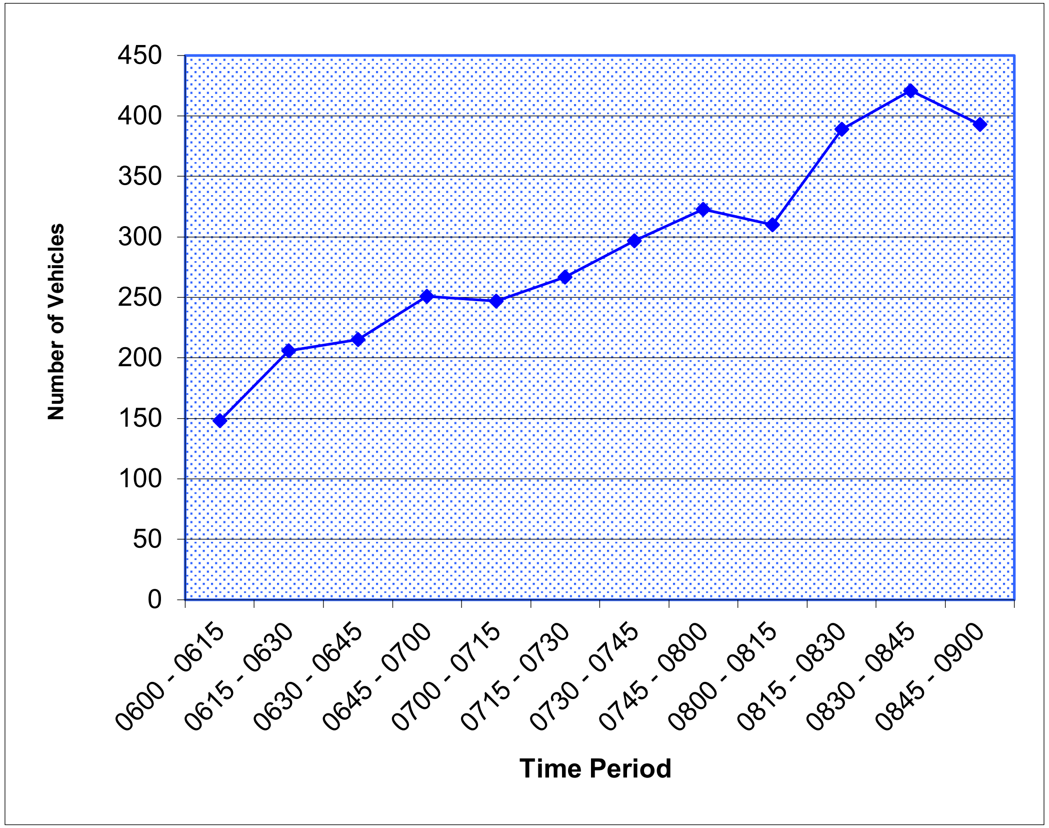
N

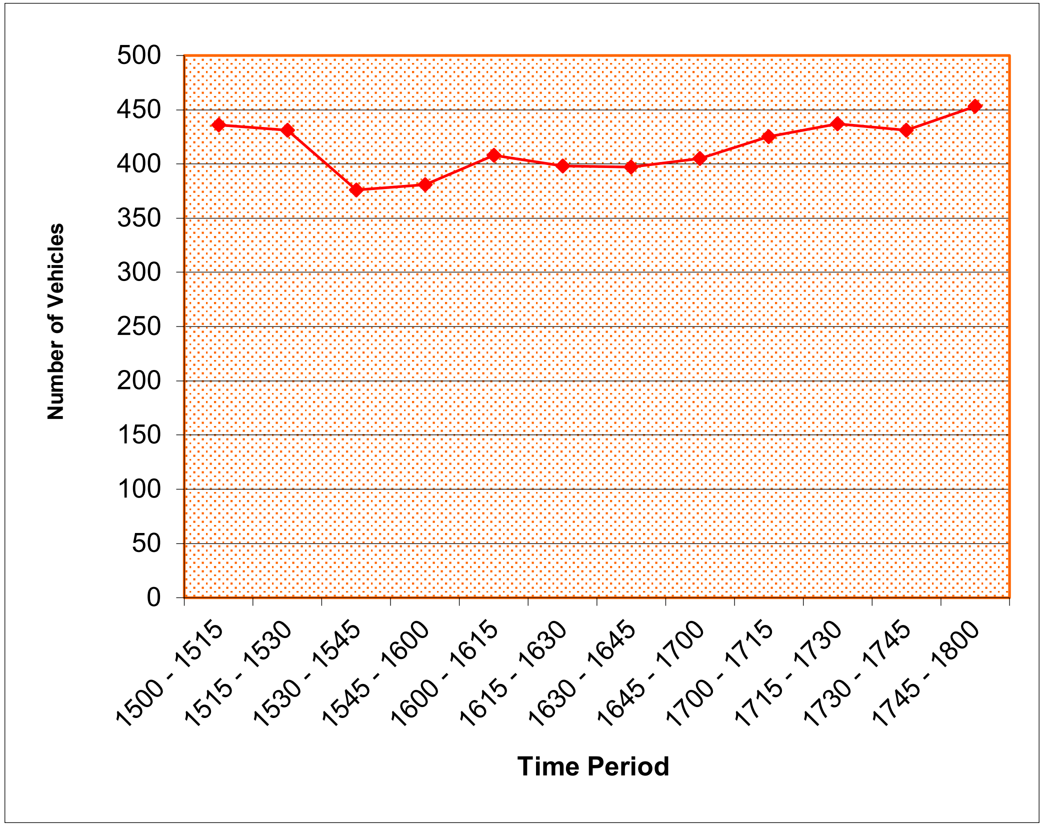




_AM_ **_PM_**

Chester Rd & Collins Prm





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Client : Positive Traffic
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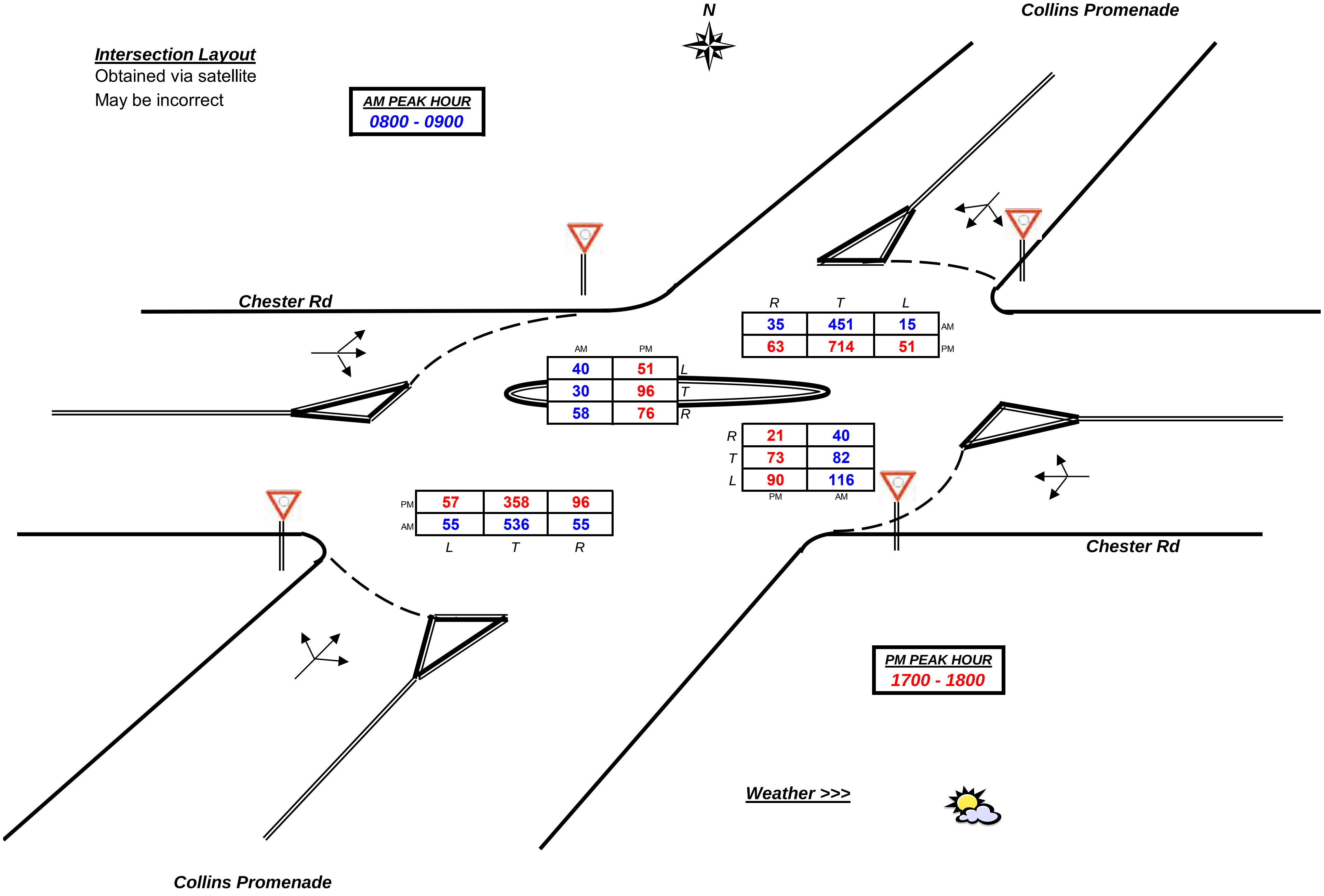
Day/Date : Thursday 15th October 2015

Intersection Layout
Obtained via satellite
May be incorrect

AM PEAK HOUR
0800 - 0900



Collins Promenade (north) approach:

	R	T	L
AM	35	451	15
PM	63	714	51

Chester Rd (west) approach:

	AM	PM
L	40	51
T	30	96
R	58	76

Chester Rd (east) approach:

	PM	AM
R	21	40
T	73	82
L	90	116

Collins Promenade (south) approach:

	L	T	R
PM	57	358	96
AM	55	536	55

PM PEAK HOUR
1700 - 1800

Weather >>> ☀

Oxford Rd & Collins Prm

To

Dean Brodie

at **Positive Traffic**

your results for

Ingleburn - Oxford Rd Counts

supplied by

R.O.A.R. DATA Pty. Ltd.

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Client : Positive Traffic
Job No/Name : 5803 Ingleburn Oxford Rd Counts
Day/Date : Thursday 15th October 2015

All Vehicles	NORTH			WEST			SOUTH			EAST			
	Harold St			Oxford Rd			Collins Prm			Oxford Rd			
Time Per	L	T	R	L	T	R	L	T	R	L	T	R	TOT
0600 - 0615	1	19	0	9	0	2	2	87	3	1	9	21	**154**
0615 - 0630	3	37	1	7	2	2	2	124	2	3	10	19	**212**
0630 - 0645	5	44	9	9	3	4	1	119	2	6	12	26	**240**
0645 - 0700	4	53	4	7	7	6	6	128	3	3	12	31	**264**
0700 - 0715	6	47	3	5	6	5	4	134	6	6	12	34	**268**
0715 - 0730	7	46	1	6	8	5	4	116	1	4	23	29	**250**
0730 - 0745	8	61	0	8	10	5	5	138	4	6	23	29	**297**
0745 - 0800	5	61	5	12	11	8	14	140	5	6	21	32	**320**
0800 - 0815	12	68	6	12	8	10	17	143	3	10	26	32	**347**
0815 - 0830	10	102	11	6	10	15	38	147	2	23	19	19	**402**
0830 - 0845	11	122	19	26	14	26	46	145	3	10	55	29	**506**
0845 - 0900	7	89	14	18	15	23	18	129	3	14	32	17	**379**
Period End	**79**	**749**	**73**	**125**	**94**	**111**	**157**	**1550**	**37**	**92**	**254**	**318**	**3639**

All Vehicles	NORTH			WEST			SOUTH			EAST			
	Harold St			Oxford Rd			Collins Prm			Oxford Rd			
Time Per	L	T	R	L	T	R	L	T	R	L	T	R	TOT
1500 - 1515	19	150	19	32	41	49	20	103	3	8	12	5	**461**
1515 - 1530	15	162	9	17	16	15	16	114	5	9	9	16	**403**
1530 - 1545	30	173	10	7	11	14	20	101	6	12	12	14	**410**
1545 - 1600	28	135	6	5	7	14	15	100	5	5	12	8	**340**
1600 - 1615	25	199	9	5	19	8	8	90	10	7	8	8	**396**
1615 - 1630	26	178	16	7	21	18	14	95	5	14	9	12	**415**
1630 - 1645	32	185	16	10	23	9	13	84	8	7	11	10	**408**
1645 - 1700	34	162	6	8	14	20	9	96	8	7	14	16	**394**
1700 - 1715	27	163	10	6	19	8	11	100	10	10	18	14	**396**
1715 - 1730	37	192	12	5	14	14	8	115	11	6	14	17	**445**
1730 - 1745	36	177	5	5	25	18	13	86	5	10	20	14	**414**
1745 - 1800	19	235	10	8	24	11	11	99	5	8	17	12	**459**
Period End	**328**	**2111**	**128**	**115**	**234**	**198**	**158**	**1183**	**81**	**103**	**156**	**146**	**4941**

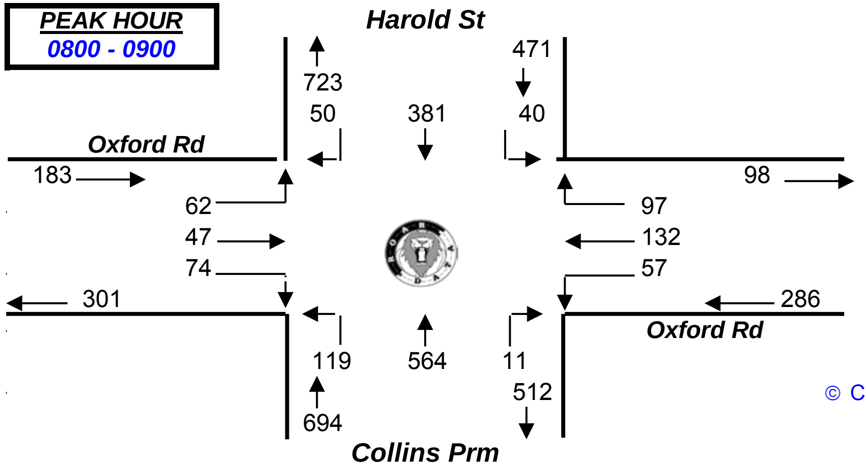
	NORTH			WEST			SOUTH			EAST			
	Harold St			Oxford Rd			Collins Prm			Oxford Rd			
Peak Time	L	T	R	L	T	R	L	T	R	L	T	R	TOT
0600 - 0700	13	153	14	32	12	14	11	458	10	13	43	97	**870**
0615 - 0715	18	181	17	28	18	17	13	505	13	18	46	110	**984**
0630 - 0730	22	190	17	27	24	20	15	497	12	19	59	120	**1022**
0645 - 0745	25	207	8	26	31	21	19	516	14	19	70	123	**1079**
0700 - 0800	26	215	9	31	35	23	27	528	16	22	79	124	**1135**
0715 - 0815	32	236	12	38	37	28	40	537	13	26	93	122	**1214**
0730 - 0830	35	292	22	38	39	38	74	568	14	45	89	112	**1366**
0745 - 0845	38	353	41	56	43	59	115	575	13	49	121	112	**1575**
0800 - 0900	40	381	50	62	47	74	119	564	11	57	132	97	**1634**

	NORTH			WEST			SOUTH			EAST			
	Harold St			Oxford Rd			Collins Prm			Oxford Rd			
Peak Time	L	T	R	L	T	R	L	T	R	L	T	R	TOT
1500 - 1600	92	620	44	61	75	92	71	418	19	34	45	43	**1614**
1515 - 1615	98	669	34	34	53	51	59	405	26	33	41	46	**1549**
1530 - 1630	109	685	41	24	58	54	57	386	26	38	41	42	**1561**
1545 - 1645	111	697	47	27	70	49	50	369	28	33	40	38	**1559**
1600 - 1700	117	724	47	30	77	55	44	365	31	35	42	46	**1613**
1615 - 1715	119	688	48	31	77	55	47	375	31	38	52	52	**1613**
1630 - 1730	130	702	44	29	70	51	41	395	37	30	57	57	**1643**
1645 - 1745	134	694	33	24	72	60	41	397	34	33	66	61	**1649**
1700 - 1800	119	767	37	24	82	51	43	400	31	34	69	57	**1714**

PEAK HOUR	**40**	**381**	**50**	**62**	**47**	**74**	**119**	**564**	**11**	**57**	**132**	**97**	**1634**

PEAK HOUR	**119**	**767**	**37**	**24**	**82**	**51**	**43**	**400**	**31**	**34**	**69**	**57**	**1714**

PEAK HOUR
0800 - 0900



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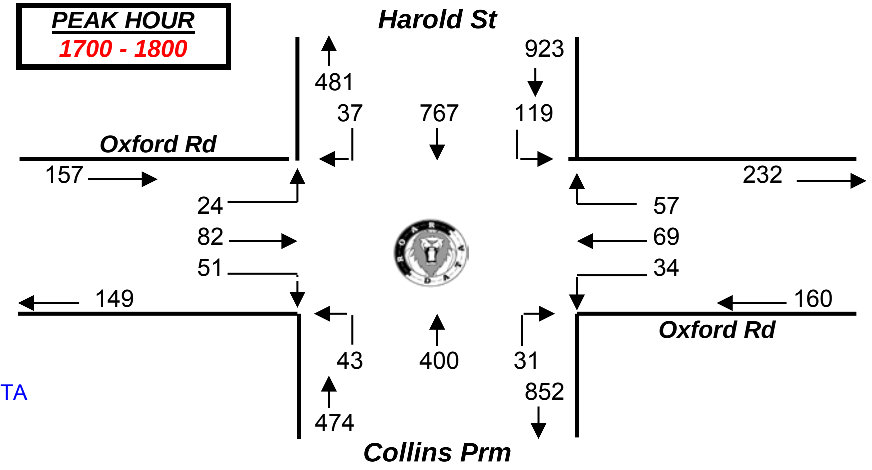
PEAK HOUR
1700 - 1800



R.O.A.R DATA
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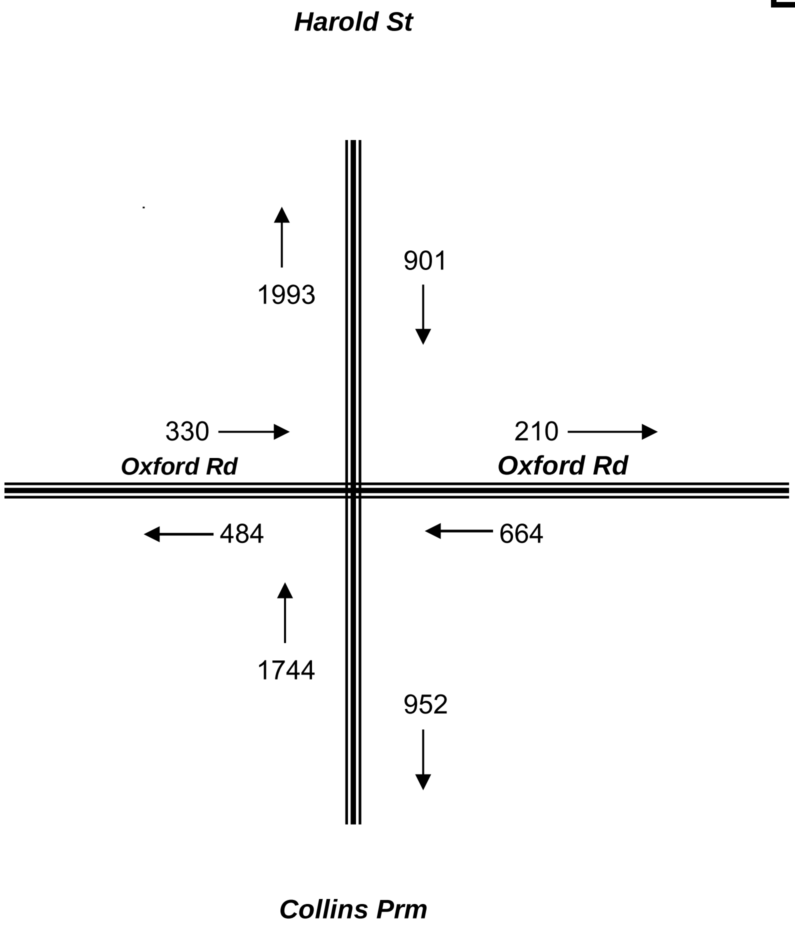
Day/Date : Thursday 15th October 2015

TOTAL VOLUMES FOR COUNT PERIOD

AM



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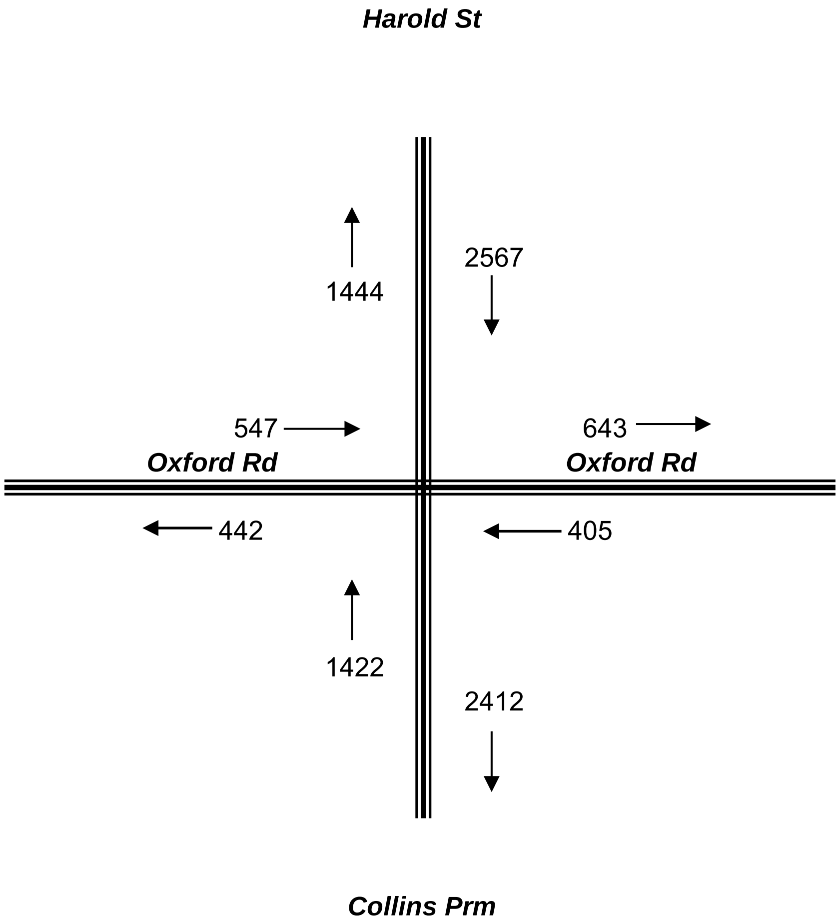
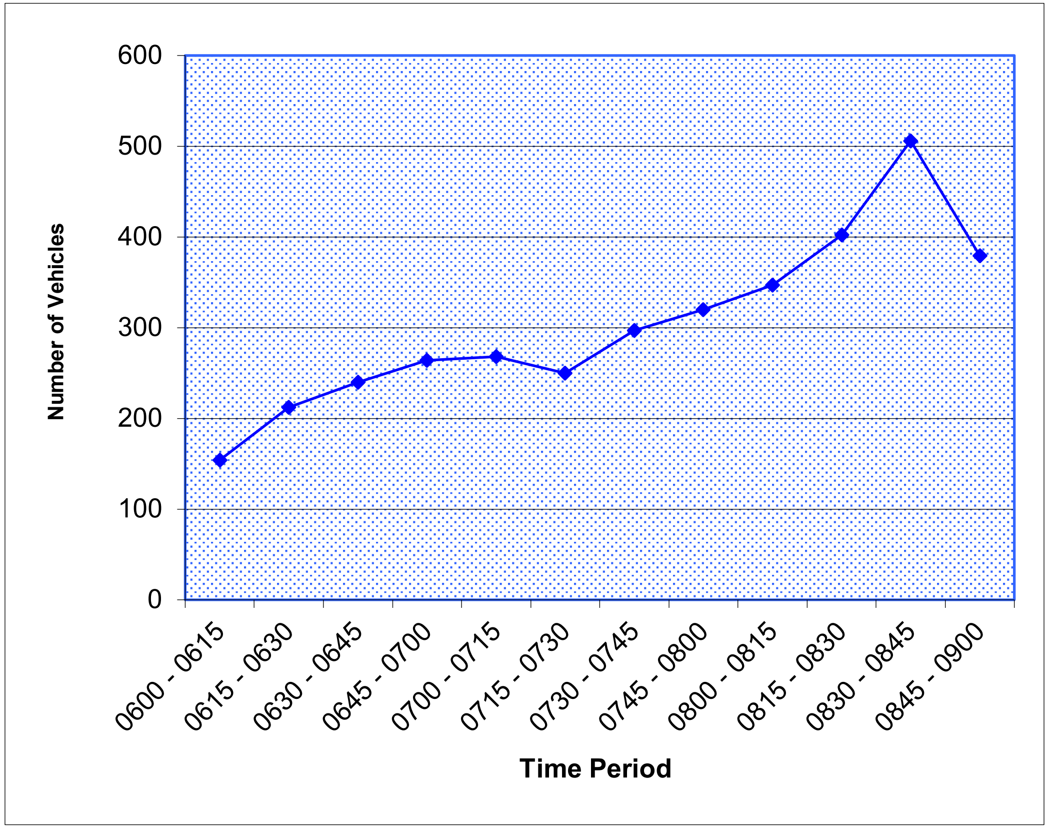
PM

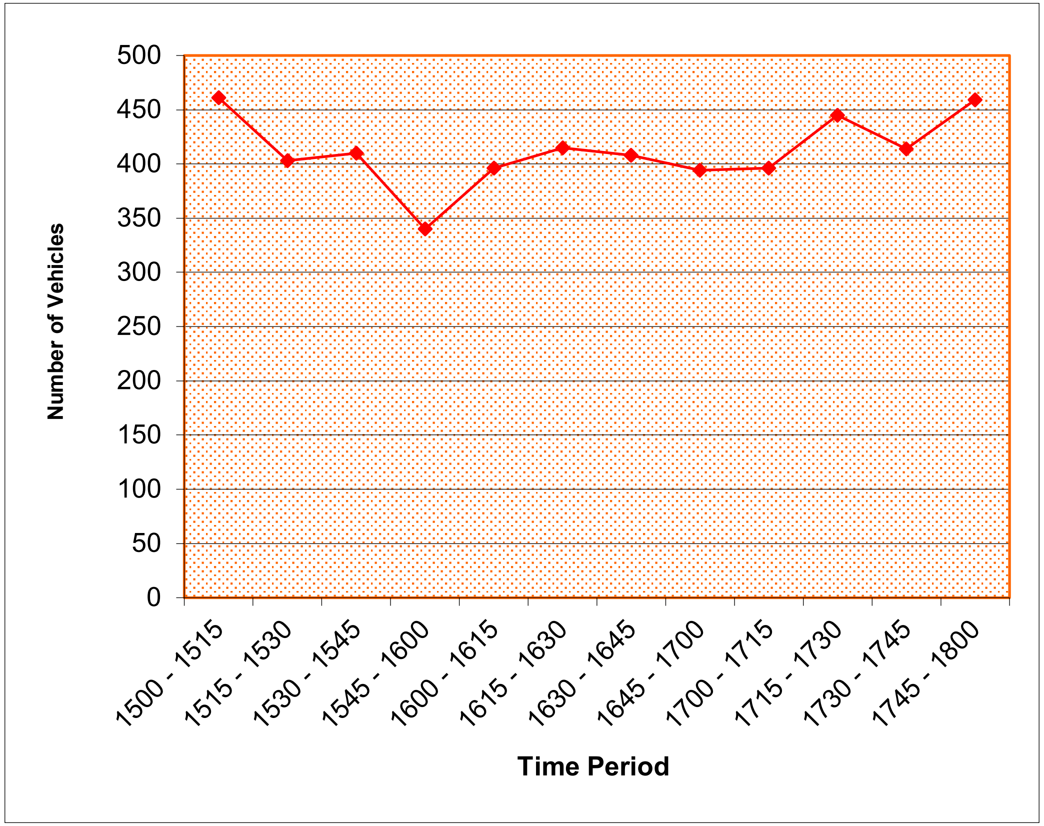


Client : Positive Traffic
Job No/Name : 5803 Ingleburn Oxford Rd Counts
Day/Date : Thursday 15th October 2015

AM **PM**

Oxford Rd & Collins Prm





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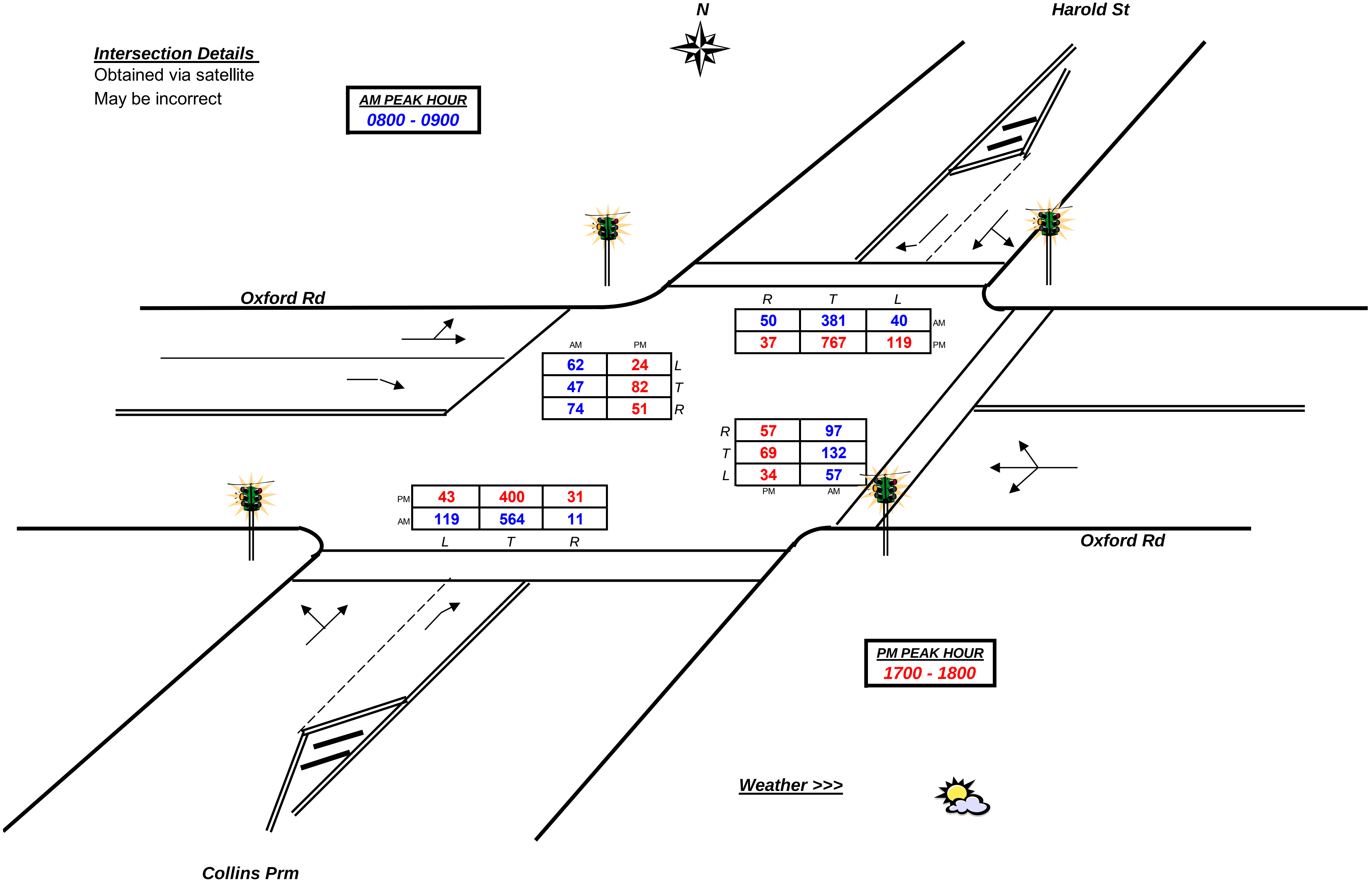
Client : Positive Traffic
Job No/Name : 5803 Ingleburn Oxford Rd Counts
Day/Date : Thursday 15th October 2015

Intersection Details
Obtained via satellite
May be incorrect

AM PEAK HOUR
0800 - 0900



	R	T	L	
	50	381	40	AM
	37	767	119	PM

AM	PM	
62	24	L
47	82	T
74	51	R

R	57	97
T	69	132
L	34	57
	PM	AM

PM	43	400	31
AM	119	564	11
	L	T	R

PM PEAK HOUR
1700 - 1800

Weather >>>

8. Appendix B Plans of Proposed Sub Division

DESIGN NOTES

1. Sandstone cottage retained with appropriate curtilage.
2. Mercedes Road entry with pocket parks and marker tree.
3. Bensley Road frontage renewed with bioswale and native tree planting to reinforce local "rural verge" character.
4. Existing Bunya Pine potential as a historic marker.
5. Minor Streets identified with medium size native trees
6. Bensley Park. Existing trees retained with open grassed areas for recreation.
7. Existing residence retained.
8. Caledonia Woodland. Existing Cumberland Plain Woodland retained as site feature.
9. Proposed Georges River Parkway with existing trees retained to reinforce of "rural verge" character.
10. "Rural verge" character to Oxford Road is retained and reparied with additional native tree planting.
11. Potential vehicular entry is an extension of the existing road network.
12. Main road access identified with wider verge and large native canopy trees

Saturday Studio **Urban Futures** TaylorBrammer

CALEDONIA

SK00 MASTER PLAN
09/12/2015 D 1:1000@A1

N

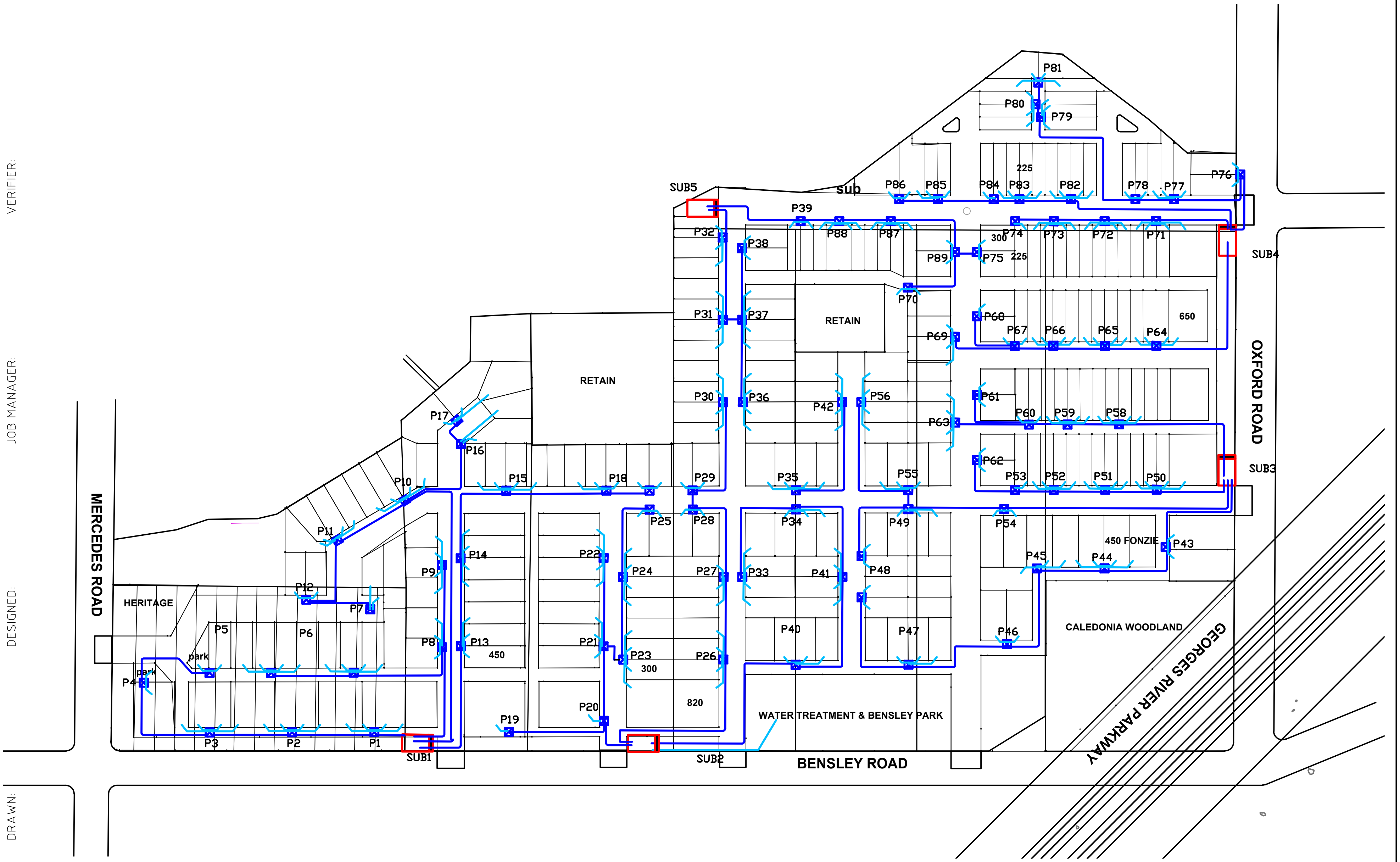
APPENDIX 4
Concept Electrical Infrastructure

VERIFIER:

JOB MANAGER:

DESIGNED:

DRAWN:



REV	DESCRIPTION	ISSUED	VER'D	APP'D	DATE
					08/12/15

NORTHROP

CLIENT Billbergia Development Team

PROJECT

Caledonia Subdivision

DRAWING TITLE

Electrical supply

JOB NUMBER

151459

DRAWING NUMBER

E01

REVISION

3

DRAWING SHEET SIZE = A3

APPENDIX 5

Electrical Infrastructure Calculations Report

NORTHROP
PO Box H171 Australia Square NSW 1215
T (02) 9241 4188 F (02) 9241 4324
E sydney@northrop.com.au

ELECTRICAL SERVICES INITIAL SITE POWER ASSESSMENT

Caledonia estate - Ingleburn

PREPARED BY
Northrop Consulting Engineers

ACN 064 775 088
Level 11, 345 George St
SYDNEY NSW 2000

Tel: 02 9241 4188
Fax: 02 9241 4324

Ref: S141296

PREPARED FOR
Billbergia, C/-
URBANFutures
Grahame Edwards
20 Alfred Street
Rozelle NSW 2039

Tel: 02 9276 1400

ELECTRICAL SERVICES SPECIFICATION

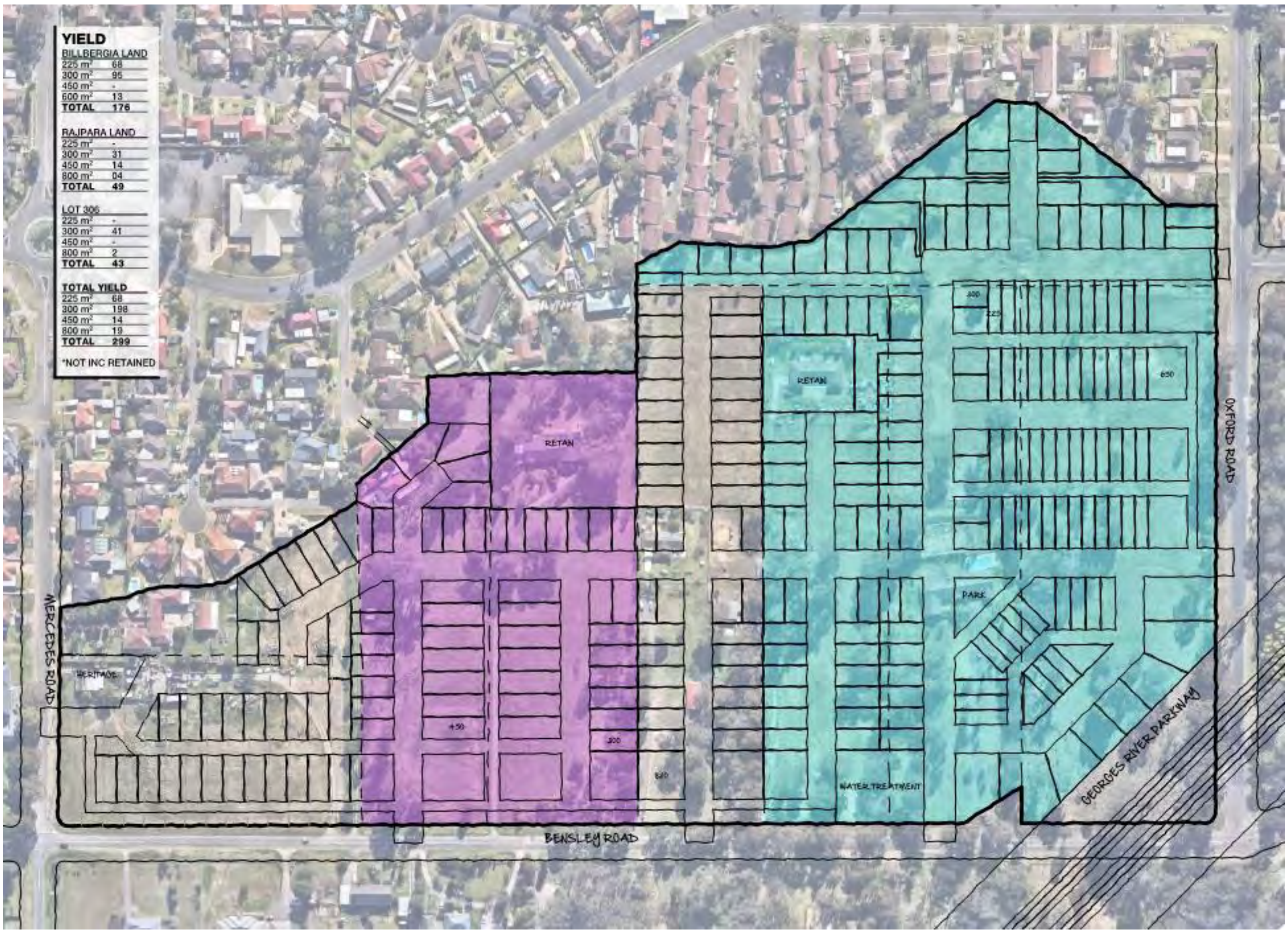
Activity schedule

Date	Revision	Issue	Initial
21.09.14	A	Preliminary Issue	SB

1 INTRODUCTION

Northrop Engineers have been engaged to provide services for the demand of power for a new development known as Caledonia on Bensley Road, Ingleburn.

This Preliminary document provides the maximum demand calculation based on AS/NZS: 3000 which would be required for the 250 residential home developments. This preliminary assessment does not include the costs for any services that cross the site that are required to be relocated for the development to go ahead.



2 ELECTRICAL SERVICES

2.1 Maximum Demand Calculations

The anticipated maximum demand is approximately 2431 Amps with an additional 243 Amps for future allowance. Therefore, the maximum demand including the spare capacity is 2674 Amps in total. The proposed development maximum demand is based on AS/NZS 3000:2007.

Edge Lands, Ingleburn				
AREA	**Blocks**	**VA**	**KVA**	**TOTAL Amps**
Land				
250 Houses	250	7000	1750	2431
Total			**1750**	**2431**
				10%
FINAL LOAD				**2674**

2.2 Substation

The most cost effective and flexible solution for providing power of this magnitude to the site would be via pad mounted kiosk substations. There will be 5 off substation required to feed this development. These kiosks will provide power to pillars which in turn will supply houses.

The substation will have four distributors dedicated to provide power to pillars which will be connected in series and/or parallel configuration supplying up to 4 houses. The substation needs to be located strategically to optimize the cost effective solution while keeping in mind the sensitivity towards the aesthetics of such pieces of equipment.

The following key points should be noted as they relate to the substation:

Pad mount Substations;

- The substation must locate inside of the property boundary not on the footpath, dimensions of the easement are 5500 (W) x 2750 (D). Additionally, a 2000 (W) easement is required from the site boundary to the kiosk substation for HV cabling and 24hr, 7 day a week unimpeded 27 ton truck access with dimensions 4000 (W) x 4000 (H).

The kiosk must not be located within;

- 1:100 flood level or in stormwater paths
- 10000 of an external fire hydrant/fire pumps etc
- 6000 of any ventilation opening
- 3000 of any part of a building unless it is 120/120/120 FRL & 2000kPa blast
- 3000 from site boundary unless provided with 120/120/120 FRL & 2000kPa blast wall
- 3000 of any glazing and fire exits
- 5000 to water tanks
- 10000 of a Telstra pit (dependant on equipment within pit)

- 20000 of 132kV structures
- Underneath aerial 22kV

2.3 Preliminary Budget Estimate

2.3.1 Substation

Referring to the preliminary details provided by Endeavour Energy, we have assessed the cost of the substation to be the following:

Substation Preliminary Budget Estimate

Detail	**Costs**	**Total**
5 x Pad Mount Kiosk Substations	$200,000	$1,000,000
HV Cabling (approximately 500m)	$1,000/m	$500,000
LV Cabling (approximately 4300m)	$500/m	$2,150,000
Low voltage Pillars x 90	$3,000	$270,000
Additional HV costs due to the substation location being unknown (50m)-	$1500/m	$0
Total		**$3,920,000**
Miscellaneous	20%	
Excluding Street lights and Street lighting reticulation		
Total Costs		**$4,704,000**

2.3.2 Electrical Services

The preliminary budget estimate for internal and external electrical services are as follows:

Qualifications

1. Under infrastructure
    1. We have included following.
        - Cabling from Substation to LV pillars
        - Trenching associated with the LV pillars.
        - Other miscellaneous work related to power supply connection and electrical infrastructure development.
    2. We have not included the following.
        - Testing and commissioning.
          Allow a PC sum of $5600 for testing and commissioning ($3600 for switching fees and $2000 for other)
        - Fuses installation at low voltage switch board at the sub-station.
          (Allow a PC sum of $3000. ($500 per each fuse plus labour)

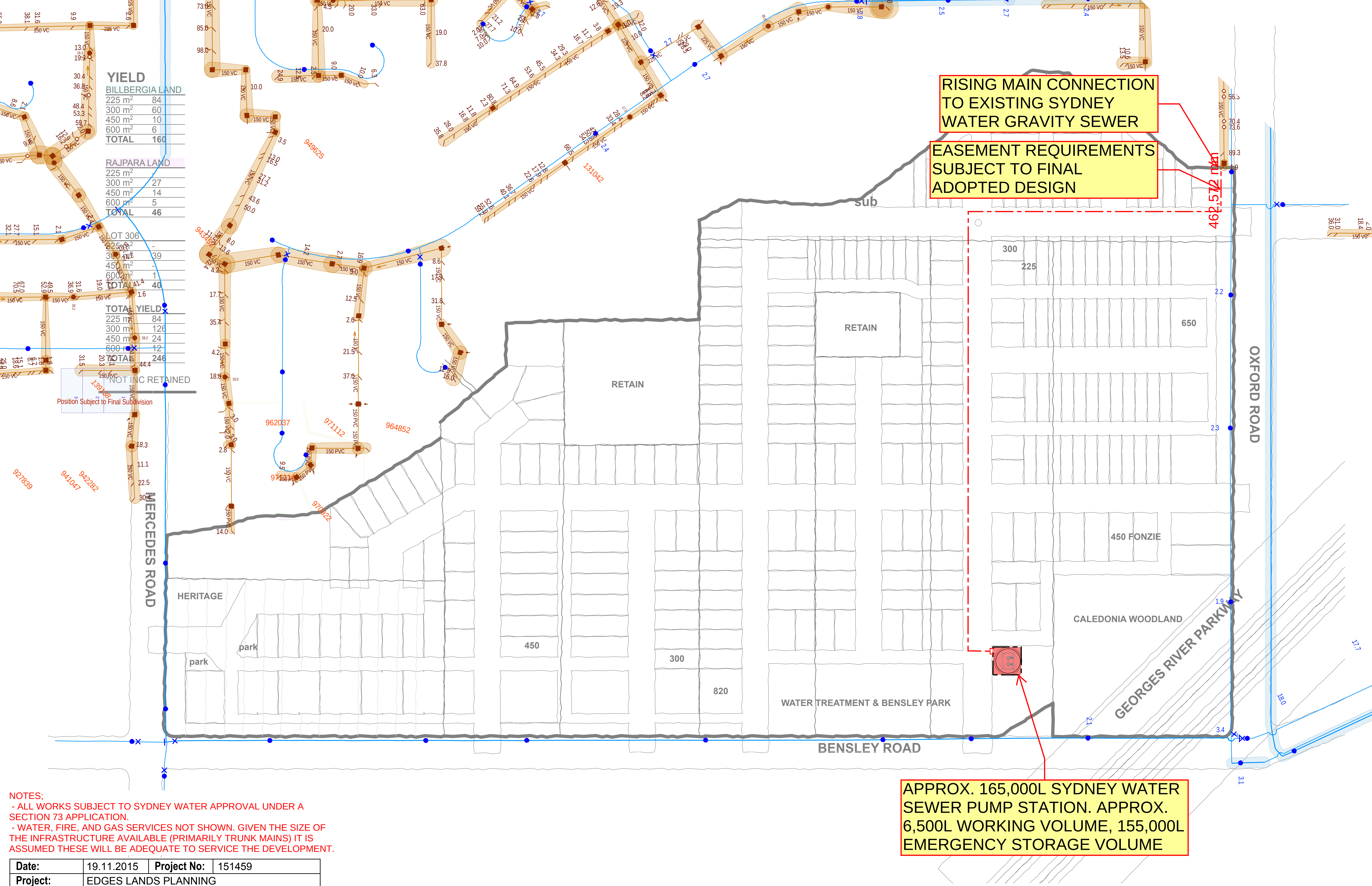
3 TELECOMMUNICATIONS SERVICES

The site will require NBN fibre network. A formal application has been lodged on NBN Co website. Investigations were done over the phone with Telstra and NBN. The below costs were derived based on the costs provided on the fact sheet provided by NBN. Currently, Ingleburn is not NBN fibre-ready and will require backhaul possibly from Campbelltown CBD. The total costs for bringing NBN into site are as follows:

Description			
	Blocks	**Costs/house**	**Total Costs**
Land			
Cost of NBN per development (Includes for Back haul, Construction and Deployment Contribution (SDU))	250	$1500	$375000
Contingency Costs			10%
FINAL LOAD			**412,500**

Please note these are indicative costs only and can change based on the formal response from NBN co.

APPENDIX 6
Sewer Concept and Water Infrastructure Drawing



YIELD

BILLBERGIA LAND	
225 m²	84
300 m²	60
450 m²	10
600 m²	6
TOTAL	**160**

RAJPARA LAND	
225 m²	-
300 m²	27
450 m²	14
600 m²	5
TOTAL	**46**

LOT 306	
225 m²	-
300 m²	39
450 m²	-
600 m²	1
TOTAL	**40**

TOTAL YIELD	
225 m²	84
300 m²	126
450 m²	24
600 m²	12
TOTAL	**246**

*NOT INC RETAINED

RISING MAIN CONNECTION TO EXISTING SYDNEY WATER GRAVITY SEWER

EASEMENT REQUIREMENTS SUBJECT TO FINAL ADOPTED DESIGN

APPROX. 165,000L SYDNEY WATER SEWER PUMP STATION. APPROX. 6,500L WORKING VOLUME, 155,000L EMERGENCY STORAGE VOLUME

NOTES;
- ALL WORKS SUBJECT TO SYDNEY WATER APPROVAL UNDER A SECTION 73 APPLICATION.
- WATER, FIRE, AND GAS SERVICES NOT SHOWN. GIVEN THE SIZE OF THE INFRASTRUCTURE AVAILABLE (PRIMARILY TRUNK MAINS) IT IS ASSUMED THESE WILL BE ADEQUATE TO SERVICE THE DEVELOPMENT.

Date:	19.11.2015	**Project No:**	151459
Project:	EDGES LANDS PLANNING		
Title:	SEWER SERVICING CONCEPT		
Drawing No:	HSK-01	**Revision:**	2
Drawn:	SM	**Scale:**	1:2000 @ A1

NORTHROP

TaylorBrammer

CALEDONIA

02 SITE CLEAN
16/11/15 F 1:2000@A3