Barangaroo South Stage 1C Crown Sydney Hotel Resort Stormwater Management and Infrastructure Assessment Project Application

Prepared for
Crown Resorts Ltd.

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1 Introduction

This report supports a Project Application submitted to the Minister for Planning and Infrastructure pursuant to Section 75J of Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act). The Project Application seeks approval for construction of the Crown Sydney Hotel Resort.

1.1 Purpose of this Report

This report has been prepared on behalf of Crown Resorts Limited to accompany a State Significant Development Application (SSDA) for the Crown Sydney Hotel Resort at Barangaroo. The Hotel Resort is proposed in accordance with the approved Barangaroo Concept Plan (as modified) and is located within Barangaroo South.

1.2 Site Location and Context

Barangaroo is located on the north western edge of the Sydney Central Business District (CBD), bounded by Sydney Harbour to the west and north; the historic precinct of Millers Point (for the northern half), The Rocks and the Sydney Harbour Bridge approach to the east; and a range of new development dominated by large CBD commercial tenants and the King Street Wharf/Cockle Bay precinct to the south.

The 22ha Barangaroo site is generally rectangular in shape and has a 1.4 kilometre harbour foreshore frontage, with an eastern street frontage to Hickson Road. The site has been divided into three distinct redevelopment areas (from north to south) – the Headland Park, Barangaroo Central and Barangaroo South, and has been subject to multiple investigations that detail the physical and natural characteristics of the site.

Refer to **Figure 1-1**.

Figure 1-1 Barangaroo South Locality Plan

1.3 Crown Sydney Hotel Development

The Crown Sydney Hotel Resort development will comprise a single high rise building that will include a hotel, casino and residential apartments. More specifically approval is sought for:

- construction and use of a hotel, VIP gaming facilities and residential apartment building with associated retail and restaurant uses and a basement car park to accommodate parking and servicing allocated to the proposed uses within the development, comprising a total Gross Floor Area of approximately 77,500m2 and a maximum building height of approximately 271 metres (RL 275);
- associated building signage; and
- provision of services and utilities required to service the building.

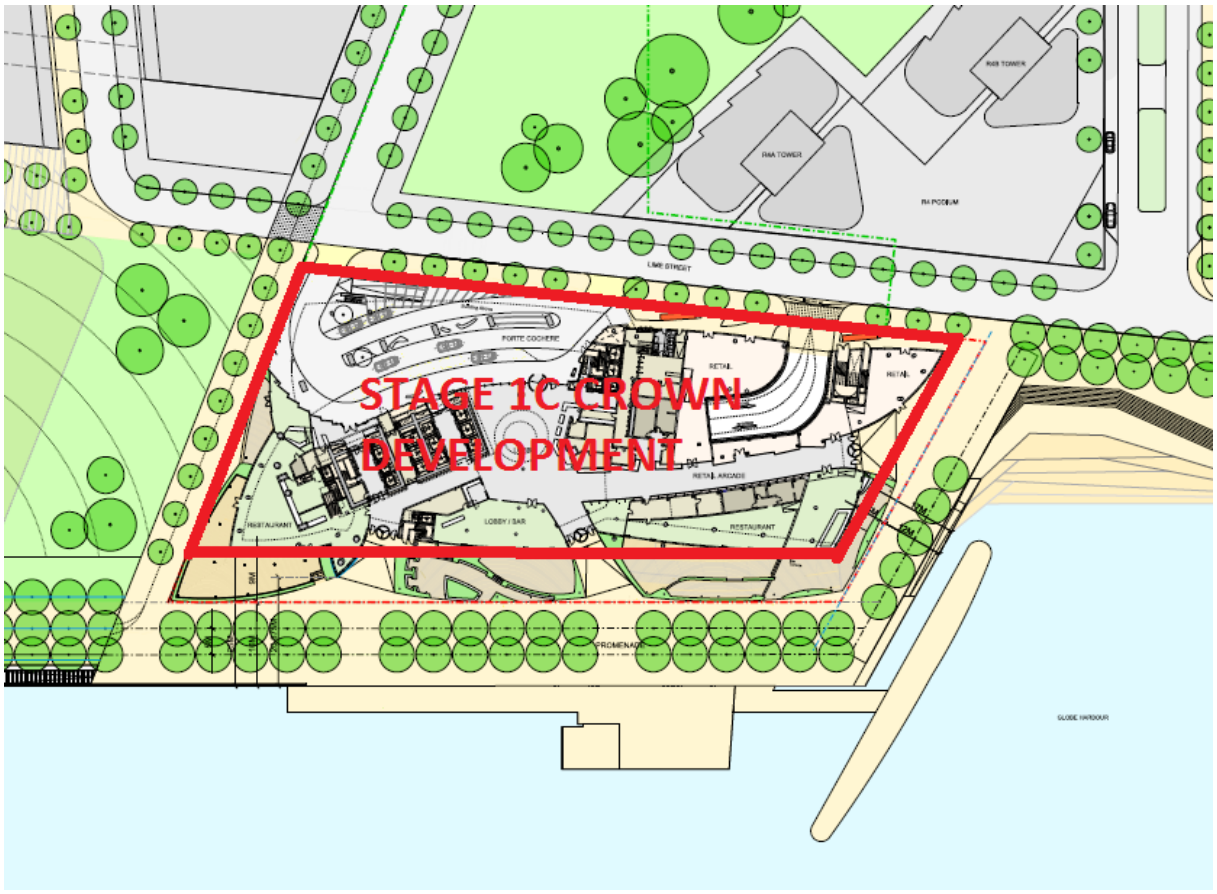

Figure 1-2 Crown Development

1.4 Planning History & Framework

On 9 February 2007 the Minister approved a Concept Plan for the site and on 12 October 2007 the Barangaroo site was rezoned to facilitate its redevelopment. The Approved Concept Plan allowed for a mixed use development involving a maximum of 388,300m^2 of gross floor area (GFA) contained within 8 blocks on a total site area of 22 hectares. The rezoning allows for residential, commercial, retail, public open space and basement car parking.

This report supports a Project Application submitted pursuant to Section 75J of Part 3A of *the Environmental Planning and Assessment Act 1979 (EP&A Act)* seeking approval for construction of the Crown Sydney Hotel Resort podium and ground plane level.

As part of Stage 3 of the Unsolicited Proposal, Crown Resorts Ltd. have committed to the NSW State Government to proceed with the development of the Crown Sydney Hotel Resort at Barangaroo South, subject to a number of conditions and approvals. The outcomes of the Stage 3 Proposal are summarised in the *Stage 3 Outcomes and Transaction Summary* published by the NSW Government.

In November 2013, Crown and the NSW State Government entered into a binding agreement whereby Crown agreed to proceed with the development of Crown Sydney and in return, the NSW State Government agreed to table legislation proposing that a restricted gaming license would be issued. The NSW Parliament passed the legislation amending the *Casino Control Act 1992* in late 2013. The legislation mandated that the license could only be issued in relation to the site where Crown Sydney is proposed to be developed at Barangaroo South.

Amendments to the Project Application will require Section 75W Modification Application and assessment by the Minister for Planning and Infrastructure.

2 Data Compilation

To assess the stormwater drainage impacts on the development, the following input data was reviewed for relevance to Stage 1C.

2.1 Topographic Survey

Airborne Laser Scanning (ALS) was undertaken by AAM-Hatch. Generally, the accuracy of ALS data is ±0.15m to one standard deviation on hard surfaces.

2.2 Ground Survey

A detailed field survey of the proposed development site, Hickson Road, Sussex Street and Shelley Street was undertaken by Rygate & Company. The ground survey and the ALS data are being used to analyse existing overland flow paths.

2.3 Site Inspection

Site inspections were undertaken by Cardno's experienced hydraulic engineers to confirm site and catchment features. The site visits provided the opportunity to identify various street drainage features and to visually identify potential flooding hotspots in the catchments.

2.4 GIS data

The following Geographic Information System (GIS) data was provided by Cardno's GIS team and Sydney Water's asset database system for this study:

- Cadastre for the catchment area;
- Topographic map with 2m contours;
- Aerial images; and
- Hydra plans featuring Sydney Water's stormwater infrastructure.

2.5 Previous Reports

The following reports, prepared by Cardno, were referred to in preparation of this report:

- 14-0033 Barangaroo South Stage 1C Crown Sydney Hotel Resort_Remediation and Earthworks_Stormwater Management and Infrastructure Assessment_Project Application_RevD;
- Flood Study – Barangaroo South – Stage 1B.

3 External Works (Stage 1A and 1B by Others)

The external works include all works within Stage 1A and 1B which influence the design outcomes of the Crown Sydney Hotel Resort development. These works will be undertaken by others. In particular these elements include:

- Integrated Water Strategy;
- Stormwater Drainage;
- Water Sensitive Urban Design;
- Climate Change Adaption;
- Overland Flows and Flooding;
- Roads and Footpaths; and
- Utility Service Provisions;

3.1 Integrated Water Strategy

Stormwater management is one aspect of the site-wide Barangaroo South water strategy. The objective of this strategy is to achieve a positive water balance based on exporting recycled water from the site in greater quantity than potable water is imported.

This objective will be achieved through a site wide approach that focuses on:

a. Potable water demand reduction including:

- Commitment to achieve a reduction in potable water consumption compared to a standard practice development.

b. Water balance modelling including:

- Review of potential sources of water;
- Investigation of sewer mining;
- Assessment of appropriate treatment measures; and
- Further development of existing conceptual water balance model; refer to **Figure 3-1**.

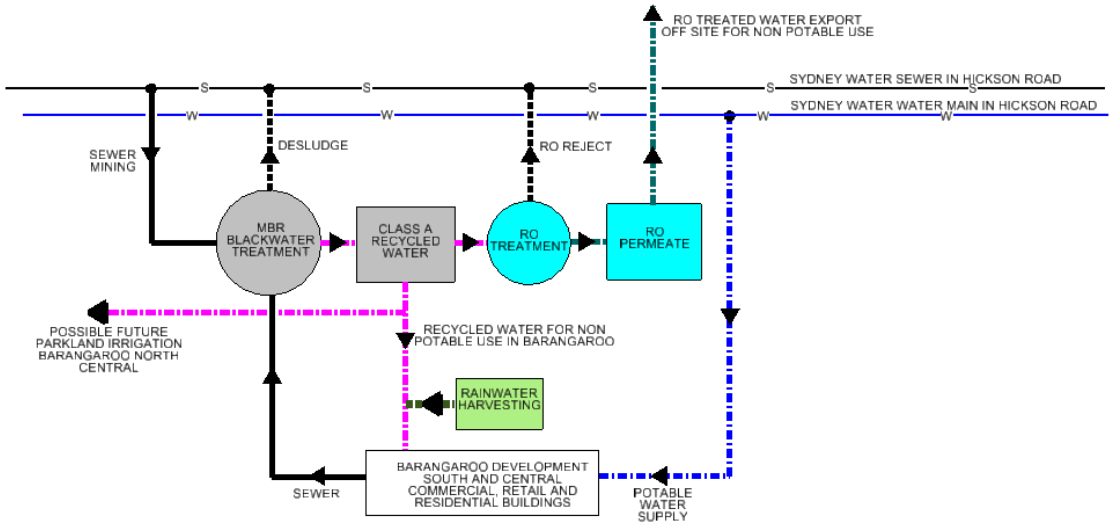

Figure 3-1 Barangaroo South – Waste Water, Potable and Recycled Water flow diagram

Stage 1C of Barangaroo South will adopt the principals of the site-wide water strategy and utilise stormwater treatment measures and infrastructure incorporated into Stage 1A and 1B. Stage 1C will also provide water quality measures internally, as discussed in Section 4.

3.2 Stormwater Drainage

3.2.1 Catchments

3.2.1.1 Stage 1A

Based on interpretation of Area Laser Scan (ALS) data (as used by City of Sydney Council), the external catchment area draining to the Barangaroo South site is approximately 13.31Ha. Details of the catchments are as follows:

- **Catchment 1 and 3**: This catchment has a total area of approximately 7.39Ha, which discharges to an existing 900mm diameter pipe in Hickson Road connecting to the existing 1500/1650mm diameter pipe which runs in a North West direction through the site. This pipe is joined by a 1200mm stormwater drainage pipe traversing Stage 1B (Catchment 5, 6 and 7 below), ultimately discharging to Darling Harbour via an 1800mm diameter stormwater pipe and box culvert.
- **Catchment 2**: Connects to an existing 1200mm diameter pipe along Sussex Street before turning into Shelley Street, ultimately discharging to Darling Harbour adjacent to Bungalow 8.
- **Catchment 4**: Connects to existing drainage within Shelley and Lime Streets, ultimately discharging to Darling Harbour adjacent to Bungalow 8.

3.2.1.2 Stage 1B and 1C

Based on interpretation of Area Laser Scan (ALS) data (as used by City of Sydney Council) and available survey data, the external catchment area draining to the Stage 1B development site is approximately 5.28Ha. Details of the catchments are as follows:

- **Catchment 5**: This catchment has a total contributing area of approximately 2.83Ha, which discharges into Gas Lane and Jenkins Street through a 750mm diameter pipe and then into an existing 1200mm diameter pipe which traverses the Stage 1B development site prior to ultimately discharging directly into Darling Harbour.
- **Catchment 6**: This catchment has a total contributing area of approximately 2.29Ha, which discharges into the existing Hickson Road in ground stormwater drainage network prior to ultimately discharging into Darling Harbour through a series of varying diameter pipes traversing the Stage 1B/1C development site.

- **Catchment 7**: This catchment has a total contributing area of approximately 0.16Ha, which discharges to Hickson Road drainage and then through the site via proposed drainage.

Drawing SK001 presented in **Appendix A** details external sub-catchment areas and nominated discharge locations.

3.2.2 Network Data

Information regarding the location of existing services has been obtained from a number of sources including a Dial Before You Dig (DBYD) search and the Services Overview Report prepared by Cardno Limited (Report number 600062-R002 Nov 2005). Additional information has been obtained from strategic field investigations.

3.2.3 Trunk Stormwater Diversion Strategy

The pre-development stormwater network is characterised by a series of in ground piped stormwater lines (typically between 300mm to 1800mm in diameter) draining Hickson Road and other external catchments through the Barangaroo South site directly to the Harbour.

Diversion of the existing stormwater assets traversing the Barangaroo South site will be implemented as part of the excavation and remediation stage, including:

- The southern stormwater system (Line A), which drains the Hickson Road and Napoleon Street intersection has been diverted south around the Stage 1A basement;
- As part of the Stage 1B works it is proposed to divert the existing Line B and C to a single stormwater line running along the southern end of the Stage 1B site which will discharge directly to the harbour. Line C runs through the Stage 1C area however the diversion works as part of Stage 1B will negate the need for any works in Stage 1C apart from demolition of the redundant stormwater pipe. The Stage 1B permanent diversion has undergone preliminary discussion with Sydney Water and will proceed to detailed design pending formal applications to Sydney Water; and
- Line D runs predominantly through Barangaroo Central however discharges to the harbour via Stage 1C Barangaroo South. Should Barangaroo Central works be undertaken in advance of Stage 1C then no diversion works would be required as part of Stage 1C and the existing discharge location could be utilised for the proposed development. However, should Barangaroo Central works not be undertaken, temporary diversion of Line D would be required, most likely to the south to join Line B and C (subject to detailed design). Ultimately Line D will be discharged within the Barangaroo Central area.

The stormwater infrastructure diversion works for Barangaroo South are presented on drawing SK003 in **Appendix B** – refer Barangaroo South Stage 1C, Remediation and Excavation – Stormwater Management and Infrastructure Assessment report.

3.2.4 Site Stormwater Drainage Strategy

It is proposed that all rainwater falling on roads or public domain areas will be collected via a combination of traditional stormwater capture devices and water quality measures such as bio-retention systems and gross pollutant traps, prior to discharge. There is no requirement for on-site detention (OSD) as the Barangaroo South site is adjacent to the Harbour and at the outlet from the catchment where attenuation would normally have little impact on upper catchment flows.

The trunk drainage system will consist of prefabricated box culverts installed above the structural slab with kerb inlet pits. Surface flows generated by the pedestrian walkways catchments will be collected through series of surface grates and connected to the trunk drainage system.

The trunk drainage will discharge via a water quality treatment system within public land prior to discharging to Darling Harbour.

3.3 Water Sensitive Urban Design

3.3.1 Design Criteria

The Barangaroo South water sensitive urban design has been developed to meet the following pollutant reduction targets:

Table 3-1 Water Quality Reduction Targets

Water Quality Parameter	BDA Obligation % Reduction	City of Sydney DCP % Reduction
Total Suspended Solids (TSS)	80	85
Total Phosphorus (TP)	45	65
Total Nitrogen (TN)	45	45
Gross Pollutants	3 Months ARI	90 (> 5mm)

The City of Sydney Development Control Plan reduction targets are consistent with current best practices. The marginally higher phosphorus and suspended solids targets are however relevant for more sensitive receiving waters.

3.3.2 WSUD Strategy

The water quality strategy will consist of treatment measures to achieve the required reductions in pollutant targets. The following external measures will be incorporated downstream of the Stage 1C discharge and form part of the treatment train prior to discharge into Darling Harbour

3.3.2.1 Gross Pollutant Traps

Underground gross pollutants trap(s) are proposed at the downstream end of the drainage system prior to discharging to the Harbour. The GPT(s) will work as the primary treatment system to remove litter, vegetative matter, free oils, grease and coarse sediments.

3.3.2.2 End of Line Proprietary System

In addition to the 'at source' treatment system an end of line proprietary system is proposed to achieve the pollutant reductions targets. The proposed 'Humes Jellyfish' system is an underground filtration system which efficiently captures high levels of stormwater pollutants without impacting on the public domain footprint.

The proposed system has a reduced maintenance schedule compared with other traditional bio-retention systems, and also provides a lower operating invert level.

3.1 Overland Flows and Flooding

3.1.1 Historic Flood Data

The City of Sydney Council has confirmed that there is no available historical flood data for the Barangaroo site or the external catchments to the site.

Localised flooding is known to occur within the bounds of Hickson Road.

3.1.2 Existing Overland Flow Paths – Stage 1A

The most prominent overland flow paths are generally:

- **Catchment 1 and 3:**
  - I. South along Kent Street to the junction with Napoleon Street;
  - II. West along Napoleon Street;
  - III. South along Hickson Road to the existing low point approximately 50 metres north of the Sussex Hotel; and

IV. Through the development site.

- **Catchment 2:**
  I. West on Erskine Street; and
  II. North on Sussex Street to the existing low point approximately 50 metres north of the Sussex Hotel.

3.1.3 Existing Overland Flow Paths – Stage 1B and 1C

The most prominent overland flow paths are generally:

- **Catchment 5:**
  I. Overland flow splits at the intersection of Gas Lane and Jenkins Street prior to discharging into the existing Hickson Road in-ground stormwater drainage network.
- **Catchments 6 and 7:**
  I. North and South on Hickson Road towards an existing low point generally located in front of "The Bond"; and
  II. Through the development site.

3.1.4 Overland Flow Impact

The key changes to overland flow paths and effects on existing stormwater infrastructure are as follows:

- The existing stormwater pipes for the external catchment that traverse the site are to be relocated due to the construction of the basement;
- A harbour highest astronomical high tide water level of RL 1.975 has been forecasted for the year 2100; and
- The proposed site levels preclude overland flow through the development from existing low points in Hickson Road. The stormwater drainage upgrade to Hickson Road, as part of Stage 1B, conveys the 100 year runoff ensuring no negative impact to flood levels within Hickson Road.

3.2 Climate Change Adaptation

The risk and likely magnitude of climate change induced sea level rise is addressed in detail in the Climate Change and Sea Level Rise Report prepared by Arup for the Project Application "*Barangaroo South Concept Plan Amendment (MP06_0162 MOD 4) Climate Change and Sea Level Rise Report*".

The above report recommends adoption of a Harbour design level of RL1.975. An allowance for surge of 600mm gives a minimum site level of 2.575 at the foreshore area, refer Figure 3-2.

It is likely that in the coming years, the existing local drainage systems in the area surrounding the development will reduce in capacity and effectiveness as the outlets to the harbour become increasingly submerged.

These risks are addressed at this stage through:

- Locating site based stormwater discharge points at a high level within the new sea wall to allow gravity flow of the run-off to the Harbour;
- Design of stormwater transport systems to incorporate partial inundation from tide flows;
- Specification of materials to marine grade to prevent accelerated degradation;
- Use of tidal flaps on stormwater discharge points; and
- Provision of overland flow paths should the discharge point become obstructed.

It is also noted that the recommended minimum seawall level for the proposed Barangaroo South development is RL2.575.

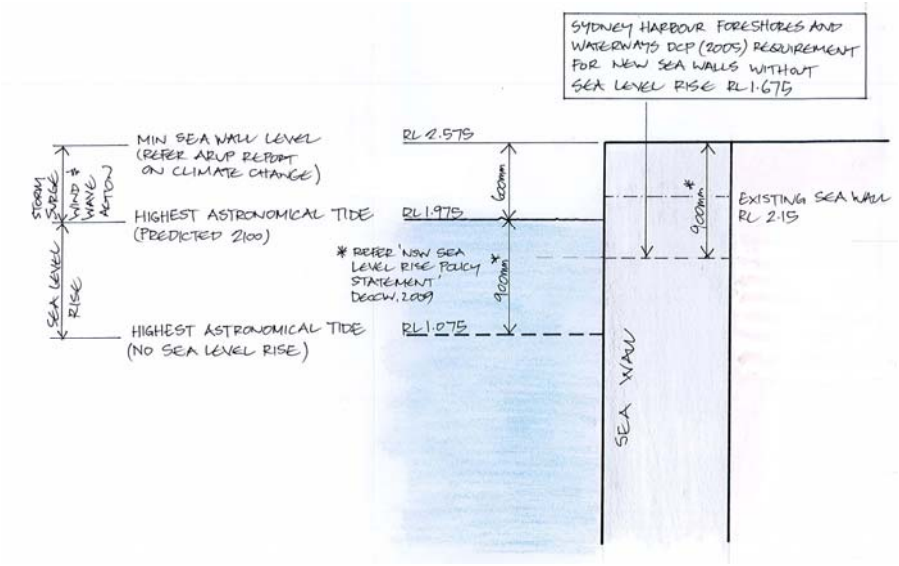

Figure 3-2 Predicted Sea Level Rise

**All Levels to Australian Height Datum – AHD

3.3 Groundwater

Due to the excavation associated with the basement construction, groundwater water will be encountered during both the construction and operational phases of the development. Groundwater will need to be discharged in accordance with authority guidelines.

3.3.1 Operational Phase

The basement will be subject to inflows from two sources, including:

- Groundwater Infiltration; and
- Car park drainage water.

Although the basement construction will be water-tight, it will not be water proof and groundwater infiltration may occur within the basement at an estimated 1kL per day. The basement will be subject to both groundwater and tidal influences. The EPA have advised that on-going discharge to the harbour would not be approved therefore a trade waste agreement with Sydney Water is recommended to discharge to the sewer system within Hickson Road.

Runoff water that enters the basement via the basement ramp and incoming cars will also not be permitted to discharge to the harbour and will need to be included on the trade waste agreement.

3.4 Roads and Footpaths

3.4.1 General

The proposed road layout is contained within Stage 1B with Lime Street fronting the Stage 1C development. The layout is based upon the approved Concept Plan (refer **Figure 1-2**) and is consistent with the established planning framework and consists of two roads, being:

- Lime Street (extension from Stage 1A);
- Connection Street to Hickson Road (east-west).

3.4.2 Design Vehicle

The roads will be designed to cater for the following vehicles:

- 12.5 m truck access to the loading dock via the basement driveway;
- 9.8 m garbage truck along Lime Street and the connection Street to Hickson Road; and

- Passenger vehicles to all car parks access and exits.

Design turning paths will be modelled (Autoturn – Austroads 2006 vehicle templates) to determine where local increases in pavement width were required to ensure the design vehicle could negotiate turns and bends safely with adequate clearances.

Where necessary, 'No Stopping' signs will be provided to ensure that required turning areas are free of parked vehicles.

3.4.3 Road Geometry and Grading

Road geometry design has been undertaken in accordance with the approved Concept Plan. A summary of the road type characteristics are described in 03-2 below:

Table 3-2 Summary of Roads Characteristics

Road Name	Carriageway Width	Comments
Lime Street	7.0m	• Footpath width are as generally indicated on the drawings (minimum width 3m) • On Street parking to AS2890
Connection Street to Hickson Road	8.0m	• Footpath width are as generally indicated on the drawings (minimum width 3m) • Off Street parking to AS2890

Due to the flat nature of the site it is proposed that roads will generally been designed using a 'sawtooth' grading system with a series of localised sags and crests. Typically, road cross fall has been maintained at 3% with longitudinal fall at 1% (minimum 0.5%).

3.4.4 Footpath Geometry and Grading

Footpaths will be provided in accordance with Council's standard drawings with no provision for shared paths. Full width pedestrian footpath will also be provided around the development on the north, south and western sides, along the harbour.

Generally footpaths have been designed with 1 to 1.5% crossfall (min 0.5%, max 2.5%) to comply with AS1428.

3.4.5 Road and Walkway Pavements

Preliminary road pavement designs have been prepared and presented in Table 3-3 and Table 3-4 below. In all cases pavements for roads and walks are over suspended structure.

Table 3-3 Road Pavement Design

Material	Thickness
Asphaltic Concrete	75mm
Primer Seal	10mm
Base course	150mm
Sub Base	200mm

Table 3-4 Walkways & Lanes Pavement Design

Material	Thickness
Pavers	To landscape architects
Mortar Bed	20mm
Reinforced Concrete Slab	125mm
Base Course	100mm

3.4.6 Intersections

There are three intersections as part of the Stage 1B road network, being:

- Intersection with Stage 1A Lime Street and Globe Street (Lime Street extension) – This will be an unsignalised T junction;
- Intersection of "Connection Street to Hickson Road" and Lime Street – This will be a right hand bend with future provision for extension of Lime Street to Barangaroo Central; and
- Intersection with Hickson Road – This will be a signalised intersection.

3.5 Utility Service Provision

3.5.1 Potable Water Supply

A Sydney Water owned 300mm watermain is located on the western side of Hickson Road and extends for the full frontage of the Barangaroo South development. Sydney Water has confirmed, through approval of the "Site Servicing Strategy – Barangaroo South", prepared by Cardno and dated March 2013, that this main has adequate capacity to provide potable water to the development.

All existing supplies to the development site, serving buildings and other structures have been disconnected and either disused or removed.

For the Stage 1A site a 250mm water main from Hickson Road runs along Shelley St, Lime Street, and Globe Street.

Connection will be made to the 1B site via the existing 250mm diameter watermain in Globe Street, described above. From this connection, a potable water main will be constructed along the internal road network. The new main will be laid above the podium level structural slab.

It is intended Sydney Water will own and maintain the new assets.

3.5.2 Recycled water services

There were no recycled water services as part of the pre-developed site for Barangaroo South however recycled services were introduced through the development of Stage 1A.

The recycled water supplies are drawn from a central Recycled Water Treatment Plant (RWTP) which treats waste water from Barangaroo South and also from sewer mining from the existing Sydney Water sewer in Hickson Road. The water will be treated in compliance with Australian Recycled Water guidelines and reticulated through Barangaroo South for non-potable use. General by-products from the RWTP are proposed to be discharged to Sydney Water sewer as trade waste. A trade waste application is currently being prepared by Lend Lease for submission to Sydney Water.

The mains are generally to be located within the Barangaroo South Basement, reticulating to customer recycled water meters located within the basement.

The system is to be provided with a backup water supply connected to the Sydney Water potable water supply system serving Barangaroo South.

The recycled water mains for the Stage 1B basement will be extended from the existing termination point within the Stage 1A basement.

3.5.3 Sewer Services

The pre-developed sewerage network is owned by Sydney Water and consists of 225 and 450mm gravity drainage in Hickson Road. This network drains to existing Sydney Water owned Sewage Pump Station SP1129 located north of Barangaroo South.

The existing pump station serves catchments extending to Sussex Street, Kent Street and includes the catchment served by Sewage Pump Station SP0014 located at Headland Park. SP0014 will be disused as part of the Headland Park works with flows diverted to SP1129.

All existing supplies to the development site, serving buildings and other structures have been disconnected and disused or removed.

The RWTP installed as part of Stage 1A works will capture and treat the sewerage from Barangaroo South. The RWTP will be owned and operated under the Water Industry Competition Act.

Additional storage within the local sewerage network is required to offset the peak load from the development for when the RWTP is offline. This will be achieved through re-use of the redundant Stage 1A temporary stormwater diversion pipework or construction of storage at the SP1129 location. Sydney Water is reviewing these options.

An overflow from the RWTP will be required and has been approved, in principal, by Sydney Water through the "Site Servicing Strategy".

Provision of wastewater services to the development has been addressed through the Site Servicing Strategy as agreed with Sydney Water.

3.5.4 Electricity Services

Existing electrical services in Hickson Road include:

- Disused Railcorp 33KV feeder 746 and 745. Advice regarding the assets has confirmed that they consist of "…old gas cables and no longer required for Railcorp's rail network purposes and are to be de-commissioned". However these assets are, on advice from Railcorp, to be treated as live. This service is located in close proximity to the eastern kerb alignment of Hickson Road;
- An existing HV supply and concrete encased bank of conduits feeding "The Bond". The bank of conduits is believed to consist of 150mm conduits laid in 4 rows of 4 conduits generally between 800mm and 1.2m depth;
- Existing HV supplies to substations serving the previous site which are to be disused and removed;
- Existing temporary HV supplies to temporary substations providing construction supply; and
- Various LV services for street lighting, parking ticket machines and other purposes.

As part of the Stage 1A works the following electrical approvals and augmentations were undertaken:

- In 2008, Ausgrid (then Energy Australia) advised that the Barangaroo South development would be serviced from their City North Zone substation at 11kV and fed from their CBD Triplex grid;
- Subsequent to this, Ausgrid determined that the site would instead be serviced at 33kV from their Pyrmont Switching Station. Lend Lease has since decided to own and operate the 33kV network and substations on site as a private embedded network. This will be configured in a triplex configuration and will provide a similar level of redundancy to the 11kV CBD system;
- The feeders from Pyrmont Switching Station will be a combination of new and existing feeders. New Ausgrid feeders will be run from Slip St to the Barangaroo South development, where they will terminate on switchgear which demarcates the Ausgrid network from the private embedded network. At Slip St the new feeders will be jointed to existing feeders which run to Pyrmont. These feeders were recently in service but were decommissioned when the new City North Zone substation was brought on line.

Electrical services for Stage 1B will be a continuation of the basement reticulation from Stage 1A with branch connections to services the above development.

3.5.5 Telecommunications services

The Kent Street telephone exchange is located relatively close to the site, and a number of telecommunications carriers have existing cables in the vicinity of the site.

All telecommunications infrastructure previously existing within the basement footprint was capped off at the boundary and removed.

It is proposed for Stage 1A that a range of telecommunications providers will be able to extend existing pit and pipe infrastructure to service site at two diverse entry points, from Shelley Street at the south and from Hickson Road at the north. It is expected that incoming telecommunications cables will be optic fibre. Reticulation through Stage 1A will be via cable tray at high level within the basement and will provide diverse paths from site entry points to individual buildings to allow for a high level of network resilience.

Telecommunication services for Stage 1B basement will be a continuation from Stage 1A.

3.5.6 Natural gas services

In the pre-developed case, there was an existing 110mm low pressure (7kPa) nylon gas main along Hickson Road and a high pressure gas main located at the corner of Sussex and Napoleon Streets. There was no existing high pressure main connection serving the Barangaroo site but there were small low pressure connections. The existing gas network from the low pressure main has been decommissioned and capped off at the site boundary and removed.

The gas servicing strategy for Barangaroo south has been developed with Jemena, the gas asset owner and manager for the area.

The Stage 1A site includes a low pressure 7kPa gas main located within the roadways. A regulator installation is proposed to be connected to the existing Jemena gas main located in Hickson road adjacent to the project. Gas mains shall be reticulated within the local roadways strategically located to provide service points to each of the buildings requiring gas. The new gas reticulation mains shall be owned and maintained by Jemena.

Low pressure gas services for Stage 1B will be a continuation of the basement reticulation from Stage 1A with branch connections to services the above development.

3.5.7 Chilled water services

There was no chilled water supply as part of the pre-development site. A centralised chiller plant and harbour heat rejection system are being constructed as part of Stage 1A works to provide reticulated chilled water to the Barangaroo South development.

The Harbour Heat Rejection plant, and associated reticulation of chilled water, was approved in August 2013 as part of the MP10_0023 MOD5 planning application by Lend Lease. It is proposed to discharge filter backwash to the sewer system as trade waste.

Chilled water services for Stage 1**C** basement will be a continuation of the reticulation from Stage 1A through a privately owned pipework.

4 Internal Works (Stage 1C Crown Sydney Hotel Resort development)

4.1 Sediment and Erosion Control

The objectives of the erosion and sediment control for the development site are to ensure:

- Adequate erosion and sediment control measures are implemented prior to the commencement of construction and are maintained during construction; and
- Construction site runoff is appropriately treated in accordance with the requirements of City of Sydney Council, EPA, and relevant authorities.

As part of the works, erosion and sedimentation controls shall be constructed generally in accordance with the drawings, Council requirements and the NSW Department of Housing Manual, “Managing Urban Stormwater Soils & Construction” 2004 prior to any earthworks commencing on site.

4.1.1 Construction Phase

Prior to any earthworks commencing on site, all erosion and sediment control measures will be implemented generally in accordance with the Construction Certificate drawings. The measures shown on the drawings are intended to be a minimum treatment only, as the contractor will be required to modify the erosion and sedimentation control measures to suit the construction program, sequencing and techniques. These measures may include:

- A site security fence and silt fence is to be constructed around the site;
- Installation of sediment fencing downstream of disturbed areas, including any stockpiles;
- Installation of silt arrestors to collect site runoff and retain suspended particles;
- Use of dust control measures including covering stockpiles, hessian to site fences and watering of exposed areas;
- Placement of hay bales or mesh and gravel filters around and along proposed catch drains and around stormwater inlet pits; and
- Construction of temporary sediment basins as required, and
- Harbour silt curtains.

4.1.2 Operational Phase

The prevention of erosion is achieved by protecting soils from the erosive forces of water and/or by controlling the flow of water to reduce erosive forces.

During the operational phase, erosion and sediment control will be achieved through:

- Selection and sizing of appropriate GPTs;
- Regular maintenance of all water quality measures to remove built-up sediment (by the asset owner);
- Separation of construction drainage and operational drainage during phase delivery if appropriate; and
- Adopting landscaped batter slopes appropriate to the soil type used.

4.2 Stormwater Drainage

4.2.1 Design Criteria

The stormwater network is proposed to be designed to provide:

- Low flows directed through water quality measures;

- Internal site piped drainage for major storm event flows (1 in100 year); and
- Safe overland flow paths to convey emergency overland flows.

4.2.2 Design Standards

The stormwater drainage network will be designed generally in accordance with the following standards and guidelines:

- Australian Rainfall and Runoff Volume 1 and 2, 1997;
- NSW Floodplain Development Manual 2005;
- City of Sydney Council Policies;
- AS3500 – Stormwater and Drainage Design codes;
- AS3725 – Loads on Buried Concrete Pipes;
- Managing Urban Stormwater – Soils and Construction Volume 1, 4th edition; and
- WSUD best practice, currently:
  - 95% GP,
  - 85% TSS
  - 65% TP
  - 45% TN.

4.2.3 Catchments

Based on available architectural plans, the development site will be divided into separate sub-catchments as a result of architectural layout staging and open space areas above the podium slab. The combined sub-catchments for Stage 1C total approximately 1.2ha which will drain to Darling Harbour.

Drawing SK004 contained in **Appendix C** provide details of sub-catchment areas and nominated discharge locations for Stage 1B and 1C.

4.2.4 Site Stormwater Drainage Strategy

It is proposed to collect rainwater runoff from roof areas, awnings, internal driveways and associated public domain areas utilising traditional stormwater capture devices, water quality measures and WSUD principles prior to storage or discharge.

Further design of the above system will be the subject of design development, however, it is intended to treat catchment flows in line with current industry best practice.

All internal drainage shall be based on rainfall intensity for a 1:100 year average recurrence interval for a storm event of 5 minute duration.

4.3 Water Sensitive Urban Design

4.3.1 Design Criteria

Stage 1C of Barangaroo South will adopt the principals of the site-wide water strategy with the following measures:

- Harvesting and reuse of rainwater;
- Reuse of treated water for landscape irrigation, flushing of public toilets and potentially top-up of the fire tanks; and
- Stormwater quality treatment prior to discharge to Sydney harbour.

Stage 1C will adhere to the Barangaroo South WSUD strategy and meet the pollutant reduction targets shown in Figure 3-1.

4.3.2 WSUD Strategy

The water quality strategy will consist of both internal and external treatment measures to achieve the required reductions in pollutant targets. The following internal measures will be incorporated into the development prior to discharge to Darling Harbour.

4.3.2.1 Rainwater Tanks

Rainwater tanks will be adopted to collect stormwater from the roof and balcony areas. Stormwater collected by the rain water tanks will not be used in other typical building water demands such as toilet flushing or supply water to mechanical plant.

4.3.2.2 Bio–Retention System

A series of bio retention systems are proposed as 'at source' treatment devices. The proposed system may include planter beds to podium and building roofs as well as tree pits along driveways and promenades.

4.4 Building Floor Levels

Minimum floor levels within the proposed development site are driven by three factors:

- Tie in to existing and proposed levels surround the development site;
- Future Harbour water levels; and
- Overland flow from upstream catchments.

4.4.1 Minimum Building Floor Levels

Main building floor levels are driven primarily by future harbour water levels. As discussed above, the future harbour level is predicted to rise to RL1.975 by the year 2100. It is recommended that the proposed seawall be constructed at RL2.575 to allow 300mm freeboard for each of storm surge and wave action.

To ensure that an emergency overland flow path exists for internal areas, it is proposed to grade the surface at from the top of the proposed new seawall and apply a freeboard of 200mm and local emergency flow depth of 100mm which results in a minimum floor level of approximately RL3.35.

Based on the current architectural design the proposed floor level is at 3.8m, well exceeding the recommended minimum.

4.5 Driveways

4.5.1 General

The driveway network is presented in **Figure 1-2** and is consists of:

- Basement carpark entry at the southern end of the development, off Lime Street; and
- One-way Porte-cochere off Lime Street.

4.5.2 Design Vehicle

The driveways have been designed to comply with the following vehicles:

- 12.5 m truck access to the loading dock via the basement driveway;
- Passenger vehicles to all carparks access and exits.

Design turning paths were modelled (Autoturn – Austroads 2006 vehicle templates) to determine where local increases in pavement width were required to ensure the design vehicle could negotiate turns and bends safely with adequate clearances.

4.5.3 Driveway Geometry and Grades

Driveway geometry and grades will be designed in accordance with AS2890 – Off-Street Parking.

4.6 Utility Service Provision

4.6.1 Potable Water Supply

Potable Water for the 1C development will be connected to the main within the road ways of Stage 1B and metered through privately owned pipework. A metering strategy will be provided to Sydney Water for approval. Minor water reticulation lines will be required to service public domain areas. Final details, routing and location of assets are to be agreed with Sydney Water during detailed design.

Existing and proposed potable water supply servicing plans are presented in **Appendix D**.

4.6.2 Recycled water services

Recycled water services extract take treated water from the central Recycled Water Treatment Plant for the following uses:

- Landscape Irrigation;
- Public toilet flushing.

Existing and proposed recycled water supply servicing plans are presented in **Appendix E**.

4.6.3 Sewer Services

Sewerage from Stage 1C will discharge to the central RWTP installed as part of Stage 1A works. Alternatively, the sewer may be connected directly to the existing sewer main in Hickson Road subject to future design assessment.

Internal sewerage reticulation within Stage 1C will be privately owned.

Existing and proposed sewer servicing plans are presented in **Appendix F**.

4.6.4 Electricity Services

Electrical services will be connected to the basement reticulation of 1B and directed to a main switch board within the development.

Existing and proposed electrical servicing plans are presented in **Appendix G**.

4.6.5 Telecommunications services

Telecommunication services will be connected to the basement reticulation of 1B and directed to a main communications distribution board within the development.

Existing and proposed telecommunications servicing plans are presented in **Appendix H**.

4.6.6 Natural gas services

Natural Gas for the development will be connected to the gas main within the road ways of Stage 1B and metered through privately owned pipework.

Existing and proposed gas servicing plans are presented in **Appendix I**.

4.6.7 Chilled water services

Chilled water services for will be connected to the reticulation main within the basement carpark and metered through privately owned pipework.

5 Conclusion

This report supports a Project Application submitted to the Minister for Planning and Infrastructure pursuant to Section 75J of Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Project Application seeks approval for construction of the Crown Sydney Hotel Resort.

The report addresses the following:

- Infrastructure and Stormwater drainage works external to the Stage 1C site, which has a direct effect on the Crown Sydney Hotel Resort development;
- Infrastructure and Stormwater drainage works within the Stage 1C site.

This report describes the proposed civil infrastructure for the site along with the strategy to manage stormwater including the following:

- Integrated Water Strategy;
- Stormwater Drainage;
- Water Sensitive Urban Design;
- Climate Change Adaption;
- Overland Flows and Flooding;
- Roads, Footpaths and Driveways;
- Utility Service Provisions;

The Barangaroo South Stages 1A and 1B have been designed and constructed to accommodate the servicing of Stage 1C.

The internal drainage system will capture large stormwater rainfall events (up to 100 year ARI) and safely convey these to Darling Harbour whilst also providing water quality treatment through a comprehensive treatment train.

The climate change induced sea level rise predicted for 2100 poses a risk to the effectiveness of the existing local stormwater drainage system in the Barangaroo area. However, the proposed diversion seeks to improve the capacity and allow for future climate change-driven increases in harbour water levels.

Lend Lease will enter into the necessary arrangements and obtain the necessary approvals for water supply, electrical supply, communications, sewer and stormwater connections from the relevant authorities, as required.

The measures proposed for Stage 1C are at a level of technology and innovation required by the governing authorities and in accordance with the controls and strategies developed for Barangaroo South. These measures have been adopted to warrant approval for the development.

APPENDIX A
EXTERNAL CATCHMENT PLAN

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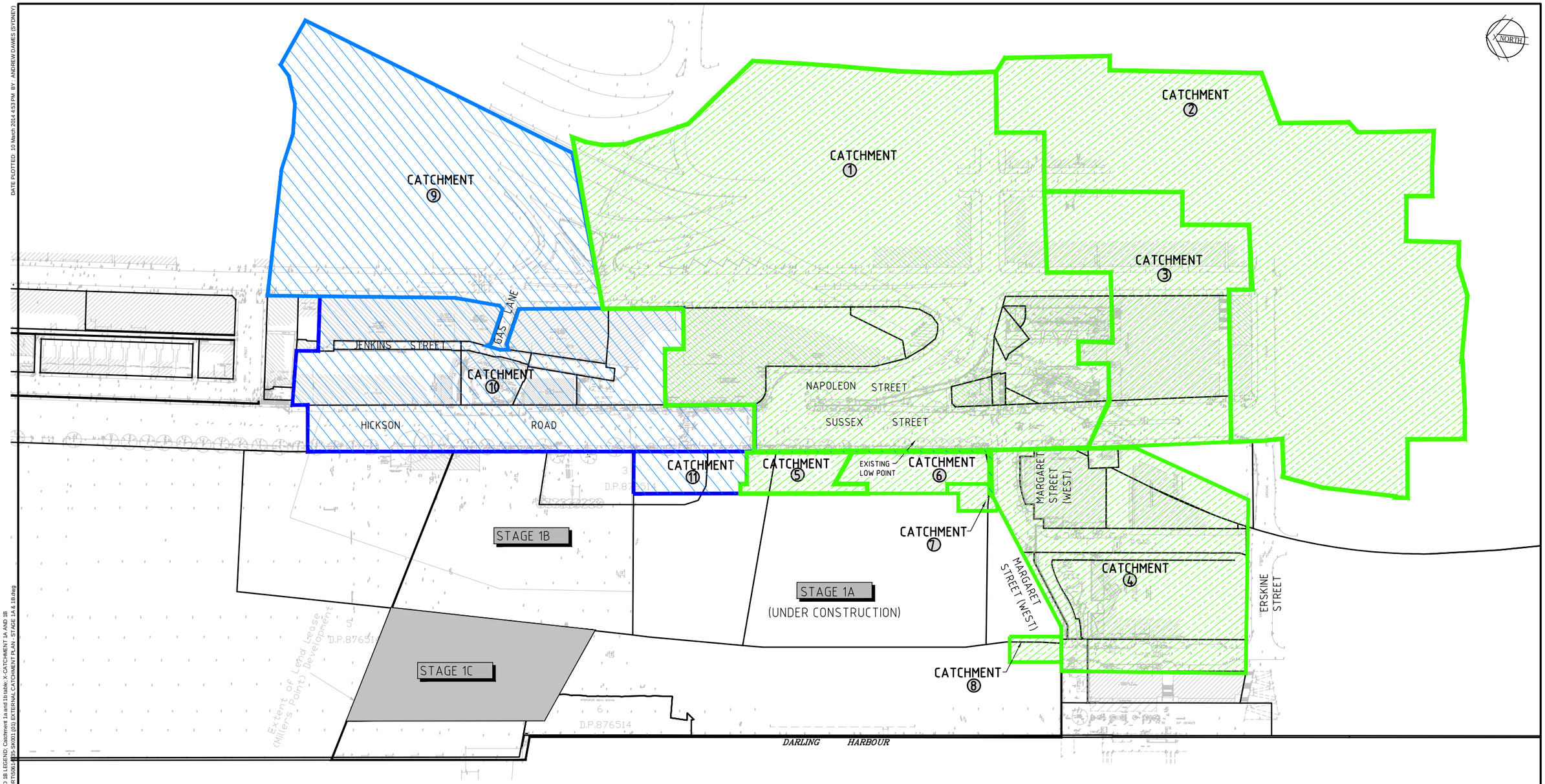

LEGEND

EXISTING STORMWATER

- SYDNEY WATER
- CITY OF SYDNEY COUNCIL
- MARITIME SERVICES BOARD

CATCHMENTS

- 1A CATCHMENTS
- 1B CATCHMENTS

STORMWATER DRAINAGE SUMMARY 1A

CATCHMENT No.	FLOW (100yr ARI) (m^3/s)	AREA (Ha)	DESCRIPTION
1	Q_{des} = 3.35	6.47	CATCHMENT DISCHARGES TO EXISTING LOW POINT WITHIN SUSSEX STREET AND THEN CONVEYED TO DARLING HARBOUR VIA PROPOSED STORMWATER CULVERT.
2	Q_{des} = 0.73	4.12	CATCHMENT DISCHARGES TO EXISTING DRAINAGE NETWORK ALONG ERSKINE STREET, OVERLAND FLOWS DISCHARGE THROUGH CATCHMENT 4 TO EXISTING LOW POINT WITHIN SUSSEX STREET.
3	Q_{des} = 2.34	4.79	NORTHERN CATCHMENT DISCHARGES TO 750Φ STORMWATER PIPE VIA HICKSON ROAD, THEN INTO STORMWATER CULVERT THROUGH DEVELOPMENT SITE.
4	Q_{des} = 0.92	1.80	CATCHMENT DISCHARGES TO PROPOSED STORMWATER CULVERT AND OVERLAND FLOWS DISCHARGE DIRECTLY TO DARLING HARBOUR.

STORMWATER DRAINAGE SUMMARY 1A

CATCHMENT No.	FLOW (100yr ARI) (m^3/s)	AREA (Ha)	DESCRIPTION
5	Q_{des} = 1.19	0.17	INTERNAL CATCHMENT DISCHARGES TO PROPOSED STORMWATER CULVERT AND THEN CONVEY TO DARLING HARBOUR.
6	Q = 0.256	0.21	INTERNAL CATCHMENT DISCHARGES TO PROPOSED STORMWATER CULVERT AND THEN CONVEY TO DARLING HARBOUR.
7	Q = 0.072	0.11	INTERNAL CATCHMENT DISCHARGES TO PROPOSED STORMWATER CULVERT AND THEN CONVEY TO DARLING HARBOUR.
8	Q = 0.038	0.05	INTERNAL CATCHMENT DISCHARGES TO PROPOSED STORMWATER CULVERT AND THEN CONVEY TO DARLING HARBOUR.

STORMWATER DRAINAGE SUMMARY 1B/1C

CATCHMENT No.	FLOW (100yr ARI) (m^3/s)	AREA (Ha)	DESCRIPTION
9	Q_{des} = 2.35	2.83	CATCHMENT DISCHARGES INTO GAS LANE THROUGH A Φ600 PIPE, THEN INTO AN EXISTING Φ1200 PIPE THROUGH THE STAGE 1B DEVELOPMENT SITE DIRECTLY INTO DARLING HARBOUR. OVERLAND FLOW SPLITS AT THE INTERSECTION OF GAS LANE AND JENKINS STREET AND DISCHARGES INTO HICKSON ROAD DRAINAGE.
10	Q_{des} = 1.69	2.29	CATCHMENT DISCHARGES INTO HICKSON ROAD DRAINAGE AND THEN DRAINS TO EXISTING STORMWATER SYSTEM, THROUGH THE STAGE 1B DEVELOPMENT SITE.
11	Q_{des} = 0.2	0.182	CATCHMENT DISCHARGES INTO HICKSON ROAD DRAINAGE, THEN DRAINS TO EXISTING STORMWATER SYSTEM THROUGH THE STAGE 1B DEVELOPMENT SITE.

Rev.	Date	Description	Des.	Verif.	Appd.
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SCALE 1:1000 (0, 20, 40, 60, 80, 100m) B1

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Approved	AD	FEB'14

Client: CROWN MELBOURNE LIMITED

CIVIL ENGINEERING CONSTRUCTION DESIGN
CROWN DEVELOPMENT BARANGAROO

EXTERNAL CATCHMENT PLAN - STAGE 1A & 1B

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A.H.D.		1:500	B1

Drawing Number: 50614035-SK001
Revision: 01

APPENDIX B
PROPOSED STORMWATER DIVERSIONS

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JENKINS STREET

TEMPORARY DIVERSION AS PART OF STAGE 1A.

HICKSON ROAD

NAPOLEON STREET

SUSSEX STREET

MARGARET STREET (WEST)

MARGARET STREET (WEST)

WORKS PROPOSED FOR BARANGAROO CENTRAL DIVERSION

WORKS COMPLETED UNDER STAGE 1B STORMWATER DIVERSION WORKS

WORKS COMPLETED UNDER STAGE 1A STORMWATER DIVERSION WORKS

WORKS COMPLETED UNDER STAGE 1A STORMWATER DIVERSION WORKS

LINE A

LINE B

LINE C

LINE D

LINE OF BASEMENT BELOW

STAGE 1A

STAGE 1B

STAGE 1C

STAGE 1B D-WALL

EXISTING SYDNEY WATER ASSET TO BE RETAINED.

MAINTAIN DISCHARGE OUTLETS FOR FUTURE CONNECTION

D.P.876514

NORTH

LEGEND

- SW — SYDNEY WATER
- SW — CITY OF SYDNEY COUNCIL
- SW — MARITIME SERVICES BOARD

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PROPOSED STORMWATER DIVERSIONS

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A.H.D.		1:500	B1

Drawing Number: 50614035-SK003
Revision: 01

APPENDIX C
INTERNAL CATCHMENT PLAN

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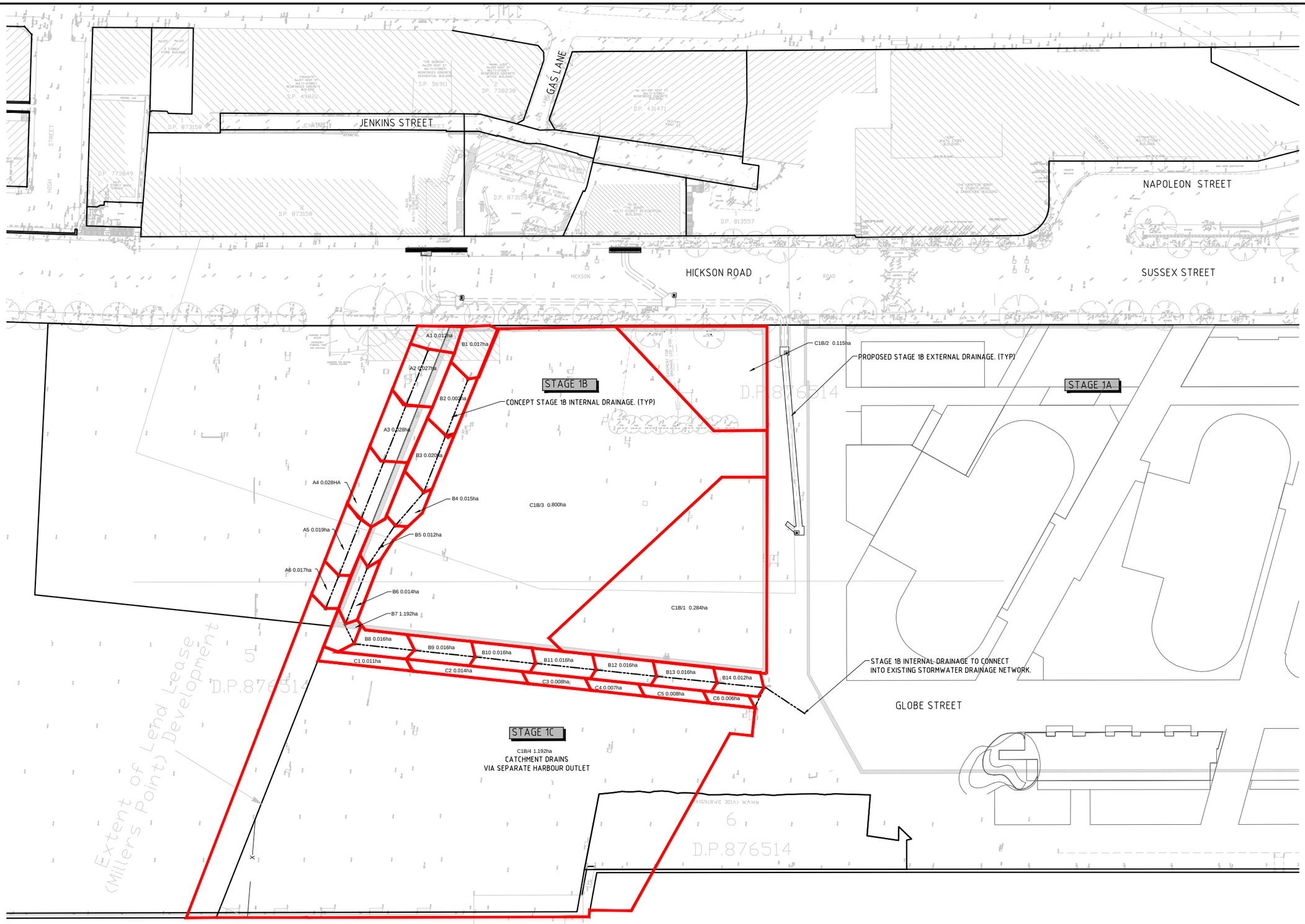

Rev.	Date	Description	Des.	Verif.	Appd.
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CIVIL ENGINEERING CONSTRUCTION DESIGN
CROWN DEVELOPMENT BARANGAROO

STAGE 1B INTERNAL CATCHMENT PLAN

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Datum	Register	Scale	Size
A.H.D.		1:500	B1

Drawing Number: 50614035-SK004
Revision: 01

APPENDIX D
POTABLE WATER SERVICING PLANS

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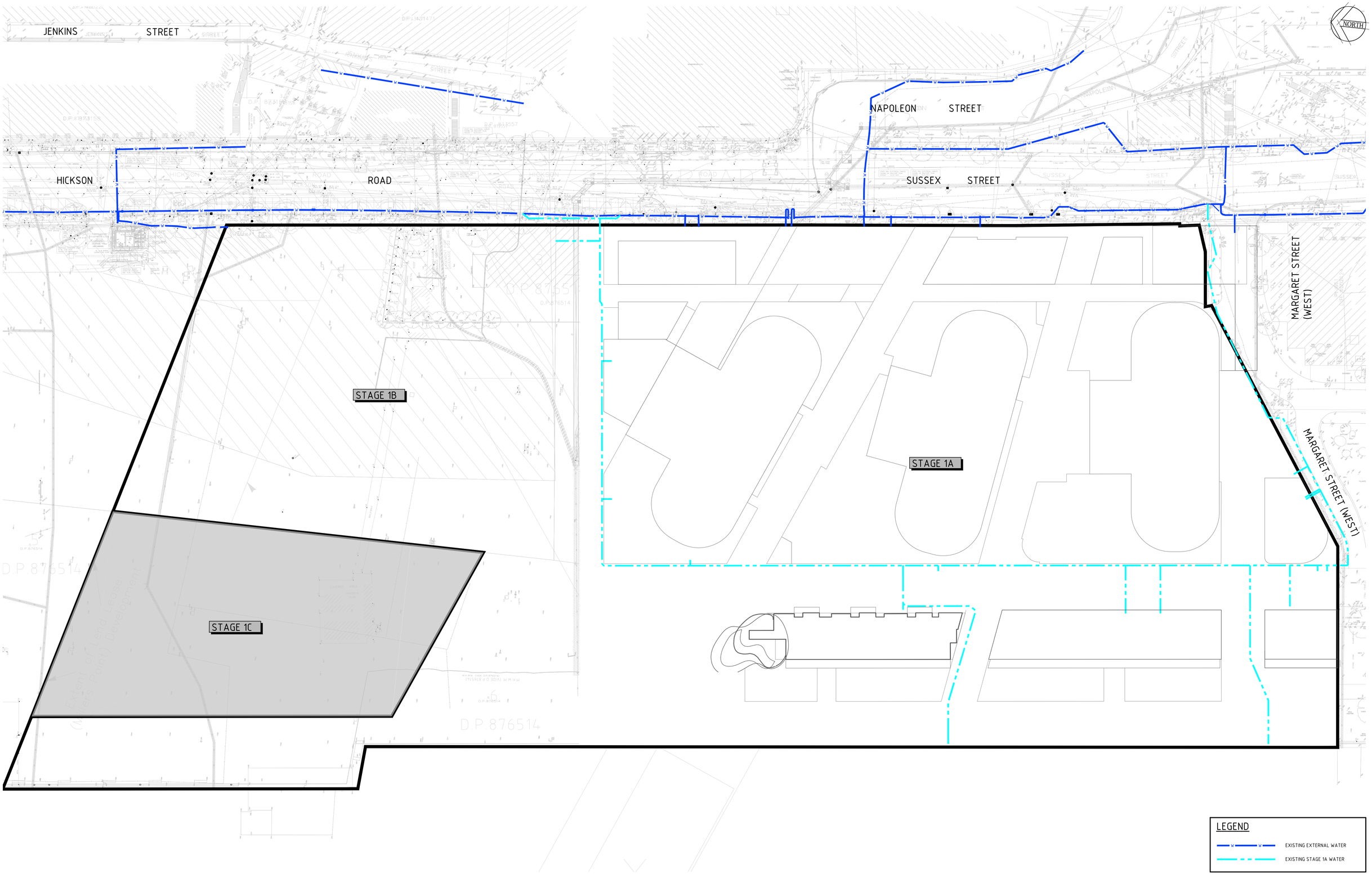

Rev.	Date	Description	Des.	Verif.	Appd.
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CROWN DEVELOPMENT BARANGAROO

EXISITNG WATER SERVICES

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Drawing Number: 50614035-SK003
Revision: 01

DATE PLOTTED: 14 February 2014 3:50 PM BY : RICHARD TU (SYDNEY)

XREF's: GRP-SHT-B1; BU-LOGO-B1; 74216-36a_m; X-STAGE BOUNDARIES; X-ARCHITECTURE MASTER MOD 6_m; X-WATER SERVICE PROPOSED; CID-SHT-B1; X-WATER SERVICE EXISTING; X-STG1B ARCH GROUND; X-STG1C ARCH BASEMENT L3; X-DETAIL SURVEY; X-ARCH ALL STAGES
CAD FILE: N:\Projects\506\FY14\035_Crown Development Barangaroo\Drawings\Build1.SKETCHS\50614035-SK004 (01) PROPOSED WATER SERVICES.dwg

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CROWN DEVELOPMENT BARANGAROO

PROPOSED WATER SERVICES

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APPENDIX E
RECYCLED WATER SERVICING PLANS

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CIVIL ENGINEERING CONSTRUCTION DESIGN
CROWN DEVELOPMENT BARANGAROO

EXISITNG RECYCLED WATER SERVICES

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A.H.D.		1:500	B1

Drawing Number: 50614035-SK005
Revision: 01

DATE PLOTTED: 14 February 2014 3:51 PM BY : RICHARD TU (SYDNEY)

XREFs: GRP-SHT-B1; BU-OCO-B1; 74216-36a_m; X-STAGE BOUNDARIES; X-ARCHITECTURE MASTER MOD 6_m; X-RECYCLED WATER SERVICE EXISTING; CID-SHT-B1; X-ARCH ALL STAGES; X-DETAIL SURVEY
CAD FILE: N:\Projects\506\FY14\035_Crown Development Barangaroo\Drawings\Build\1.SKETCHS\50614035-SK005 (01) EXISTING RECYCLED WATER SERVICES.dwg

JENKINS STREET

HICKSON ROAD

NAPOLEON STREET

SUSSEX STREET

MARGARET STREET (WEST)

MARGARET STREET (WEST)

NORTH

CONNECT TO EXISTING RECYCLED WATER SERVICE

RECYCLED WATER DELIVERY PUMP

RECYCLED WATER STORAGE TANKS

STAGE 1B

LINE OF BASEMENT BELOW

RECYCLED WATER RETICULATION LOCATED AT HIGH LEVEL IN BASEMENT

STAGE 1A

STAGE 1C

STAGE 1C RECYCLED WATER CONNECTION

D.P.876514

LEGEND

- EXISTING STAGE 1A RECYCLED WATER
- PROPOSED STAGE 1B & 1C RECYCLED WATER

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Verified	AD	Date FEB'14
Approved	AD	Date FEB'14

Client: CROWN MELBOURNE LIMITED

CIVIL ENGINEERING CONSTRUCTION DESIGN
CROWN DEVELOPMENT BARANGAROO

PROPOSED RECYCLED WATER SERVICES

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Datum	Register	Scale	Size
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Drawing Number: 50614035-SK006
Revision: 01

APPENDIX F
SEWER SERVICING PLANS

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