Warren Smith & Partners

INFRASTRUCTURE SERVICES REPORT

MACARTHUR MEMORIAL PARK, VARROVILLE

SEPTEMBER 2015

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APPROVALS

A	Laura Shaughnessy *Civil Engineer*	M. Cahalane *Director of Civil & Water Engineering*
Rev	**Author**	**Reviewer**

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SCHEDULES

1. INTRODUCTION

Warren Smith and Partners (WS+P) has been engaged by the Catholic Metropolitan Cemetery Trust to undertake a services investigation of the infrastructure located in, and in close proximity, to the Macarthur Memorial Park development site. The site is located between Camden Valley Way and the Hume Highway, south of Saint James Road and encompasses several parcels of land known as Lot B, Lot 22 and Lot 1 on Saint Andrews Road, Varroville. Please refer to Figure 1 below for an aerial view of the precinct boundary.

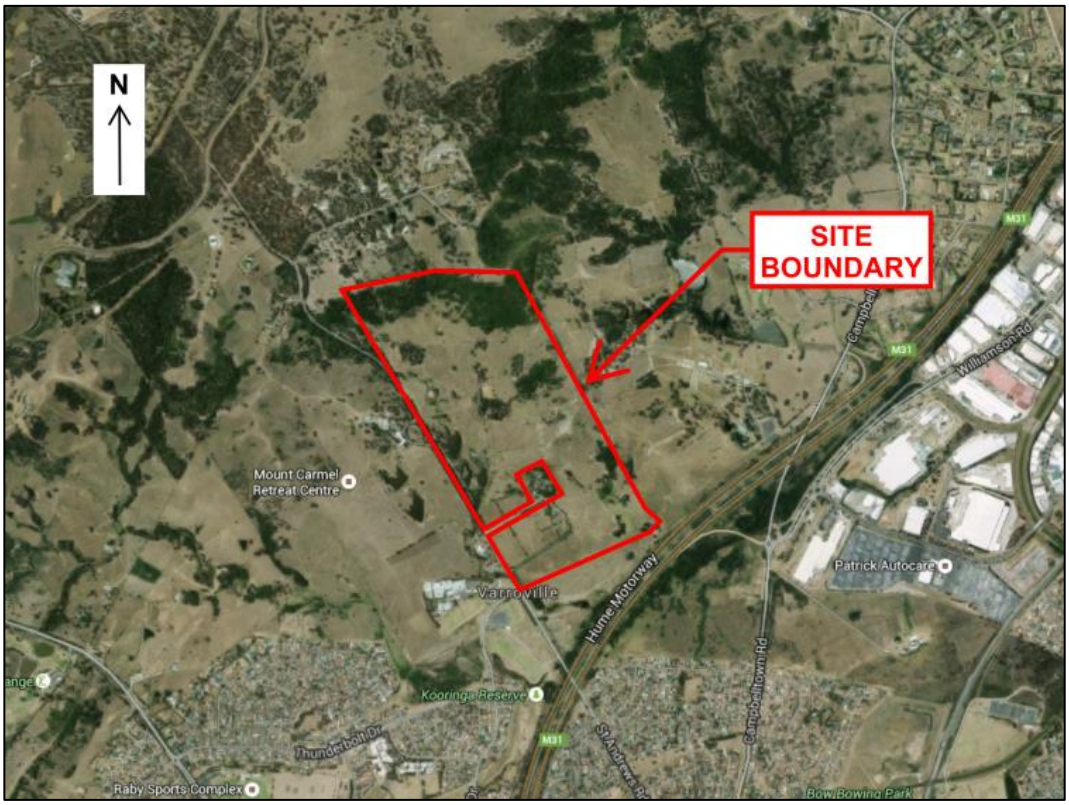


Figure 1: Aerial View of Site Boundary (Source: Google Map)

The purpose of the investigation is to ascertain what services will be affected by the proposed developments and to provide a recommendation on what works are required, if any, in terms of diversions. WS+P will also make recommendations on the required infrastructure extensions/amplifications that will need to be installed in order for the proposed buildings to be served by sewer and water.

The following tasks were undertaken in relation to gathering information for the purposes of the investigation:-

- Receipt and checking of the proposed development plan with the existing services drawings;
- 'Dial Before You Dig' services search, and;
- Report providing recommendation on the works required.

1.1 PROPOSED DEVELOPMENTS

The key proposed buildings to be constructed as part of the memorial park include the following:-

- A gatehouse information building near the cemetery entry;
- An office administration building to accommodate up to 10 staff members and consultation rooms;
- A multipurpose chapel building;
- Mortuary facilities;
- A café and flower shop;
- A function room, and;
- Vehicle shelter and administration facilities for ground staff.

Please refer to *Schedule 1* for details on the location of these buildings.

1.2 WATER SENSITIVE URBAN DESIGN

At these early stages of development it is important to consider water sensitive urban design (WSUD) principles and potentials for WSUD initiatives on site. This will ensure the developments will minimise the impacts on the urban water cycle including drinking water, wastewater stormwater and groundwater.

The following WSUD initiatives have been proposed in the Macarthur Memorial Mark Masterplan:-

- Lakes of a sustainable size and depth, to avoid potential for algal blooms;
- Vegetated swales for water treatment of road run-off where possible;
- Bio-retention swales for water treatment and flood mitigation;
- Wetland planting on lakes edge;
- Safe access to water's edge;
- Passive irrigation wherever possible;
- Investigation of the potential for water retention within the site's lakes for irrigation purposes, and;
- Minimisation of water usage in buildings with the use of rainwater tanks.

2. DATA COLLECTION

2.1 SYDNEY WATER HYDRA DATABASE DRAWINGS

WS+P has obtained Sydney Water's hydra database to assess the available Sydney Water water and sewer infrastructure traversing the development site.

Please find attached in Schedule 2, the following drawing:-

- Sydney Water Hydra plan at Scale 1 in 10,000 which shows the development site between Saint James Road and Hume Motorway.

The database has shown that two (2) Sydney Water water assets traverse the development site and one (1) runs along the southern section of Saint Andrews Road:-

- Two (2) DN600mm watermains, and;
- A DN375mm watermain.

The following Sydney Water sewer assets have also been identified in close proximity to the development site:-

- A DN750 main reticulating alongside the Hume Motorway and past the south west corner of the site.

Please refer to Figure 2 for details.

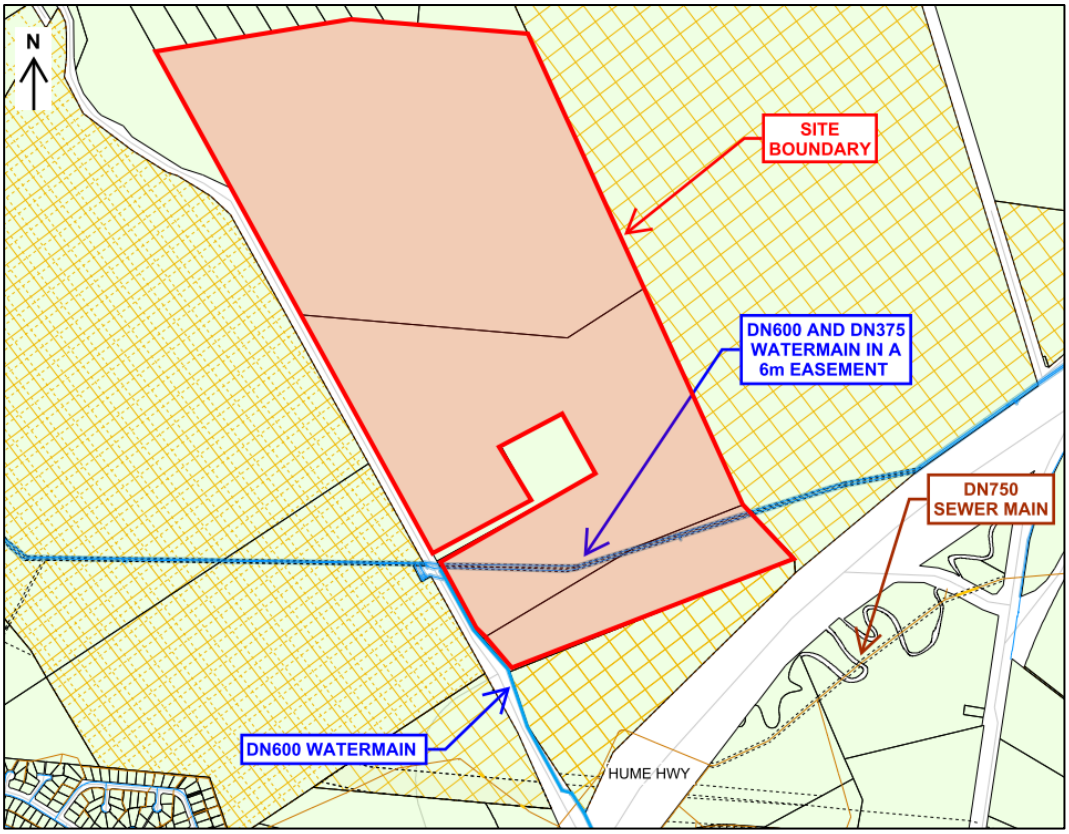


Figure 2: Sydney Water Asset Plan (Source: Sydney Water)

2.2 JEMENA GAS DIAGRAM

The Jemena diagrams received illustrates that there are no network mains traversing the site or running along the Hume Motorway, Saint James Road or Saint Andrews Road.

The following is a list of gas networks which run nearest to the development site as illustrated in Figure 3 and Figure 4 below:-

- A DN32mm high pressure 210kPa network main along Boomerang Crescent;
- A DN50mm high pressure 210kPa network main along Lochalsh Street;
- A DN32mm high pressure 210kPa network main along Lochalsh Street, and;
- A 7000kPa trunk pipeline running perpendicular to Saint Andrews Road, north of Saint James Road.

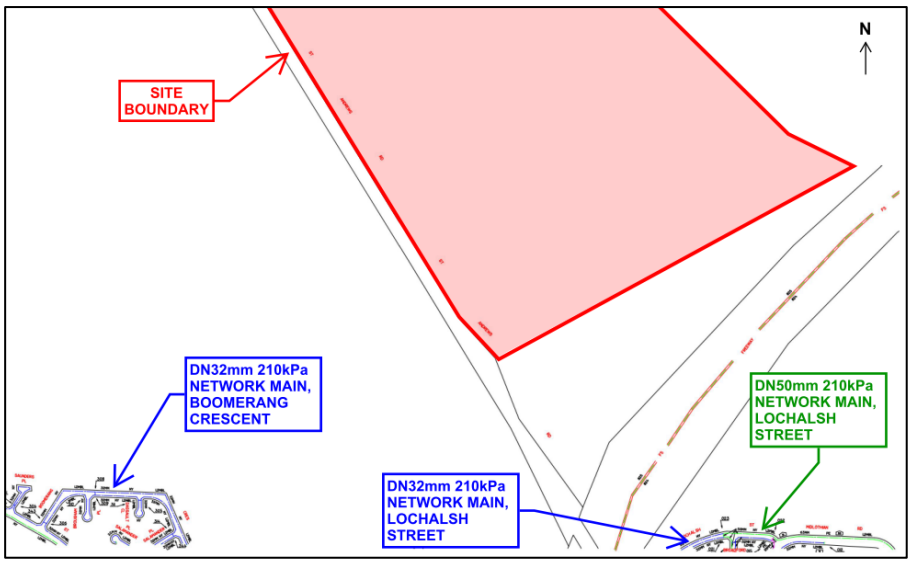


Figure 3: Jemena Asset Plan South (Source: Jemena Gas)

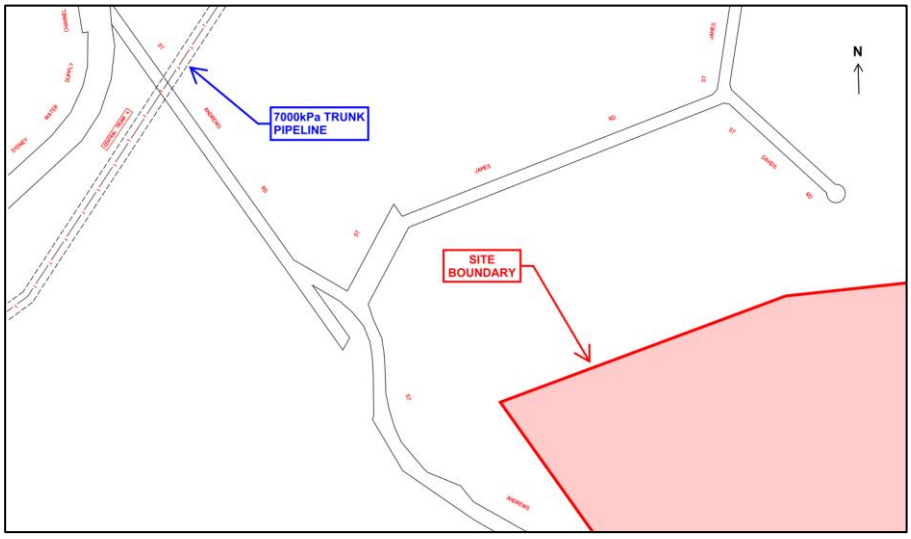


Figure 4: Jemena Asset Plan North (Source: Jemena Gas)

Please refer to *Schedule 3* for Jemena Gas Diagrams.

3. PROPOSED WORKS TO EXISTING SERVICES

3.1 SYDNEY WATER ASSETS

The Sydney Water Hydra plan has been assessed to determine the best possible option to service the proposed development. Please refer to Figure 5 below for an illustration of the development locations within the Hydra plan.

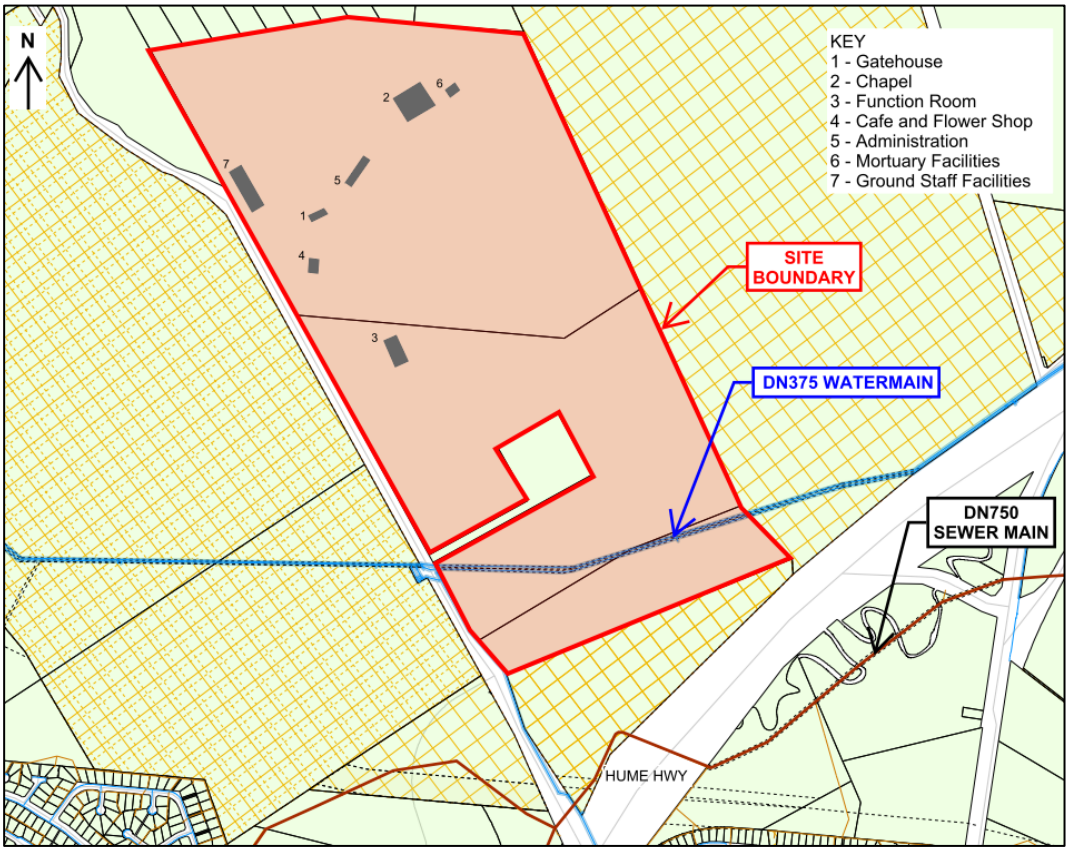


Figure 5: Development Location within the Hydra Plan (Source: Sydney Water)

A feasibility application has been made to Sydney Water in relation to obtaining direction for connecting the development to its water and sewer assets. It is expected to have a response from Sydney Water in late October/early November.

3.1.1 SYDNEY WATER WATERMAINS

In order to serve each of the new buildings, it is proposed that a new DN150 potable water main connection and hydrant service connection be constructed from the existing DN375mm watermain traversing the site. The proposed hydrant service connection will traverse in order to serve the newly proposed buildings. The total length of the proposed watermain connection will be approximately 2,150m

As the site currently has frontage to Sydney Water watermains, there is no requirement for the new service to be a Sydney Water asset and can be a private water service. Please refer to Figure 6 below for an illustration of the proposed watermain connection to the existing Sydney Water asset.

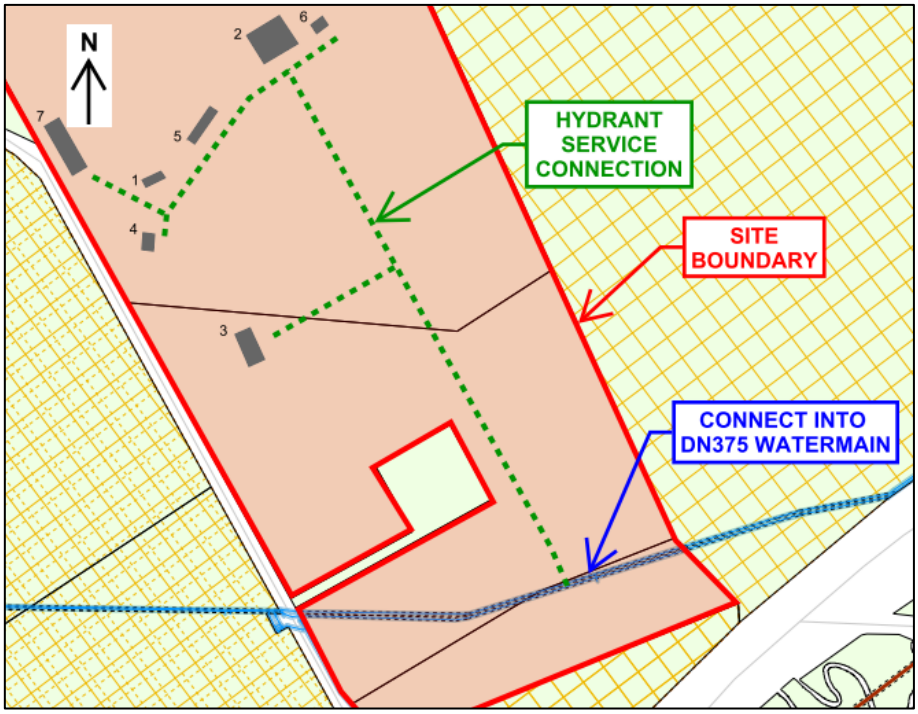


Figure 6: Proposed Watermain Connection to Existing Sydney Water Asset (Source: Sydney Water)

3.1.2 SYDNEY WATER SEWER MAINS

OPTION 1

In order to serve each of the new buildings, Option 1 proposes that the development site connects into the Sydney Water sewer main at the intersection of the Hume Highway and Saint Andrews Road. A new DN225 sewer line will run for approximately 1600m along Saint Andrews Road and into the site at a location in close proximity to the new building developments. It is proposed that a private sewer line will then serve each of the newly proposed buildings.

Please refer to Figure 7 below for an illustration of the proposed Option 1 sewer main connection to the existing Sydney Water asset.

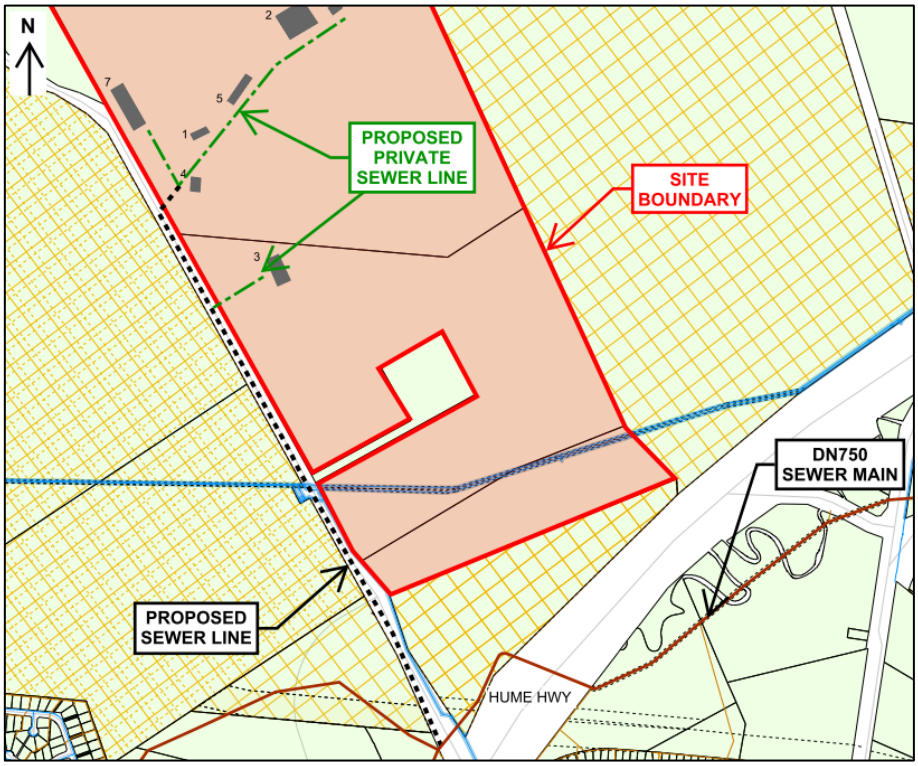


Figure 7: Proposed Option 1 Sewer Main Connection to Existing Sydney Water Asset (Source: Sydney Water)

It is recommended that the proposed Option 1 should only be considered if Sydney Water offers to provide funding for the Sydney Water sewer main extension in Saint Andrews Road.

OPTION 2

Option 2 proposes that the development site connects into the Sydney Water sewer main at the intersection of the Hume Highway and Saint Andrews Road. A new DN225 sewer line will run for approximately 900m along Saint Andrews Road and into the site on the south end. It is then required that a private sewer main be installed within the site from the proposed sewer line in Saint Andrews Road which would run through the development site to the newly proposed building at the north of the site

Please refer to Figure 8 below for an illustration of the proposed Option 2 sewer main connection to the existing Sydney Water asset.

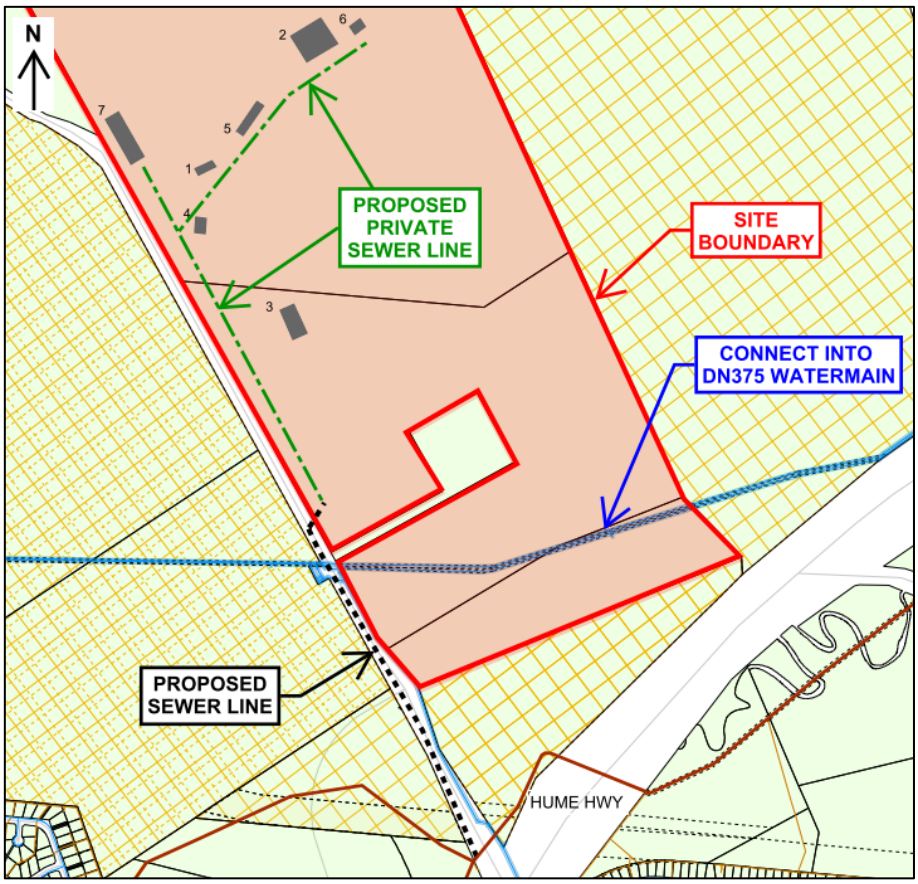


Figure 8: Proposed Watermain Connection to Existing Sydney Water Asset (Source: Sydney Water)

3.2 JEMENA GAS ASSETS

If gas is required, it is proposed that the site connect into the DN32mm high pressure 210kPa network main in Lochalsh Street. In order to connect into this service, a new line approximately 1km long will need to be run from the south end of the site along the Saint Andrews Road Bridge and into Lochalsh Street. It is also proposed that a private gas line will then traverse the site in order to serve the newly proposed building to the north of the site.

Please refer to Figure 9 for details. This asset has sufficient capacity to accommodate the developments should a natural gas service be required.

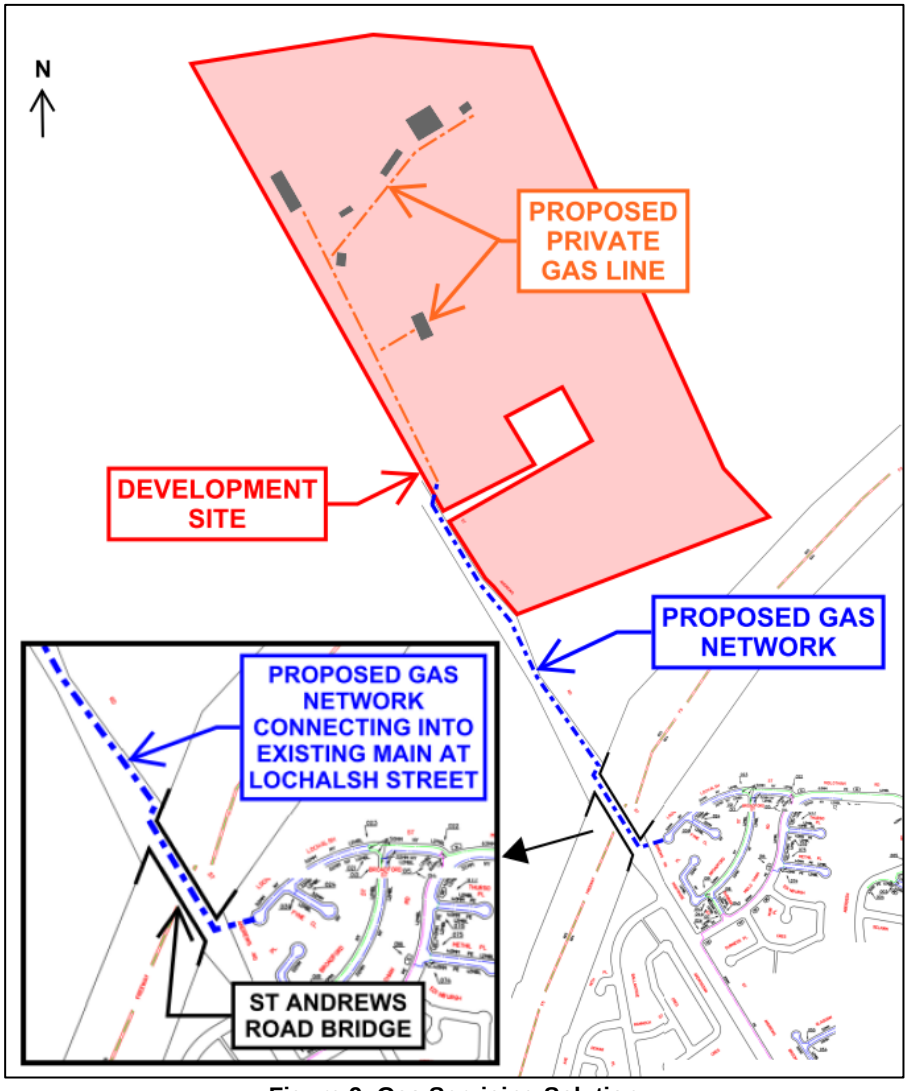


Figure 9: Gas Servicing Solution

3.3 STORMWATER ASSETS

The site stormwater infrastructure will be designed in accordance with Campbelltown DCP Volume 2, Engineering Design for Development. The DCP stormwater requirements include, but are not limited to, the following:-

- The combined piped and overland flow paths must be designed to accommodate the 1 in 100 year storm event;
- There will be a safe passage for the Probable Maximum Flood (PMF) event;
- Determining catchment areas and utilising the Glenfield district for IFD rainfall data, and;
- Incorporating WSUD principles to optimise the use of rainwater and minimise the amount of water transported out of the site catchment;

4. ON SITE WASTEWATER SERVICING

WS+P engaged Whitehead and Associates Environmental Consultants to prepare a costings review for on-site wastewater servicing options for Macarthur Memorial Park. The report recommends appropriate levels of wastewater treatment for on-site land application and indicative costs. The following is a summary of the main findings of the report:-

- The overall wastewater generation rate will be approximately 31,000 L/day and will be of a largely domestic nature. The majority of the waste will be produced by the Multi-function Chapel/training rooms.
- Two on-site wastewater treatment technologies have been recommended; an aerated wastewater treatment system or a recirculating media filter. Both these options have the ability to meet the standard of treatment required for effluent to be reused as subsurface irrigation.
- Effluent reuse as subsurface irrigation poses a low risk to visitors; however appropriate buffers between the treated effluent and existing bodies of water in the park will need to be maintained. Please refer to *Schedule 4* for buffer details.
- The development site consists of two main soil types:-
  - The Luddenham Soil Landscape making up approximately three quarters of the site, and;
  - The Blacktown Soil Landscape making up approximately one quarter. Please refer to Figure 10 below.

Figure 10: Soil Landscape (Source: Whitehead & Associates Environmental Consultants)

- Both soils have poor fertility and are inherently deficient in phosphorous, nitrogen and calcium. The treated effluent will provide a sustainable water supply for irrigation, whilst the nutrient content of the treated effluent will contribute to vegetation growth and reduce the requirement for additional fertilizer.
- In order to achieve sustainable management of the hydraulic and nutrient loads, as determined by the water and nutrient balances, minimum irrigation areas are required for each soil type.
  - Luddenham soil requires 17,600m² of irrigation area, and;
  - Blacktown soil requires 13,578m² of irrigation area. For Blacktown soil this area could be reduced to 11,350m² if the wastewater treatment system were to incorporate a phosphorous reduction measure. However, this would come at an additional cost.

- Irrigation areas can be located on either of the soil types or a combination of the two. If a combination of the two is preferred, the irrigation area requirement will be determined in proportion to the amount of irrigation on each soil type.
- The following is a table of the indicative capital and operating costs:-

	Capital Cost	Operating Cost Per Year $/Yr
Treatment Plant		
Aerated Treatment System	$265,000	$12,250
Recirculating Media Filter	$290,000	$6,690
Phosphorous Reduction	$5,000	$1,000
Land Application System		
Subsurface Irrigation	$68,100 - $105,600 ($6/m²)	$6,000

Please refer to *Schedule 4* for a copy of the report.

The capital cost of installing the treatment and irrigation system has been estimated at between $340,000 and $400,000 with operating costs below $20,000 per annum. In addition, design costs are estimated at $40,000.

The above costs do not allow for the requirement to empty the seepage storage tank in the event that the system is not capable of irrigating in prolonged periods of wet weather. The system typically possesses a one (1) week storage tank which would have a volume of 217kL. The costs of emptying the tank and discharging it to the Emu Plains seepage treatment plant is estimated at $30,000 per event.

5. PRELIMINARY CONSTRUCTION COSTS

Preliminary Construction Cost Estimate

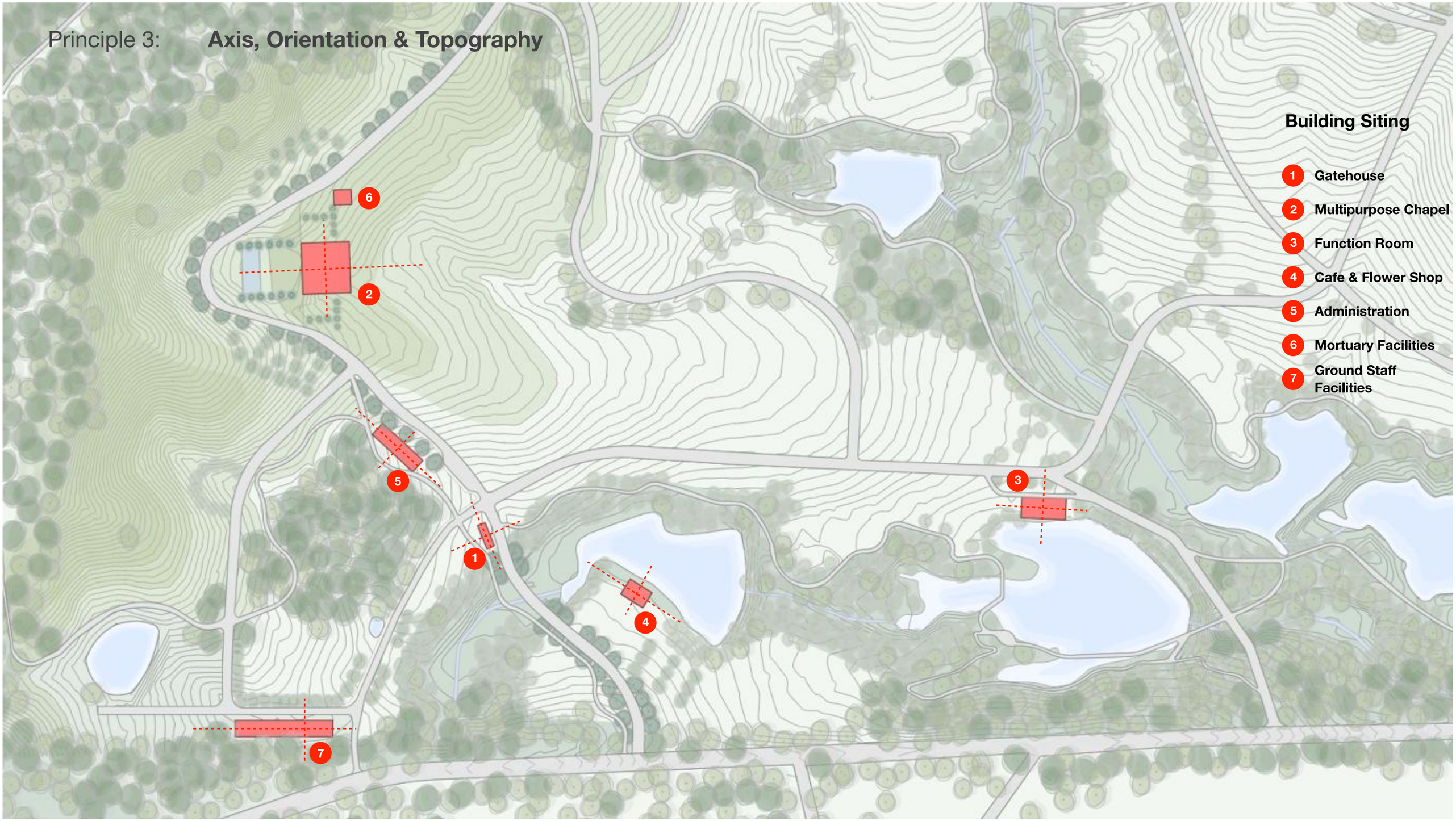
Description of Item	Unit	Quantity	Rate $	TOTAL $
WATER				
Watermain Connection & Private Hydrant Service	m	2,150	250	**537,500**
SEWER				
Option 1*				
Sydney Water Sewer Extension	m	1,600	1,200	1,920,000
Private Sewer Main	m	900	350	315,000
			Option 1 Total	2,235,000
Option 2				
Sydney Water Sewer Extension	m	900	1,200	1,080,000
Private Sewer Main	m	1,500	350	525,000
			Option 2 Total	**1,605,000**
Option 3				
On-site Wastewater Treatment Plant	Item	1	400,000	400,000
Private Sewer Main	m	1,100	350	385,000
			Option 3 Total	785,000
Option 3 Ongoing Maintenance Costs				
Operating Costs	Annum	1	20,000	20,000
Tank Pump Out Costs	Event	1	30,000	30,000
JEMENA GAS				
Jemena Gas Main Extension	m	1000	600	600,000
Jemena Gas Main Extension Crossing St Andrews Rd Bridge	Item	1	75,000	75,000
Private Gas Main	m	1,600	250	400,000
			Jemena Total	**1,075,000**
DESIGN	Item	1	90,000	**90,000**
			TOTAL	**$3,307,500**

Disclaimer: - This estimate has been prepared by Warren Smith & Partners Pty Ltd & forms our preliminary opinion. The final estimate should be provided for and certified by a Professional Quantity Surveyor.

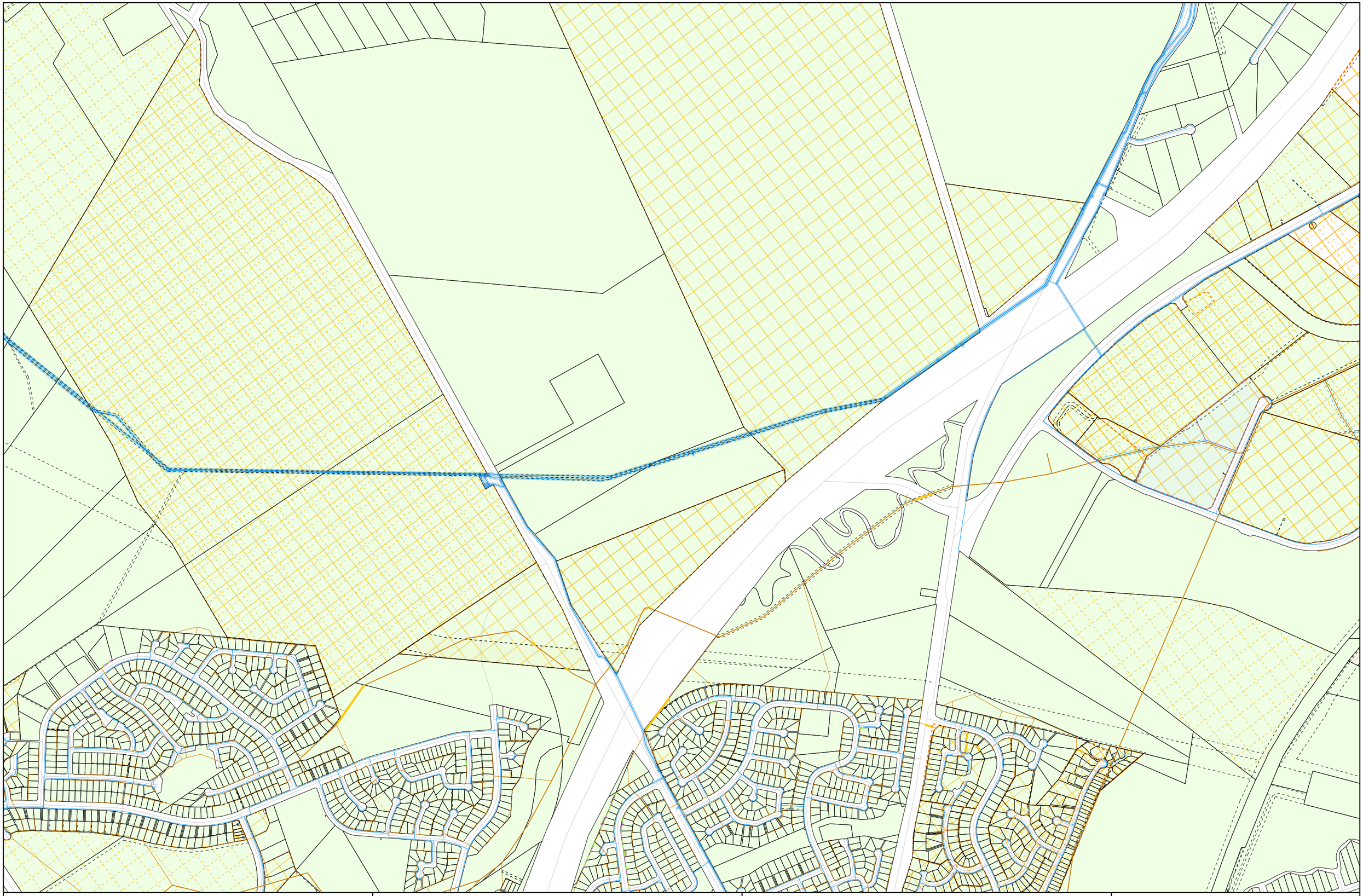
*Sewer Option 1 shall only be considered if Sydney Water offers to provide funding for the extension section.

SCHEDULE 1 BUILDING LOCATIONS

Principle 3: **Axis, Orientation & Topography**



SCHEDULE 2 SYDNEY WATER HYDRA PLAN



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Date of Production: 05/06/2015

SYDNEY WATER CORPORATION

Map:306 Grid:Q9 Edition:Sydney UBD Edition 41

0m 80m 160m 240m 320m 400m

Scale 1:10000

Page

SCHEDULE 3 JEMENA GAS DIAGRAM

MINTO IA

SCALE 1:2000

50 0 50 100 150 200

THIS MAP UPDATED ON 06/07/10
THIS PLAN IS DIAGRAMATIC ONLY. DISTANCES SCALED FROM THIS PLAN MAY NOT BE ACCURATE.

DATE ALTERED:..... BY:.....

-	L7C	L7D
N3B	MIIA	MIIB
N3D	MIIC	MIID

ADJOINING MAPS

	CAMPBELLTOWN

NETWORK AREA | MUNICIPALITY AREA

Jemena

KEY

		MAX ALLOWABLE OPERATING PRESSURE
T	TRUNK PIPELINE	7000 kPa
P	PRIMARY MAIN	3500 kPa
S	SECONDARY MAIN	1050 kPa
400	NETWORK MAIN	400 kPa
	NETWORK MAIN	300 kPa
	NETWORK MAIN	210 kPa
100	NETWORK MAIN	100 kPa
30	NETWORK MAIN	30 kPa
	NETWORK MAIN	7 kPa
	NETWORK MAIN	2 kPa
	PROPOSED MAINS	
PR II-2 3	STEEL MAIN PROJECT NUMBER	
P	PRESSURE MONITORING STATION	
	VALVE	
	SYSTEM PRESSURE REGULATOR	
S	SIPHON	
123	NETWORK NODE	
123S	NETWORK VALVE NODE	
298	VALVE NUMBER	
6NB	6 INCH CAST IRON MAIN	
150MM	150MM STEEL MAIN	
110MM PE/NY	110MM POLYETHYLENE/NYLON MAIN	
6NB 50MM NY	50MM NYLON INSERTED INTO 6NB MAIN CAST IRON MAIN	
1.2MBL	DISTANCE IN METRES OF MAIN FROM BOUNDARY LINE	
1957	YEAR LAID	
	MUNICIPALITY BOUNDARY	
	NETWORK BOUNDARY	
123	HOUSE NUMBER	

MINTO IA

MINTO IC

SCALE 1:2000

50 0 50 100 150 200

THIS MAP UPDATED ON 01/11/04
THIS PLAN IS DIAGRAMATIC ONLY. DISTANCES SCALED FROM THIS PLAN MAY NOT BE ACCURATE.

DATE ALTERED:..... BY:.....

N3B	MIIA	MIIB
N3D	MIIC	MIID
N6B	MI4A	MI4B

ADJOINING MAPS

NETWORK AREA	MUNICIPALITY AREA
825	CAMPBELLTOWN

Jemena

KEY

		MAX ALLOWABLE OPERATING PRESSURE
T	TRUNK PIPELINE	7000 kPa
P	PRIMARY MAIN	3500 kPa
S	SECONDARY MAIN	1050 kPa
400	NETWORK MAIN	400 kPa
	NETWORK MAIN	300 kPa
	NETWORK MAIN	210 kPa
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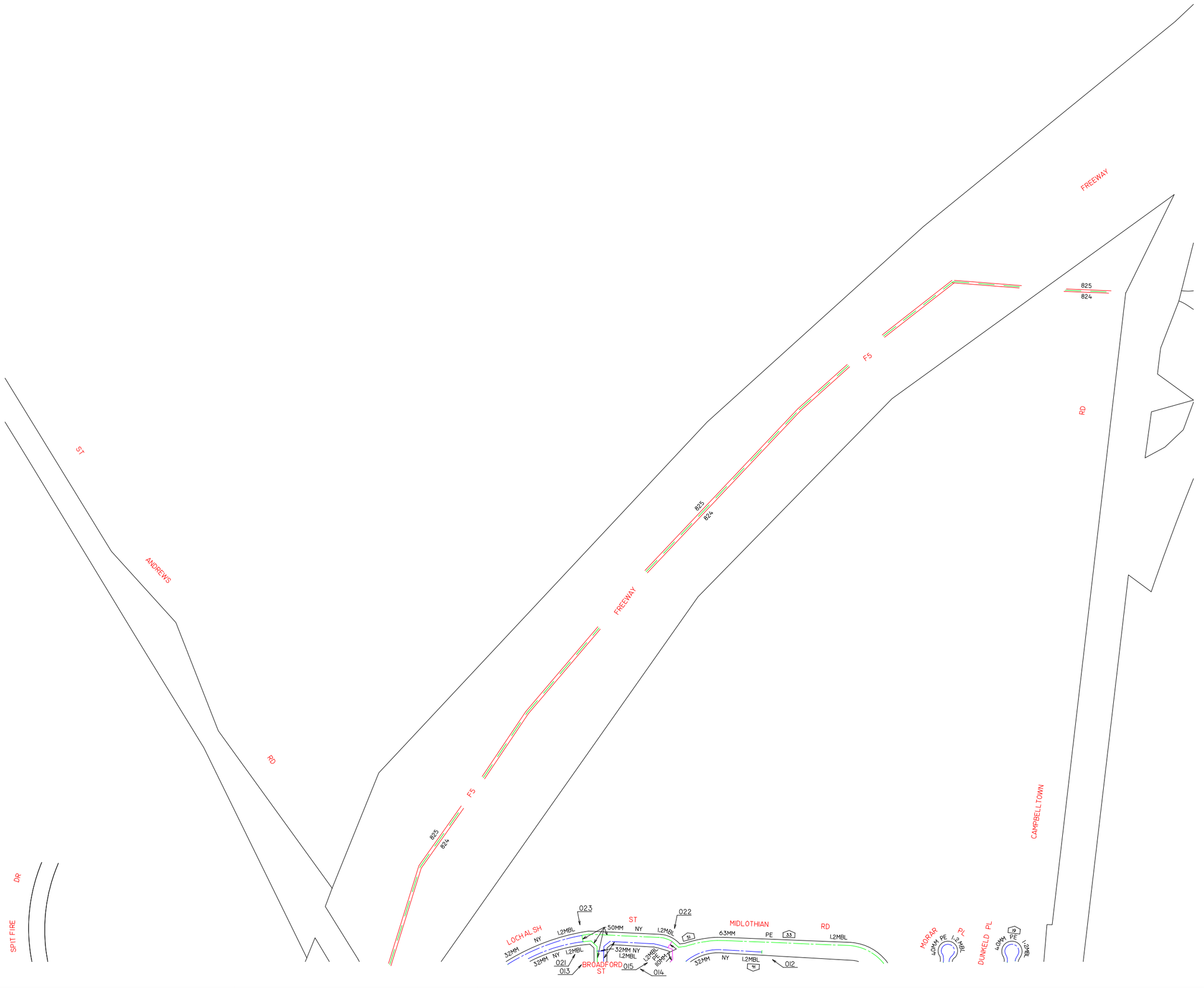
1.2MBL	DISTANCE IN METRES OF MAIN FROM BOUNDARY LINE	
1957	YEAR LAID	
	MUNICIPALITY BOUNDARY	
	NETWORK BOUNDARY	
123	HOUSE NUMBER	

MINTO IC



MINTO ID

SCALE 1:2000

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THIS PLAN IS DIAGRAMATIC ONLY. DISTANCES SCALED FROM THIS PLAN MAY NOT BE ACCURATE.

MI1A	MI1B	MI2A
MI1C	MI1D	MI2C
MI4A	MI4B	MI5A

ADJOINING MAPS

825 / 824 — NETWORK AREA

CAMPBELLTOWN — MUNICIPALITY AREA

Jemena

KEY

		MAX ALLOWABLE OPERATING PRESSURE
T	TRUNK PIPELINE	7000 kPa
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	SYSTEM PRESSURE REGULATOR	
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123S	NETWORK VALVE NODE	
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(6)NB 50MM NY	50MM NYLON INSERTED INTO 6NB MAIN CAST IRON MAIN	
1.2MBL	DISTANCE IN METRES OF MAIN FROM BOUNDARY LINE	
1957	YEAR LAID	
	MUNICIPALITY BOUNDARY	
	NETWORK BOUNDARY	
123	HOUSE NUMBER	

MINTO ID

MINTO 4B

SCALE 1:2000

50 0 50 100 150 200

THIS MAP UPDATED ON 23/09/11
THIS PLAN IS DIAGRAMATIC ONLY. DISTANCES SCALED FROM THIS PLAN MAY NOT BE ACCURATE.

DATE ALTERED:..... BY:.....

MI1C	MI1D	MI2C
MI4A	MI4B	MI5A
MI4C	MI4D	MI5C

ADJOINING MAPS

825 824

NETWORK AREA

CAMPBELLTOWN

MUNICIPALITY AREA

Jemena

KEY

MAX ALLOWABLE OPERATING PRESSURE

T	TRUNK PIPELINE	7000 kPa
P	PRIMARY MAIN	3500 kPa
S	SECONDARY MAIN	1050 kPa
400	NETWORK MAIN	400 kPa
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	NETWORK MAIN	7 kPa
	NETWORK MAIN	2 kPa
	PROPOSED MAINS	

PR 11-2 3 — STEEL MAIN PROJECT NUMBER

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VALVE

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1.2MBL — DISTANCE IN METRES OF MAIN FROM BOUNDARY LINE

1957 — YEAR LAID

MUNICIPALITY BOUNDARY

NETWORK BOUNDARY

123 — HOUSE NUMBER

SCHEDULE 4 WHITEHEAD AND ASSOCIATES WASTEWATER SERVICING REPORT

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Email mail@whiteheadenvironmental.com.au

Michael Cahalane
Warren Smith & Partners
123 Clarence Street
Sydney
NSW 2000

(via email)

7 September 2015

Dear Michael,

Wastewater Servicing Options Costing Review, MacArthur Memorial Park, 166 - 176 St Andrews Road, Varroville, NSW 2566

This letter report presents a brief overview of on-site wastewater servicing options for the MacArthur Memorial Park, Varroville, NSW.

1 Introduction

The site of the proposed MacArthur Memorial Park, 166 - 176 St Andrews Road, Varroville, NSW is currently unsewered. Connection to the sewer is an option for consideration but should the site remain unsewered, it would be necessary to treat wastewater generated on-site, with the treated effluent being managed by land application or reuse, also on-site.

This letter report considers the wastewater generation capacity of the proposed activities at the site and estimates the quantity and quality of effluent generated, recommends an appropriate level of wastewater treatment for on-site land application and an indication of the land area requirements for irrigation and indicative capital and operating costs for an on-site wastewater treatment and land application system.

The findings of this letter report are based on a desk study of available published information and our experience of other similar studies in the region. The site has not been visited as part of this investigation and no field investigations or soil sampling has been undertaken.

2 Wastewater generation capacity of the proposed activities

A review of the Limited Design Competition Brief documentation indicates that wastewater generating activities will be associated with the following operations at the site:

- Multi-function Chapel, training rooms

- Mortuary
- Function room
- Flower shop, café
- Administration office
- Ground staff facilities
- Gatehouse

We have used typical industry standard generation rates for the scale and frequency of activity outlined in the Limited Design Competition Brief to estimate likely wastewater generation. Table 1 summarises the wastewater generation estimates for the different activities.

Table 1 Wastewater generation estimates

Facility	Number	Frequency of use	Generation rate	Average Daily Load (L)
Multi-function Chapel, training rooms				
(Services/light refreshments)				
Toilet facilities				
3 chapels 167 seats/chapel	167	six/chapel/day, 5 days/week	10 L/person	21,471
Verandah overflow area [1]				
Mortuary				
(Wash, dress, prepare bodies)		18/day, 5 days/week	20L/body	257
Staff	2	5 days/week	50 L/person	71
Function room				
(Wakes, morning and afternoon teas, lunches, dinners)				
Kitchen, toilet facilities				
Seats	300	One/day, 6 days/week	30 L/person	7,714
Verandah overflow area [1]				
Flower shop, café				
Small kitchen, verandah area, toilet facilities				
Staff	2	7 days/week	50 L/person	100
Administration office				
Lunch room, staff toilets and showers, separate public toilet, tea and coffee making facilities				
Staff	10		50 L/person	357
Management	2		50 L/person	71
Consultation rooms	4	As above x 3 persons x 2 meetin	6 L/person	103
Ground staff facilities				
Toilet and shower, lunchroom				
Staff	4	increasing to 12 over 5/10 years	50 L/person	429
Laundry, industrial washing machine		1 wash/day, 5 days/week	100L/wash	71
Washdown area for burial equipment		2 washes/day	separator - soakaway or trade waste	
Gatehouse				
Toilet				
Staff	3		10 L/person	30
Total				**30,676**

[1] Verandah overflow areas - for wastewater generation purposes the excess of numbers over and above the capacity of the associated rooms, on occasions where the room capacity is exceeded, is considered to equate to the underutilisation on other occasions.

We recognise that the site will experience some growth over time and that initial activity will ramp-up over an initial period, but most of the wastewater generating elements of

activity are expected to plateau at an early stage of development. The only significant change in staffing flagged is of ground staff, increasing from 4 to 12 over 5 to 10 years and this is likely to have only minimal effect on wastewater generation. Consequently, we have estimated wastewater generation for the higher number of ground staff from the outset.

Thus the overall wastewater generation rate is likely to be of the order of 31,000 L/day. Although wastewater will not be generated at the same rate each day, the imbalance between the higher generation rates on weekdays and the lower generation rates on weekends may be managed by use of a balance tank to deliver uniform and average loads to the wastewater treatment system each day.

The wastewater generated will be of a largely domestic nature and is appropriate for treatment by a package wastewater treatment plant of the sort used at other community facilities such as resorts, caravan parks, recreation and sporting clubs or restaurants. Such package wastewater treatment plants are available from a large number of suppliers and their performance characteristics are well known and documented.

Appropriate treatment technologies would be an aerated wastewater treatment system or a recirculating media filter. Of the two technologies, both can comfortably manage some fluctuation in loads, particularly with appropriate use of a balance tank, but recirculating media filter technology offers greater capacity for incremental growth, should that be desired.

3 Appropriate level of wastewater treatment

An appropriate level of treatment for effluent reuse by subsurface irrigation in such a public open space would be to secondary standard with disinfection. This level of treatment will meet the requirements of Local Government and State Government regulatory agencies and comply with the relevant Australian Standards. Both of the technologies described above can readily meet this standard of treatment.

Subsurface irrigation will allow the beneficial reuse of treated effluent in landscaped areas whilst maintaining an appropriately low level of risk to visitors to the Memorial Park.

It will be necessary to maintain appropriate buffers between treated effluent irrigation areas and water bodies in the park. These buffers should be 100 metres to permanent surface waters (rivers, streams, lakes) and 40 metres to other waters (farm dams, intermittent waterways and drainage channels).

4 Land area requirements for irrigation

Reference to the Soil Landscape map for the site indicates that the site comprises predominantly two soil landscapes, the Luddenham Soil Landscape (lu) in the northern and eastern portions of the site and the Blacktown Soil Landscape (bt) in the western and south-western portion. The Luddenham Soil Landscape makes up approximately three-quarters of the site and the Blacktown Soil Landscape approximately one-quarter. Figure 1 shows the distribution of soil landscapes over the site.

Figure 1 Soil Landscapes

The Luddenham Soil Landscape typically comprises approximately 400 mm of clay loam overlying medium clay and the Blacktown Soil Landscape typically comprises approximately 300 mm of loam or clay loam overlying light clay.

Indicative Design Irrigation Rates for the two soil types are as follows:

- Luddenham Soil Landscape: 2 mm/day
- Blacktown Soil Landscape: 3 mm/day

Both the Luddenham and Blacktown soils have poor fertility and are intrinsically deficient in phosphorus, nitrogen and calcium (Hazelton and Tille, 1990). Treated effluent will provide a sustainable year-round water supply for irrigation, whilst the nutrient content of the treated effluent will contribute to vegetation growth and reduce the requirement for additional fertilizer.

To determine the aerial requirement for sustainable irrigation of treated effluent, we have undertaken water and nutrient balances for both soils using climate data from local Bureau of Meteorology stations (Camden Airport – rainfall, Badgery's Creek – evaporation), using appropriate representative data for soil and vegetation characteristics and for 31,000 L/day of irrigated effluent, treated to a typical secondary standard. The irrigation area requirements for sustainable management of the hydraulic and nutrient loads, as determined by the water and nutrient balances, are outlined in Table 2. The water and nutrient balances are appended to this report.

Table 2 Irrigation area requirements

Soil type	Hydraulic load	Nitrogen load	Phosphorus load
Luddenham	**17,600 m^2**	11,097 m^2	13,578 m^2
Blacktown	11,350 m^2	11,097 m^2	**13,358 m^2**

Limiting areas shown in **bold**

The limiting area for the Luddenham soil is determined by the hydraulic load (17,600 m^2), whilst the limiting area for the Blacktown soil is determined by the phosphorus load (13, 578 m^2). Hence to irrigate at sustainable rates on the Luddenham soil would require 17,600 m^2 of irrigation area or to irrigate at sustainable rates on the Blacktown soil would require 13,578 m^2 of irrigation area. In the case of the Blacktown soil, the irrigation area requirement could be reduced to 11,350 m^2 if the wastewater treatment system were to incorporate phosphorus reduction to 10 mg/L in the treated effluent, but this would incur additional cost.

The irrigation area(s) may be located on either of the soil types or a combination of the two. In the latter case, the irrigation area requirement would be determined in proportion to the amount of irrigation on each soil type.

5 Indicative capital and operating costs

Table 3 outlines indicative capital and operating costs for suitable secondary treatment systems, additional phosphorus reduction and subsurface irrigation, at current prices.

Table 3 Capital and operating costs

	Capital cost	Operating cost/year
Treatment Plant		
Aerated Treatment System	$265,000	$12,250
Recirculating Media Filter	$290,000	$6,690
Phosphorus Reduction	$5,000	$1,000
Land Application System		
Subsurface Irrigation	$68,100 - $105,600 ($6/m^2)	$6,000

We trust that the above provides you with an appropriate level of information at this stage. If you have any questions, please do not hesitate to contact the undersigned.

If, at a later stage, you require further detailed design, we would be most pleased to assist.

6 References

Hazelton, P.A. and Tille, P.J. (1990), Soil Landscapes of the Wollongong – Port Hacking 1:100,000 Sheet. Soil Conservation Service of NSW, Sydney

Yours sincerely,

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