



SYDNEY INTERNATIONAL CONVENTION, EXHIBITION AND ENTERTAINMENT PRECINCT
THE HAYMARKET PRECINCT – SOUTH WEST PLOT

FLOODING, STORMWATER & WSUD

FOR SSDA5



DARLING HARBOUR LIVE

SICEEP – THE HAYMARKET (SOUTH WEST PLOT)

FLOODING, STORMWATER & WSUD FOR SSDA5

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EXECUTIVE SUMMARY

Hyder Consulting has been engaged by Lend Lease to provide a stormwater management and Water Sensitive Urban Design (WSUD) strategy to support a Stage 2 Development Application (referred to as SSDA4), to be submitted in relation to the South Western Plot in The Haymarket precinct to be developed on part of the Darling Harbour area known as the Sydney International Convention, Exhibition & Entertainment Precinct (SICEEP).

This report addresses Director General's Requirements for this site relevant to flooding, stormwater and Water Sensitive Urban Design (WSUD).

Flooding and Stormwater

The SICEEP site is downstream of several large stormwater catchments totalling approximately 190 ha, as outlined in Figure A.

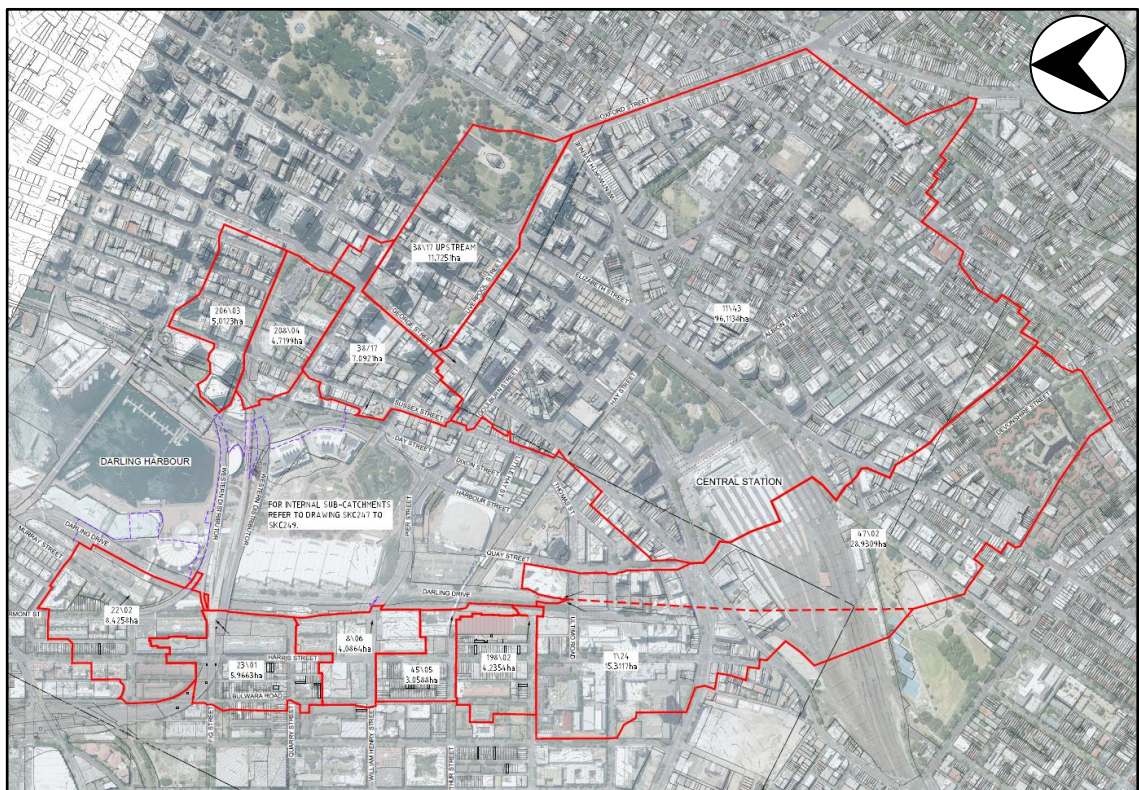


Figure A: Darling Harbour Catchments

There are a number of large Sydney Water underground culvert systems that convey the Darling Harbour catchment runoff through the site and into Darling Harbour. However these underground systems do not convey all runoff up to the 100 year ARI flood event and as a result there are a number of significant overland flow paths that run through the site.

The general flood assessment and design approach for the proposed development has been to retain the existing Sydney Water box culvert systems, and mitigate the potential flood impact on overland flows by amplifying the underground culvert system.

To demonstrate no adverse flood impacts as a result of the proposed development, a flood assessment has also been carried out for existing conditions. Existing conditions, proposed development condition and flood impact figures are all included within Hyders Flooding and Stormwater Report No. DN00341 dated 18th March 2013 (refer to Appendix A for a copy of this report which was also annexed to Hyders Flooding and Stormwater Report No. DN00342 dated

15th March 2013 submitted with the SSDA2) and demonstrate conformance to the Director General's requirements.

A formal Flood Risk Assessment is not available for this site but will be required to assess proposed floor levels with respect to formal flood planning levels.

In relation to proposed architectural floor levels, it should be noted that:

- Floor levels within the South West Plot are nominally at RL3.6 which is generally above the 100 year flood level (including climate change) as shown in Appendix D.
- An exception is the retail areas adjacent the boulevard where floor levels are noted as RL 2.6 which is below the 100 year flood level. A separate report (SSDA5 - SW Plot Retail Boulevard) has been prepared by Lend Lease with respect to this area.

Works that impact on Sydney Water culverts (Section 4.2.1)

The site is located adjacent to existing Sydney Water assets. This report recommends that further consultation with authorities is required.

Water Quality Analysis and Water Sensitive Urban Design (WSUD)

The DGR specifies the provision of “an Integrated Water Management Plan including alternative water supply, proposed end uses of potable and non-potable water, water sensitive urban design and water conservation measures.”

The Development Control Plan (DCP) of the City of Sydney Council, the adjoining LGA, stipulates that for developments greater than 1,000 m² a stormwater quality assessment must be undertaken to demonstrate the following:

- The baseline annual pollutant load for **litter and vegetation larger than 5mm** is reduced by **90%**.
- The baseline annual pollutant load for **Total Suspended Solids (TSS)** is reduced by **85%**.
- The baseline annual pollutant load for **Total Phosphorous (TP)** is reduced by **65%**.
- The baseline annual pollutant load for **Total Nitrogen (TN)** is reduced by **45%**.

The above pollutant reduction targets were adopted as reference targets in developing a stormwater quality control strategy for the site.

Hyder undertook a detailed water quality analysis to develop a Water Sensitive Urban Design (WSUD) strategy for the South West Plot with site-specific opportunities and constraints identified to allow the development of the plot while achieving industry accepted / best practice water quality targets.

The MUSIC modelling for the proposed development scenario which incorporates the proposed WSUD initiatives has demonstrated that the combination of a rainwater tank, gross pollutant traps and filter devices will result in lower levels of Gross Pollutants, Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) compared to values resulting from the 'untreated' proposed development scenario. These proposed WSUD initiatives will meet the pollution reduction objectives of the DGR and the targets for Gross Pollutants, TSS, TP and TN specified in the City of Sydney Council DCP.

1 INTRODUCTION

This report supports a State Significant Development (SSD) Development Application (DA) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

The Application (referred to as SSDA 5) follows the submission of a staged SSD DA (SSDA 2) submitted in March 2013 to the Department of Planning and Infrastructure that set out a Concept Proposal for a new mixed use residential neighbourhood at Darling Harbour known as 'The Haymarket'. The Haymarket forms part of the Sydney international convention, exhibition and entertainment precinct (SICEEP) Project, which will deliver Australia's global city with new world class convention, exhibition and entertainment facilities and support the NSW Government's goal to "make NSW number one again".

More specifically this subsequent DA seeks approval for the residential building within the South West plot of The Haymarket and associated public domain works. The DA has been prepared and structured to be consistent with the Concept Proposal DA.

2 OVERVIEW OF PROPOSED DEVELOPMENT

The proposal relates to a detailed ('Stage 2') DA for a residential development in the South West Plot of The Haymarket together with associated public domain works. The Haymarket Site is to be developed for a mix of residential and non-residential uses, including but not limited to residential buildings, commercial, retail, community and open space. The South West Plot is one of six development plots identified in the Concept Proposal DA.

More specifically, this SSD DA seeks approval for the following components of the development:

- Demolition of existing site improvements;
- Associated tree removal and planting;
- Construction and use of one residential building within the South West Plot;
- Public domain improvements,
- Extension, realignment and augmentation of physical infrastructure / utilities as required.

3 BACKGROUND

On 21 March 2013 a critical step in realising the NSW Government's vision for the SICEEP Project was made, with the lodgement of the first two SSD DAs with the Department of Planning and Infrastructure. The key components of these proposals are outlined below.

Public Private Partnership SSD DA (SSD 12_5752)

The Public-Private Partnership (PPP) SSD DA (SSDA 1) includes the core facilities of the SICEEP Project, comprising the new, integrated and world-class convention, exhibition and entertainment facilities along with ancillary commercial premises and public domain upgrades.

The Haymarket Concept Proposal SSD DA (SSD 13_5878)

The Haymarket Concept Proposal SSD DA (SSDA 2) establishes the vision and planning and development framework which will be the basis for the consent authority to assess detailed development proposals within the Haymarket Site.

More specifically the Stage 1 Concept Proposal seeks approval for the following key components and development parameters:

- Staged demolition of existing site improvements, including the existing Sydney Entertainment Centre (SEC), Entertainment Centre Car Park, and part of the pedestrian footbridge connected to the Entertainment car park and associated tree removal;
- A network of streets, lanes, open space areas and through-site links generally as shown on the Public Domain Concept Proposal, to facilitate reintegration of the site into the wider urban context and connection with the broader SICEEP Site;
- Street layouts;
- Development plot sizes, development plot separation, building envelopes (maximum height in RLs), building separation, building depths, building alignments and a benchmark for natural ventilation and solar provision for the precinct;
- Land uses across the site, including residential and non-residential uses;
- A maximum total gross floor area (GFA) across The Haymarket Site of 197,236m² for the mixed use development (excluding ancillary above ground car parking), comprising of:
 - A maximum of 49,545m² non-residential GFA; and
 - A maximum of 147,691m² residential GFA;
- Above ground parking including public car parking;
- Residential car parking rates to be utilised in the subsequent detailed (Stage 2) Development Applications, being:
 - Zero (0) spaces per studio apartment;
 - Maximum one (1) space per two (2) one bedroom apartments;
 - Maximum one (1) space per one bedroom + study apartment, plus one (1) additional space per five (5) apartments;
 - Maximum one (1) space per two bedroom apartment, plus one (1) additional space per five (5) apartments; and

- Maximum two (2) spaces per 3+ bedroom apartment.
- Design Guidelines to guide future development and the public domain; and
- A remediation strategy.

This report has been prepared to support a detailed Stage 2 SSD DA for a commercial building (including public carpark) and associated public domain works within The Haymarket (SSDA 4), consistent with the Concept Proposal SSD DA.

4 SITE DESCRIPTION

The SICEEP Site is located within Darling Harbour. Darling Harbour is a 60 hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides a mix of functions including recreational, tourist, entertainment and business.

With an area of approximately 20 hectares, the SICEEP Site is generally bound by the Light Rail Line to the west; Harbourside shopping centre and Cockle Bay to the north, Darling Quarter, the Chinese Garden and Harbour Street to the east, and Hay Street to the south (refer to Figure 1).

The Haymarket Site is:

- located in the south of the SICEEP Site, within the northern portion of the suburb of Haymarket;
- bounded by the Powerhouse Museum to the west, the Pier Street overpass and Little Pier Street to the north, Harbour Street to the east, and Hay Street to the south; and
- Irregular in shape and occupies an area of approximately 43,807m².



Figure 1: SICEEP site Location

The Concept Proposal DA provides for six (6) separate development plots across the Haymarket Site (refer to Figure 2):

1. North Plot;
2. North East Plot;
3. South East Plot;
4. South West Plot;
5. North West Plot; and
6. Western Plot (Darling Drive).



Figure 2 – Concept Proposal Development Plots

The Site area for this Stage 2 DA relates to the South West Plot and surrounds as detailed within the architectural and landscape plans submitted in support of the DA (see Figure 3).

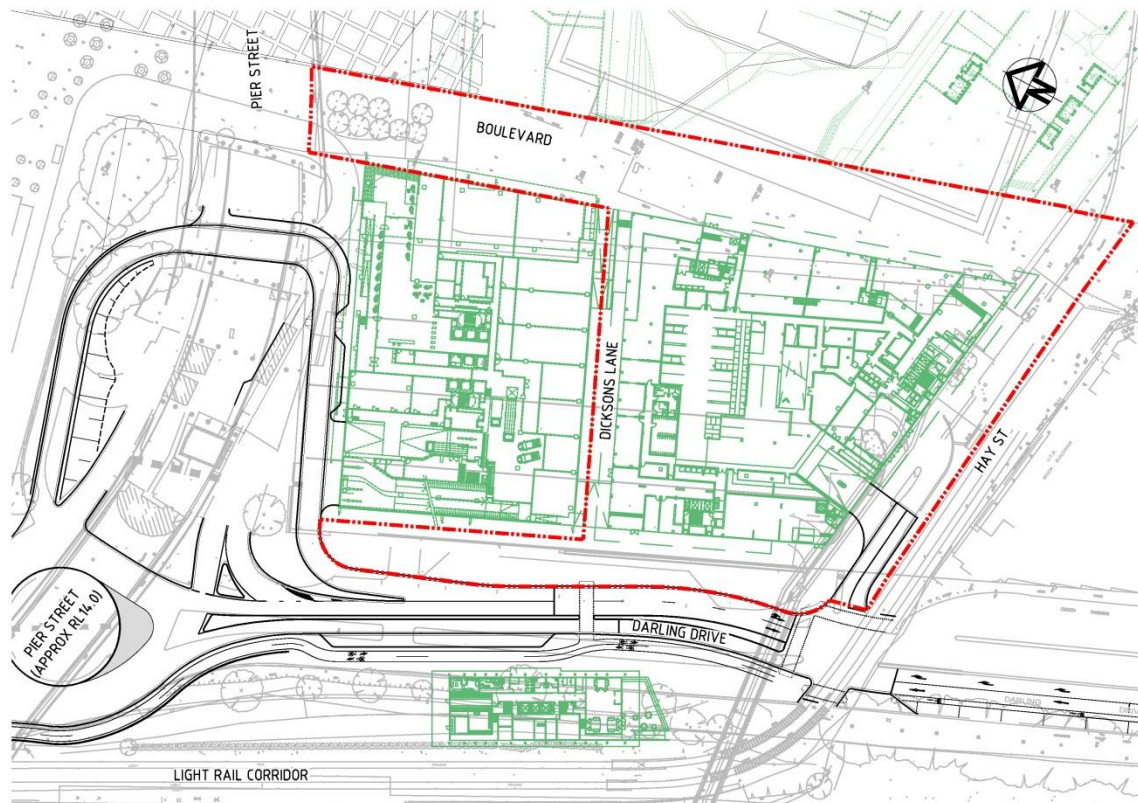


Figure 3 –Works boundary for subject DA

5 PLANNING APPROVALS STRATEGY

The SICEEP Project will result in the lodgement of numerous SSD DAs for the various components of the redevelopment project. SSD DAs have already been lodged for the PPP component of the SICEEP Project (comprising the convention centre, exhibition centre, entertainment facility and ancillary commercial premises and associated public domain upgrades), and the Stage 1 Concept Proposal for The Haymarket. Separate 'Stage 2' SSD DAs for the development of the North West Plot and the Western Plot (including Darling Drive realignment) and associated public domain works will be lodged concurrently with this application. Future applications will be lodged for the Hotel complex, and the remaining development plots of The Haymarket Site.

6 PURPOSE OF REPORT

This report has been prepared to accompany the Stage 2 DA for the South West Plot component of The Haymarket. It addresses the relevant requirements of the DGR's for the project, issued on the 21st of January 2013 and updated on 27th March 2013. A summary of the relevant DGRs is listed below.

6.1 DIRECTOR GENERAL'S REQUIREMENTS

Table 1 Director General's Requirements

DGR Reference	Key Assessment Requirement
4 – Public Domain and Urban Design	Address Water Sensitive Urban Design (WSUD) opportunities within the public domain and landscaping.
5 – Ecologically Sustainable Design (ESD)	Provide an integrated Water Management Plan including alternative water supply, proposed end uses of potable and non-potable water, water sensitive urban design and water conservation measures.
9 – Drainage, Flooding, climate change and Sea Level Rise	Provide a drainage concept for the site incorporating water sensitive urban design
9 – Drainage, Flooding, climate change and Sea Level Rise	Address the likely groundwater, flooding and sea level rise risks on the site and measures to ameliorate any impacts
14 – Water Quality	Address water quality impacts during construction including details of the source, volume, frequency and on-going monitoring methods
14 – Water Quality	Provide mitigation and management measures to minimise soil and stormwater impacts to the surrounding area.

This report relates to the portion of The Haymarket identified in Figure 3 and provides a drainage concept for the site which addresses the flooding and sea-level rise risks on the site.

Initial WSUD analysis and discussion of initiatives proposed to be adopted to achieve pollutant reduction targets are provided later in this report however we have not addressed potential groundwater risks or impacts as these are of a geotechnical nature.

7 FLOODING & STORMWATER DRAINAGE

Flood mapping and flow regimes through The Haymarket area, for both existing conditions and the proposed development, is provided in the Flooding & Stormwater report (Appendix A).

Concept design plans in Appendix B outline the proposed stormwater management for the South West Plot.

An overview of the flood regimes for this and the adjacent sites, and stormwater management is described in the following sections.

7.1 INTRODUCTION

Figure 4 shows the extent of the South West Plot proposed site works boundary for SSDA5. Located in The Haymarket at the southern end of the SICEEP site, the site area is generally bound by Darling Drive to the west, Pier Street to the north, Hay Street to the south and the existing Entertainment Centre to the east.

Under existing conditions there are a number of overland flow paths which converge along Hay Street to then be directed north through or adjacent to The Haymarket precinct via one of three defined overland flow paths, as illustrated in Figure 4. This demonstrates that the South West Plot is affected by an existing overland flow path which requires diversion as part of the proposed development and consideration of the overland flow path water levels when designing the building.

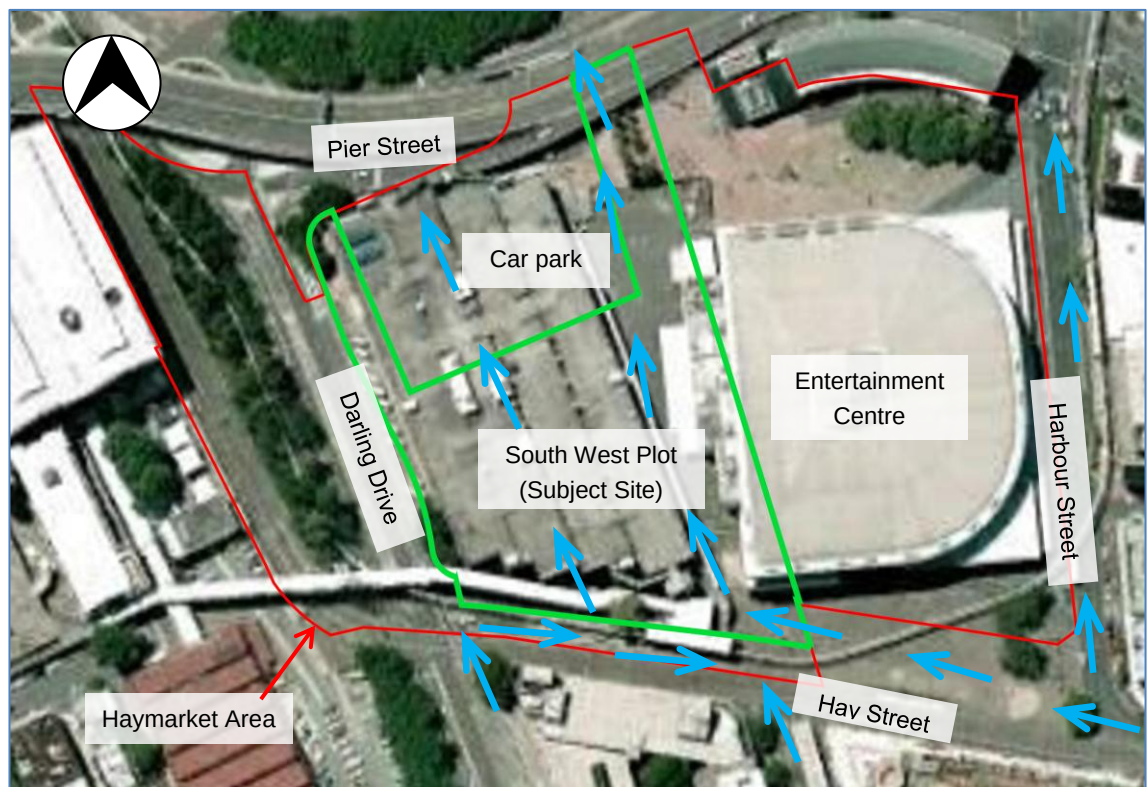


Figure 4 – Subject site indicating existing (1% AEP) overland flow paths (denoted by arrows)

7.2 PROPOSED FLOODING & STORMWATER MANAGEMENT

The proposed South West site works involves demolition of the existing Entertainment Centre car park and the construction of a multi-storey residential apartment building. This DA is also seeking the approval for demolition of the entertainment centre to allow the construction of the boulevard as part of the south west plot extents. The proposed flooding and stormwater management for this development includes:

- Modifications to the existing local stormwater systems in accordance with the intent of the Flooding & Stormwater report (Appendix A);
- Works that impact on the Sydney Water underground conduit system; and
- Sediment and Erosion Control measures during construction.

7.2.1 MODIFICATIONS TO EXISTING STORMWATER SYSTEM

The Flooding & Stormwater report submitted with the Stage 1 DA (SSDA2) contemplated modifications / amplifications required to the existing stormwater system for the Haymarket precinct including the South West Plot (Refer Appendix A).

Flood modelling has been revised from the Flooding & Stormwater report (Appendix A) to assess an alternate amplification option at the south east corner of The Haymarket. The proposed amplification option will run parallel with Hay Street (refer Appendix E) This proposal will, where possible, improve on the existing overland flow conditions through the site ensuring that they are no worse than existing conditions. This revised flood model has been used to determine flood levels across the site and as documented on drawing SKCPD060 (Appendix D).

To facilitate the construction of the South West building, part of the existing stormwater system needs to be upgraded and the building constructed over existing stormwater culverts. These modifications, proposed amplification option and the connection of building stormwater to the existing stormwater system (Refer to Appendix C) are consistent with the Stage 1 (SSDA2) strategy for the control of stormwater through the Haymarket precinct.

7.2.2 WORKS THAT IMPACT ON SYDNEY WATER CONDUITS

The Flooding & Stormwater report (Appendix A) provides details of the Sydney Water conduit systems, capacities and performances. The proposed development impacts on the systems are discussed below.

Surface Works

The South West plot development includes the demolition of structures currently located over Sydney Water culverts and building construction over these culverts as indicated in Figure 5. Where new buildings are proposed over existing culverts, the building structure will be designed to ensure building loads are not supported by the culverts and the culverts are not affected in terms of structural integrity and function. In addition, construction methodology will be developed to ensure excessive temporary construction loadings are not imposed on the existing culverts. Consultation with relevant authorities to secure approval for these works has commenced and is on-going.

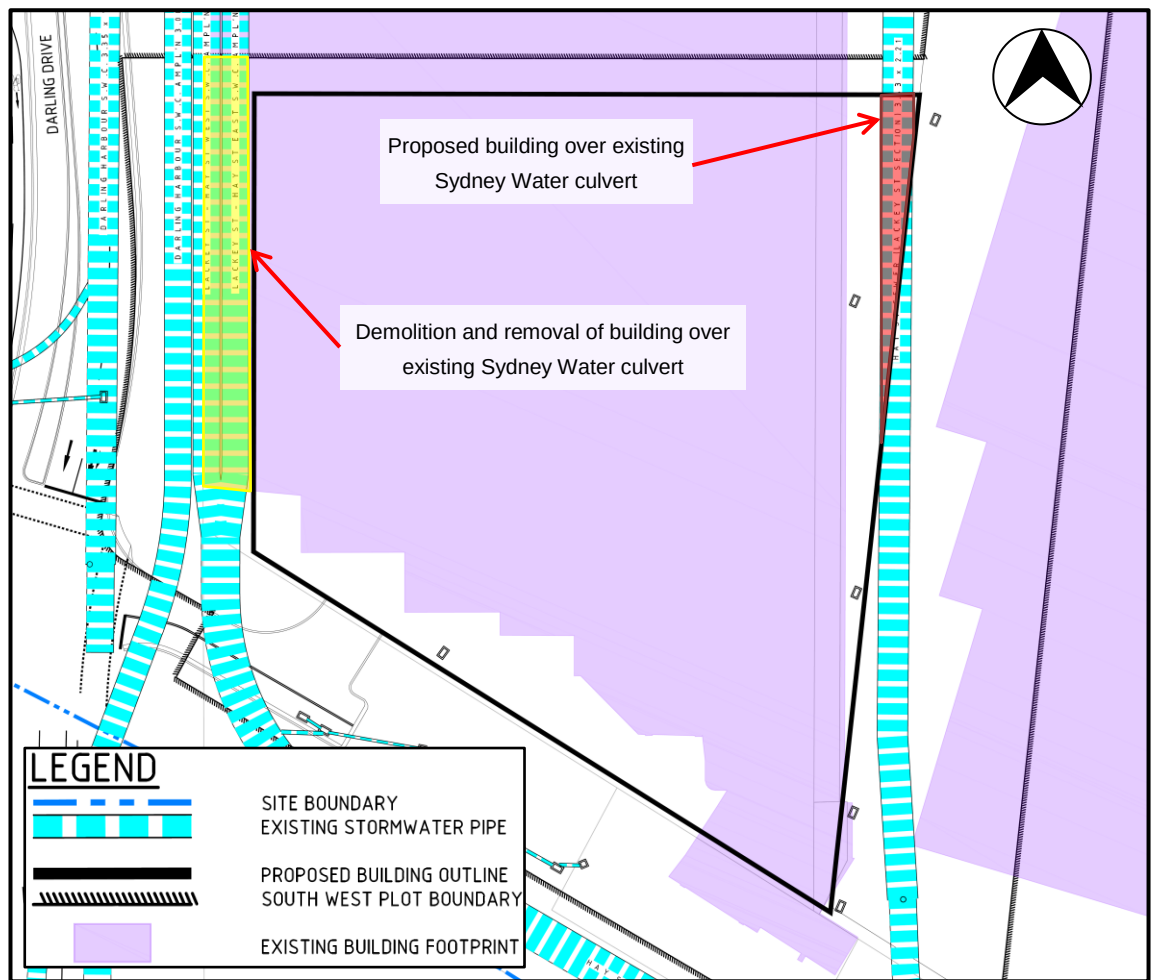


Figure 5 – Building adjacent to and over Sydney Water stormwater assets

Conduit Amplification Works

The Flood & Stormwater report (Appendix A) included an amplification option of the Sydney Water underground conduit system so as to mitigate potential flood impacts as a result of the proposed (ultimate) development. The proposed amplification alignment, referred to as Option 2b, is outlined in Figure 6.

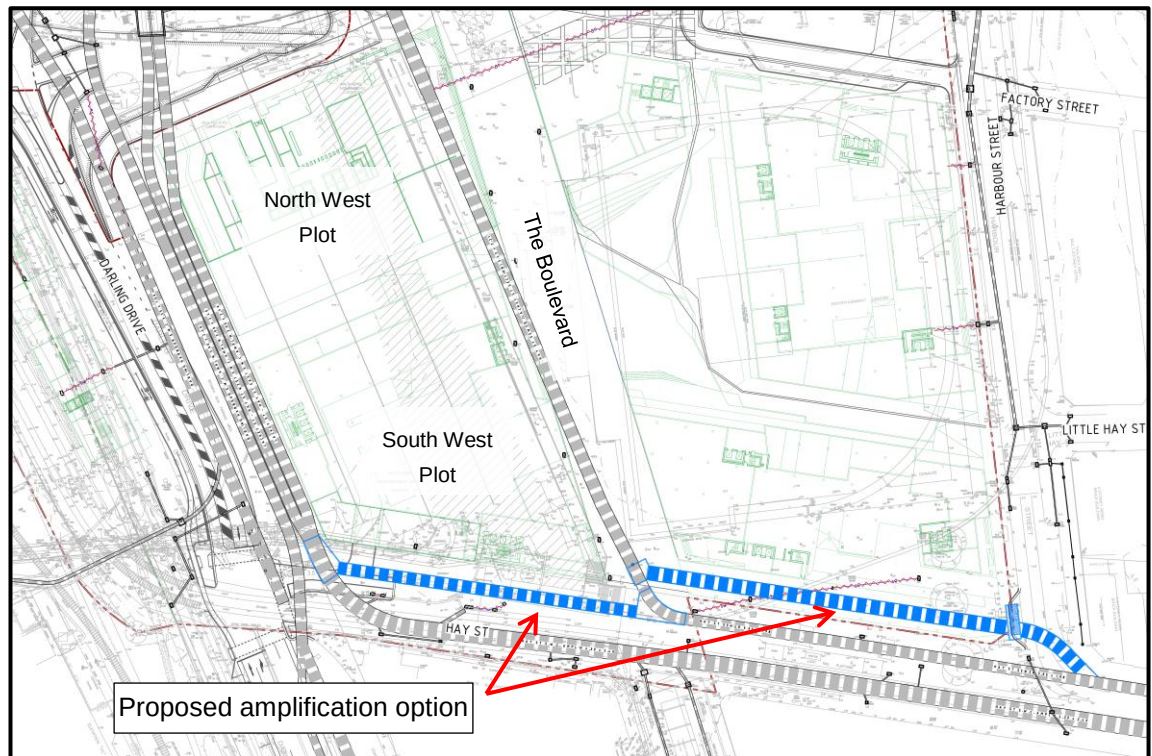


Figure 6 –Proposed amplification option (2b) for Haymarket Precinct

This Option 2b culvert amplification:

- retains the off-take culvert (W3.6m x H2.4m) from the existing Hay Street W3.0m x H2.0m culvert at the eastern side of Harbour Street (proposed in the Flood & Stormwater report, Appendix A);
- retains the 16m² of grated inlet and associated kerb inlets, within the proposed parking bay on the western side of Harbour Street near its intersection with Hay Street (proposed in the Flood & Stormwater report, Appendix A);
- extends westward under the proposed colonnade parallel to Hay Street, to the proposed Boulevard where it connects to the existing Hay Street (W3.0m x H2.2m) culvert;
- includes a disconnection of the existing Hay Street (W3.0m x H2.0m) culvert from its northward heading direction (along the Boulevard);
- includes extending the existing Hay Street (W3.0m x H2.0m) culvert, with a new W3.6m x H2.4m culvert, that is to continue west along Hay Street to the intersection at Darling Drive;
- requires the existing twin culverts in Darling Drive to be extended upstream (south) to Hay Street where a new junction pit is to accommodate the Hay Street culvert systems (existing and proposed).

The TUFLOW model developed for the Flooding & Stormwater report (Appendix A) has been modified to represent the Option 2b amplification. Model details and results are included in Appendix E, with the model results summarised in Table 3 below.

Table 3 – Flood level impact results

100 year ARI (no climate change)			
Location	Existing Conditions	Proposed Development Conditions	
		Option 2b	
	Water Level (mAHD)	Water Level (mAHD)	Water Level Change (mm)
Hay Street*	3.42	3.43	5-10
Hay Street Sag*	4.24	4.26	5-10
100 year ARI (including potential climate change)			
Location	Existing Conditions	Proposed Development Conditions	
		Option 2b	
	Water Level (mAHD)	Water Level (mAHD)	Water Level Change (mm)
Hay Street*	3.49	3.54	45-50
Hay Street Sag*	4.51	4.52	10-15
20 year ARI (including potential climate change)			
Location	Existing Conditions	Proposed Development Conditions	
		Option 2b	
	Water Level (mAHD)	Water Level (mAHD)	Water Level Change (mm)
Hay Street*	3.59	3.59	0-5
Hay Street Sag*	4.14	4.15	0-5

* Location has been chosen to record maximum flood impact.

7.2.3 SEDIMENT AND EROSION CONTROLS

An erosion and sediment control plan (refer Appendix B) has been prepared to assist the implementation of erosion and sedimentation control measures in accordance with 'Managing Urban Stormwater: Soils and Construction' Landcom 2004 publication. These measures include;

- Hay Bales;
- Silt Fences;
- Inlet filters;
- Diversion channels; and
- Stabilised site access and truck wash-down area.

7.2.4 LOCAL STORMWATER MANAGEMENT

As proposed in the precinct Flooding & Stormwater report (Appendix A):

- building hydraulic and ground surface connections are to discharge into the Sydney Water conduits. While these local drainage systems will be sized to convey up to 20 year ARI flows their performance will be limited by the Sydney Water system capacities; and
- no on-site detention is proposed for The Haymarket.

A conceptual stormwater layout is provided in Appendix C.

7.3 FLOOD PLANNING LEVELS

The mapping provided in the precinct Flooding & Stormwater report (Appendix A) has been provided to allow Architects and the developer to determine initial floor levels. Floor levels are prescribed through the flood planning level requirements of the local authority through their flood risk management plan which is developed with the input of numerous stakeholders in order to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods.

Hyder has provided drawing SKCPD060 (Appendix D) to provide a comparison of the proposed architectural floor level relative to the proposed surface level and flood results from flood modelling undertaken for the whole of SICEEP site (Appendix A) which now includes a modified amplification option from Harbour street along Hay Street proposed as part of this DA.

From this drawing along with figure 4, it can be seen that the proposed building in the South West Plot (points I to N) is affected by flood waters and existing overland flow paths. The existing overland flow paths through The Haymarket have been diverted to run along the pedestrian boulevard to the east of the South West building in the proposed design.

A formal Flood Risk Assessment is not available for this site but will be required to assess proposed floor levels with respect to formal flood planning levels.

In relation to proposed architectural floor levels, it should be noted that:

- Floor levels within the South West Plot are nominally at RL3.6 which is generally above the 100 year flood level (including climate change) as shown in Appendix D.
- An exception is the retail areas adjacent the boulevard where floor levels are noted as RL 2.6 which is below the 100 year flood level. A separate report (SSDA5 - SW Plot Retail Boulevard) has been prepared by Lend Lease with respect to this area.

Final flood levels and flow regimes may change as a result of future refinement of the flood model (due to design adjustments and issues identified in the Flooding & Stormwater report (Appendix A)). If so, this will impact on the minimum floor levels.

7.4 CONSTRUCTION PHASING

Hyder have assessed potential flood impacts during the Haymarket construction phase of the SW and NW and Student Accommodation plots. The assessment approach and findings are discussed as follows.

7.4.1 BACKGROUND

The SICEEP Flood Study and Stormwater Assessment by Hyder Consulting (March 2013), modelled the proposed development based on ultimate construction of the SICEEP precinct and does not include discussion on construction staging.

As indicated in the March 2013 flood assessment, the Haymarket portion of the SICEEP precinct is located at the downstream of two large catchments totalling approximately 150ha. Subject to the limitations of the March 2013 flood assessment; this current investigation of the Haymarket plot quantifies potential flood impacts during the construction of the SW, NW and Student Accommodation Plots with the retention of the Entertainment Centre for various flood mitigation options.

7.4.2 MODELLING METHODOLOGY

The TUFLOW model used in the March 2013 flood assessment (to represent SICEEP development conditions) was modified to represent the development phase of the NW, SW and Student Accommodation plots with associated ground levels as indicated in the accompanying Drawing SKCPD044. The construction phase flood modelling has included combinations of flood mitigation measures which have involved:

- providing an overland flow path through the building as per SKCPD044;
- including a portion of the conduit amplification option adjacent to Hay Street, and the inclusion of a temporary inlet pit (four 1m x 1m grated inlet pits);
- including a restriction on overland flow based on likely hoarding arrangements with a 100mm high opening at ground level, and applying 50% blockage;
- a modified Digital Elevation Model (DEM) to represent the proposed construction of the NW, SW (with the inclusion of an overland flow path) and Student Accommodation with the retention of the existing Entertainment Centre.

All other TUFLOW model parameters including blockages and tail water level conditions remain consistent with the March 2013 flood assessment.

7.4.3 RESULTS

TUFLOW model flood impact results for the 5, 20 and 100 year ARI events are presented in Appendix F, with the impact results summarised in Table 4.

Table 4: Summary of Potential Flood Level Increases During Construction Staging

LOCATIONS	POTENTIAL FLOOD LEVEL INCREASE (m)		
	5 YEAR	20 YEAR	100 YEAR
Hay & Harbour Street*	0.00	0.00	0.02
Entertainment Centre*	-0.10	-0.15	0.20
West Hay Street*	0.04	0.05	0.18
Sag beneath Pier Street*	0.22	0.22	-0.20

*Location has been chosen to record maximum flood impact

The risk of flooding beyond the 20 year ARI during the construction period is small (prior to the demolition of the Sydney Entertainment Centre and full amplification of the stormwater system) and flood impacts due to construction staging (Appendix F) are minimal up to the 20 year ARI with the exception of the sag beneath Pier Street which will be fenced off to restrict access.

8 WATER SENSITIVE URBAN DESIGN

The Water Sensitive Urban Design component of the precinct Flooding & Stormwater report (Appendix A) focuses on the PPP precinct within SICEEP whilst also assessing The Haymarket at a conceptual level. This report sets out a more specific WSUD strategy for The Haymarket precinct and assesses this Stage 2 DA (SSDA5) in the context of that overall strategy.

A detailed water quality analysis has been undertaken by Hyder to develop the WSUD strategy for The Haymarket with site-specific opportunities and constraints identified to allow the re-development of the precinct while achieving the DGR water quality objectives (see Section 6.1) and meeting the adopted water quality targets specified in the City of Sydney Council DCP (see Section 8.3.2).

The Haymarket precinct has been subdivided into the following six sub-precincts in terms of the WSUD strategy:

1. The Western Plot (North Site);
2. The Western Plot (South Site);
3. The North West Plot;
4. The South West Plot;
5. The South East Plot; and
6. The North Plot and North East Plot.

The WSUD boundaries of these sub-precincts have been established with reference to stormwater catchments rather than the Stage 2 DA boundaries. These WSUD boundaries have been determined based on how the site is graded and hence is consistent with how stormwater runoff will be likely conveyed and discharged within these sub-precincts.

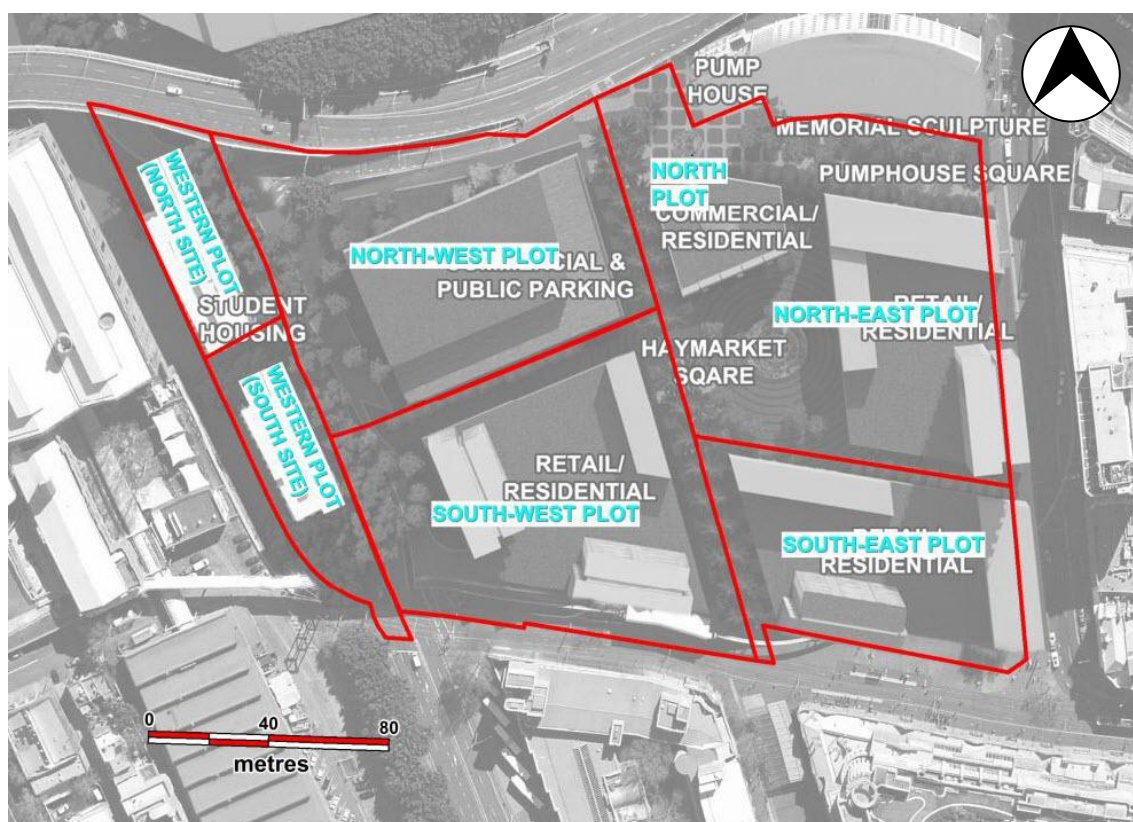


Figure 7 Extents of the South West Plot adopted in MUSIC modelling

8.1 WATER QUALITY MODELLING SETUP & SCENARIOS

The water quality analysis for this study was undertaken using the industry standard software model MUSIC (Model for Urban Stormwater Improvement Conceptualisation) Version 5.1 (Build 16). This water quality modelling software was first released in July 2002, and was developed by the Cooperative Research Centre (CRC) for Catchment Hydrology (CRC for Catchment Hydrology, 2005), which is based at Monash University in Melbourne, Australia.

The model provides a number of features relevant for the South West Plot development:

- It is capable to model the potential nutrient reduction benefits of gross pollutant traps, bio-retention systems, and it incorporates mechanisms to model stormwater reuse as a treatment technique.
- It provides mechanisms to evaluate the attainment of water quality objectives.

The catchment considered in the water quality analysis is the South West Plot which has an area of approximately 1 ha. This site includes a section of the Darling Drive road corridor and the land being occupied by the Entertainment Centre car park. The boundary of the South West Plot sub-catchment adopted for MUSIC modelling is as shown in Figure 7.

MUSIC modelling was undertaken to estimate the stormwater runoff pollutant loads within the South West Plot for the following scenarios:

- Existing Conditions
- Proposed development without treatment (Baseline Scenario)
- Proposed development with treatment (Treated Scenario)

The first two models enable the determination of the changes in the annual pollutant loads, attributed to the proposed development. An increase in developed areas will result in increases in the loadings of the stormwater runoff pollutants within the development and vice versa.

8.2 MODELLING DATA & PARAMETERS

Rainfall and evapotranspiration data used in the MUSIC modelling of the proposed SICEEP PPP development (Appendix A), located to the north of The Haymarket, are used in this study. Being in close proximity to each other suggests similar climate conditions and hence warrants the use of identical rainfall and evapotranspiration data for both the PPP and The Haymarket sites.

The soil / groundwater parameters used in the MUSIC model were obtained from the Draft NSW MUSIC Modelling Guidelines (BMT-WBM, 2010). The soil and groundwater parameters are reported in the precinct Flooding & Stormwater report (Appendix A).

The pollutant loading rates adopted for the site for Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) are based on the recommended parameters provided by the Cooperative Research Centre for Catchment Hydrology (CRC, 2004). The adopted parameters are consistent with the values adopted in the MUSIC model for the proposed PPP development (Appendix A).

8.3 WATER QUALITY TREATMENT TARGETS

In terms of water quality, the following requirements formed as the basis in developing the Stormwater Quality Management Strategy for The Haymarket development.

8.3.1 DIRECTOR-GENERAL'S REQUIREMENTS

The Director-General Requirements (DGR) relevant to Water Management is listed under Ecologically Sustainable Development (ESD), which is Item 5 of the general requirements in Schedule 2 of the Environmental Planning and Assessment Regulation 2000 (NSW Government, 2000).

The DGR specifies the provision of “an Integrated Water Management Plan including alternative water supply, proposed end uses of potable and non-potable water, water sensitive urban design and water conservation measures” (see Section 6.1).

This Report has identified and presented WSUD opportunities for the South West Plot development.

8.3.2 CITY OF SYDNEY COUNCIL DCP 2012

Section 3 of the City of Sydney Council's 2012 Development Control Plan (DCP) (City of Sydney Council, 2012) stipulates that for developments greater than 1,000 m² a stormwater quality assessment must be undertaken to demonstrate the following:

Stormwater Quality

The development should achieve the proposed development pollutant load standards indicated below:

- The baseline annual pollutant load for **litter and vegetation larger than 5mm** is reduced by **90%**.
- The baseline annual pollutant load for **Total Suspended Solids (TSS)** is reduced by **85%**.
- The baseline annual pollutant load for **Total Phosphorous (TP)** is reduced by **65%**.
- The baseline annual pollutant load for **Total Nitrogen (TN)** is reduced by **45%**.

8.3.3 WATER HARVESTING AND REUSE

The development will need to incorporate measures into the design of the development that will ensure harvested water is fit for reuse. These measures are to clean the water to exclude contaminants such as litter, sediment and oil.

8.3.4 WATER SENSITIVE URBAN DESIGN (WSUD)

Water Sensitive Urban Design aims to minimise the hydrological impacts of urban development and maximise the multiple use benefits of a stormwater system.

Australian Runoff Quality (Engineer's Australia, 2006) identifies the objectives of WSUD to include:

- Reducing potable water demand through water efficient appliances, rainwater and grey water reuse
- Minimising wastewater generation and treatment of wastewater to a standard suitable for effluent reuse opportunities and/or release to receiving waters
- Treating urban stormwater to meet water quality objectives for reuse and/or discharge to surface waters
- Preserving the natural hydrological regime of catchments

Australian Runoff Quality also identifies WSUD as the adoption of the following planning and design approaches that integrate the following opportunities into the built form of cities and towns:

- Detention, rather than rapid conveyance of stormwater
- Capture and use of stormwater as an alternative source of water to conserve potable water
- Use of vegetation for filtering purposes
- Protection of water-related environmental, recreational and cultural values
- Localised water harvesting for various uses

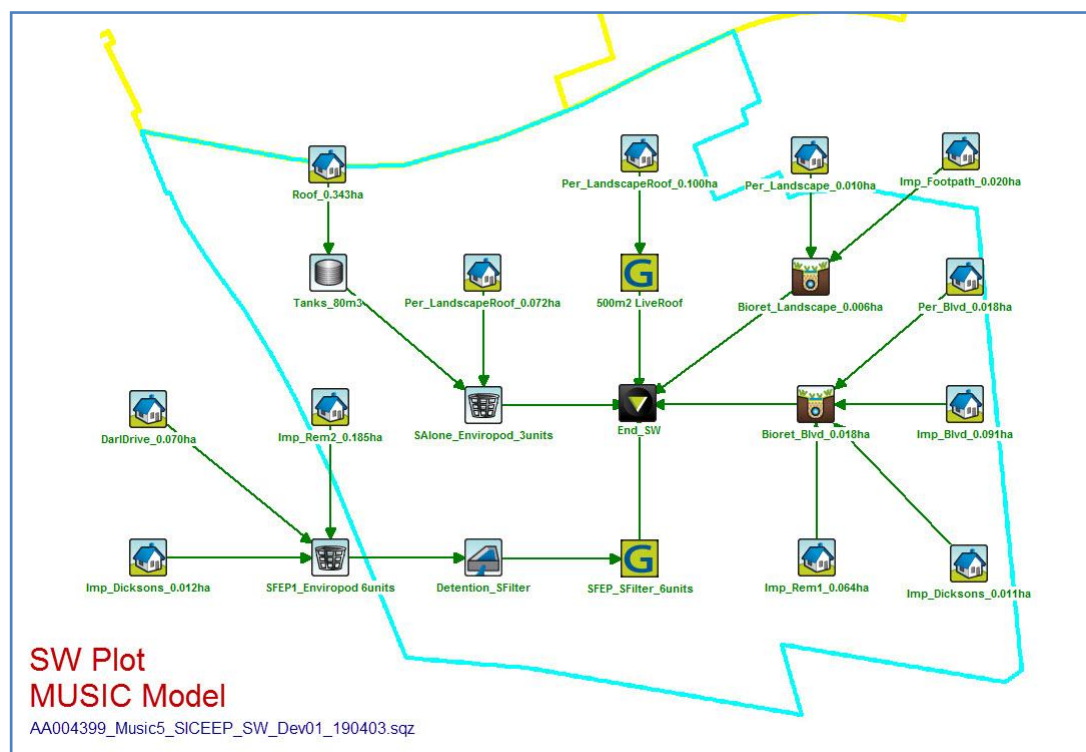


Figure 8 MUSIC model layout for the South West Plot

8.4 MUSIC MODEL & ASSUMPTIONS

A MUSIC model (see Figure 8) was developed to represent the stormwater quality management strategy proposed for the South West Plot.

8.4.1 ASSUMPTIONS

As indicated in the layout of the MUSIC model developed for the site (see Figure 8), the following treatment devices were assumed:

- Tank with first-flush device
- Gross pollutant traps or pit inserts (Figure 8: SFEP_EnviroPod or SALone_EnviroPod)
- Engineered filtration device (Figure 8: SFEP_SFilter)
- Green Roof (Figure 8: 500m2_LiveRoof)
- Bioretention tree pits and landscaped areas

These devices are discussed in more detail in Section 8-5 of this report.

In addition, the following assumptions were taken into consideration in developing the MUSIC model:

- Urbanised and landscaped areas will generally discharge to the water quality elements prior to discharge from the site;
- All impervious areas are 100% impervious; and
- The entire 'un-landscaped' roof area drains into the rainwater tank.

8.4.2 PERCENTAGE IMPERVIOUSNESS

Areas for the impervious components (i.e. roof, road, pavements, and other impervious areas) were determined using the available architectural and landscape plans, prepared for the DA.

Impervious areas include the following components of the proposed development:

- Darling Drive and medians
- Roof
- Footpath
- Dickson Lane
- All hardstand and paved areas

Pervious areas include landscaped areas, tree pits and permeable paving.

Impervious areas for the entire South West Plot development total approximately 0.8 ha, making the post-developed site about 80% impervious, which is 19% less than the existing site's imperviousness. The pervious and impervious component areas for the South West Plot under Existing and Proposed Development scenarios are summarised in Table 5 and Table 6 respectively. The significant reduction of the South West Plot's imperviousness is a result of incorporating a landscaped roof in the South West building and providing more landscaped areas along Darling Drive and the Boulevard. With imperviousness reduced, resultant annual pollutant loads produced within the South West Plot will be less than current levels even without introducing any treatment scheme i.e. under Existing Conditions.

Table 5 Pervious and impervious areas in the South West Plot – Existing Scenario

Subcatchment	Component Areas (ha)		% Impervious
	Pervious	Impervious	
Roof	-	0.500	100%
Road	-	0.070	100%
General Impervious	-	0.417	100%
Landscaped Areas	0.009	-	0%
Entire South West Plot	0.009	0.987	99%

Table 6 Pervious and impervious areas in the South West Plot – Proposed Development Scenario

Subcatchment	Component Areas (ha)		% Impervious
	Pervious	Impervious	
Roof	-	0.343	100%
Road	-	0.070	100%
General Impervious	-	0.219	100%
Landscaped Areas	0.200	-	0%
Entire South West Plot	0.200	0.796	80%

8.5 STORMWATER MANAGEMENT CONCEPT

It is envisaged that the South West Plot development, when completed, will be a showcase of how the management of the urban water cycle can be seamlessly integrated with urban planning and design. It will demonstrate how the adoption of Water Sensitive Urban Design (WSUD) principles not only serves to reduce pollutant export but also integrates well with the urban landscape.

In addition to working with the various opportunities and constraints inherent in the proposed development, the Stormwater Management Strategy proposed for the South West Plot development was prepared with consideration of the requirements and guidelines listed in Section 8-3 of this report.

The stormwater management strategy proposed for the site focuses on minimising the impacts of the development on the total water cycle, and maximising the environmental, social and economic benefits achievable by utilising responsible and sustainable stormwater management practices.

The WSUD devices and concepts selected for South West Plot were either applied as a single treatment or as part of a treatment train. The “treatment train” approach is proposed where various types of pollutants are removed by a number of devices acting in series.

8.5.1 SALIENT FEATURES OF THE STORMWATER QUALITY MANAGEMENT STRATEGY

The stormwater management strategy proposed for the South West Plot development utilises the latest technology for water quality management; is functional; delivers the required technical performance; avoids environmental degradation and pressure on downstream ecosystems and infrastructure; and provides for a sustainable solution for stormwater management within the site. In particular, the key features of the proposed strategy are as follows:

Social

- Enhanced visual amenity through landscaping

Environmental

- Limited downstream discharge peaks and velocities
- Provision of a rainwater tank, gross pollutant traps, filtration devices and bio-retention systems to achieve water quality
- Re-vegetation of streetscapes and landscaped areas

Economic

- Integration with other land uses consistent with the achievement of environmental and social objectives
- Proposed water quality improvement measures that keep recurrent maintenance tasks and costs to a minimum

The Stormwater Quality Management Strategy proposed for the South West Plot development will consist of the following elements.

8.5.2 RAINWATER TANK

Rain falling on the roof of the South West Plot building will be collected and stored in a rainwater tank with initial flows being diverted via a first flush diverter. Hydraulics of the building and the grounds within the site will be configured to allow this rainwater to be available for non-potable uses including toilet flushing and irrigation of landscaped areas.

In addition to water savings, rainwater tanks help reduce runoff volumes from the South West Plot development during small storms and associated stormwater pollutants that would discharge into Darling Harbour.

Table 7 Tank properties and tributary roof area

Tank	Tributary Roof Area* (ha)	Tank Properties			
		Cross-Sectional Area (m ²)	Tank Height (m)	Tank Volume+ (m ³)	Area per m ³ of Storage (m ²)
South West Plot	0.343	19	4.2	80	43

* - excludes landscaped roof

+ - effective volume

The tributary roof area and properties of the rainwater tank are summarised in Table 7. This tank is proposed to be located on the ground level of the South West building.

Stormwater Reuse

Except for the first flush flows, rainwater harvested from the roof of the South West Plot building will be directed to the tank. From this tank, water is conveyed either by gravity or pressure to service the landscaped areas within the development.

Water Demand Volume

In estimating the daily irrigation water demand for each sub-catchment, it was assumed that the depth of irrigation is 25 mm per week (Note: This assumption to be confirmed during detail design).

To irrigate the landscaped areas totalling about 0.2 ha, a daily water volume of 10 m³ is required.

Tank Configuration

The South West Plot building rainwater tank will be supplemented by mains water during dry periods, days of no rainfall or to meet demand from the building use. The tank will be provided with a floating switch mechanism that activates mains water to top up when the critical level in the tank is reached. Activation of the mains water occurs when the volume of stored water in the tank reduces to 10% of the total tank volume.

A first-flush diverter will be installed for the tank. The diverter ensures that the initial (often dirty) quantity of rain water collected from the roofs is diverted away from the tank. In this study, we have assumed the first 1 mm of rain to bypass the tank.

A screen will be provided at the inlet to prevent the ingress of debris and vermin into the tank. An overflow pipe will allow excess flows to discharge, and take with them accumulated sediments at the pump out take area.

A typical configuration of the building tanks is shown in Figure 9.

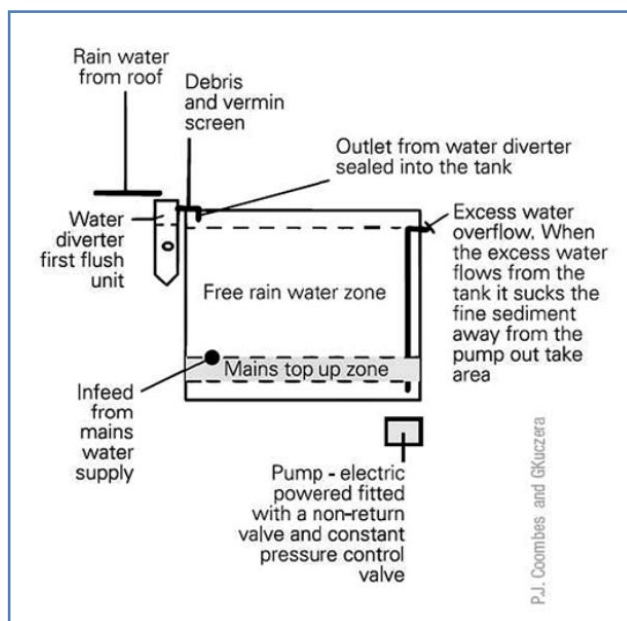


Figure 9 A typical configuration of the rainwater tank
(Source: Coomes and Kuczera, 2001)

Tanks in the MUSIC model

The rainwater tank was included in the MUSIC model taking into consideration the following assumptions:

- All roof areas drain into rainwater tank. Downpipes and related piped connections ensure no portions of the roof bypass the tank.
- Depth of the tank above the overflow pipe is 0.2 m.
- Overflow pipe diameter is 100 mm.
- Height of the water tank is approximately 1.3 m.
- Daily water demand is constant for the tank.

Tank Reliability

The reliability of a reuse tank is a measure of how many days in a typical year water is available to service the irrigation needs of the landscaped areas. A spreadsheet was developed for this study to calculate the reliability of the tank. The calculations were based on the following assumptions:

- All tributary roof leading to the tanks have a "capture efficiency" value of 0.85. Capture efficiency allows for losses due to gutter overflows, splashing of rain and other losses (e.g. system leaks, minimal evaporation) that occur. The value of 0.85 indicates that 85% of the non-absorbed rainfall is captured.
- A portion of the rain falling on the roof is absorbed by the roofing material. A "catchment absorption" value of 0.1 mm applies to all roofs.
- First flush volume is taken as the first 1 mm non-absorbed rainfall multiplied by the tributary roof area. This volume gets diverted from the tank.

The tank reliability analysis shows the South West Plot tank has a 37% reliability which means that on average rainwater is available in the tank for 137 days only in a year. The annual volume of mains water saved by reusing roof runoff is about 1,365 m³.

8.5.3 BIORETENTION SYSTEMS

A stormwater bioretention system is a widely accepted WSUD concept that improves the quality of stormwater by filtering water through a biologically influenced media. A typical bioretention system consists of a vegetated surface overlaying a porous filter medium with a drainage pipe at the bottom. Stormwater directed into the bioretention system flows through dense vegetation, and temporarily ponds on the surface, before slowly filtering down through the filter media. Depending on the design, treated flows are either infiltrated to underlying soils, or collected in the underdrain system for conveyance to downstream drainage systems.

All bioretention systems will be constructed as second generation raingardens. They will capture and treat stormwater flows from the adjoining urban catchment (e.g. roads, pervious or paved surfaces), before they enter the proprietary stormwater drainage system. The vegetated top layer filters sediment and gross pollutants (including plastics, bottles and wrappers) before water gets filtered through a series of layered media (e.g. soil, sand). Together with the plants' root system, the layered media treats the flows to remove nitrogen, phosphorus, sediment, grease and oils before it enters the stormwater system.

A good opportunity to incorporate WSUD principles would be the immediate surrounds of the two rows of trees along the Boulevard and also in the landscaped areas along Darling Drive.

The soil or media around the trees can be used as bioretention tree pits, either bifurcated or contiguous, to treat runoff coming from the adjoining impervious areas. The PPP report (Hyder, 2013) included typical sections of the Boulevard that show the bifurcated and contiguous configurations of the tree pits.

All bioretention systems will be designed and appropriately sized to achieve the nutrient reduction targets for the associated development site catchment areas.

8.5.4 GROSS POLLUTANTS REMOVAL

Pit inserts, also known as litter baskets, could be provided where applicable in stormwater pits within the South West Plot. A pit insert, which is considered as an at-source primary treatment solution, is an efficient and cost-effective pre-screening primary treatment system that captures and retains solid pollutants at drainage entry points. These pit inserts, consisting of a capture basket and a filter mesh liner, are typically fitted below the road invert or surface of the pit and hence are visually unobtrusive (see Figure 10).

For highly urbanised and public areas such as the South West Plot development, stormwater discharging into pits is expected to be heavily laden with sediments and gross pollutants. Pit inserts used for the South West Plot development would need to have a by-pass overflow mechanism to allow flows to eliminate the risk of ponding and flooding. The by-pass mechanism should also ensure that the already-captured pollutants are not remobilised.

Pit inserts can be customised to fit almost any stormwater inlet pit and the mesh liner opening could vary depending on the targeted capture of solids, sediment and attached pollutants. Mesh liners are either made of plastic or stainless steel fabric.



Figure 10 A typical Enviropod pit insert assembly (Source: Stormwater360)

Cleaning of the pit inserts is undertaken either manually or using a small vacuum truck. The cleaning frequency depends on the catchment type, size and expected pollutant loading. As a guide, a litter basket that services a 0.3 ha residential catchment and probably less for a highly urbanised catchment such as SICEEP will typically need cleaning approximately four times annually (Source: recent communication with Stormwater 360, the product supplier).

Pit inserts for a multitude of pits may be substituted during design development by a centralised GPT (e.g. CDS). Further modelling will be undertaken during the design development stage, to investigate such alternative solution. The final option adopted will require input from the long-term manager of the site.

8.5.5 MECHANICAL FILTRATION

Mechanical filtration devices can be used as substitute where bioretention systems (e.g. swales and raingardens) are not possible. As a best management practice treatment option, such engineered devices are designed to remove a range of target pollutants including fine solids, soluble heavy metals, oils and total nutrients. Apart from meeting stringent regulatory requirements, these filtration systems (e.g. Stormwater 360's StormFilter) are usually installed below ground allowing savings in land space and hence increase development yield and more efficient maintenance and management.

Enviropods are usually used in tandem with the StormFilter system as part of the StormFilter and Enviropod (SFEP) treatment train (see Figure 11). Treatment efficiencies of the Enviropod, when used in the SFEP system, in reducing gross pollutants, TSS, TN and TP are 100%, 54%, 21% and 30% respectively. These values are a result of a three-year field testing conducted in Kuranda Queensland that was funded by the Queensland Department of main Roads and peer reviewed by the Queensland University of Technology. Additional discussion about this field testing and its results were included in the Hyder Report for the PPP (Appendix A).

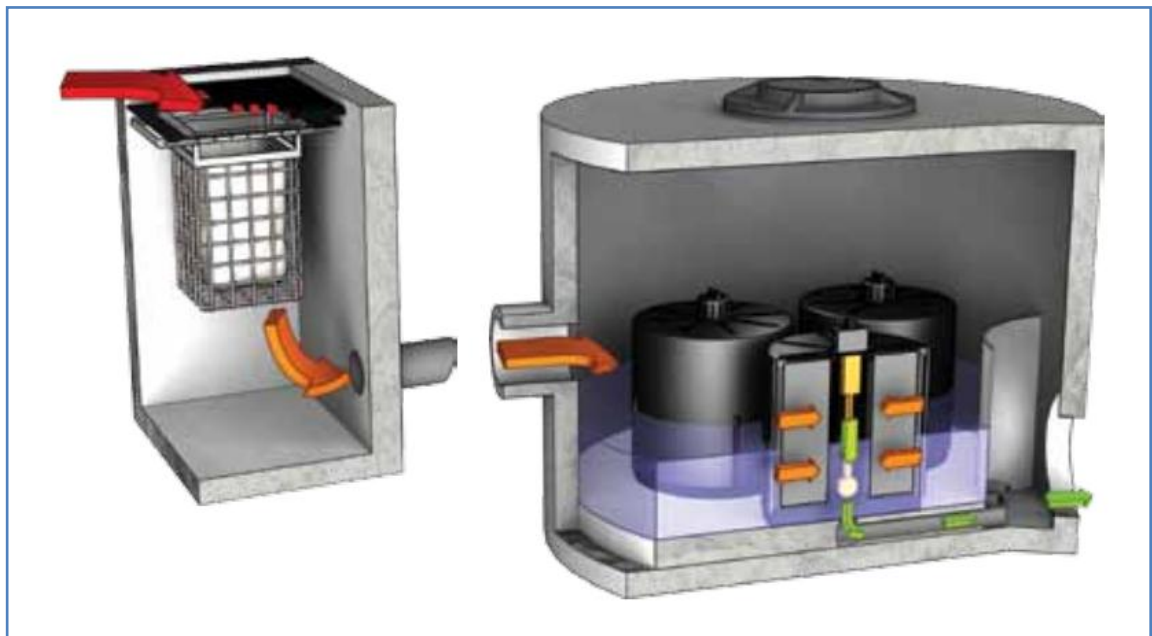


Figure 11 Screening & enhanced filtration of stormwater pollutants in an SFEP treatment train

8.5.6 GREEN ROOF

Green roofs are modular a pre-vegetated engineered filtration systems that can be easily installed onto the roofing membrane in a similar manner to readymade lawn products. Pre-vegetation may be undertaken at local nurseries using localised plant stock for a few months prior to installation.

Typically, green roofs, once installed should only require minimal maintenance. Also, minimal watering should be necessary under normal climate conditions.

8.6 POLLUTANT LOAD ESTIMATES

8.6.1 EXISTING AND BASE SCENARIOS

Total annual pollutant load estimates were derived using MUSIC for the South West Plot for both the Existing and Proposed Development (Without Treatment) Conditions. The mean annual pollutant loads resulting from both the Existing and untreated Proposed Development scenarios are similar with the latter scenario having equal or slightly less mean annual loads in Gross Pollutants, TP and TN. The estimated annual pollutant loads for the South West Plot site under Existing and Proposed Development conditions are presented in Table 8.

Table 8 Summary of estimated mean annual pollutant loads for the South West Plot

Criteria	Mean Annual Loads (kg/yr)			
	Gross Pollutants	TSS	TP	TN
Existing Conditions				
South West Plot	284	1290	2.78	25.8
Proposed development Conditions (Without Treatment)				
South West Plot	226	1230	2.54	22.3

8.6.2 PROPOSED DEVELOPMENT TREATMENT SCENARIO

Total annual pollutant load estimates were derived using MUSIC for the South West Plot incorporating the proposed water quality treatment systems. The estimated annual pollutant loads and reductions for these sub-catchments are presented in Table 9.

Table 9 Summary of estimated mean annual pollutant loads and reductions for the South West Plot development

Criteria	Pollutant			
	Gross Pollutants	TSS	TP	TN
Total Development Source Loads (kg/yr)	226	1230	2.54	22.3
Minimum Reduction Required (%)	90%	85%	65%	45%
Minimum Reduction Required (kg/yr)	203.4	1045.5	1.6	10.0
Total Residual Load to Darling Harbour (kg/yr)	0.00	125.00	0.90	10.40
Total Reduction Achieved (kg/yr)	226.0	1105.0	1.6	11.9
Total Reduction Achieved (%)	100%	90%	65%	53%

8.7 CONCLUSIONS

8.7.1 EXISTING AND BASE SCENARIOS

Results of the MUSIC modelling for the Existing and Base Scenarios show that pollutant loadings in the latter scenario are slightly less than the former scenario. This is a result of the overall slight reduction in imperviousness of the proposed development due to the introduction of more landscaped areas.

In the proposed development, a stormwater quality treatment strategy will be put in place to ensure that pollutant levels are below the base or untreated scenario and hence allowing the proposed development to comply with DGR's objectives and achieve Council's nominated pollutant reduction targets.

8.7.2 PROPOSED DEVELOPMENT TREATMENT SCENARIO

The MUSIC modelling for the Proposed Development Treated Scenario has also demonstrated that the proposed water quality management strategy in the South West Plot will result in lower levels of Gross Pollutants, TSS, TP and TN compared to values resulting from the Existing and Base Scenarios.

The performance of the proposed water quality management strategy for the proposed South West Plot development obtained from the MUSIC model, as summarised in Table 9 shows that:

- In order to achieve the objective of a 90% reduction in Gross Pollutants from the proposed South West Plot development, the minimum Gross Pollutants reduction is 203 kg/yr. The MUSIC modelling predicts that Gross Pollutants are reduced by 226 kg/yr. The water quality management strategy therefore achieves the target reduction for Gross Pollutants.
- In order to achieve the objective of an 85% reduction in TSS from the proposed South West Plot development, the minimum TSS reduction is 1,046 kg/yr. The MUSIC modelling predicts that TSS is reduced by 1,105 kg/yr. The water quality management strategy therefore achieves the target reduction for TSS.
- In order to achieve the objective of a 65% reduction in TP from the proposed South West Plot development, the minimum TP reduction is 1.6 kg/yr. The MUSIC modelling predicts that TP is reduced by 1.6 kg/yr. The water quality management strategy therefore achieves the target reduction for TP.
- In order to achieve the objective of a 45% reduction in TN from the proposed South West Plot development, the minimum TN reduction is 10 kg/yr. The MUSIC modelling predicts that TN is reduced by 11.9 kg/yr. The water quality management strategy therefore achieves the target reduction for TN.

The combination of a rainwater tank, vegetated buffer, gross pollutant traps and filtration devices as elements of the Stormwater Quality Management Strategy for the proposed South West Plot development, achieves the objectives specified in the Director General's Requirements (DGR) and the nominated pollution reduction targets for Gross Pollutants, Total Suspended Solids, Total Phosphorus and Total Nitrogen specified in the City of Sydney Council DCP.

9 REFERENCES

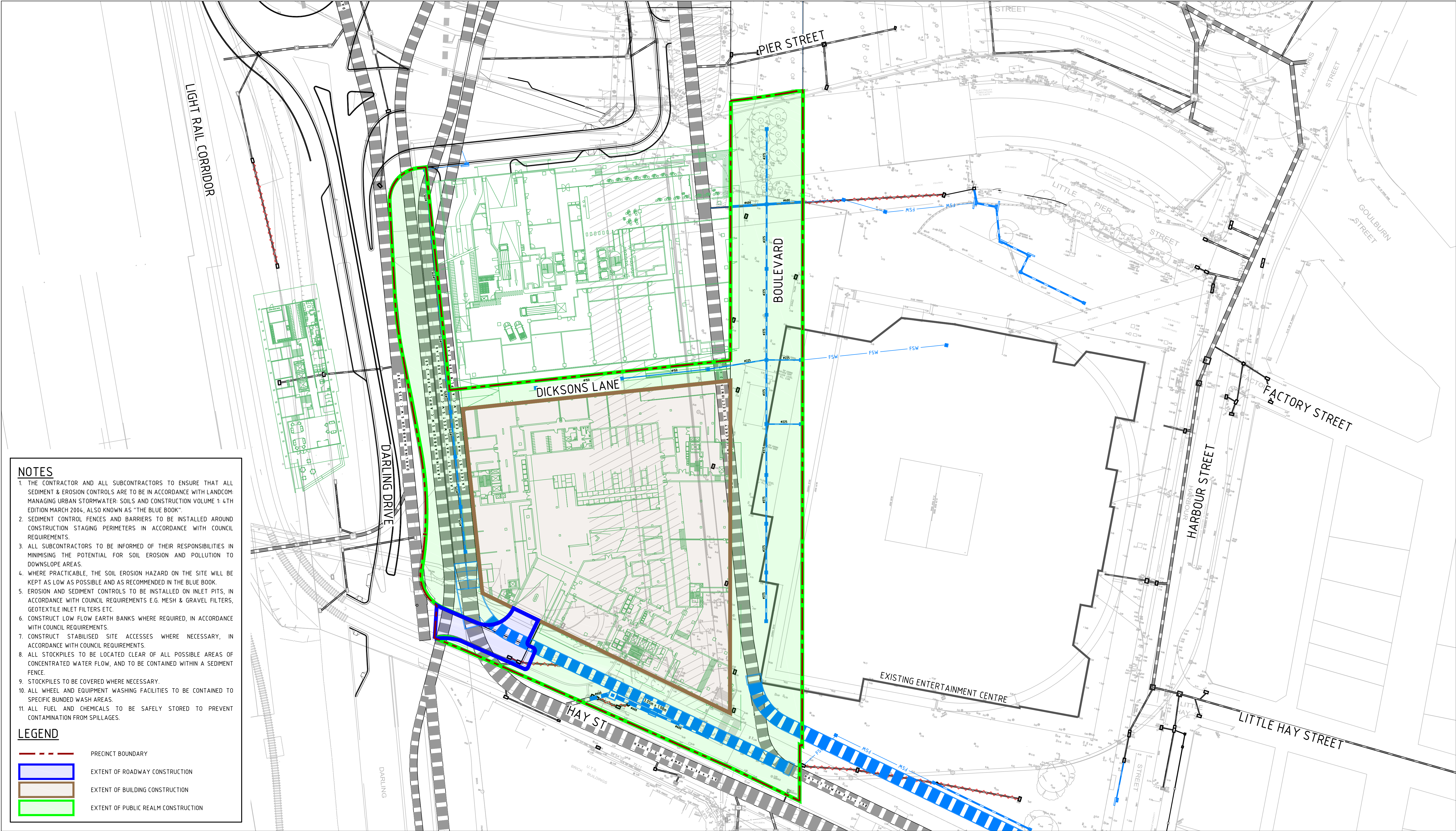
1. BMT-WBM (2010). Draft NSW MUSIC Modelling Guidelines. Prepared for Sydney Metropolitan Catchment Management Authority.
2. City of Sydney Council (2012). Sydney Development Control Plan.
3. CRC For Catchment Hydrology (2005). MUSIC Model for Urban Stormwater Improvement Conceptualisation – User Guide Version 3.
4. CRC For Catchment Hydrology (2004). Stormwater Flow and Quality, and the Effectiveness of Non Proprietary Stormwater Treatment Measures – A Review and Gap Analysis. Technical Report 04/8
5. Coombes, P. and Kuczera, G. (2001). Rainwater tank design for water supply and stormwater management. Proceedings of the Fifth Stormwater Industry Association Regional Conference on Stormwater Management, Port Stephens, April 2001, Stormwater Industry Association.
6. Engineers Australia (2006). Australian Runoff Quality – A Guide To Water Sensitive Urban Design.
7. NSW Government (2000). Environmental Planning and Assessment Regulation 2000. Published in Gazette No. 117 8 September 2000 page 9935.

APPENDIX A

FLOODING AND STORMWATER REPORT

APPENDIX B

SEDIMENT AND EROSION CONTROL PLAN



NOTES

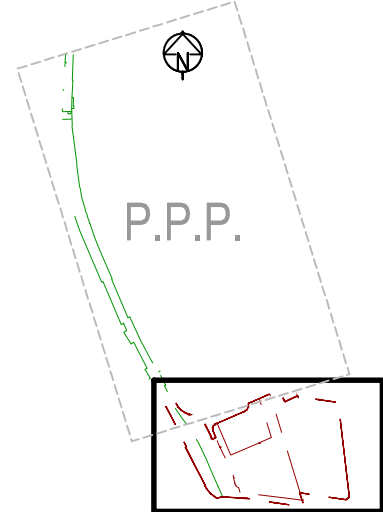
1. THE CONTRACTOR AND ALL SUBCONTRACTORS TO ENSURE THAT ALL SEDIMENT & EROSION CONTROLS ARE TO BE IN ACCORDANCE WITH LANDCOM: MANAGING URBAN STORMWATER: SOILS AND CONSTRUCTION VOLUME 1: 4TH EDITION MARCH 2004, ALSO KNOWN AS "THE BLUE BOOK"
2. SEDIMENT CONTROL FENCES AND BARRIERS TO BE INSTALLED AROUND CONSTRUCTION STAGING PERIMETERS IN ACCORDANCE WITH COUNCIL REQUIREMENTS.
3. ALL SUBCONTRACTORS TO BE INFORMED OF THEIR RESPONSIBILITIES IN MINIMISING THE POTENTIAL FOR SOIL EROSION AND POLLUTION TO DOWNSLOPE AREAS.
4. WHERE PRACTICABLE, THE SOIL EROSION HAZARD ON THE SITE WILL BE KEPT AS LOW AS POSSIBLE AND AS RECOMMENDED IN THE BLUE BOOK.
5. EROSION AND SEDIMENT CONTROLS TO BE INSTALLED ON INLET PITS, IN ACCORDANCE WITH COUNCIL REQUIREMENTS E.G. MESH & GRAVEL FILTERS, GEOTEXTILE INLET FILTERS ETC.
6. CONSTRUCT LOW FLOW EARTH BANKS WHERE REQUIRED, IN ACCORDANCE WITH COUNCIL REQUIREMENTS.
7. CONSTRUCT STABILISED SITE ACCESSES WHERE NECESSARY, IN ACCORDANCE WITH COUNCIL REQUIREMENTS.
8. ALL STOCKPILES TO BE LOCATED CLEAR OF ALL POSSIBLE AREAS OF CONCENTRATED WATER FLOW, AND TO BE CONTAINED WITHIN A SEDIMENT FENCE.
9. STOCKPILES TO BE COVERED WHERE NECESSARY.
10. ALL WHEEL AND EQUIPMENT WASHING FACILITIES TO BE CONTAINED TO SPECIFIC BUNDED WASH AREAS.
11. ALL FUEL AND CHEMICALS TO BE SAFELY STORED TO PREVENT CONTAMINATION FROM SPILLAGES.

LEGEND

- PRECINCT BOUNDARY
- EXTENT OF ROADWAY CONSTRUCTION
- EXTENT OF BUILDING CONSTRUCTION
- EXTENT OF PUBLIC REALM CONSTRUCTION

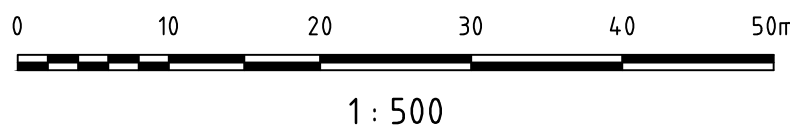
DARLING HARBOUR LIVE

REFERENCE MAP



NOTES:

1. DO NOT SCALE FROM DRAWINGS. WORK TO WRITTEN DIMENSIONS ONLY.
2. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
3. ALL COORDINATES TO MGA. ALL LEVELS TO AHD.
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03	DRAFT ISSUE	01/05/2013
02	DRAFT ISSUE	24/04/2013
01	DRAFT ISSUE	12/04/2013

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PROJECT

**SICEP - DARLING HARBOUR
HAYMARKET (PDA)
SOUTH WEST PLOT**



DRAWING TITLE

**SEDIMENT AND EROSION
CONTROL PLAN**

STATUS

PRELIMINARY ONLY

SCALE @ A1	DRAWN	DESIGNED	REVIEWED	APPROVED
1 : 500	RD	-		
PROJECT NUMBER	DRAWING NUMBER	REV		
AA004399	PD-CI-3201	03		

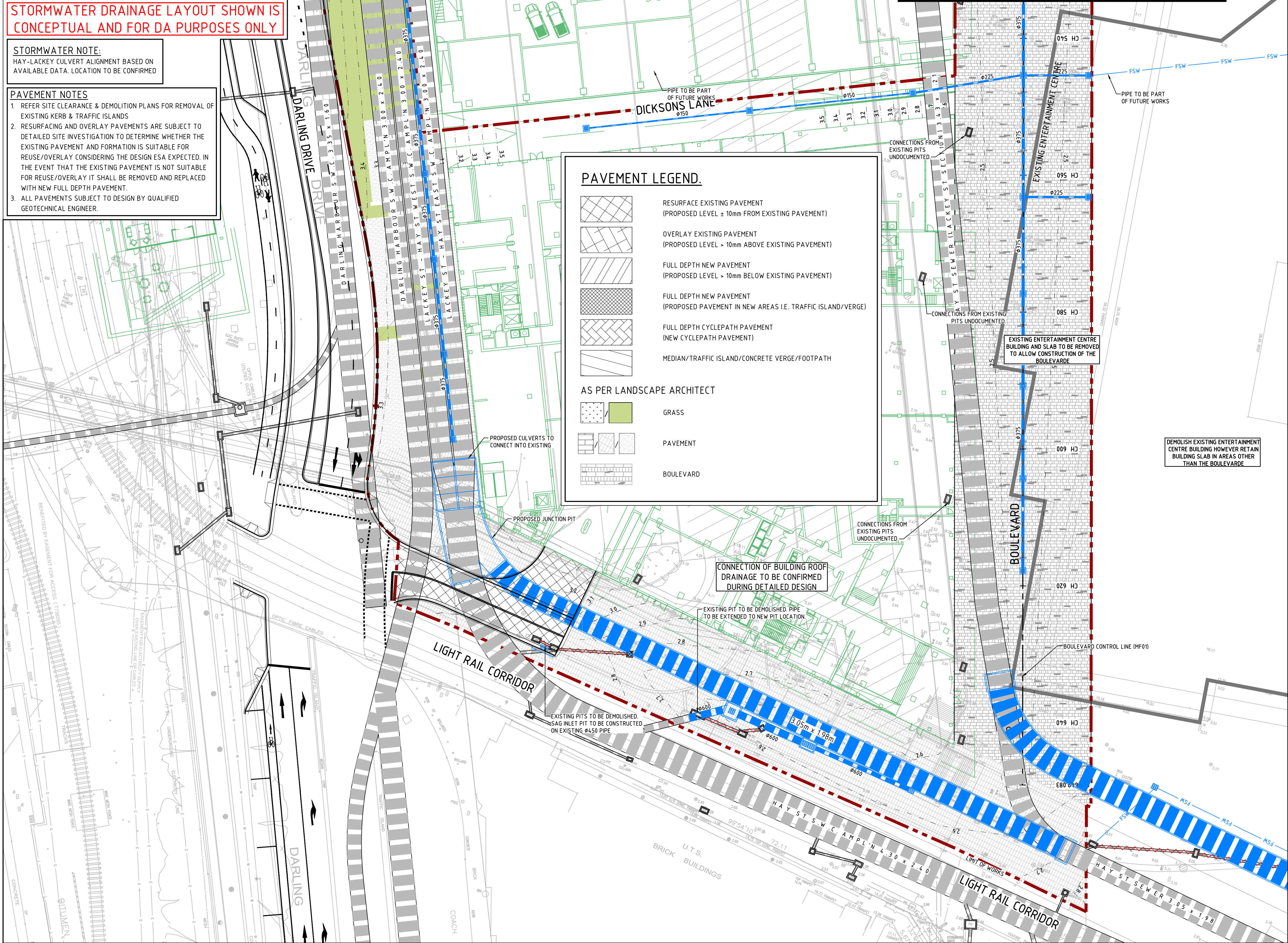
APPENDIX C

CIVIL WORKS AND STORMWATER PLAN

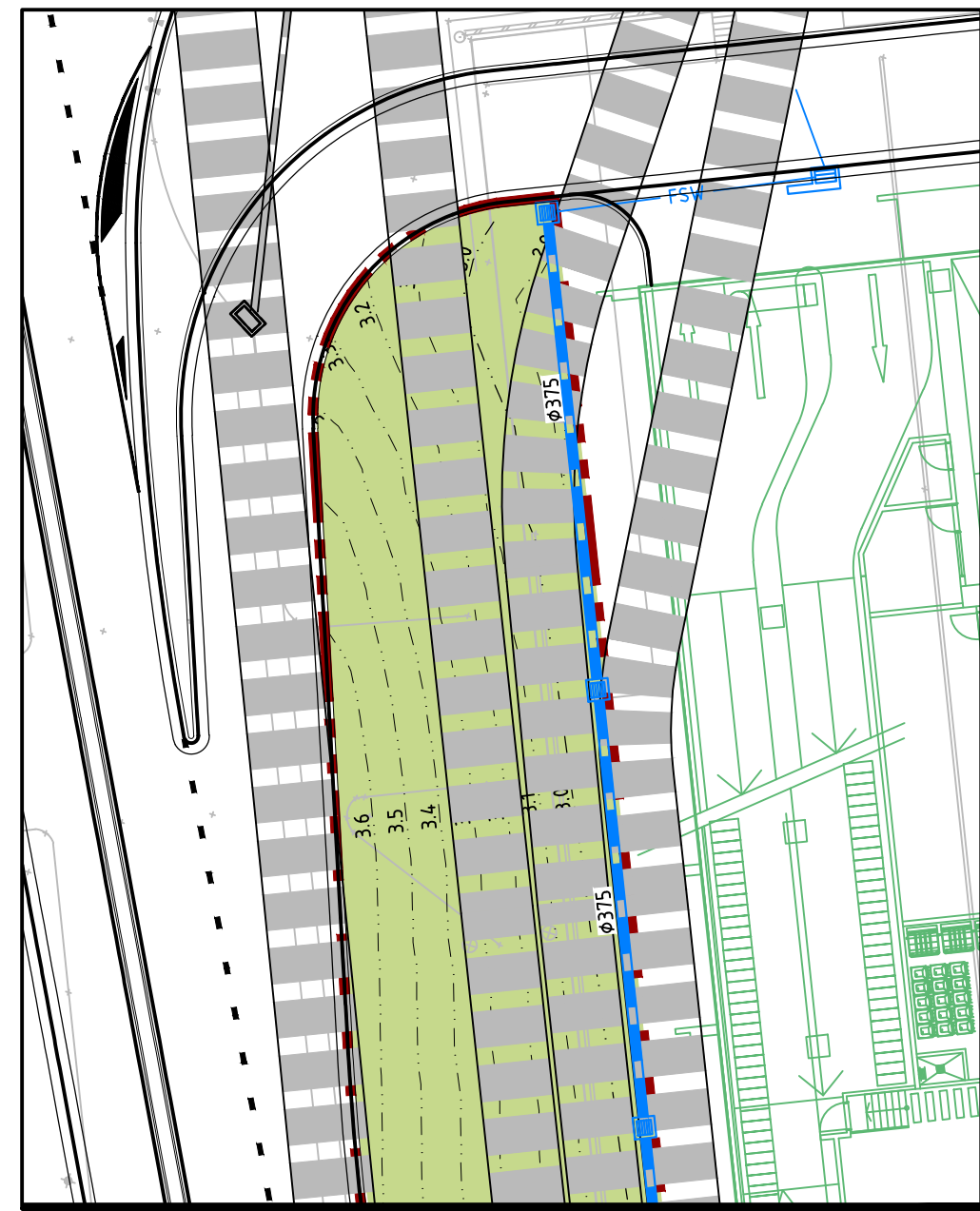
STORMWATER DRAINAGE LAYOUT SHOWN IS CONCEPTUAL AND FOR DA PURPOSES ONLY

STORMWATER NOTE:
HAY-LACKEY CULVERT ALIGNMENT BASED ON AVAILABLE DATA. LOCATION TO BE CONFIRMED

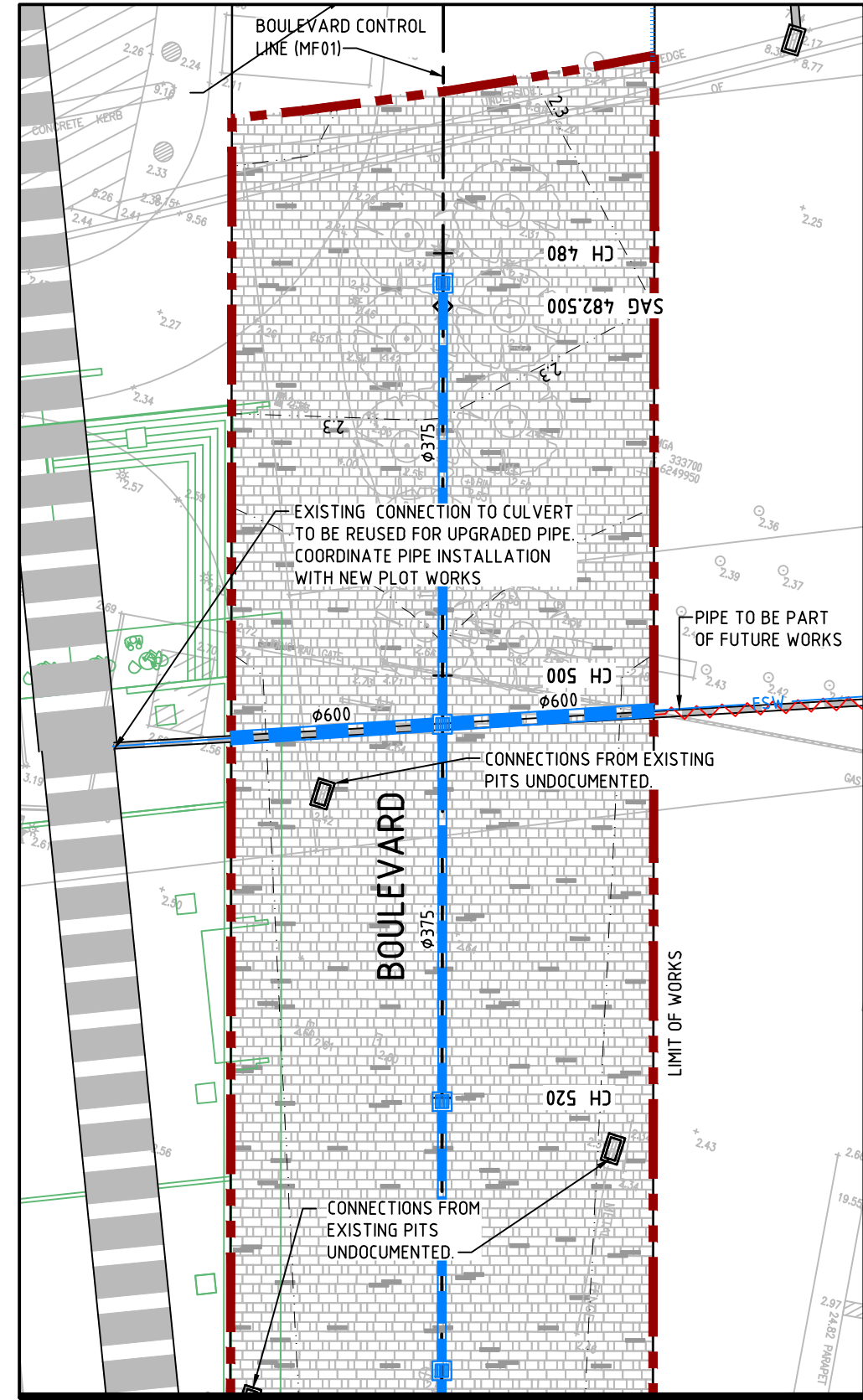
- PAVEMENT NOTES
1. REFER SITE CLEARANCE & DEMOLITION PLANS FOR REMOVAL OF EXISTING KERB & TRAFFIC ISLANDS
 2. RESURFACING AND OVERLAY PAVEMENTS ARE SUBJECT TO DETAILED SITE INVESTIGATION TO DETERMINE WHETHER THE EXISTING PAVEMENT AND FORMATION IS SUITABLE FOR REUSE/OVERLAY CONSIDERING THE DESIGN ESA EXPECTED. IN THE EVENT THAT THE EXISTING PAVEMENT IS NOT SUITABLE FOR REUSE/OVERLAY IT SHALL BE REMOVED AND REPLACED WITH NEW FULL DEPTH PAVEMENT.
 3. ALL PAVEMENTS SUBJECT TO DESIGN BY QUALIFIED GEOTECHNICAL ENGINEER.



REFER TO INSET A FOR CONTINUATION



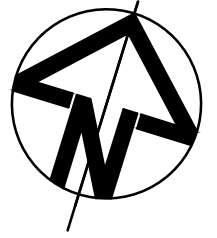
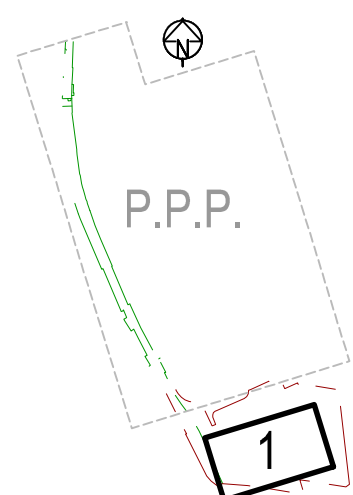
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REFER TO MAIN PLAN FOR CONTINUATION
INSET B
1: 300

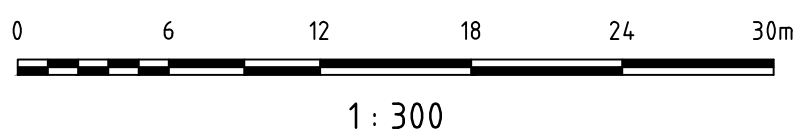
DARLING HARBOUR LIVE

REFERENCE MAP



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02	DRAFT ISSUE	24/04/2013
01	DRAFT ISSUE	12/04/2013

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PROJECT

SICEP - DARLING HARBOUR HAYMARKET (PDA) SOUTH WEST PLOT



DRAWING TITLE

CIVIL WORKS AND STORMWATER PLAN

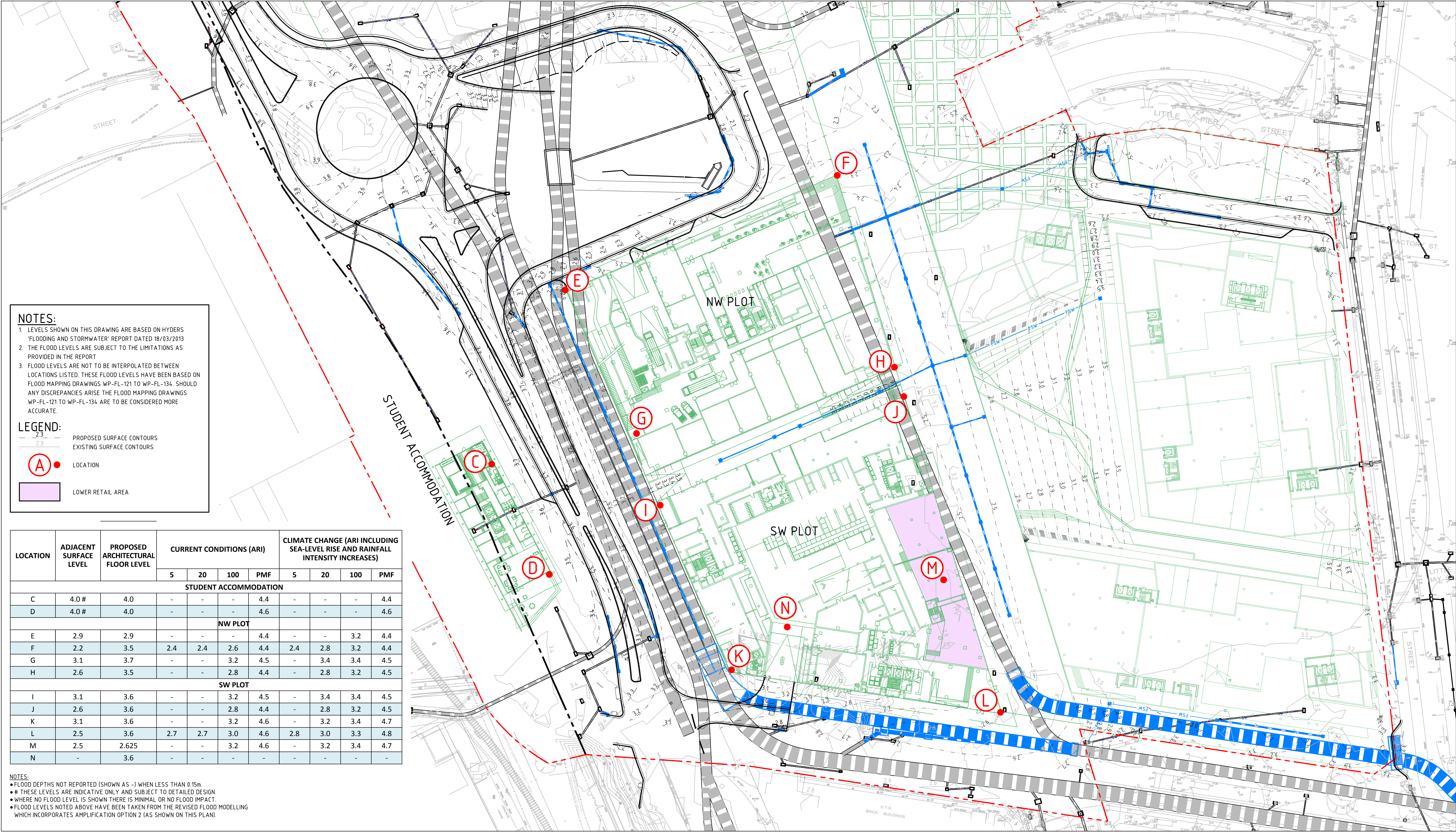
STATUS

PRELIMINARY ONLY

SCALE @ A1	DRAWN	DESIGNED	REVIEWED	APPROVED
1: 300	RD	RR		
PROJECT NUMBER	DRAWING NUMBER	REV		
AA004399	PD-CI-3301	03		

APPENDIX D

PROPOSED FLOOR LEVEL GRADING AND FLOOD LEVEL (INCLUDING CLIMATE CHANGE) PLAN



NOTES:

- LEVELS SHOWN ON THIS DRAWING ARE BASED ON HYDERS 'FLOODING AND STORMWATER' REPORT DATED 18/03/2013
- THE FLOOD LEVELS ARE SUBJECT TO THE LIMITATIONS AS PROVIDED IN THE REPORT
- FLOOD LEVELS ARE NOT TO BE INTERPOLATED BETWEEN LOCATIONS LISTED. THESE FLOOD LEVELS HAVE BEEN BASED ON FLOOD MAPPING DRAWINGS WP-FL-121 TO WP-FL-134. SHOULD ANY DISCREPANCIES ARISE THE FLOOD MAPPING DRAWINGS WP-FL-121 TO WP-FL-134 ARE TO BE CONSIDERED MORE ACCURATE.

LEGEND:

- 2.3
2.3
- PROPOSED SURFACE CONTOURS
EXISTING SURFACE CONTOURS
- (A) LOCATION
- LOWER RETAIL AREA

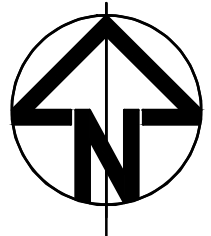
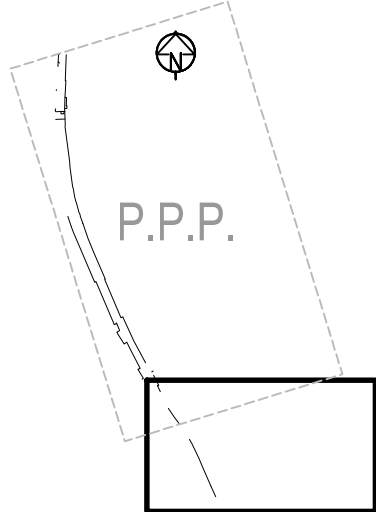
LOCATION	ADJACENT SURFACE LEVEL	PROPOSED ARCHITECTURAL FLOOR LEVEL	CURRENT CONDITIONS (ARI)				CLIMATE CHANGE (ARI INCLUDING SEA-LEVEL RISE AND RAINFALL INTENSITY INCREASES)			
			5	20	100	PMF	5	20	100	PMF
STUDENT ACCOMMODATION										
C	4.0 #	4.0	-	-	-	4.4	-	-	-	4.4
D	4.0 #	4.0	-	-	-	4.6	-	-	-	4.6
			NW PLOT							
E	2.9	2.9	-	-	-	4.4	-	-	3.2	4.4
F	2.2	3.5	2.4	2.4	2.6	4.4	2.4	2.8	3.2	4.4
G	3.1	3.7	-	-	3.2	4.5	-	3.4	3.4	4.5
H	2.6	3.5	-	-	2.8	4.4	-	2.8	3.2	4.5
SW PLOT										
I	3.1	3.6	-	-	3.2	4.5	-	3.4	3.4	4.5
J	2.6	3.6	-	-	2.8	4.4	-	2.8	3.2	4.5
K	3.1	3.6	-	-	3.2	4.6	-	3.2	3.4	4.7
L	2.5	3.6	2.7	2.7	3.0	4.6	2.8	3.0	3.3	4.8
M	2.5	2.625	-	-	3.2	4.6	-	3.2	3.4	4.7
N	-	3.6	-	-	-	-	-	-	-	-

NOTES:

- FLOOD DEPTHS NOT REPORTED (SHOWN AS -) WHEN LESS THAN 0.15m.
- # THESE LEVELS ARE INDICATIVE ONLY AND SUBJECT TO DETAILED DESIGN.
- WHERE NO FLOOD LEVEL IS SHOWN THERE IS MINIMAL OR NO FLOOD IMPACT.
- FLOOD LEVELS NOTED ABOVE HAVE BEEN TAKEN FROM THE REVISED FLOOD MODELLING WHICH INCORPORATES AMPLIFICATION OPTION 2 (AS SHOWN ON THIS PLAN).

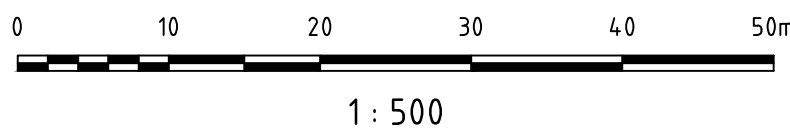
DARLING HARBOUR LIVE

REFERENCE MAP



NOTES:

- DO NOT SCALE FROM DRAWINGS. WORK TO WRITTEN DIMENSIONS ONLY.
- ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
- ALL COORDINATES TO MGA. ALL LEVELS TO AHD.
- ALL DIMENSIONS, COORDINATES AND LEVELS TO BE VERIFIED ON SITE BEFORE PROCEEDING WITH WORK. HYDER SHALL BE NOTIFIED IN WRITING OF ANY DISCREPANCIES.
- THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.



DRAFT		
01	ISSUE FOR INFORMATION	16/05/13
REV	DESCRIPTION	DATE

CLIENT

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PROJECT

SICEEP
DARLING HARBOUR
PRIVATE DEVELOPMENT AREA (PDA)



DRAWING TITLE

PROPOSED FLOOR LEVEL GRADING AND FLOOD LEVEL (INCLUDING CLIMATE CHANGE) PLAN

STATUS

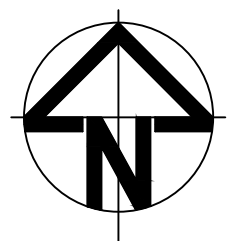
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SCALE @ A1	DRAWN	DESIGNED	REVIEWED	APPROVED
1 : 500	JJB	CM	MK	-
PROJECT NUMBER	DRAWING NUMBER	REV		
AA004399	SKCPD060	01		

APPENDIX E

AMPLIFICATION OPTION 2B FLOOD MODELLING

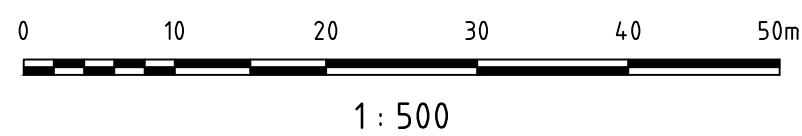
REFERENCE MAP



NOTE:
HAY-LACKEY CULVERT ALIGNMENT BASED ON
AVAILABLE DATA. LOCATION TO BE CONFIRMED

NOTES:

1. DO NOT SCALE FROM DRAWINGS. WORK TO WRITTEN DIMENSIONS ONLY.
2. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
3. ALL COORDINATES TO MGA. ALL LEVELS TO AHD.
4. ALL DIMENSIONS, COORDINATES AND LEVELS TO BE VERIFIED ON SITE BEFORE PROCEEDING WITH WORK. HYDER SHALL BE NOTIFIED IN WRITING OF ANY DISCREPANCIES.
5. THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.



01	ISSUE FOR REVIEW	02/04/2013
REV	DESCRIPTION	DATE

CLIENT



DEVELOPMENT
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PROJECT

SICEEP
DARLING HARBOUR
PRIVATE DEVELOPMENT AREA (PDA)



DRAWING TITLE

CONCEPT HAY/LACKEY STORMWATER
CULVERT AMPLIFICATION
OPTION 2B

STATUS

PRELIMINARY ONLY

SCALE @ A1	DRAWN	DESIGNED	REVIEWED	APPROVED
1:500	KM	CM	CM	GI
PROJECT NUMBER	DRAWING NUMBER			REV
AA004399	SKCPD041			01

APPENDIX F

CONSTRUCTION PHASE FLOOD MODELLING

Original Sheet Size A1 - 841 x 594mm