Figure 2-1 Project Redevelopment Area

2.4.1 PRIVATE PUBLIC PARTNERSHIP (PPP)

The proposed development involves construction of the PPP component of the SICEEP Project, comprising new, integrated and world-class convention, exhibition and entertainment facilities with associated retail and public domain upgrades.

The application more specifically seeks approval for the following development:

- Demolition of existing improvements on the site, including existing Sydney Convention Centre (part) and Sydney Exhibition Centre;
- Associated tree removal and replanting;
- Construction of a new, integrated and world-class Convention, Exhibition and Entertainment Centre;
- Public domain improvements, including:
  - reinvigorating and expanding Tumbalong Park;
  - provision (part) of a new active north-south pedestrian connection (known as the Boulevard);
  - provision of new east-west connections, including Harbourside Place and Tumbalong Place;
  - Provision of a pedestrian bridge link from Quarry Street;
  - Retention of the tidal cascade water feature;
  - Reconfiguration and upgrade of Darling Drive (part);
  - Provision of a new square adjoining the Chinese Garden;
  - Provision of a new open space 'event deck' (connected with the Exhibition Centre);
  - Integrated art, play zones, water play and recreation areas;
  - Provision of retail kiosks;
- Provision of ground level parking within the Exhibition and Entertainment Centre facilities;
- Ground and elevated loading docks (accessed off Darling Drive) for Convention, Exhibition and Entertainment Centre facilities;
- Two vehicle drop off points off Darling Drive;
- Provision of signage; and
- Extension and augmentation of physical infrastructure / utilities as required.

2.4.2 PRIVATE DEVELOPMENT AREA (PDA) – THE HAYMARKET

The PDA proposal relates to a staged development application and seeks to establish concept proposal details for The Haymarket, located within the southern part of the SICEEP Site.

The Haymarket will indicatively include student housing, public car parking, a commercial office building, and four mixed use development blocks (retail/commercial/residential podium with residential towers above) centred around a new public square to be named Haymarket Square.

More specifically approval is sought for the following:

- Demolition of existing site improvements, including the existing Sydney entertainment Centre (SEC), Entertainment car park, and part of the pedestrian footbridge connected to the Entertainment car park and associated tree removal;

- North-west block – construction of a part public car park and part commercial/office building;
- North-east block – construction of a mixed use podium (comprising retail, commercial, above ground parking, and residential);
- South-east block - construction of a mixed use podium (comprising retail, commercial, above ground parking, and residential);
- South-west block - construction of a mixed use podium (comprising retail, commercial, above ground parking, and residential);
- North block – construction of a low rise mixed use building comprising retail, commercial and residential;
- Student housing – construction of two buildings providing for student accommodation;
- Public domain improvements including a new square, water features, new pedestrian streets and laneways, streetscape embellishments, and associated landscaping. (It is intended that a Stage 2 DA seeking approval for parts of the part of the public domain (The Boulevard and Haymarket Square) will be lodged with the first residential stage);

2.5 PLANNING APPROVALS STRATEGY

In response to separate contractual agreements with the NSW Government and staging requirements, Darling Harbour Live is proposing to submit a number of separate development applications for key elements of the PPP Project.

This Application involves the PPP component of the SICEEP Project, comprising the convention centre, exhibition centre, entertainment facility, and associated public domain upgrades.

In response to separate contractual agreements with the NSW Government and staging requirements Lend Lease (Haymarket) Pty Ltd is proposing to submit a number of separate development applications for key elements of the PDA Project.

This staged development application involves the establishment of building envelopes and design parameters for a new neighbourhood and a community hub (The Haymarket) within the southern part of the SICEEP Site. Detailed development applications will accordingly follow seeking approval for specific aspects of The Haymarket in accordance with the approved staged development application.

A separate development application will also be submitted for the Hotel Complex. Figure 2-2 outlines the currently preferred master plan.

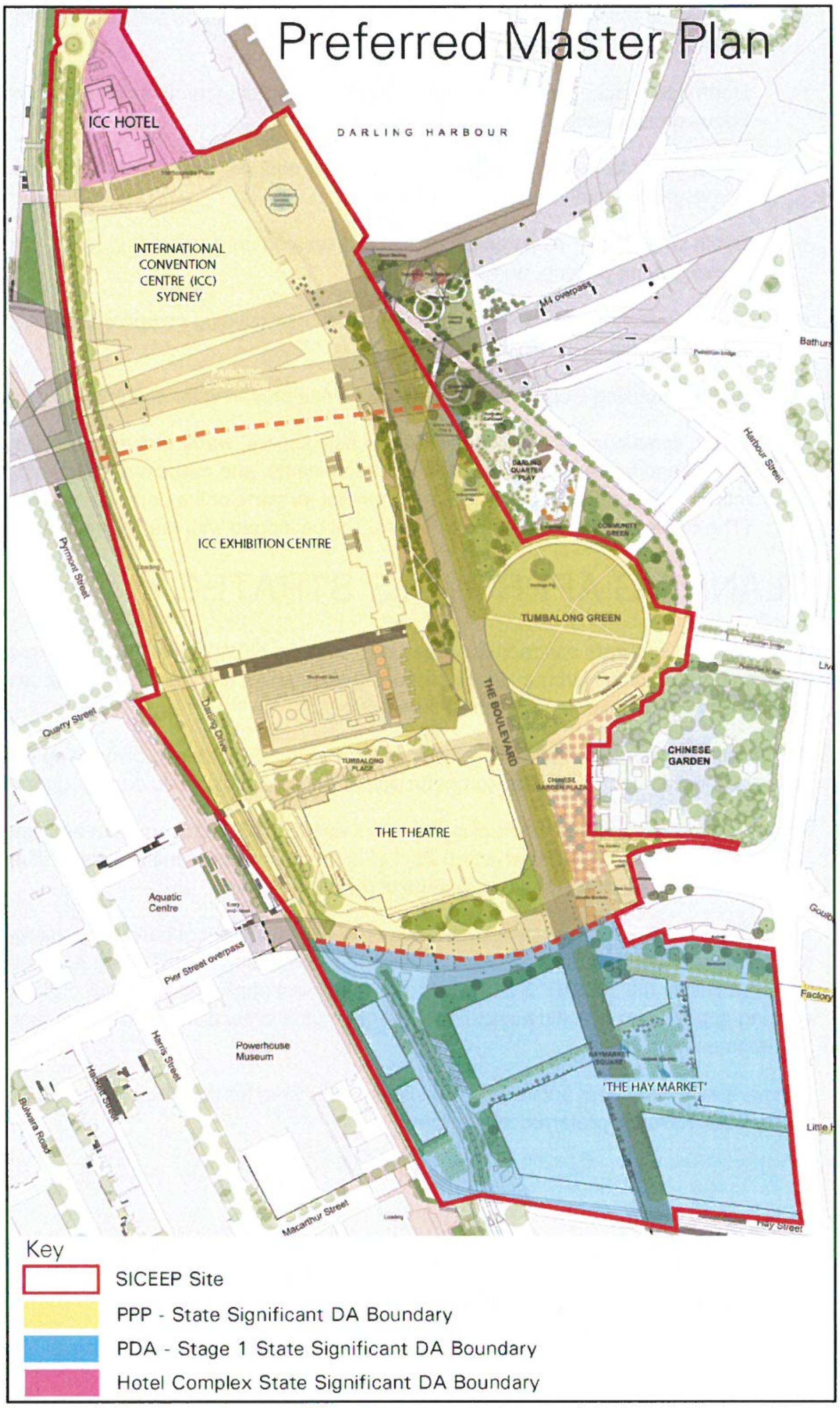

Figure 2-2 Preferred Project Master Plan

2.6 DIRECTOR GENERAL'S REQUIREMENTS

Table 2-1 Director General's Requirements

DGR Reference	Key Assessment Requirement	Report Section Reference
4 – Public Domain and Urban Design	Address Water Sensitive Urban Design (WSUD) opportunities within the public domain and landscaping.	Section 5
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.	Section 5 ESD Report for other key requirements.
9 – Drainage, Flooding, climate change and Sea Level Rise	Provide a drainage concept for the site incorporating water sensitive urban design	Section 3, 4 and 5
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	Section 3 Groundwater risk to the site is not addressed as part of this Report.
14 – Water Quality	Address water quality impacts during construction including details of the source, volume, frequency and on-going monitoring methods	Section 4
14 – Water Quality	Provide mitigation and management measures to minimise soil and stormwater impacts to the surrounding area.	Section 3, 4 and 5

2.7 INFRASTRUCTURE NSW PROJECT BRIEF REQUIREMENTS

Table 2-2 Infrastructure NSW Project Brief Requirements

Project Brief	Key Requirement	Report Section Reference
2.11.2 (b) Drainage Design Parameters	The Project Company must design and construct the minor (piped) and major (overland) drainage systems to convey all the SICEEP precinct stormwater, including accommodation of roof drainage outlets and upstream catchments, through the precinct. The minor and major systems must be designed to convey the 5% and 1% Annual Exceedance Probability (AEP) rainfall events respectively, subject to the limitations of the existing drainage systems, which the project systems discharge into.	Section 3 and 4
2.11.2 (c) Drainage Design Parameters	The Project Company must ensure all stormwater pipes within the Public Realm areas are rubber ring jointed reinforced concrete pipes with a minimum diameter of 375mm.	Section 4
2.11.3 (a) Overland Flow	The Project Company must design and implement an overland flow path through the precinct in accordance with the NSW Floodplain Development Manual. As a minimum the Project Company shall improve upon the existing overland flow conditions through the site, but ensure they are no worse than existing conditions.	Section 3

Project Brief	Key Requirement	Report Section Reference
2.11.4 (a - d) Flood Levels	a) The Project Company must undertake a Flood Risk Assessment in accordance with the procedures set out in NSW Floodplain Development Manual (2005) – Appendix C. b) The Project Company must design and construct the project works to comply with the requirements of the Flood Risk Assessment. This assessment must be undertaken in conjunction with that described in Section 2.11.5 of the Project Brief, and be submitted for review in accordance with the Project Deed. c) The Project Company must ensure that no part of the project works result in adverse flooding or risk of flooding for any external property or third party facility d) The Project Company must identify and apply flood planning levels for the facilities in accordance with the flooding and risk assessment, as described in Section 2.11.4 of the Project Brief and the guidelines specified in Section 2.11.2 of the Project Brief. Notwithstanding these requirements, the Project Company must ensure that the following minimum flood planning levels are applied to the Facilities: ▪ Habitable building floor level - 1% AEP + 0.5m. Where habitable floor levels are below the 1% AEP flood level, 500mm freeboard shall be applied above the 1% AEP flood level at all points of entry. Existing ground floor levels of the Convention Centre and the Exhibition Centre car park are to remain. ▪ Underground car park - 1% AEP + 0.5m. Where this cannot be practicably achieved, determination of appropriate levels shall be subject to a risk based assessment. ▪ Installations containing infrastructure control equipment - 1% AEP + 0.5m ▪ Other floor levels - 1% AEP and subject to a risk based assessment	Section 3
2.11.5 (a) Climate Change and Sea Level Rise	In accordance with requirements for planning approval, the Project Company must undertake a risk assessment of the impacts of sea level rise and climate change on the Precinct, in accordance with the guidelines specified in Section 2.11.2 of the Project brief, and submit the risk assessment report for review in accordance with the Project Deed.	Section 3
2.11.6 (a) Subsoil Drainage	The Project company must provide subsoil drainage, as required under pavement areas to ensure appropriate drainage to all areas of sub-grade, sub-base and base areas.	Section 4
2.11.7 (a) Water Quality	The Project company must provide for meeting the following performance criteria for water quality for all water falling within the areas of the Public Realm and the Facilities: ▪ Litter and Vegetation larger than 5mm - 90% reduction on the baseline annual pollutant load ▪ Total Suspended Solids - 85% reduction on the baseline annual pollutant load ▪ Total Phosphorus - 65% reduction on the baseline annual pollutant load ▪ Total Nitrogen - 45% reduction on the baseline annual pollutant load	Section 5

3 FLOOD STUDY

This flood study of the proposed development, carried out by Hyder Consulting, is a consolidated assessment incorporating The Haymarket, PPP and ICC Hotel developments within the SICEEP project area.

The flood study is a comprehensive technical investigation of flood behaviour of the project area (under proposed concept development conditions) that follows the processes set out in the 'Floodplain Development Manual: the management of flood liable land' (April 2005) prepared by the NSW Government, and in compliance with the Director General requirements. In particular, the flood study:

- Quantifies flows, water levels and hydraulic hazard categories to facilitate the setting of flood planning levels by the Project Company (Lend Lease) in accordance with those set by the project brief (INSW); and
- Identifies overland flow paths, underground conduit systems, and waterway works necessary to mitigate potential adverse flood impacts that may otherwise result from the proposed development.

3.1 METHODOLOGY

The first step in the flood assessment process has been to identify and retain (where possible) major overland flow paths and underground drainage systems that currently exist through the site. This process has been facilitated by:

- Sydney Water 'work-as-execute' drawings of the substantial storm water systems which convey flows under the site and into Sydney Harbour; and
- City of Sydney Council drainage asset information.

With this information, and the project 'Preferred Master Plan', Hyder has developed a catchment rainfall runoff model using DRAINS software to quantify proposed development flows, which have subsequently served as inputs into a site specific TUFLOW 2D dynamic software model. The TUFLOW model fully integrates surface and sub-surface stormwater systems, so as to quantify conduit flows and surface flood levels, depths, velocities and extents for proposed development conditions.

The process and findings of the Hyder hydrological analysis and site flow regimes assessment are described as follows.

3.2 HYDROLOGICAL ANALYSIS

3.2.1 ASSESSMENT METHODOLOGY

DRAINS software has been used to quantify rainfall runoff for the SICEEP site (under its concept design condition) and its upstream catchment. The DRAINS model has been built using the following information:

- Aerial photography and aerial laser scanning (ALS) data provided by The City of Sydney Council, covering the entire site and its upstream catchment areas;
- Ground survey and digital elevation model (DEM) provided by Rygate and Company Pty Ltd, of the site and immediately adjacent areas;
- Site and catchment inspections during the project period;

- Intensity-frequency-duration (IFD) design rainfall data from the Bureau of Meteorology for the site catchment;
- Sydney Water 'work-as-execute' drawings of their storm water systems which convey flows under the site and into Sydney Harbour; and
- City of Sydney Council drainage asset information.

Catchment drawings and its associated sub-areas are included in Appendix B. Overall the catchment covers an area of approximately 210 ha (inclusive of the SICEEP site area) which is predominantly urbanised and impervious with approximately 20% of the catchment pervious vegetated areas.

The DRAINS model adopts the ILSAX module run under standard mode with parameters which are summarised in Table 3-1. The DRAINS model was run for various storm durations, from 5 minutes to 3 hours, for the 5 year, 20 year and 100 year ARIs, and 15 minute to 2 hours for the probable maximum flood (PMF), and +15% rainfall intensities to represent climate change.

Table 3-1 DRAINS Model Parameters

Model Parameter	Adopted Value
Soil Type – Normal	3
Paved (Impervious) Area Depression Storage	1mm
Supplementary Area Depression Storage	1mm
Grassed Area Depression Storage	5mm
Antecedent Moisture Condition	3.0
Conduit and surface flow travel times	Based on ARR guidelines

In addition to the catchment sub-areas, the DRAINS model includes stormwater pit and conduit systems which have also been replicated in the TUFLOW modelling of the SICEEP site. A summary of the model input data for re-development site conditions is included in Appendix B.

3.2.2 MODEL RESULTS

Drains model outputs for proposed development conditions is included in Appendix B. The output hydrographs from each sub-catchment area (for the various storm events) have been put into the TUFLOW model to quantify site flow regimes for both underground conduit systems and overland.

3.3 SITE FLOW REGIMES

3.3.1 MODEL SETUP

A site specific TUFLOW 2D dynamic model was developed to quantify conduit flows, flood levels, depths, velocities and extents through the SICEEP site under the proposed development condition.

Figure 3-1 highlights the layout of the existing Sydney Water closed conduit systems under the Darling Harbour area. Some of these systems date back to 1928 and 1936, and have been extensively amplified in subsequent years to accommodate land reclamation and development. The most recent amplification was carried out in the mid to late-1980s to accommodate Darling Harbour development at that time.

There is some concern that broader upstream catchment drainage conduit systems may limit flows entering the amplified Sydney Water systems. As such the TUFLOW model extents extend upstream to include smaller, potentially 'restrictive' trunk drainage systems of the broader catchment, and the inclusion of numerous subareas and pit and pipe systems downstream (through the SICEEP site) to adequately determine the underground conduit flows through the site.

The TUFLOW model incorporates:

- A digital elevation model (DEM) developed from land survey data and aerial laser scanning (ALS). There is uncertainty over the accuracy of the DEM with an explanation provided in Appendix C.
- Overland flow path terrain roughness's of:
  - n = 0.02 for road corridors and open paved areas,
  - n = 0.035 for grassed,
  - n = 0.05 for landscaped areas.
- Some blocked out areas to represent rows of columns or trees.
- Stormwater inlets and conduit systems based on City of Sydney Council drainage asset information (outlined in the Appendix B catchment figures) and Sydney Water 'work-as-execute' drawings (Refer to Appendix B).
- Conduit 'Mannings n' roughness values of:
  - n = 0.011 for concrete pipes,
  - n = 0.010 for PVC pipes,
  - n = 0.020 for 1928 box culverts,
  - n = 0.018 for 1936 box culverts,
  - n = 0.015 for 1980s box culverts.
- Runoff hydrographs generated from the DRAINS modelling.
- Inflow locations for the major lumped catchments (external to the site) are indicated on the Appendix C TUFLOW figures. Smaller flows from within site sub-catchment areas (identified in the Appendix C catchment figures) have been included in the TUFLOW models however the locations are not explicitly indicated. The TUFLOW models are available on request for this purpose.
- An amplification option of the Sydney Water culvert system. The culvert amplification option includes a new concrete box culvert which;
  - starts as an off-take from the existing W3.m x H2.0m culvert at the eastern side Harbour Street at its intersection with Hay Street;
  - has approximately 16m^2 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;
  - extends westward, under the proposed colonnade parallel to Hay Street, to the proposed Boulevard, then northward under the Boulevard, then just before Pier Street it cuts under the proposed north eastern corner of the proposed Office and Public Parking area (cutting through the existing 'Lackey Street-Hay Street W3.4m x H2.2m culvert, 30P'), before linking and discharging into the existing culvert systems just south of Pier Street.

In addition, the TUFLOW modelling includes various system blockages and downstream boundary conditions which are discussed as follows.

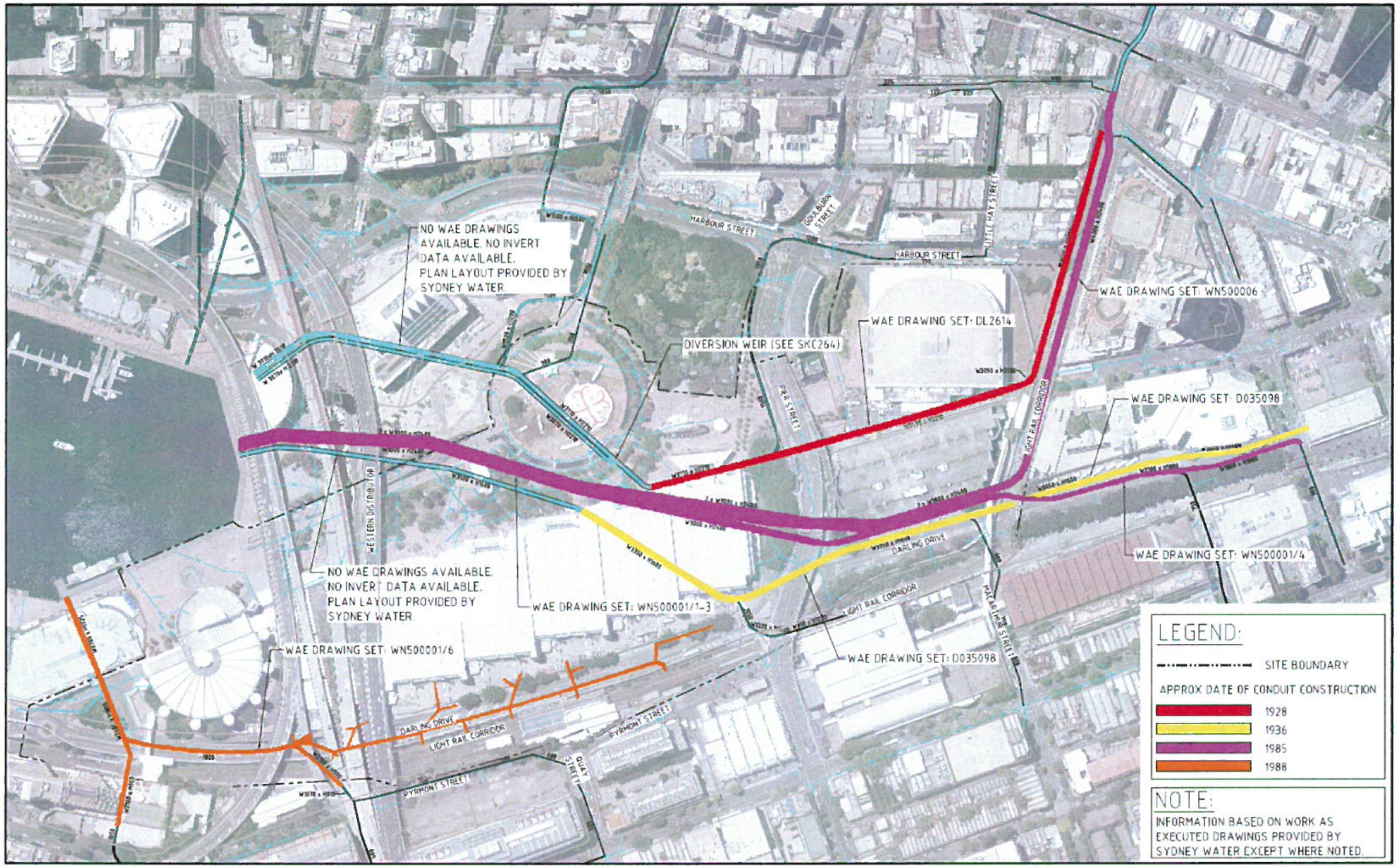

Figure 3-3 Existing Sydney Water Closed Conduit Systems

System Blockages

Conduit Blockage

Careful consideration has been given to the potential for blockage of the large closed conduit box culvert systems which convey flows under the SICEEP site.

The culverts, being the extension of fully closed conduit systems (with standard stormwater street pit inlets or direct building hydraulic connections) would be unlikely to block from upstream debris. At a meeting with City of Sydney Council (on 17 January 2013 and follow-up email on 18 January) Council concurred, adding that their 'Sydney Development Control Plan 2012 Section 3.7.5(4) (c)', which calls for 50% blockage of culverts and bridges, refers only to structures over open waterways and not to the Darling Harbour Sydney Water box culvert systems under the SICEEP site.

With respect to potential blockage of the culverts from downstream sediment washed into the systems from Cockle Bay, Hyder has obtained bathymetry levels of Cockle Bay from the Roads and Maritime Services NSW. Based on soundings taken between 1995 and 2011, sea bed levels in the vicinity of the culvert outlets are no higher than -5.5mAHD (see Appendix D). The invert of the lowest culvert outlet is no lower than approximately -1.6mAHD, almost four metres above the expected formal sea bed. As such, heavy sea bed material, with the potential to resist mobilization and flushing out from the culverts by catchment runoff flows, is unlikely.

The dilapidation condition of the various Sydney Water systems is also a factor particularly with respect to the older 1928 (SWC 30P) and 1936 (SWC 30A) structures. A Sydney Water report 'Stormwater Planning Asset Management, City Area SWC 30, Closed Conduit Inspection Report' (August 2003) provides significant information regarding the box culverts. The report covers inspection findings for the culvert systems constructed in 1927 and 1938 (however, not the three culvert systems constructed in the 1980s). Hyder has prepared a plan layout figure (see Appendix D) which indicates areas of siltation (and non-siltation) within the culverts and an internal weir structure. The internal weir is located on SWC 30P (under the upstream of Tumbalong Park). Its height has been estimated as 1.2m, and diverts flows into the parallel western culvert amplification (of the 1980s).

Sydney Water has also advised that major structural defects of the 1928 (SWC 30P) system under Hay Street were identified in 2003. This system is a sandstone arch structure (approximate W3.05m x H1.98m) which was failing and had collapsed block work. Subsequently some 170m length was repaired with works completed in 2008. The repairs included internal lining and external reinforced concrete to carry overburden loading.

Based on the above noted information, no blockage (due to siltation) has been applied to the Sydney culvert systems under the SICEEP site.

Inlet Pit Blockage

In discussion with City of Sydney Council, on-grade stormwater pits are assumed to have 30% blockage, and sag pits 50% blocked.

At the upstream limits to the TUFLOW (and DRAINS) modelling of the conduit systems, the Council data base of stormwater assets (see Appendix B) indicates that even with the 30% and 50% blockage assumptions there are sufficient inlet pits, such that the underground stormwater conduit systems will not be limited by surface inlet capacities (but conduit size) and therefore the modelled upstream capacities assume 'unlimited' surface inlet capacity.

Overland Blockage

Based on the Preferred Project Master Plan it has been assumed that there are no fences, gate or other obstructions along the modelled overland flow paths apart from some stands of trees and building columns, which have been represented in the TUFLOW modelling by reduced grid area and the introduction of hydraulic loss effects.

Downstream Boundary Conditions

Sydney Harbour

The various stormwater drainage systems through the SICEEP site discharge into Cockle Bay in Sydney Harbour. The adopted Cockle Bay 'design still water levels' for present day and future planning horizons have been based on the DECC (2008) "Fort Denison: Sea Level Rise Vulnerability Study" with details included in Appendix E and summarised in Table 3-2. This Table 3-2 also includes predicted sea level rise benchmarks (for the year 2100) in accordance with the 'NSW Sea Level Rise Policy Statement' (2009).

Table 3-2 Sydney Harbour Design Still Water Levels

ARI (years)	Design Still Water Level (mAHD)	
	2008	2100
5	1.32	2.22
20	1.38	2.28
100	1.44	2.34
PMF *	1.8	2.7

*Approximate only (see Appendix E)

Coincidence of Cockle Bay and Catchment Runoff

While Table 3-2 outlines the peak Sydney Harbour design levels, further consideration has been given to the coincidence with catchment runoff. On this matter Australian Rainfall & Runoff Revision Project 18 'Interaction of Coastal Processes And Severe Weather Events' (June 2012, p46), advises that for small catchments, including many urban stormwater catchments with rapid response times, the dependence between rainfall and storm surge is likely to be relatively low.

Since the catchment impacting on the SICEEP has a rapid response time of only 25 minutes, Hyder has investigated such independence for the Darling Harbour catchment by examining 99 years (1914-2012) of continuously recorded Sydney Harbour water levels (from Fort Denison), and 155 years (1858 to 2012) of rainfall data from the Observatory Hill recorder. Plots which superimpose catchment rainfall runoff and Sydney Harbour water levels for the most significant events are included in Appendix F.

The plots indicate the independent nature of the rainfall runoff and storm surge (as advised by the ARR June 2012 Project 18), and the independence of rainfall runoff with tidal fluctuation. Interestingly, of the twenty maximum recorded rainfall events since 1914 eleven events are coincident with Sydney Harbour water levels ranging between 0.05mAHD and 1.25mAHD, and nine events coincidence with Sydney Harbour water levels ranging between 0.00mAHD and -0.40mAHD, with the average coincident water level 0.2mAHD.

Also, of the fifteen maximum recorded Sydney Harbour water levels, the highest recorded level of 1.475mAHD (on 25 May 1974) had a maximum recorded surge component of 0.6m yet was not associated with major event rainfall. In fact none of the fifteen worst Sydney Harbour water levels are associated major event rainfall.

Based on the independence between rainfall and storm surge found by ARR Project 18 (June 2012) for small urban stormwater catchments with rapid response times, and the 'snap shot' review of historic events carried out by Hyder, it may be reasonable to adopt a coincident Sydney Harbour water level of 0.2mAHD (being the average coincident water level for the twenty maximum recorded rainfall events), however due to uncertainties Hyder has adopted a more conservative fixed coincident water level of 0.9mAHD with all catchment rainfall runoff conditions, which allows for an additional 0.7m surge component. As such Table 3-3 summarises the adopted coincidence Sydney Harbour Water Levels Coincident with Catchment Runoff for current and climate change conditions.

Table 3-3 Sydney Harbour Water Levels Coincident with Catchment Runoff

ARI (years)	Design Still Water Level (mAHD)	
	Current Conditions	2100
5	0.90	1.80
20	0.90	1.80
100	0.90	1.80
PMF	1.3 *	2.2

*An addition of 0.4m compared to the 100 year 0.9mAHD level, i.e. the same as the incremental increase in still water levels (see Table 3-2).

3.3.2 SENSITIVITY ASSESSMENTS

In addition to the analysis of 5 year, 20 year, 100 year and PMF flow regimes, the following sensitivity assessments have been carried out.

Sydney Harbour Coincident Water Level

The 100 year ARI event was run with the coincident water level in Sydney Harbour increased from 0.9mAHD to 1.435mAHD.

Climate Change

The 20 year, 100 year and PMF events were run with increased (2100) Sydney Harbour water levels as per Table 3-3, and associated rainfall increases of 15%, which is an upper limit estimate based on the NSW Department of Environment and Climate Change (DECC) 'Flood Risk Management Guideline – Practical Consideration of Climate Change' (October 2007) Table 1 for Sydney Metropolitan Catchments.

No Culvert Amplification Option

The 100 year ARI and '100 year with climate change' events were run with no culvert amplification.

3.3.3 MODEL RESULTS

TUFLOW model flow regimes figures for proposed development conditions are included in Appendix C. The modelling has indicated that for 5 year, 20 year and 100 year ARI conditions, 25 minute and 60 minute duration rainfall events generate peak catchment flows through the site. Further discussion and comments are provided in Section 3.5.

3.4 POTENTIAL FLOOD IMPACTS

So as to assess potential flood impacts of the proposed SICEEP development on existing flow regimes, the DRAINS and TUFLOW models used to represent proposed developed condition flow regimes were adjusted to represent existing conditions, then the proposed development condition and existing conditions flow regimes compared.

The existing conditions DRAINS and TUFLOW modelling is discussed in Appendix G. TUFLOW flow regime existing conditions and flood impact figures are included in Appendix C.

3.5 DISCUSSION AND COMMENTS

3.5.1 NO CLIMATE CHANGE

Under no climate conditions the proposed development figures indicate that:

- Maximum overland flows within the site would be along the Boulevard, being up to 0.5m^3/s and 3.9m^3/s in the 20 year and 100 year respectively. Furthermore, the hydraulic hazard throughout the site would be low hazard up to the 100 year ARI, except locally over the existing large inlet pit under Pier Street (within the SHFA workshop).
- The proposed culvert amplification option effectively captures and conveys sufficient overland flows that would otherwise be impeded by the proposed development and result in adverse flood impacts on neighbouring property.
- There are significant areas where flood levels are reduced by 20mm to 50mm (in comparison to existing conditions), although with a few very local increases of typically less than 10mm, which are considered to within the tolerance of model accuracy.
- For the sensitivity run of;
  - no culvert amplification, 100 year ARI flood levels in Hay Street, Harbour Street and Pier Street, adjacent to the SICEEP development, would increase by up to 100mm (in comparison to existing conditions).
  - the Sydney Harbour water level 100 year ARI event, increasing the coincident water level from 0.9mAHD to 1.435m AHD resulted in flood level increases within the SICEEP site of up to 0.2m to the south of Pier Street, and 0.1m north of Pier Street.

3.5.2 WITH CLIMATE CHANGE

Under climate conditions the proposed development figures indicate that:

- 100 year ARI flood levels (in comparison to existing conditions with climate change) would increase by up to approximately 0.2m along the southern Hay Street site boundary, with a maximum increase within the site of up to 0.4m under Pier Street.
- the maximum overland flows within the site would be along the Boulevard (south of the Chinese Gardens), being up to 4.4m^3/s and 12.9m^3/s in the 20 year and 100 year

respectively. Along the Boulevard to the north of the Chinese the overland flows reduce to 0.7m^3/s and 4.4m^3/s in the 20 year and 100 year respectively.

- hydraulic hazard throughout the site would be low hazard up to the 20 year climate change, except locally over the existing large inlet pit under Pier Street (within the SHFA workshop). Under 100 year climate change flood condition there would be high hydraulic hazard along the Boulevard upstream of Pier Street, similar to what would be experienced if the existing development remained.
- the proposed culvert amplification option effectively captures and conveys sufficient overland flows that would otherwise be impeded by the proposed development and result in adverse flood impacts on neighbouring property.
- there are significant areas where flood levels are reduced by 20mm to 50mm (in comparison to existing conditions with climate change), although with a few very local increases of typically less than 10mm, which are considered to within the tolerance of model accuracy.
- For the sensitivity run of;
  - no culvert amplification, 100 year ARI flood levels in Hay Street and Harbour Street, adjacent to the SICEEP development, would increase by up to 100mm (in comparison to existing conditions with climate change).

3.5.3 FLOOD PLANNING LEVELS

The flood mapping in this report is considered adequate for the Project Company to complete flood risk assessment and set concept design planning levels.

The INSW Project Brief clause 2.11.4 (d) specifies Flood Planning Levels as 1% AEP plus 0.5m. The 1% AEP flood levels vary across the precinct as indicated by the contours on Drawing WP-FL-0123 as included in Appendix C. As such the flood planning levels, in accordance with the INSW Project brief, also vary across the site and can be assessed from the flood contours.

As an example, the 1% AEP flood level on the Boulevard north of Pier Street is approximately RL 2.8 (3.2 with potential climate change) and the flood planning level based on the INSW Project Brief is RL 3.3 (3.7 with potential climate change) whilst the northern end of the Boulevard adjacent Cockle Bay the flood level is RL 2.4 (2.4 with potential climate change) and thus the flood planning level is RL 2.9 (2.9 with potential climate change).

The INSW Project Brief also notes that the existing ground floor levels of the Convention Centre and Exhibition Centre car park are to remain, subject to compliance with the flood risk assessment in accordance with the Floodplain Development Manual (2005), and that where floor levels higher than flood planning levels cannot be practically achieved, determination of appropriate levels (and mitigation) shall be subject to a risk based assessment. This flood risk assessment is not included in this report and, if required, will be carried out at detail design stage.

Final flood regimes and mapping design are subject to up to date ground survey and detailed internal survey of culvert systems. Once available, a comparison of the survey information to that made available to Hyder for this current flood study will be necessary. Should the comparative geometry reveal significant variation then it may be necessary to refine the current flood study.

3.5.4 EVACUATION AND REFUGE

Flood Emergency Response

Under Probable Maximum Flood (PMF) conditions much of the site would be high hazard with flood depths in some locations exceeding 2 metres. Being a small urban catchment there would be no adequate warning of extreme flooding for the site. With no response time for very short duration storms that would potentially produce significant flows in this area, the only realistic safe option in extreme flood events is for persons to seek refuge and remain within the proposed building above the defined PMF flood levels. With respect to evacuation, since hazardous flows would subside with the storm duration, evacuation would not be impeded.

Structural Stability

During the PMF the flood emergency response is to be for refuge within the proposed buildings. Therefore the buildings are to be structurally stable during the PMF event.

The flood mapping in this report is considered adequate for the Project Company to determine hydraulic flood loadings for concept building design.

Final flood regimes and mapping design are subject to up to date ground survey and detailed internal survey of culvert systems. Once available, a comparison of the survey information to that made available to Hyder for this current flood study will be necessary. Should the comparative geometry reveal significant variation then it may be necessary to refine the current flood study.

3.5.5 DESIGN CONSIDERATIONS

While the current concept design includes for an amplification option of the Sydney Water closed conduit systems, future project design stages will, as necessary, investigate options of:

- reducing development scheme building footprints, which if found not to adversely impact existing flood conditions, may reduce the size and/or extent of the proposed conduit amplification option;
- alternative conduit amplifications within SICEEP. Sydney Water and the SICEEP stake holders may agree on an alternative amplification alignment or, the inclusion of additional amplification systems which may accommodate more extensive ground level development (extending into existing overland flow paths).
- alternative conduit amplifications external to SICEEP. Sydney Water and the SICEEP stake holders may agree on an alternative amplification alignment outside of the SICEEP project site or, the inclusion of additional amplification systems which may accommodate more extensive ground level development (extending into existing overland flow paths).
- a combination of the above.

Furthermore, to affirm the accuracy of the flood flow regimes defined in this study it will also be necessary to carry out detailed ground survey, and internal survey of culvert systems and compare the survey information to the current study by Hyder which has used Sydney Water 'work as executed' drawing information.

Should the comparative geometry reveal significant variation then it may be necessary to refine the current flood study so as to enable the appropriate setting of flood planning levels. As an example, detailed drawings of the proposed rectification of the Hay street (1928) sandstone culvert were provided to Hyder by Sydney Water immediately prior to issue of this report, and as such is not included in the flood modelling.

3.6 CONCLUSIONS

The flood mapping in this report is considered adequate for the Project Company to set concept design planning levels.

The TUFLOW model results indicate that the impact of the proposed development, with the modelled culvert amplification option, would result in negligible flood impacts. There are however several associated risks with respect to the flood analysis and findings.

- The survey provided may not adequately define the DEM surface levels incorporated into the TUFLOW model. This may require amendments to the flood study once detailed survey is made available.
- Any proposed conduit amplification will require approval from Sydney Water and CoS.

3.7 RECOMMENDATIONS

A comparison of detailed survey information to that made available to Hyder for this current flood study will be necessary. Should the comparative geometry reveal significant variation then it may be necessary to refine the current flood study.

All overland flow paths are to remain unobstructed and ground levels are to be consistent with the proposed flood modelling.

A formal floodplain risk management plan with respect to evacuation and refuge is to be developed.

Buildings and structures are to be designed for hydraulic loadings up to the PMF event.

4 STORMWATER DRAINAGE DESIGN

In compliance with the project brief requirements (Infrastructure NSW) the minor (conduit) and major (overland) drainage systems are to convey the 5% (20 year) and 1% (100 year) Annual Exceedance Probability (AEP) rainfall events respectively, subject to the limitations of the existing drainage systems.

A concept design of the proposed minor (underground conduit) drainage system is outlined for the SICEEP project area in the design drawings that accompany this report (see Design Drawings listed at the end of this report).

4.1 METHODOLOGY

The concept drainage design has been developed with the use of the same DRAINS and TUFLOW models developed for the flood study (discussed above).

Features of the stormwater design for the SICEEP site include:

- Retaining all existing box culvert systems throughout the existing precinct.
- Re-use of existing stormwater drainage systems where possible.
- Wherever possible, retaining of existing local drainage pipe connections into the existing box culverts. However, where assessed as necessary, providing additional/larger connections in a manner approved by the asset holder (Sydney Water).
- Where necessary, providing new/additional stormwater systems to manage the proposed building structure and open space drainage.
- Provision of open space surface drainage systems with a focus on public safety, giving careful consideration to inlet type and location, and options of porous pavement areas.
- Consideration of existing and future overland flow paths throughout the Precinct.
- Subsoil drainage, as required under pavement areas to ensure appropriate drainage to all areas of subgrade, sub-base and base areas.

4.2 RESULTS AND COMMENTS

4.2.1 NO CLIMATE CHANGE

Under no climate conditions the TUFLOW figures (included in Appendix C) indicate that the proposed flood levels and hazard conditions have been significantly reduced in comparison to existing conditions. That said, it is noted that for 20 year ARI conditions along Darling Drive, there are number of local areas where surface water may be improved upon in future design stages, in particular at its:

- Northern end
- Sag just north of Tumbalong Place
- Roundabout and
- Intersection with Hay Street.

Upsizing and/or reconfiguring the local drainage systems within Darling Drive (north of Pier Street) may be possible so as overcome sheet flows over the carriageways in these areas since the existing box culverts (which are being connected into) have more than 20 year capacity.

However, further improvements to the Hay Street local drainage performance is less likely due to the flood impacts from the external upstream catchment flows and the existing Sydney Water culverts having limited capacity.

4.2.2 WITH CLIMATE CHANGE

Under the assessed climate conditions, the TUFLOW figures indicate that the proposed flood levels and hazard conditions have also been significantly reduced in comparison to existing conditions (with climate change). That said, upsizing and/or reconfiguring the local drainage systems within Darling Drive and other SICEEP site areas is unlikely to improve drainage performance due to the flood impacts from the external upstream catchment flows and the existing Sydney Water culverts having reduced capacity as a result of increased water levels in Sydney Harbour.

4.2.3 SUB-SURFACE DRAINAGE SYSTEM WORKS

Sub-surface drainage systems are to be designed during the design development stage. The main areas within the site that require sub-surface drainage are Tumbalong Park and the Boulevard.

4.2.4 STORMWATER DETENTION & RETENTION

Flood detention storage has not been considered in this proposal due to the proximity to Cockle Bay. However, a number of rainwater tanks and other water quality treatment measures are to be incorporated in the development. While these devices have not been formally modelled in the stormwater network, will in themselves reduce peak discharges and flow volumes.

4.2.5 INTERIM TREATMENT MEASURES

All construction works are to be in accordance with the Landcom "Managing Urban Stormwater: Soils and Construction Volume 1, 4th Edition (March 2004). Temporary sediment and erosion control measures are to be put in place to protect Cockle Bay and neighbouring areas from contaminants conveyed from the SICEEP site during construction.

Structural construction erosion and sedimentation controls for the construction works may include, but not be limited to the following:

- Hay bales.
- Silt fences.
- Inlet filters.
- Stabilised site access and truck washdown areas.

An indicative erosion and sedimentation control drawing is provided in the design drawings. These will be refined during detailed design stages and will be specific to the construction staging of the project.

5 WATER QUALITY ANALYSIS & WATER SENSITIVE URBAN DESIGN (WSUD)

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 SICEEP PPP development:

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

5.1 MODELLING CATCHMENT AND SETUP

The catchment considered in the water quality analysis is the entire SICEEP PPP site which has an area of approximately 13 ha. This site includes the Darling Drive road corridor, the land being occupied by Entertainment Centre car park, the existing Sydney Convention and Exhibition Centre, and the western section of Tumbalong Park.

The Haymarket and ICC Hotel development schemes are excluded from the current investigation. Separate modelling of these precincts with respect of Water Quality Analysis and Water Sensitive Urban Design will need to be undertaken at their development application phase.

To facilitate MUSIC modelling, the SICEEP PPP site was split into the following five subcatchments:

- Bayside
- North Exhibition
- South Exhibition
- The Theatre
- Tumbalong Park

Overpass structures such as Pier Street and the Western Distributor that are within the site boundary have not been included within the MUSIC models. The open area in the eastern section of the Bayside catchment is also excluded in the analysis. Only areas within the SICEEP PPP site where redevelopment works are expected were assessed in this study. The boundaries of these five subcatchments are as shown in yellow Figure 5 1.