Lend Lease (Millers Point) Pty Limited

Barangaroo South - Concept Plan Amendment (MP06_0162 MOD4)

Stormwater Concept Plan

ARUP

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Appendices

1 Introduction

1.1 Background

On the 20th December 2009, Lend lease (Millers Point) Pty Limited (Lend Lease) was appointed as the preferred proponent to develop Barangaroo South: comprising of Blocks 1 to 4 and associated public areas.

The area of land that is subject to the Concept Plan Amendment is indicatively shown in Figure 1, and is herein referred to as “Barangaroo South” or the “Site”. It comprises an open apron which is largely reclaimed over water and is identified in the existing approved Concept Plan as Blocks 1 – 4 and the immediately adjacent public recreation area. Barangaroo South also extends beyond the western edge of the existing apron and includes a north-west oriented intrusion into the existing waters of Darling Harbour (see Figure 1).

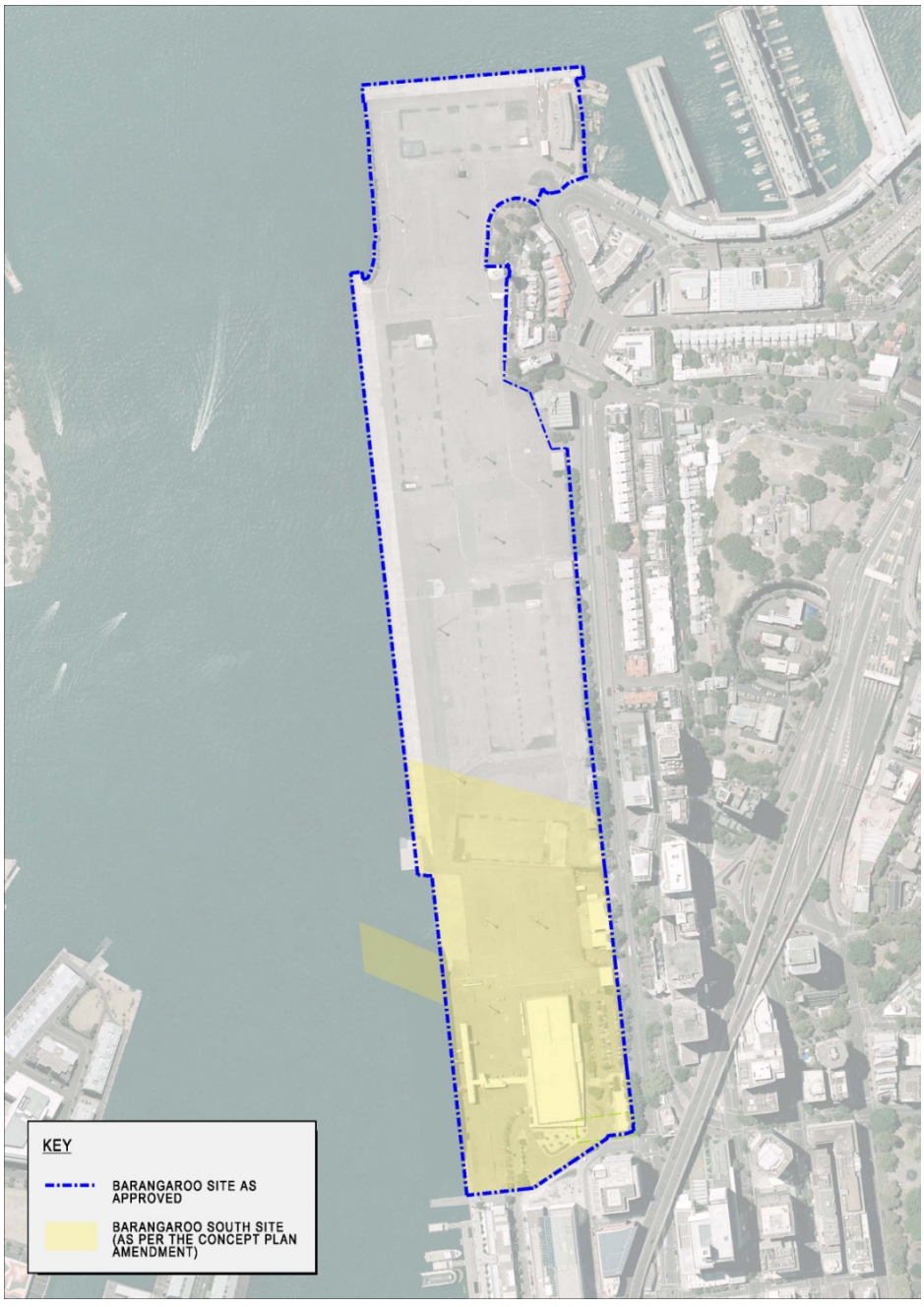

Figure 1: Indicative Site Boundary for Barangaroo South

1.2 1.2 Planning History

On 9 February 2007 the Minister approved a Concept Plan for the site and on 12 October 2007 the land 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;
- approximately 11 hectares of new public open space/public domain, with a range of formal and informal open spaces serving separate recreational functions and including a 1.4km public foreshore promenade;
- maximum building heights and maximum GFA for each development block within the mixed use zone; and
- public domain landscape concept, including parks, streets and pedestrian connections.

A condition of consent also required two enlarged water intrusions into the Barangaroo site, one at the northern end and one at the southern end and the creation of a natural northern headland.

Modification No. 1 was approved in September 2007 which corrected a number of minor typographical errors.

On 25 February 2009 the Minister approved Modification No. 2 to the Concept Plan. The Approved Concept Plan as modified allowed for a mixed use development involving a maximum of 508,300m^2 of gross floor area (GFA) contained within 8 blocks on a total site area of 22 hectares.

On 11 November 2009 the Minister approved Modification No. 3 to the Concept Plan to allow for a modified design for the Headland Park and Northern Cove. The Approved Concept Plan as modified allowed for a mixed use development involving a maximum of 489,500m^2 of gross floor area (GFA) contained within 7 blocks on a total site area of 22 hectares.

The proposed Concept Plan Amendment (MP 06_0162 MOD 4) seeks the Minister's consent for:

- additional GFA within Barangaroo South, predominantly related to an increase in residential GFA;
- redistribution of the land use mix;
- an increase in height of a number of the proposed towers within Barangaroo South;
- the establishment of the new pier and landmark building extending into the Harbour; and
- reconfiguration and activation of the public waterfront area through the introduction of uses including retail and residential to the west of Globe Street.

1.3 Purpose

This report has been prepared in support of the Concept Plan Amendment (MP06_0162 MOD 4) for Barangaroo. It addresses the Director General Requirements and is intended to comply with the statement of commitments which relate to integrated water management and guidelines.

Furthering the Principles of an integrated approach to Water Sensitive Urban Design (WSUD), this report and accompanying Figures addresses the following issues:

- The overall site water management strategy, of which stormwater is a component;

- Stormwater collection, re-use and discharge;
- Stormwater quality management; and
- Site overland flow paths

2 Integrated Water Strategy Overview

2.1 Approach Summary

2.1.1 Water Balance

A conceptual water balance for the Barangaroo South site has been completed. A summary of the water sources and strategies is provided in Figure 2 below.

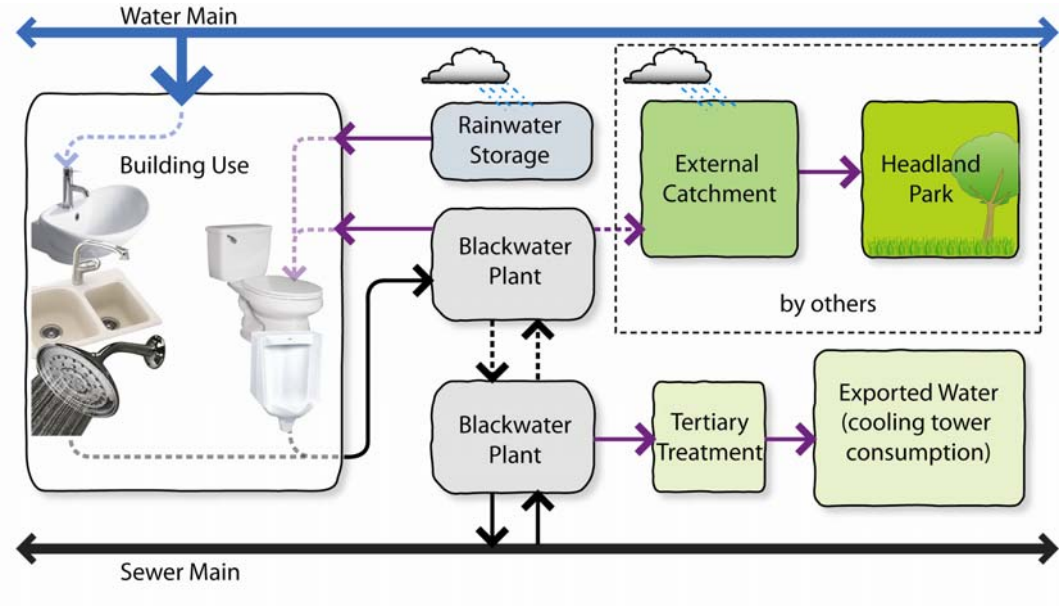

Figure 2: Barangaroo South Water flow diagram

2.1.2 Potable Water

A target of 80% reduction in potable water use for the entire development will be achieved through:

- Efficient water fittings across the Barangaroo South development;
- All possible non-potable water uses, within the commercial and residential buildings, are proposed to be supplied with non-potable water;
- Collection of stormwater run-off, from the building roofs, treated where necessary, and reticulated back through the same building as non-potable water;
- Collection and treatment of sewerage at the site's proposed Blackwater Plant, which can be reticulated to the non-potable water uses within the commercial and residential building; and
- Minimising the landscape irrigation requirements, by the selection of drought tolerant species;

It is proposed to target this 80% reduction for Barangaroo South.

The reduction in use of Potable Water will be subject to further design development and will be detailed in future relevant Project Applications.

2.1.3 Non-potable Water

The sources of the non-potable water supply will be thoroughly evaluated to ensure that they satisfy the current strategy to utilise both the rainwater from the Barangaroo South building roofs and paved area runoff (where feasible), and to utilise the supply of recycled

water produced by the centralised on site black water treatment plant, to supplement the non-potable water supply.

The Barangaroo South site is required to have the capacity to export a greater volume of recycled water off-site, than the potable water volume utilised on-site. To achieve this requirement, sewer mining of the existing adjacent Sydney Water sewerage system will need to be investigated and considered in more detail.

Non Potable Water use will be subject to further design development and will be detailed in future relevant Project Applications.

2.1.3.1 Rain water and On-site stormwater

The proposed strategy is to maximise rainwater reuse on site. Rainwater is proposed to be utilised for approved non potable uses such as toilet flushing and irrigation.

Excess stormwater shall be discharged into the harbour, after meeting the required reductions in nutrients and total suspended solids.

Rainwater reuse will be subject to further design development and will be detailed in future relevant Project Applications.

2.1.3.2 Wastewater

All wastewater discharged by the Barangaroo South buildings is to be routed to the centralised on-site black water plant, from which it can be either:

- Treated and reticulated back to the buildings as non-potable water;
- treated and exported off-site via recycled water mains to nearby buildings for their re-use of non-potable water; or
- discharged from site untreated, into the Sydney Water system, subject to a further agreement with Sydney Water.

To satisfy the requirement to have the capacity to export a Nett volume of recycled water from the site, greater than the potable water utilised on site, the use of sewer mining will need to be analysed.

The management of Waste Water will be subject to further design development and will be detailed in future relevant Project Applications.

2.1.4 External stormwater

The external catchment stormwater run-off, which currently passes through the wider Barangaroo site, will need to be managed such that the impacts of the Barangaroo South development do not increase flood inundation, either upstream or downstream of the site.

The management of external stormwater will be subject to further design development, detailed modelling and will be detailed in future relevant Project Applications. Further detailed discussion of this topic can be found in the reports submitted as part of the original Concept Plan application which was approved by the Minister for Planning in 2007.

3 Catchments

3.1 Internal catchment

The Barangaroo South site under the Concept Plan Amendment comprises the following approximate areas:

- Roof area (including canopies) = 3.3 Ha
- Paved area = 2.9 Ha
- Pervious/green space areas (and parklands) = 0.8 Ha
- TOTAL AREA = 7.98Ha (including Southern Cove and the Canal)

3.2 External catchment

Based on interpolation of Department of Lands contour data, the external catchment area draining to the Barangaroo - South site is shown approximately in *Figure 4*, *Appendix A*.

4 Stormwater Quality

4.1 Design Targets

The minimum stormwater quality criteria for Barangaroo - South development are the achievement of national Best Practice standards as follows:

- Removal of litter and gross pollutants from stormwater running into the harbour of greater than 95%;
- A reduction in average annual loads of total suspended solids (TSS) of greater than 80%; and
- A reduction in average annual loads of total nutrients of greater than 45%.

4.2 Design Standards

The stormwater treatment measures will be designed in accordance with the following standards and guidelines:

- Australian Rainfall and Runoff Volume 1 and 2, 1997; and
- Australian Runoff Quality – A Guide to Water Sensitive Urban Design (2006).

4.3 Design Strategy

4.3.1 Treatment Strategy

All stormwater discharged to the harbour is to be treated to reduce suspended solids and the nutrient levels. The strategy is to maximise the rainwater reuse to minimise treatable flow volumes (Refer Section 2 for rainwater reuse strategy).

Potential treatment strategies have been modelled in the industry-standard WSUD software “MUSIC” to evaluate pollutant removal efficiencies. Several strategies exist which can meet the discharge criteria, and the final strategy will be dependent on the details of the final development Concept Plan.

Given the size and grades across the site, it is anticipated that detailed design will determine that some areas on the ground plane will be difficult to direct through multiple steps of a treatment train. The anticipated treatment train for South will therefore be as follows, as depicted in the schematic shown in Figure 3:

Roof Areas:	Rainwater Tank → GPT
Paved and Vegetated Areas:	GPT → Swale → Bio-retention (partial site)
Paved and Vegetated Areas:	GPT only (partial site)
Paved and Vegetated Areas:	Bio-retention only (partial site)

The details of final treatment train will be the subject of further design development.

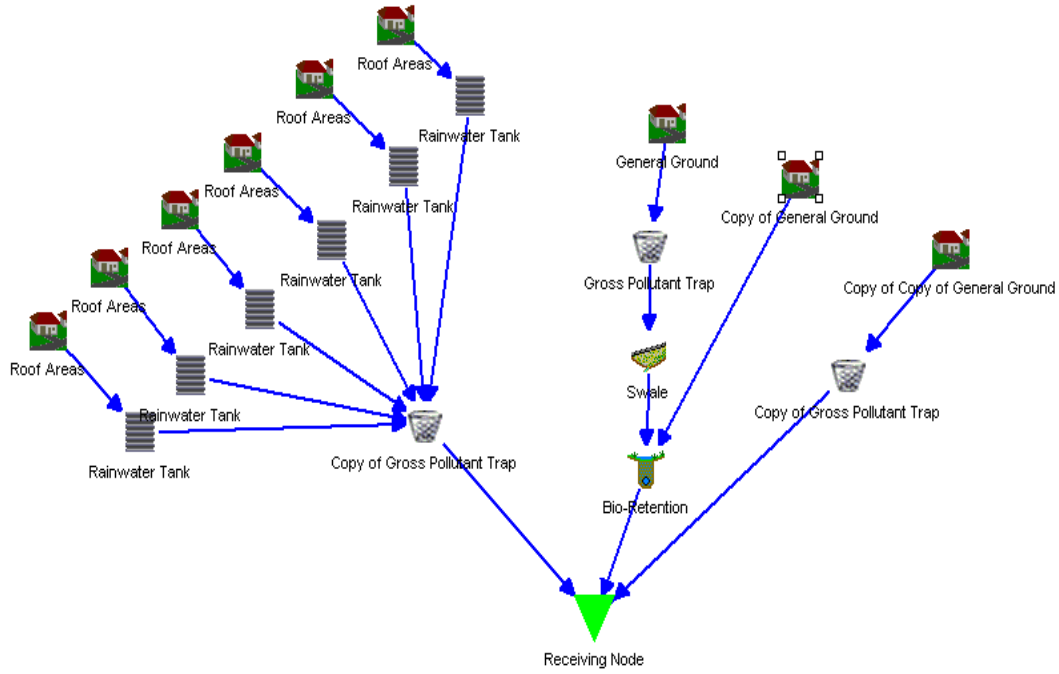

Figure 3: Conceptual Water Treatment Schematic (subject to design development)

4.3.2 Treatment Performance

Table 1 summarises the pollutant removal efficiency for the above treatment measures.

Table 1 Treatment Measures and Performance

Stage	Description	Target Performance (% Reduction)
Barangaroo South	• Roof catchment → Rainwater Tank → GPT • Ground Catchment → GPT → Swale →Bio-Retention • Ground Catchment → Bio-Retention • Ground Catchment → GPT	Litter reduced – 95% TSS – 80% Total Phosphorous(TP) – 45% Total Nitrogen (TN) – 45%

In practice, during later design stages, swales and bio-retention systems can be incorporated into the streetscape or public open space as water quality elements including bio-retention street trees, kerb side strips and rain-gardens.

The Treatment Strategy will be subject to further design development and will be detailed in future relevant Project Applications.

4.3.3 Proposed Treatment Measures

Gross Pollutant Tank (GPT)

A gross pollutant trap is a treatment device designed to remove coarse sediment, litter and other debris carried by stormwater. This option is to be a first stage treatment. The GPT's are proposed to be CDS (Continuous Deflective Separation) units, or similar.

The GPT's will typically operate under a high flow bypass system, where flows in excess of the design treatment capacity will be diverted to a conventional piped drainage system.

Vegetated Swales

A swale is an open vegetated channel which treats stormwater by delaying flows, and allowing sediment to settle out as well as reducing nutrients by means of uptake by the

vegetation. Removal efficiency is closely dependent on the density and height of vegetation which frequently is mown grass.

Bio-retention Systems and Rain-gardens

Bio-retention systems and Rain-gardens are composed of an infiltration zone for treatment of stormwater which then flows to an underlying pipe to convey flows to the outlet. There is also an element of surface storage in these systems which will attenuate peak flows, and allow treatment of a higher portion of stormwater falling on the site. These will achieve a superior level of treatment for an equivalent area when compared with swales.

Bio-retention tree pits can combine the above infiltration zone and underlying pipe with a tree pit, enabling direct irrigation of the tree as well as stormwater treatment.

4.3.4 External Stormwater Quality

Pipes draining external stormwater through the Barangaroo South site will typically be intercepted and GPT's installed to reduce the discharge of suspended solids and refuse into the harbour.

It is proposed to extend this existing stormwater network to allow some external stormwater to flow to and be stored in the cultural parkland (part of Barangaroo Central also known as Barangaroo Stage 2) for use in irrigation of the future parkland. This irrigation system could have a top-up available from the recycled water system, incorporated in Barangaroo South. This concept will be developed in applications for the Parkland.

The re-aligned pipe network is proposed to be intercepted and Gross Pollutant Traps (GPT's) installed (under a future Project Application) to reduce the discharge of suspended solids and refuse into the Harbour. This will improve the existing discharge quality for the external catchment.

Proposed Treatment measures including natural treatment systems will be subject to further design development and will be detailed in future relevant Project Applications.

5 Stormwater Drainage

5.1 Design Criteria

The stormwater network is proposed to be designed to provide:

- Positive drainage for minor storm event flows (1 in 20 year, or 5% AEP event); and
- Safe overland flow paths to convey major (1 in 100 year, or 1% AEP event) storm flows.

5.2 Design Standards

The stormwater drainage network will be generally designed 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;
- AS 3500 – Stormwater and Drainage Design codes;
- AS 3725 – Loads on Buried Concrete Pipes; and,
- Managing Urban Stormwater – Soils and Construction Vol1, 4th edition.

5.3 Existing Stormwater Network

5.3.1 Network Data

Information regarding the availability of the existing services has been obtained from a number of documents including a Dial Before You Dig (DBYD) search and the Services Overview Report prepared by Cardno Limited - Report number 600062-R002 Nov 2005.

5.3.2 Network Description

The existing stormwater network is characterised by a series of transverse piped stormwater systems draining Hickson Road and other external catchments through the Barangaroo South and Barangaroo Central directly to the harbour.

The locations of the existing network are not compatible with proposed development and their removal or relocation is proposed as indicated in *Figure 5*, *Appendix B*.

5.4 Design Strategy

5.4.1 On-site Stormwater

It is proposed that rainwater falling on roofs from Barangaroo South is collected through either a central rainwater tank or individual rainwater tanks within buildings. This rainwater typically will be harvested for reuse, reducing the runoff entering the stormwater system.

A typical minor-major drainage strategy will be adopted for stormwater drainage from paved areas. This will incorporate a piped network generally designed to meet Council drainage standards conveying minor storm event flows (1 in 20 year) to the harbour, and overland flow paths conveying major (1 in 100 year) storm flows. Building/basement entries will be designed to provide adequate freeboard above the predicted 1 in 100 year overland flow levels.

The concept stormwater drainage network is provided in *Figure 5*, *Appendix B*.

The management of on-site Stormwater will be subject to further design development and will be detailed in future relevant Project Applications.

5.4.2 On-site Detention

City of Sydney Council has confirmed that due to the proximity of the site to the harbour, no on-site detention of stormwater will be required.

5.4.3 External Stormwater

Pipes draining the stormwater run-off from the external catchments, through the Barangaroo South site will be generally relocated as shown in *Figure 5*, *Appendix B*, to suit the proposed development layout and easements or reserves should be created where necessary.

It is proposed to extend this existing stormwater network to allow external stormwater to flow to and be stored in the cultural parkland (part of Barangaroo Central also known as Barangaroo Stage 2) for use in irrigation of the future parkland. This irrigation system could have a top-up available from the recycled water system, incorporated in Barangaroo South. This concept will be developed in applications for the Parkland.

The management of external stormwater will be subject to further design development and will be detailed in future relevant Project Applications.

5.5 Overland Flows

5.5.1 Historic Flood Data

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.

5.5.2 Existing Scenario

The 1% AEP flow rates generated by the external catchments refer to Figure 5, Appendix B, have been estimated by applying the Rational Method flow estimation technique.

The management of Overland Flows will be subject to further stakeholder consultation, design development and will be detailed in future relevant Project Applications.

6 Erosion and Sediment Control

6.1 Construction Phase

Erosion and Sediment Control Plans will be prepared as part of each Project Application for works and will be implemented.

6.2 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:

- Minimising disturbance and fast re-vegetation of disturbed areas, during phased delivery of the site for occupation;
- A properly designed and maintain drainage system which will include:
  - selection of appropriate vegetation for swales and bio-retention areas;
  - selection of appropriate filter media for bio-retention systems;
  - incorporating multiple drainage entry points to bio-retention systems to avoid concentration of flow;
  - incorporating energy dissipaters at drainage outfalls;
  - selection and sizing of appropriate GPT's;
  - regular maintenance of all water quality measure to remove built-up sediment;
  - separation of construction drainage and operational drainage during phase delivery; and
- Adopting permanent landscaped batter slopes appropriate to the soil type used.

The Operational Phase Erosion and Sedimentation controls will be subject to further design development and will be detailed in future relevant Project Applications.

7 Climate Change Adaptation

Please refer to the Barangaroo - South, *Climate change and Sea level rise report*, prepared by Arup for the subject Concept Plan Amendment.

It should be noted that the levels of the existing stormwater system, and the proposed levels of any the augmentation of the existing stormwater system, will be significantly impacted upon by the potential effects of sea level rise. This is because there is limited fall between existing street kerb levels and current sea levels and it is current industry practice to rely entirely on gravitational flow. In the event that sea levels increase to a height where the functionality of city stormwater infrastructure is impacted it is assumed that mitigation measures on a scale beyond Barangaroo will need to be considered.

8 Conclusion

It is concluded that in the absence of potential climate change induced rises in sea level, appropriate stormwater management for the Barangaroo South site, as per proposed Concept Plan Amendment (MP06_0162 MOD4), can be designed and constructed utilising industry standard and proven design and construction techniques.

If the climate change induced sea level rises eventuate as forecast for the year 2100, the management of overland flows from upstream of Barangaroo will be problematic using current industry practices. This issue will not be limited to Barangaroo and will need to be assessed on a holistic citywide scale. In this context, a detailed risk assessment identifying appropriate mitigation measures is to be developed as part of design development.

Appendix A

Existing Stormwater Catchments

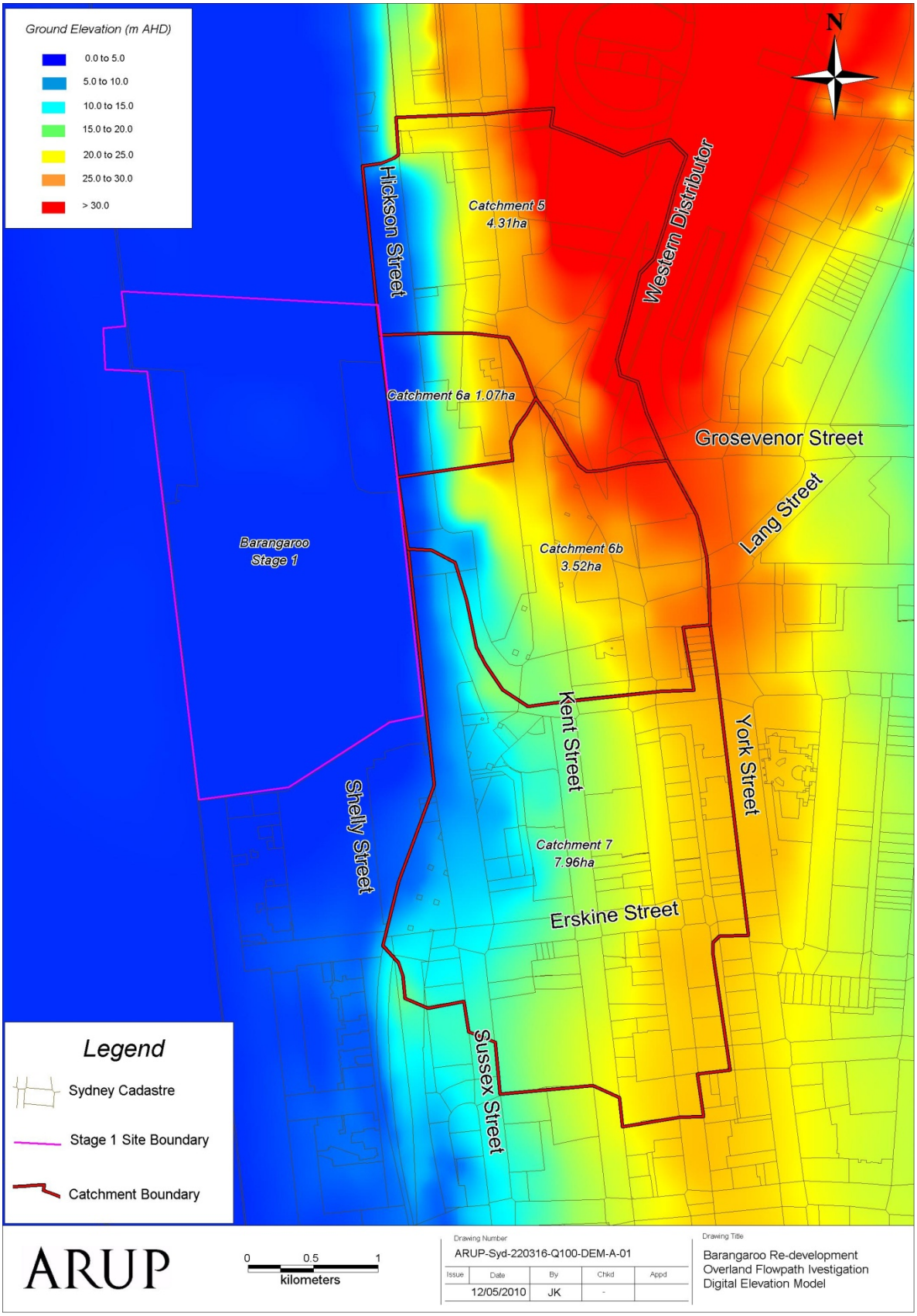

Figure 4 Digital Elevation Model (DEM) of the Sydney City Precinct, showing Barangaroo – South external stormwater catchments

Appendix B

Proposed Stormwater Concept Plan

A3

FUTURE CONNECTION OF STORMWATER TO CENTRAL PARKLAND STORAGE. CENTRAL PARKLAND STORAGE PROVIDED BY BDA

UPGRADE & REALIGN EXTERNAL STORMWATER PIPE SYSTEM. AROUND BASEMENT AND SOUTH COVE FOOTPRINT.

UPGRADE EXTERNAL STORMWATER PIPE SYSTEM WITH ROAD RE-ALIGNMENT.

PLACE GPT ON LINE BEFORE HARBOUR DISCHARGE

REALIGNED EXTERNAL STORM WATER MAIN AROUND BASMENT AND SOUTH COVE FOOTPRINT.

PLACE GPT ON-LINE BEFORE HARBOUR DISCHARGE

EXISTING Ø600 EXTERNAL MAIN TO BE REMOVED

LEGEND

- REVISED SITE STORMWATER DRAINAGE
- EXISTING SITE STORMWATER DRAINAGE RETAINED.
- EXISTING SITE STORMWATER DRAINAGE REMOVED.
- EXISTING OVERLAND FLOW PATHS 1% AEP EVENT TO BE MAINTAINED

THIS LAYOUT IS INDICATIVE ONLY AND WILL BE SUBJECT TO DESIGN DEVELOPMENT CHANGES

Issue	Date	By	Chkd	Appd
C	29/07/10	MJD	AP	AP
B	03/06/10	MMH	AP	AP
A	19/05/10	MMH	AP	AP

Client
LEND LEASE (MILLERS POINT) PTY LIMITED

Job Title
BARANGAROO
BARANGAROO SOUTH
- CONCEPT PLAN AMENDMENT

Scale at A3 1:2000

Discipline Civil

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Drawing Title
PROPOSED STORMWATER CONCEPT PLAN

Drawing Status
PRELIMINARY

Job No	Drawing No	Issue
220316	FIGURE 1	B

Do not scale