RobertBirdGroup

Stormwater Management Plan

One Carrington Street

Issue: D

Prepared For: Sovereign Wynyard Centre Pty Ltd

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Report Amendment Register

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1.0 Introduction

1.1 Purpose of Document

This Stormwater Management Plan (SWMP) has been prepared by Robert Bird Group (RBG) who are engaged by Sovereign Wynyard Centre Pty Ltd under its nominee, Brookfeld to provide civil engineering design in respect of the development of One Carrington Street (the site). Aspects of the report pertaining to the internal buildings drainage and water reuse have been supplied by the project building hydraulics consultant, Arup.

The purpose of this document is to address the management of stormwater to support a State Significant Development Application (SSDA) for the site. This report presents the investigation and analyses results for the proposed stormwater management systems.

The following Director General's Requirements (Ref SSD13_5824 3rd May 2013) are addressed in this report:

- Public Domain – Address Water Sensitive Urban Design opportunities within the public domain and landscaping; and

- Ecologically Sustainable Development (ESD) – Provide an Integrated Water Management Plan considering the proposed end uses of potable and non-potable water, water sensitive urban design and water conservation measures.

In addition, the report addresses the following Development Application (ref MP 09 0076) conditions:

- Water Management: –

    - Stormwater drainage from roof and terrace areas is to be sized to cater for a 1:100 year ARI storm frequency and connected to a rainwater re-use tank;

    - The potential for reuse of rainwater using a suitable filtration method for water closet and flushing and landscape irrigation is to be explored during the detailed design stage; and

    - The City of Sydney Council is to be consulted during the preparation of the Stormwater Management Plan.

1.2 Project Description

The project consists of the redevelopment of four existing buildings, Shell House, Menzies Hotel, Thakral House and 285 George Street which are collectively located between Carrington Street and George Street in the Wynyard area of Central Sydney. The existing Menzies Hotel and Thakral House buildings sit above the Wynyard underground railway station and are also connected to each other over the top of Wynyard Lane, as indicated by the site boundary in Figure 1. The site occupies a footprint of approximately 4,500 m2.

Menzies Hotel and Thakral House are to be demolished and replaced by a new building, whilst Shell House and 285 George Street are to be refurbished but will retain their existing outer walls. The overall building footprints and roof areas are not proposed to be changed as a result of this development.

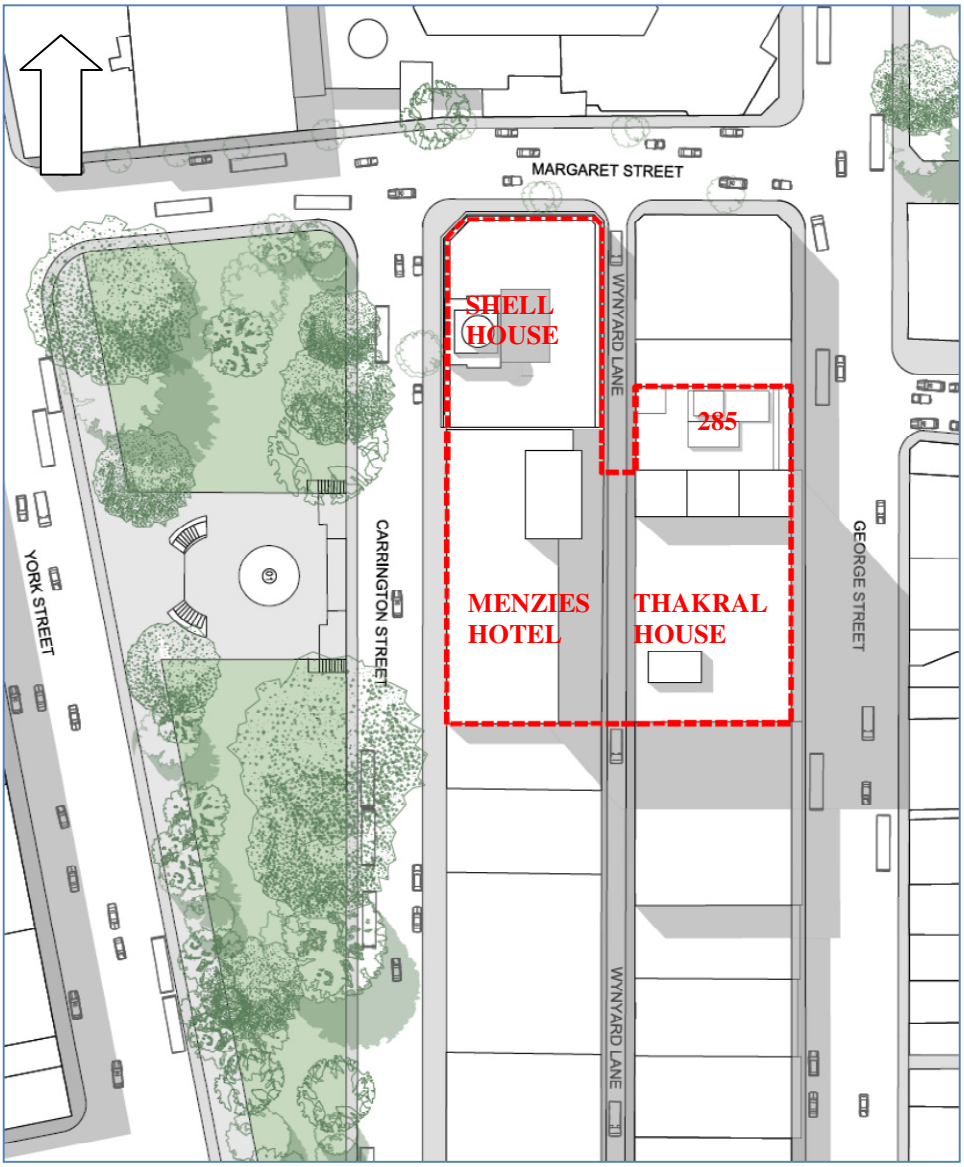

Figure 1 – Existing Site Plan

1.3 References and Inputs

The following documents have been referred to in completing this report:

- Sydney Development Control Plan (DCP) – City of Sydney Council, 2012
- Botany Bay and Catchment Water Quality Improvement Plan (WQIP) – Sydney Metropolitan Catchment Management Authority, 2011

2.0 Site Characteristics

2.1 Roof Drainage

From preliminary investigations on site, it is believed that the existing roof drainage of the four subject buildings and other adjacent buildings discharge via downpipes directly to the kerb / gutter at road level. Kerb perforations are evident along all building frontages in Carrington Street, Wynyard Lane, Margaret Street and George Street. It is assumed for the purpose of this report that the roof area drainage is split proportionately according to the length of each frontage.

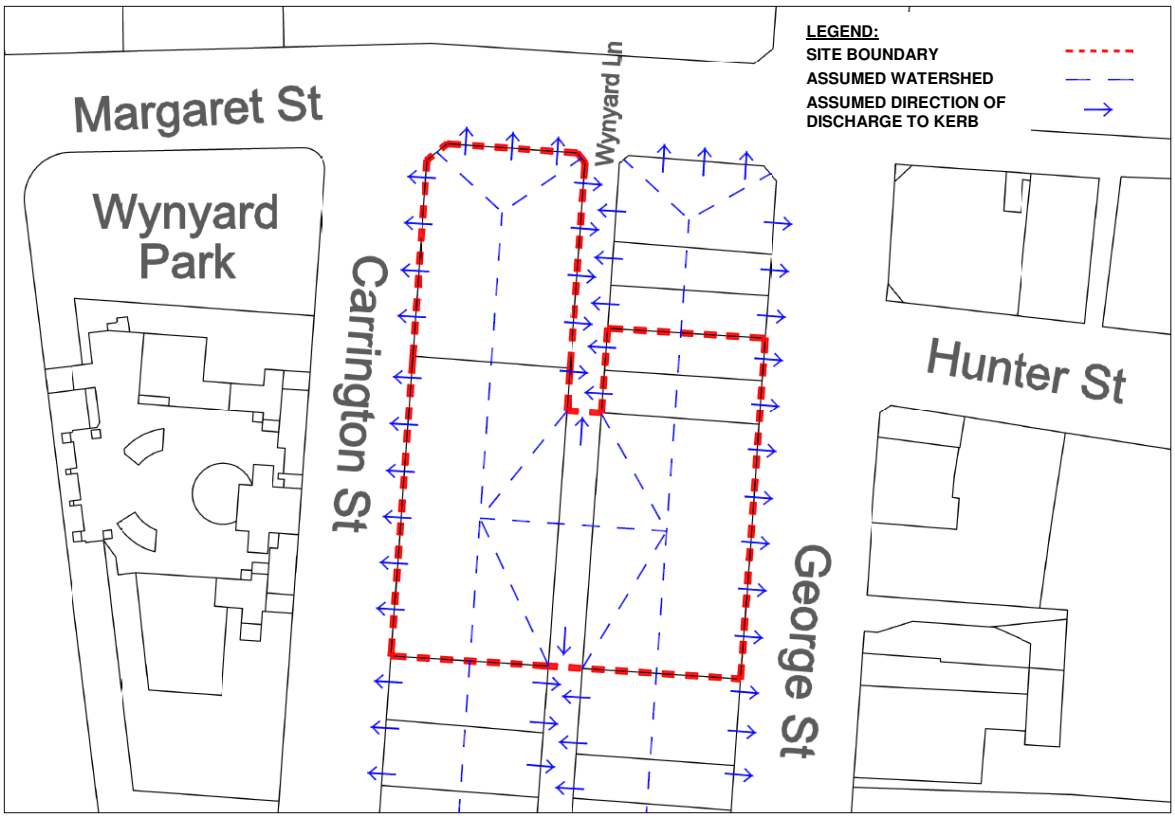

Figure 2 - Existing Roof Drainage

2.2 Overland Flow

From inspection of the site topography, it is evident that York Street acts as a ridge line to the west of the site and the surface flows around the site are all directed towards Hunter Street to the east as depicted in Figure 3. The Wynyard Park and Carrington Street area has two catchments, one flows to Margaret Street to the north and a second to Wynyard Street to the south. Wynyard Lane also splits surface flows north and south.

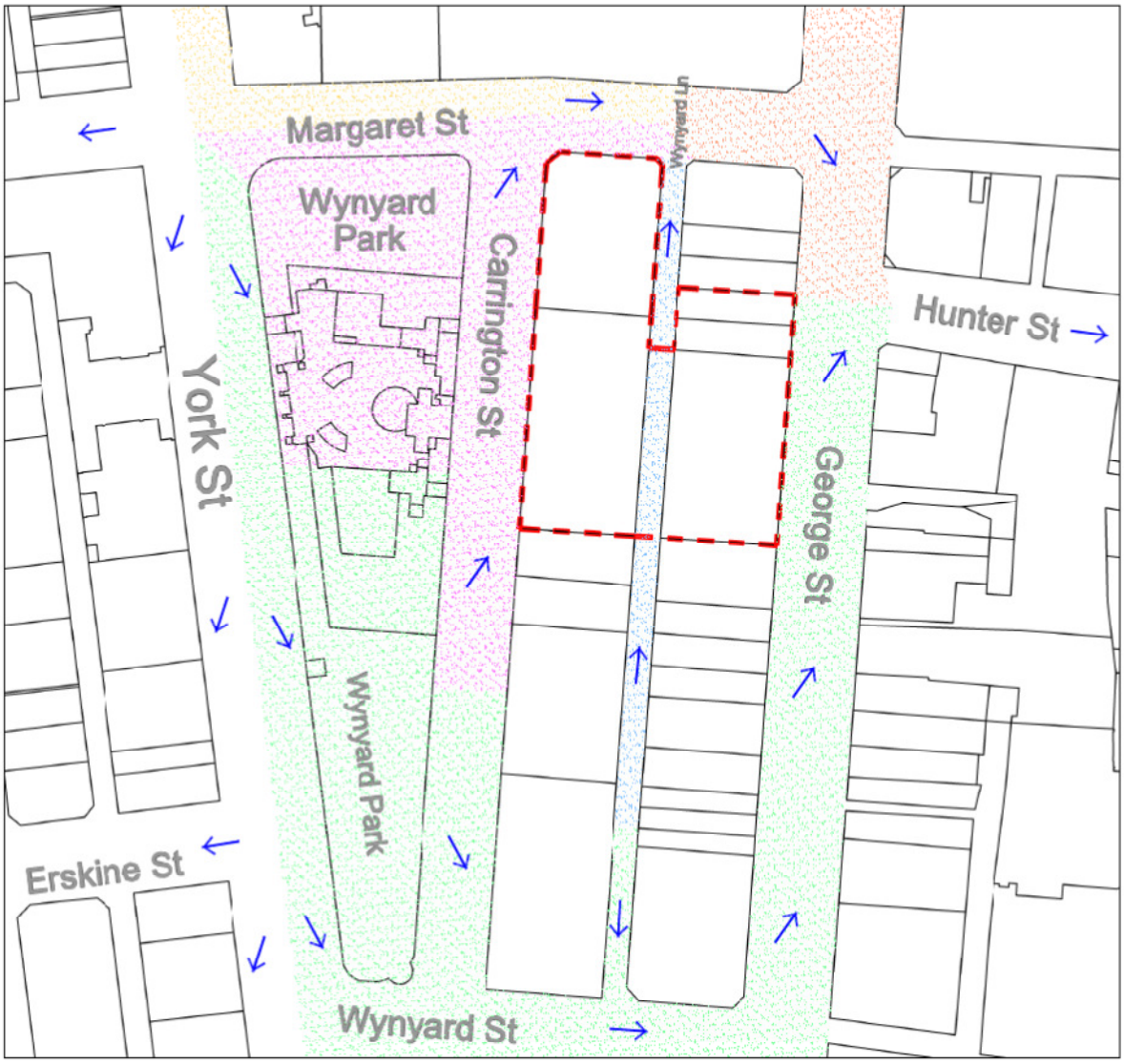

Figure 3 – Existing Overland Flow Paths

2.3 Road Drainage

Existing road drains are owned by Sydney Water (SW). The Dial Before You Dig asset plans and advice provided by SW show that there are two separate existing stormwater pipe systems in Wynyard Lane, both of which are 300mm diameter vitrified clay. The Wynyard Lane northern pipe connects to a system in Margaret Street, the other Wynyard lane pipe connects to a separate system to the South. The road drainage in George Street is also 300mm diameter. Pipes in Margaret Street and further downstream are of 600mm diameter or larger.

The existing stormwater pits and pipes on Carrington Street are on the high side of the street, opposite the buildings and do not collect rainwater from the Carrington Street building roofs discharged at road level. Roof runoff from these buildings flows along the Carrington Street eastern kerb gutter to Margaret Street where it is collected by stormwater pits.

Figure 4 shows a schematic representation of the existing road drainage infrastructure. Reference should be made to SW asset information for more accurate information about the stormwater systems.

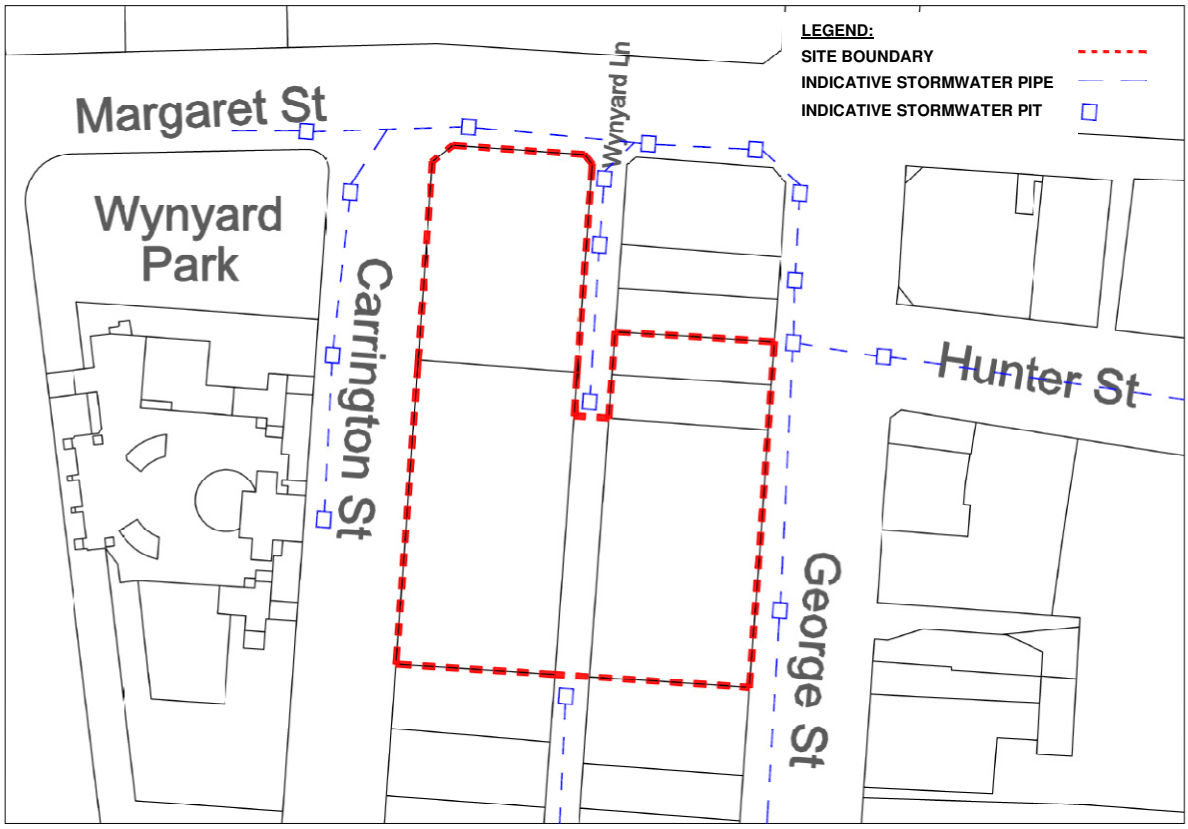

Figure 4 - Existing Stormwater Infrastructure

2.4 Riparian Features

The site appears to have no riparian features within 500m of the site and hence no further consideration of waterway corridor issues has been documented in this SWMP.

2.5 Flooding

It is understood that the Wynyard area has not previously been included on flood studies carried out on behalf of either City of Sydney Council or Sydney Water. However, the area is not believed to be a high risk for backwater flooding. As such the only flood risk that has been considered in this report is the risk of localised flooding caused by overland flow during 100 year ARI storm events, refer to section 2.1.

3.0 Concept Stormwater Management Strategy

In development of the stormwater management strategy for the site, the following factors have been considered:

- Collection and Discharge of Rainwater, including:
  - Changes to rainwater drainage flow from building roofs;
  - Opportunities for storage and reuse of rainwater; and
  - Overflow rates and point of discharge
- Rainwater Quality and Treatment
- Stormwater Detention
- Road Drainage Infrastructure
- Public Domain Works
- Groundwater Ingress to Basements

The following constraints have been used in the development of this strategy and are taken from the Sydney DCP 2012:

- Stormwater flows up to the 5% annual exceedance probability (AEP) event are to be conveyed by a minor drainage system and flows above the 5% AEP are to be conveyed in a major drainage system;
- The development is to achieve the post-development treatment targets indicated below (see note 1):
  - Reduce the baseline annual pollutant load for litter and vegetation larger than 5mm by 90%;
  - Reduce the baseline annual pollutant load for total suspended solids by 85%;
  - Reduce the baseline annual pollutant load for total phosphorus by 65%; and
  - Reduce the baseline annual pollutant load for total nitrogen by 45%.

In determining the design run off rates for the development the following rainfall intensity rates have been adopted (source Australian Government, Bureau of Meteorology).

Major flow intensity: (100 Year ARI, 5 minute storm duration): $^{100}I_5$ = 269 mm/hr
Minor flow intensity: (20 Year ARI (see note 2), 5 minute storm duration): $^{20}I_5$ = 209 mm/hr

Notes:

(1) The water quality treatment targets from the Botany Bay and Catchment WQIP are equal or lower than those shown in the Sydney DCP and therefore the higher targets have been adopted in this strategy;

(2) Use of the 20 year average recurrence interval (ARI) storm event, equivalent to a 4.9% AEP event is slightly conservative

3.1 Collection and Discharge of Rainwater

Rainwater from the roof areas of the development will not be discharged to the kerb gutter as per the existing. It is proposed for the roof rainwater to be collected and directed to a 40m3 capacity central rainwater tank where it will be stored for reuse in the buildings. Modelling undertaken by Arup indicates that approximately 80% of the total rainwater will be reused (refer to Appendix A) the majority of which is associated with the building's cooling towers.

In extreme storm events, the rainwater tank will overflow to the road drainage on the northern section of Wynyard Lane. The overflow will consist of 2 No. 375 mm diameter pipes, sufficient to convey the full 100 year ARI storm discharge (0.336 m3/sec).

Q = Roof Area (A) x Storm intensity (i_{100}) / 3.6×10^6 $\quad A = 4{,}500\ m^2$

= $0.336\ m^3$ / sec $\quad {}^{100}I_5 = 269$ mm/hr

3.2 Rainwater Quality and Treatment

Rainwater collected from the building roofs will be treated prior to internal re-use within the central cooling tower for example. Treatment options prior to reuse include filtration, disinfection and ultra-violet treatment.

Most rainwater collected from the building roof will be reused on site and as such, the site would achieve a corresponding reduction in pollutant loads. Preliminary calculations suggest that approximately 80% of rainwater will be reused, and therefore it is expected that the pollutant loads discharging to public drains are reduced by the same proportion. If this reduction is achieved it would exceed the quality targets for phosphorus (65%) and nitrogen (45%). Additional treatment would still be required to reduce the pollutant loads for suspended solids to 85% and gross pollutants to 90%. Appropriate measures will be included in the detailed design to ensure that the full targets are achieved if possible and will be confirmed using MUSIC or similar computer models. This is likely to involve the use of a gross pollutant trap such as HumeGard or equivalent. Refer to the Building Services Stormwater Management Report (ARUP) in Appendix A.

3.3 Stormwater Detention

We have received advice from SW as to whether they require detention of stormwater prior to discharge to the road drainage network. SW has advised that the location of the development does not necessitate any stormwater detention and as such, none is proposed for the site.

3.4 Road Drainage Infrastructure

Rainwater from the development buildings will be diverted away from the existing discharge to kerb gutters on Carrington Street, Margaret Street and George Street to discharge to Wynyard Lane. The existing system in the northern part of Wynyard Lane running to Margaret Street consists of a single 300mm diameter vitrified clay pipe. This pipe has a calculated flow capacity of 0.048 m3/s (see note 1).

The post development flows to the northern catchment area of Wynyard Lane have been calculated for minor ($^{20}I_5$ = 209 mm/hr) and major ($^{100}I_5$ = 269 mm/hr) events and are as follows:

Source	Surface Area, m^2	Minor Flow, m^3 / sec	Major Flow, m^3 / sec
Development buildings	4,500	0.261	0.336
Other buildings (north)	320	0.018	0.023
Other buildings (south)	1,940	- (note 2)	0.144
Wynyard Lane (north)	270	0.016	0.020
Wynyard Lane (south)	420	- (note 2)	0.031
TOTAL	**7,450**	**0.295**	**0.554**

As shown above, the existing northern piped system does not have sufficient capacity to convey the minor and major storm flows expected. It is therefore proposed to replace this system with a new piped system. In order to convey the major storm event, the replacement pipe will be a minimum of 675mm diameter which has a flow capacity of 0.623 m^3/s (see note 3) allowing for a 25% blockage factor. The provision of a piped system to convey the major flows negates any need to provide an overland flow path in the northern section of Wynyard Lane.

Notes:

(1) Calculation based on Manning's equation for a 300mm pipe with a fall of 1:100 and Manning's n of 0.013 with design flow depth of half the pipe diameter. Refer Appendix B.

(2) Stormwater from the buildings and Wynyard Lane road surface to the south of the development are assumed to be conveyed by the existing southern piped system during the minor storm event.

(3) Calculation based on Manning's equation for a 675mm pipe with a fall of 1:100 and Manning's n of 0.012 with design flow depth of 75% of the pipe diameter and a blockage factor of 25%. Refer Appendix B.

The stormwater infrastructure in the Southern part of Wynyard Lane, as well as in Carrington Street, Margaret Street, Wynyard Street and George Street is not proposed to be altered since no additional stormwater will be directed in to these systems. Indeed, by diverting stormwater from the development away from kerb gutter discharge, the infrastructure in these areas will have reduced catchment areas.

The proposed 675mm diameter pipe in Wynyard Lane will connect to the existing 600mm diameter pipe in Margaret Street, It is therefore possible that the existing chamber may need to be replaced at the connection point which will be determined during detailed design. Design will also take account of the need to accommodate the potential for surcharge from this pit in extreme events without causing a hazard to pedestrians and road users.

3.5 Public Domain Works

The public domain proposals associated with the project consist of treatment of the northern section of Wynyard Lane (from the southern extent of Menzies Hotel / Thackral House to the intersection with Margaret Street) which is to become a shared surface zone (refer to L-100 Public Domain Concept Plan prepared by Oculus).

The existing arrangement of the lane consists of narrow footpaths, approximately 300mm wide, with 150mm high kerbs. As discussed in Section 3.4, the existing arrangement does not provide sufficient freeboard to property thresholds to act as an overland flow path and the existing stormwater pipe is of insufficient size to convey major or minor storm flows.

The proposals for the lane include removal of the existing narrow footpaths and kerbs and grading the whole road width to slope towards a centrally located drainage strip (eg. a dished channel with pits at regular intervals or a grated channel). Drainage pipes in Wynyard Lane will be augmented and sized to convey the 100 year ARI storm event without overland flow.

3.6 Groundwater Ingress and Basement Drainage

Drainage of the basement levels of the buildings, including groundwater seepage through basement walls will be collected and pumped to the building's stormwater system.

4.0 Stormwater Management Concept

The stormwater management strategy for the site consists of measures to reduce reliance on potable water supply and reduce runoff volumes to public drains whilst also improving safety and amenity for users of the roads around the site. The concept stormwater management strategy for the site is summarised in Figure 5.

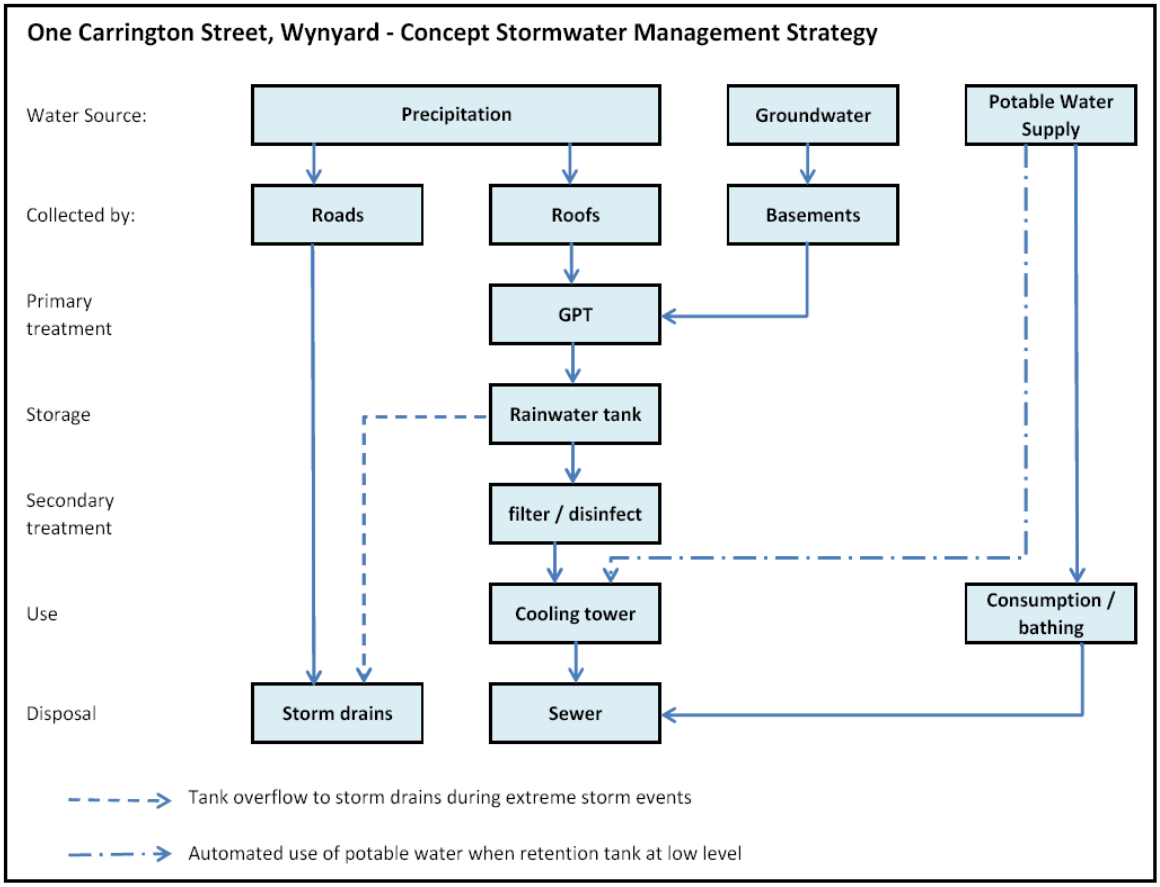

Figure 5 - Concept Stormwater Management Strategy

The stormwater management strategy will be delivered through the proposals discussed in section 3 of this report and shown in Figure 6.

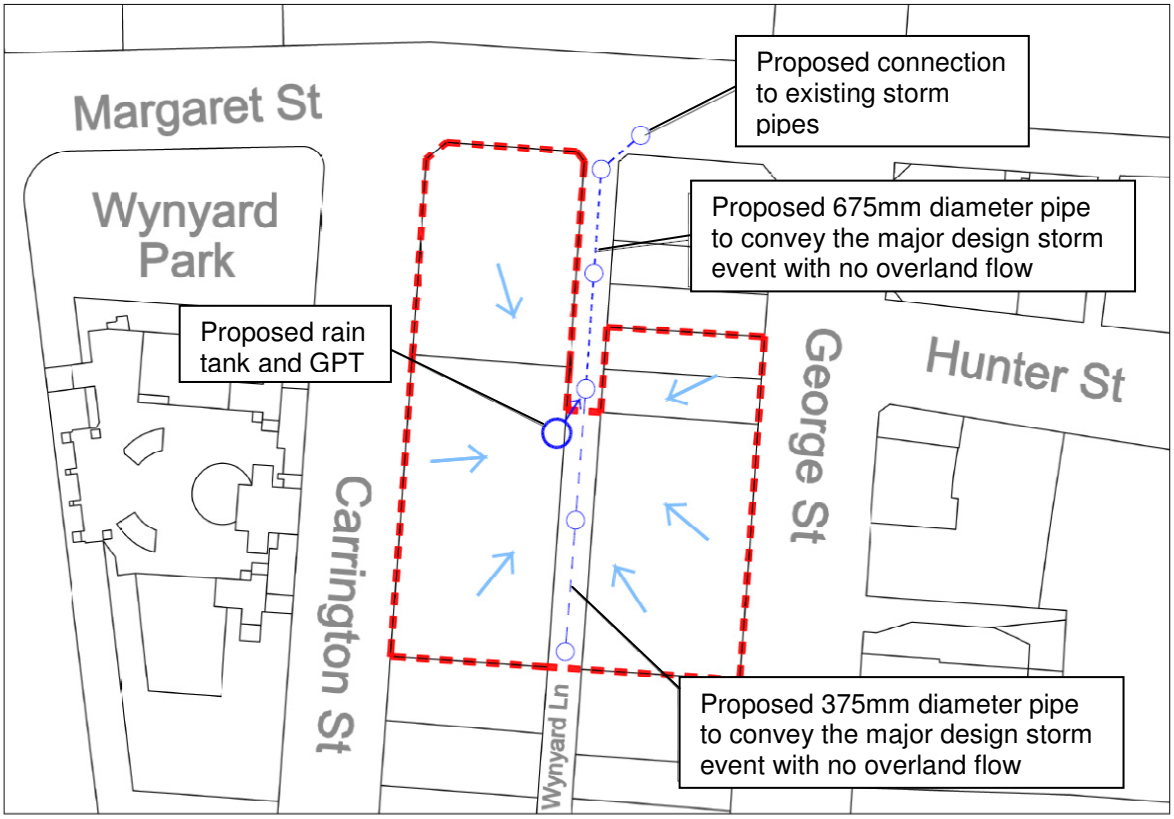

Figure 6 - Proposed Stormwater Infrastructure

The rationale and expected benefits of this approach are as follows:

Proposal:	**Rationale:**
Redirect all roof drainage to central rainwater tank for reuse	• Reduced discharge to kerb gutters (safety & amenity benefits) • Maximise collection volumes for reuse in cooling towers (environmental benefits) • Reduce use of imported potable water for uses other than consumption (environmental) • Reduction of nitrogen and phosphorus pollutant loads to meet water quality targets of Sydney DCP (environmental)
Primary treatment (GPT) of rain water prior to storage	• Reduce total gross pollutant and suspended solid loads discharging to public drains to meet water quality targets of Sydney DCP (environmental)
Provide 375mm diameter storm pipe in covered section of Wynyard Lane	• Convey major storm flows (100 Yr ARI) without overland flow path (safety and amenity)
Provide 675mm diameter storm pipe in northern section of Wynyard Lane	• Convey major storm flows (100 Yr ARI) without overland flow path (safety and amenity)
Connect new storm infrastructure to existing system in Margaret Street	• Move potential surcharge point away from susceptible basement entries (safety and amenity)
Basement water and groundwater seepage pumped to building drainage	• Additional supply for re-use (environmental)
Secondary treatment of rain water prior to reuse	• Water quality sufficient for non-potable re-use (health)

Although stormwater from this development will discharge to the existing stormwater system and eventually into Sydney Harbour, the stormwater quality management measures proposed for this site offer sound management practices and therefore no stormwater quality monitoring has been proposed.

5.0 Summary

This stormwater management plan demonstrates that under the proposed plan, stormwater management for the site addresses the relevant guidelines, including

- Water Quality – water quality and quantity targets for discharges from the site and detention and water quality treatment measures and/or future controls proposed for the development;
- Water Cycle Management – water cycle management is addressed through reuse of rainwater on site, eg. for the cooling tower.
- Flooding – The risk of flooding is reduced significantly by redirecting rainwater away from discharge to kerb gutters and providing stormwater infrastructure in Wynyard Lane of sufficient size to convey the major flood event without reliance on overland flow.

Appendix A
Building Services Stormwater Management Report (Arup)

Brookfield

One Carrington Street

Building Services Stormwater Management

Issue | 20 February 2014

Job number 229159-00

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ARUP

Document Verification

ARUP

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1 Introduction

The stormwater works for the project are split in scope between buildings services stormwater and external stormwater. The demarcation is the building boundary, with external stormwater being part of civil design works that are described elsewhere in this report. Internal works such as roof, canopy and basement drainage are part of the hydraulic building services design works.

The project's internal building design is at conceptual design stage with significant design evolution to take place.

The detail of the concepts will evolve with the building design in line with the intent described below.

The rainfall landing on the building's roofs will be harvested and reused on site for non-potable uses such as cooling towers. The harvesting of rainwater will capture an estimated 80% of total building run-off. Surcharge from the harvesting tank will discharge to the utility stormwater infrastructure.

2 Tower and Shell House Internal Drainage System

Roof rainwater drainage will be collected via roof outlets and gutters. These are proposed to use a siphonic system where appropriate. Some roof sections may be more suited to gravity drainage, and as such will drain via gravity.

Emergency overflows will be provided to offer relief in the event of roof drainage failure and will discharge in accordance with Council and Sydney water requirements.

The building system will be designed in accordance with the building code of Australia. It will generally drain a 1 in 100 year ARI storm. Canopies and roofs deemed non-critical may be designed to a 1:20 year ARI storm with overflow path for 1 in 100.

The roof water will be directed from gutters and roof outlets to a rainwater harvesting tank via a series of downpipes. The water will be stored for future reuse. Surcharge from this tank will discharge at full flow to the Sydney water storm water mains. At this stage it is envisaged that rainwater from the site will discharge to the new external stormwater main in Wynyard Lane provided as part of civil works.

Rainwater from shell house currently discharges to the surrounding streets' kerbs and gutters via downpipes. While the primary objective is to divert the downpipes to the new rainwater tank, this may not be feasible in all cases. As such some downpipes may remain as presently installed.

Drainage of basement car park rainwater and wash down in will be collected in gravity drains and pumped into the building's storm water systems

Ground water seepage, where present, will also be drained to the same pump system. This would not classify as permanent dewatering, and will be subject to geotechnical investigation to mitigate against and prevent permanent dewatering.

Sydney water has confirmed that this project will not require onsite detection (OSD) due to its proximity to the harbour.

3 285 George Street

Rainwater from 285 George Street currently discharges to the surrounding streets' kerbs and gutters via downpipes. The roof and building fabric is not proposed to undergo any changes. As such downpipes will remain in the status quo.

4 Rainwater Reuse Performance

Arup have determined the rainwater reuse capability and performance using a proprietary in house model. The Model uses in excess of 50years of daily rainfall data from the Observatory Hill weather station and balances inflow (rain) against outflow (demand) on a day by day basis to determine ideal tank sizes. The demand is based on recognised consumption models (eg Greenstar) and cooling tower energy models (both baseline and project specific).

The model outputs performance metrics such as demand met, tank empty/full time and stormwater overflow. Due to the extent of real data used for input, the model offers realistic performance data that allows accurate tank sizing.

For One Carrington Street this model demonstrates that a 40,000L tank would trap and reuse over 80% of rain falling onsite. The model currently uses preliminary demand data inclusive of safety factors, which will be refined as equipment selections and energy models evolve. The outputs will evolve as the inputs are updated.

The following figures summarise the input data in the model.

RAINWATER CATCHMENT AREA	4500	m2
OFFICE		*NOTE: if assesing greenstar points, the combination of
Days of **OFFICE** use per year	260.00	Note: 260 days = 5 days per week 52 weeks per year
OFFICE GROSS FLOOR AREA	73,171	m2

Input Sumary

	Li/day	Li/year	M³/year
WC + Urinals water demand + Clothes washing water	27,073	7,039,050	7,039
Basin Taps + shower heads + Kitchen demand	30,183	7,847,590	7,848
Total fixtures Potable water demand	30,183	7,847,590	7,848
Total fixtures Recycled water (rain water) demand	27,073	7,039,050	7,039
Irrigation Requirement	-	-	-
Cooling Tower average make-up (space cooling)	76,110	27,799,332	27,799

Cooling Tower peaking factors	2.178551	max/avg
	0.510221	Min/avg

The following figures summarise the output data in the model.

Potential Potable water use without recycling	42,685,971.72	L/year
Potable water consumed	39,371,102	L/year
Potable water consumed	151,427	L/day
Reduction in Potable water use resulting from reuse	7.766%	
Potable water saved per year with recycling	3,314,870	L/year
% of recycled demand met	9.556%	
% of recycled water overflowed	19.287%	
volume of recycled water overflowed	867,950	L/year
% of time tank empty	95.86%	
% of time tank full	2.345%	
Rainwater tank size	40	KL
Rainwater run-off in 50 years	4,500,240	L/year
BW generated in 50 years	0	L/year
percentage of rain water in the recycled water supply	100%	
Rainwater that overflows to stormwater system	19.287%	

The rainwater harvested will be stored in a tank within the building. When drawn from the tank for consumption it will pass through a booster pump and any treatment/filtration/disinfection deemed necessary. It will then serve connected fixtures

An automatic changeover will be installed to automatically switch to the Sydney Water supply during low tank levels.

5 Treatment

City of Sydney Council DCPs stipulate stormwater discharge quality for the project (see following extract).

3.7.3 Stormwater quality

(1) Development of a site greater than 1,000sqm must undertake a stormwater quality assessment to demonstrate that the development will achieve the post-development pollutant load standards indicated below:

(a) reduce the baseline annual pollutant load for litter and vegetation larger than 5mm by 90%;

(b) reduce the baseline annual pollutant load for total suspended solids by 85%;

(c) reduce the baseline annual pollutant load for total phosphorous by 65%; and

(d) reduce the baseline annual pollutant load for total nitrogen by 45%.

(2) The stormwater quality assessment is to be prepared by a suitably qualified engineer with experience in water sensitive urban design (WSUD) and include:

(a) modelling of pollutant load standards with an industry standard water quality model;

(b) the design of WSUD measures used to achieve the post-development pollutant load standards; and

(c) maintenance schedules of any proposed WSUD measure that requires maintenance or full replacement including the likely recycling or disposal location of any wastes that may be generated.

(3) Development on a site with an area less than 1,000sqm is to be designed so that the flow of pollutants from the site due to stormwater is reduced.

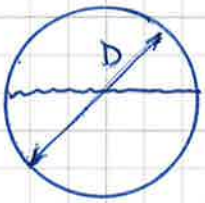
Arup will assess the stormwater quality as described in the DCP and where required implement measures to achieve the required quality.

6 Conclusion

The stormwater drainage within the proposed development will be designed in accordance with the requirements of The City of Sydney Council, Sydney Water and the Building Code of Australia. Rainwater will be harvested for reuse. Surcharge from the tank will discharge to the utility infrastructure systems. Stormwater discharged from site will meet council requirements for quality.

Appendix B
Hydraulic flow capacity calculation Manning's Equation

Manning's equation calculation for flow in existing 300 mm dia pipe in Wynyard Lane.



$D = 0.3\,m$

Assume pipe runs at half depth

$d = 0.5\,D$
$= 0.15\,m$

Wetted perimeter $= \pi D/2$
$= 0.471\,m$

Area of flow $= \pi D^2/8$
$= 0.0353\,m^2$

(R) Hydraulic Radius = Area / wetted perimeter
$= 0.0353 / 0.471$
$= 0.075\,m$

Manning's equation

$$V = \frac{K}{n} \times R^{2/3} \times S^{1/2}$$

where V = velocity of flow (m/s)

k = 1

n = constant for material
use 0.013 for ex clay pipe

R = Hydraulic Radius – see above

S = Slope (pipe assumed to follow ground slope of approx 0.01)

$V = 1/0.013 \times 0.075^{2/3} \times 0.01^{1/2}$
$= 1.368\,m/s$

discharge $Q_{max} = V \times A = 1.368 \times 0.0353$
$= 0.0483\,m^3/sec$

CRope
21/02/2014

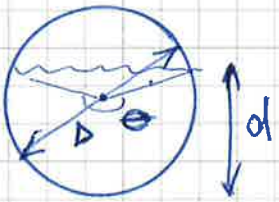
Manning's equation calculation for flow in proposed 675mm dia pipe in Wynyard Lane.

Assume pipe runs at 75% depth

$D = 0.675\ m$

$d = 0.75 \times D$

$= 0.506\ m$



$\cos\left(\frac{\theta}{2}\right) = \left(\frac{D}{2} - d\right) / D/2$

$= -0.5$

$\theta/2 = 120°$

$\theta = 240°$

Wetted Perimeter $= \frac{\theta}{360} \times \pi D$

$= 1.414\ m$

Flow Area $= \frac{\theta}{360} \times \frac{\pi D^2}{4} - \frac{D^2}{4} \sin\left(\frac{\theta}{2}\right) \cos\left(\frac{\theta}{2}\right)$

$= 0.239 - -0.049$

$= 0.288\ m^2$

(R) Hydraulic radius = Area ÷ W Perimeter

$= 0.288 \div 1.414$

$= 0.204\ m$

CRope

21/02/2014

Calculation for flow in proposed 675 mm dia pipe continued.

Manning's equation

$$V = k/n \times R^{2/3} \times S^{1/2}$$

$k = 1$

$n = 0.012$ (assumed smooth concrete pipe)

R = Hydraulic radius - see P2

$S = 0.01$ (see P1).

V = Velocity

$$V = 1/0.012 \times 0.204^{2/3} \times 0.01^{1/2}$$

$$= 2.88 \text{ m/s}$$

$$Q = V \times A$$

$$= 2.88 \times 0.288$$

$$= 0.830 \text{ m}^3/\text{sec}$$

Assume allowance of 25% blockages

$$Q_{75} = 0.75 \times 0.830$$

$$= 0.623 \text{ m}^3/\text{sec}$$

CROPE

21/02/2014

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