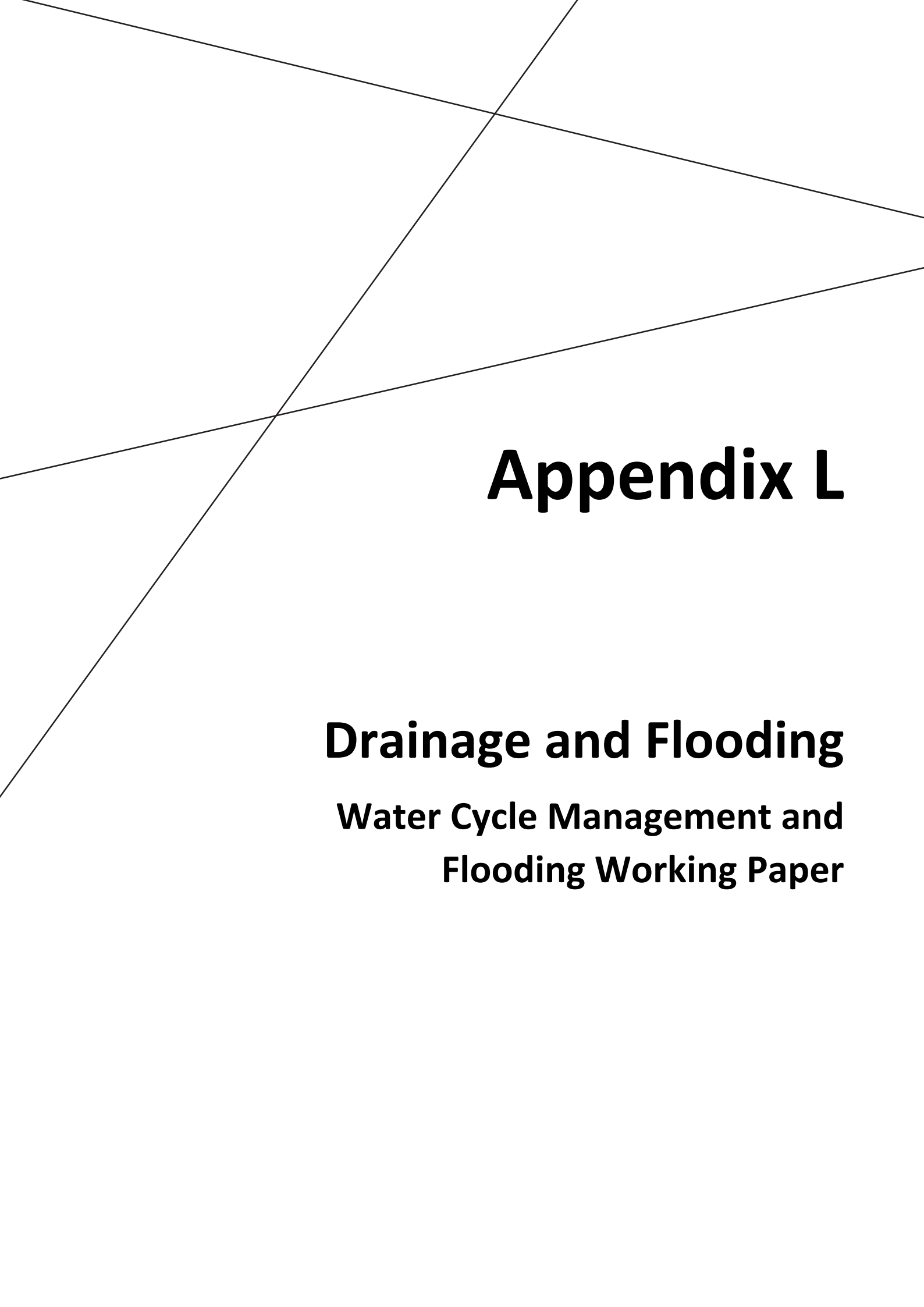


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Appendix L

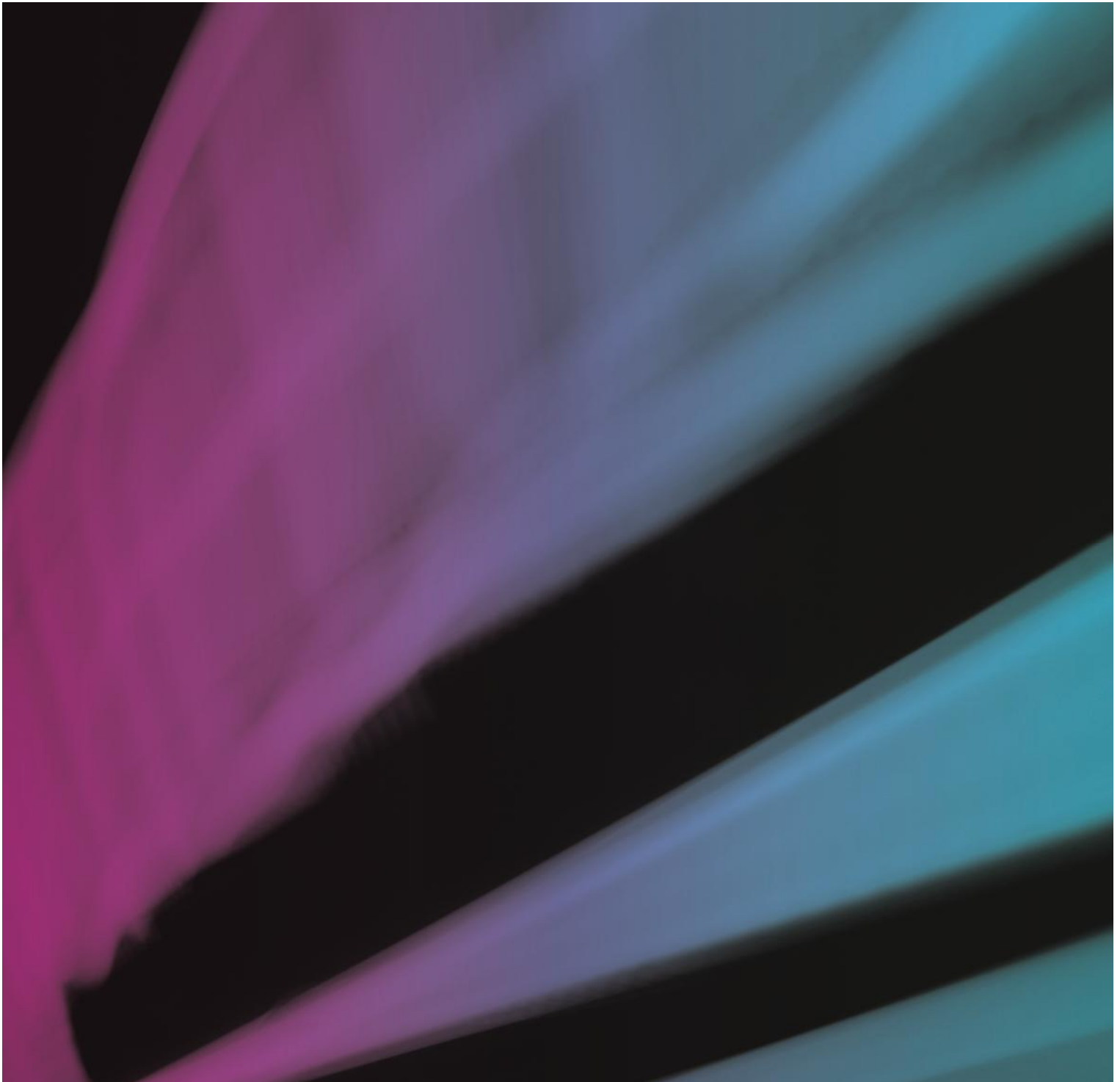
Drainage and Flooding

Water Cycle Management and Flooding Working Paper

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Western Sydney Stadium

Water Cycle Management and Flooding Working Paper



Western Sydney Stadium

Water Cycle Management and Flooding Working Paper

Contact: Kimberly Everett
Infrastructure NSW
Level 15, 167 Macquarie Street
Sydney NSW 2000
Ph: 02 8016 0100 www.insw.com

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

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Quality Information

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Prepared by David Meyer

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Executive Summary

A new 30,000 seat stadium is proposed (the Project) at the site of the existing Parramatta Stadium (the Site) west of Sydney. An Environmental Impact Statement (EIS) is being prepared for the concept proposal and demolition works (the Proposal). This working paper provides an impact assessment specifically for water consumption and drainage, to support the EIS.

The Site is located immediately adjacent to the eastern bank of the Parramatta River. The Site is elevated and modelling indicates that it is not within the 100yr Average Recurrence Interval (ARI) floodplain. However the existing and proposed grass pitch has a lower elevation and would be impacted by the 100yr ARI floodplain if mitigation works are not implemented.

Geotechnical investigations indicate that the Site generally consists of a layer of brown fine sand and silt material on top of clay. It is likely that there is perched groundwater on top of the clay layer.

There are no drainage corridors through the Site to convey upstream catchment runoff. The runoff from the urbanised catchments is conveyed by pipe and road surface around the Site via O'Connell Street and Grose Street to the Parramatta River. During extreme runoff events, some runoff would enter the Site via the site entrance road at Victoria Road; however, this runoff is likely to flow south through the Parramatta Swimming Centre and into the Parramatta River. The new stadium will include mitigation works to prevent this inflow into the Site during extreme runoff events.

The existing Site captures runoff from the stadium complex and surrounding carparks. This is conveyed via a pipe network and discharged into the Parramatta River near the north west corner of the existing stadium. This discharge point may be utilised for the new stadium. It is proposed that the majority of the runoff from minor rainfall events will be captured and the water reused within the complex (i.e. grass irrigation, non-potable water uses). Major runoff events can be conveyed to the existing swale along the northern boundary and discharged into the Parramatta River. This will reduce the risk of excessive flooding of the Site.

The risk to the Project in relation to drainage, flooding and water consumption has been assessed to determine the likelihood of occurrence and extent of impact. Mitigation strategies have been proposed which aim to reduce the risk to the Project. Residual impacts in relation to drainage, flooding and water consumption are not considered to be significant and can be managed during detail design of the stadium and facilities.

Terms

Terminology used in this EIS	Definition
the Site	The land where the Project would be developed as shown on Figure XXX. This land is legally described in Section 1.2 and predominantly includes the existing Parramatta Stadium complex and also the Parramatta Swimming Centre. The Site is inclusive of the demolition works area and any exclusion zones.
the Project	The proposed Western Sydney Stadium. It involves all works from concept proposal and demolition (i.e. Stage 1) to detailed design, construction and operation of the new stadium (i.e. Stage 2).
the demolition works area	The parts of the Site where the demolition works and supporting activities would take place. The area excludes the two vegetated areas to the north and west and part of the training field.
the Concept Proposal	The Concept Proposal for the Western Sydney Stadium, including parking and access facilities, ancillary infrastructure and landscaping, which is to be assessed within this EIS. Construction impacts related to the Western Sydney Stadium will not be assessed until Stage 2 of the Development Application process once a detailed design has been prepared.
demolition works	The 'stage 1 construction early works' as listed in the SEARs. It includes the staged demolition and removal of the existing stadium and associated infrastructure, including car park to the west of the existing stadium and other hardstand areas (footpaths and roadways). It also includes demolition of the Parramatta Swimming Centre. For this assessment the demolition works only involve the removal of structures to the existing ground level.
the Western Sydney Stadium and the Western Sydney Stadium complex	The new stadium to be located on the Site of the existing stadium, and the new stadium complex under the Project respectively. These terms will only be used when "the Project" cannot be used (e.g. detailing the facilities that will be provided in the new stadium or stadium complex).
the Study Area	The assessment envelope for each technical discipline. This envelope may vary between technical working papers and will be defined in each technical working paper and subsequent assessment chapter in this EIS.

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1.0 Introduction

1.1 Background

In September 2015, the NSW Government announced a package of works to renew the Sydney Stadium network over the next decade. The Western Sydney Stadium Project (the Project) forms a key part of this package and involves a proposal to construct a new 30,000 seat stadium on the site of the existing stadium in Parramatta (the Site). Assessment and approval for the Project will be undertaken in two stages under Section 83B of the *Environmental Planning and Assessment Act 1979* (EP&A Act):

1. initial application for the Concept proposal and demolition works to accommodate the Western Sydney Stadium (Stage 1) (subject of this Working Paper); and
2. a second separate application for the detailed design and subsequent construction and operation of the Western Sydney Stadium (Stage 2).

The development application which this EIS supports is only seeking approval for the Proposal (i.e. Stage 1). Specifically, the Proposal includes:

- Concept Proposal for the Western Sydney Stadium, including parking and access facilities, ancillary infrastructure and landscaping; and,
- Staged demolition and removal of the existing stadium and associated infrastructure, including the existing stadium and the associated hardstand areas where required (footpaths, roads, car parks etc.) as well as the Parramatta Swimming Centre.

Works associated with the removal of below ground infrastructure and excavation works will be assessed under Stage 2 once a detailed design has been prepared. These works will not be considered further for the Stage 1 assessment.

1.2 Purpose of this technical working paper

This working paper specifically responds to items 15 and 16 of the *Secretary's Environmental Assessment Requirements (SEARs)* for the Proposal, which encompass drainage and flooding issues (refer to Table 1).

Table 1 Secretary's Environmental Assessment Requirements - drainage and flooding

SEARs item	Requirements
15 Drainage	Provide a stormwater Concept Proposal detailing how water quality and quantity impacts on drainage systems would be managed.
16 Flooding	Assess any flood risk on site and consideration of any relevant provisions of the NSW Floodplain Development Manual (2005) including the potential effects of climate change, sea level rise and an increase in rainfall intensity.

1.3 Scope of work

Key items in the scope of works for this working paper include:

- Water Cycle Management Study: to determine strategies to minimise water demand, improve stormwater discharge water quality and manage stormwater quantity runoff;
- Audit of existing and proposed water uses for the stadium;
- Review existing surface water modelling of the site. In the absence of suitable modelling data, construct a model of the site to determine the impact of flooding from the Parramatta River;
- Water quality modelling of a potential water treatment system for the site; and
- DRAINS hydraulic model of the potential stormwater system for the site.

1.4 Report structure

The technical working paper is structured as follows: -

- **Chapter 1 – Introduction.** This chapter introduces the Proposal and outline the purpose of this report.
- **Chapter 2 – Description of the Proposal.** This chapter provides a description of the Proposal as relevant to this impact assessment.
- **Chapter 3 – Existing environment.** This chapter provides a description of the existing environment within the study area based on a review of previous studies and background information.
- **Chapter 4 – Assessment methodology.** This chapter summarises the design objectives and assessment methods that applies to this assessment.
- **Chapter 5 – Assessment Results.** Supporting calculations for the reduction in risk due to the investigations and/or implementation of the mitigations strategies. The risk to the project and mitigation measures are provided in the following Chapters (6 to 7).
- **Chapter 6 – Risk and Impact assessment.** This chapter identifies potential risks and impacts to the environment due to water quantity and quality aspects of the Proposal.
- **Chapter 7 – Mitigation and management.** The chapter presents potential mitigation measures to reduce the impact and likelihood of the identified risks. These solutions have been verified using various computational models. The residual risk has been also been assessed and identified if the mitigation measure is utilised.
- **Chapter 8 – Conclusion.** This chapter presents the conclusion to the report, including a summary of the work completed and recommendations for future work.

2.0 Description of the Proposal

2.1 Site location

The Site is located at 11-13 O'Connell Street Parramatta, approximately 25 kilometres west of Sydney Central Business District (CBD) (refer to **Figure 1**). The Site is situated within the broader context of Parramatta Park, approximately one kilometre north west of Parramatta Station and the Parramatta central business district (CBD). The Site is shown in detail in **Figure 1**, and comprises the existing stadium and stadium complex, surface car parking facilities (to the north and west of the stadium), Parramatta Swimming Centre to the east of the stadium (located on Crown Land), and a training field to the south of the stadium. The Site is legally described as Lots 951, 952, 953, 954, 955, 956, 957, 958, 959, 961, 962, 963 in Deposited Plan (DP) 42643 and Crown Land Lot 80-3000 (part).

The demolition works area comprises the parts of the Site where the demolition works and supporting activities will take place. This area excludes two predominantly vegetated areas to the north and west, and part of the training field to the south. No activities or impacts are proposed in these excluded areas.

A key feature of the local area is Parramatta River, which is located to the west and south of the Site and eventually flows into Sydney Harbour approximately 20 kilometres south east of the Site. Parramatta Park extends across Parramatta River to the west of the Site and includes the world heritage listed Old Government House, approximately 200 metres south west of the Site boundary.

Other land uses surrounding the Site include the Parramatta Park Trust car park to the south east on Parramatta Park land, the old Kings Oval to the south west and the Parramatta Leagues Club and associated surface car park immediately adjacent to the north.

Land use to the east of the Site across O'Connell Street is predominantly comprised of low density residential development, as well as mixed use and public recreation. Notable uses include schools and places of worship (our Lady of Mercy College and St Patricks Cathedral), and the Old Kings School site.

2.2 The Proposal

The Proposal comprises Stage 1 of development for the Project. Specifically, the Proposal includes:

- Concept Proposal for the Western Sydney Stadium, including parking and access facilities, ancillary infrastructure and landscaping
- staged demolition and removal of the existing above ground structures, including the existing stadium and the associated hardstand areas where required (footpaths, roads, car parks etc.) as well as the Parramatta Swimming Centre.

The Western Sydney Stadium Concept Proposal provides for:

- a maximum total Gross Floor Area (GFA) of up to 65,000 m² for the stadium development
- a maximum total GFA of 12,000 m² for community uses
- transport accessibility and parking facilities
- landscaping and public domain elements throughout the Site.

The Concept Proposal is shown in **Figure 2**. Further description of the proposed stadium facilities are provided in Appendix A. The requirements of this working paper primarily relate to this Concept Proposal and the completed development of the Site but also the temporary requirements during demolition and construction of the Site.

The Concept Proposal referred to during the development of this working paper is release date 31/05/2016. Minor amendments to the Concept Proposal have been incorporated in release date 6/06/2016 as shown in **Figure 2**. Review of these amendments has determined that the extent of changes to the Site design, topography, land use and surface characteristics are not significant enough to alter the overarching drainage and flooding management philosophies of the Site.





Figure 2 - Western Sydney Stadium Concept Proposal

3.0 Existing Environment

3.1 Climate

The Site experiences daily mean summer temperatures of approximately 30 degrees Celsius and 18 degrees Celsius in winter. The period of highest rainfall is during summer, with average monthly rainfall of approximately 95 mm and 38 mm in winter (BoM, 2016a).

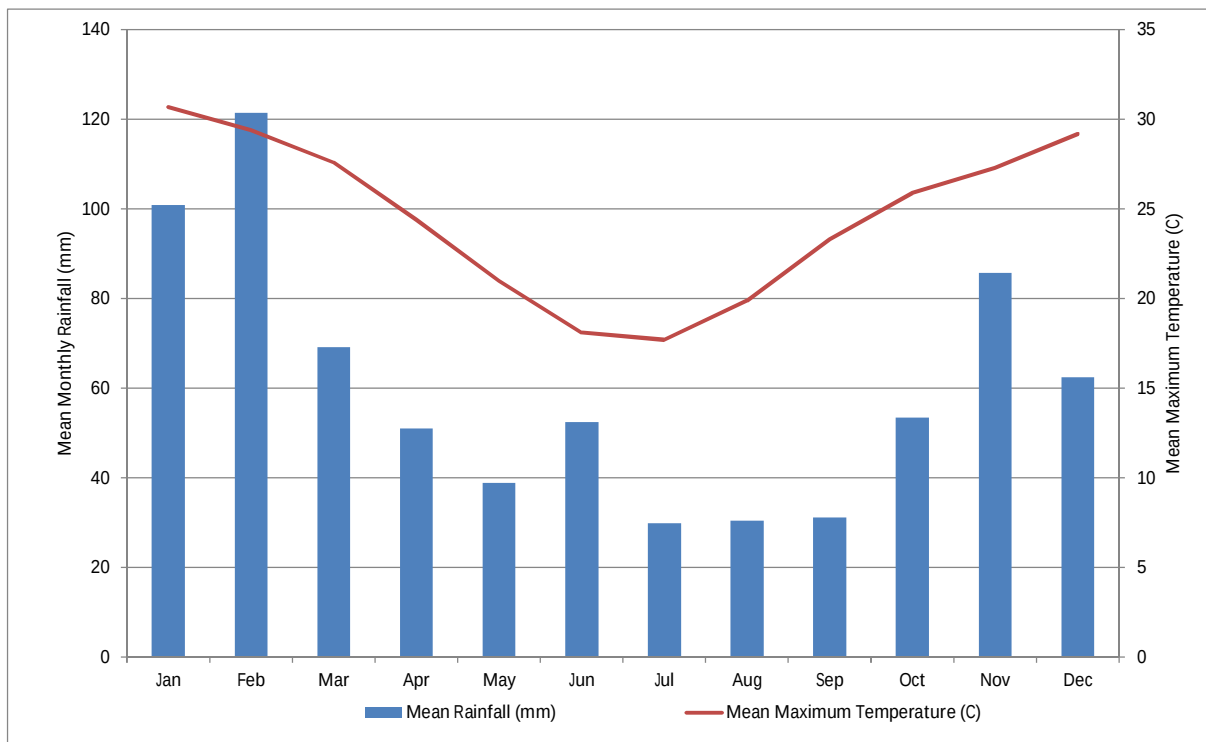


Chart 1: Mean Monthly Rainfall and Temperature.

3.2 Site topography

The Site is located on the eastern side of a bend in the Parramatta River. The Site has a ground surface which ranges from 9 mAHD to 16 mAHD (**Figure 3**). Historically, the land would have been graded from the north eastern corner of the site down to the Parramatta River along the north western and southern boundaries.

The pre-urban terrain would appear to have been considerably modified to incorporate the stadium facilities, playing surface and surrounding ovals. The existing stadium pitch has an elevation of approximately 9 mAHD and is the lowest elevation within the Site.

3.3 Local drainage network

The runoff generated outside of the Site is conveyed by the Parramatta City Council stormwater network to the Parramatta River.

Surface runoff on O'Connell Street is collected by road side pits and conveyed by pipes southward to the Parramatta River. During larger runoff events, it is likely some runoff which exceeds the capacity of the pipe network would flow into the Site via the road entrance at Victoria Road (Hyder, 2014). This water would likely flow south through the Parramatta Swimming Centre and into the Parramatta River (refer to **Figure 3**) for internal and external drainage flow paths). This is the only location where external runoff may flow into the Site. In all other locations, the existing site is elevated above the surrounding land and this prevents runoff entering the site from external catchments.

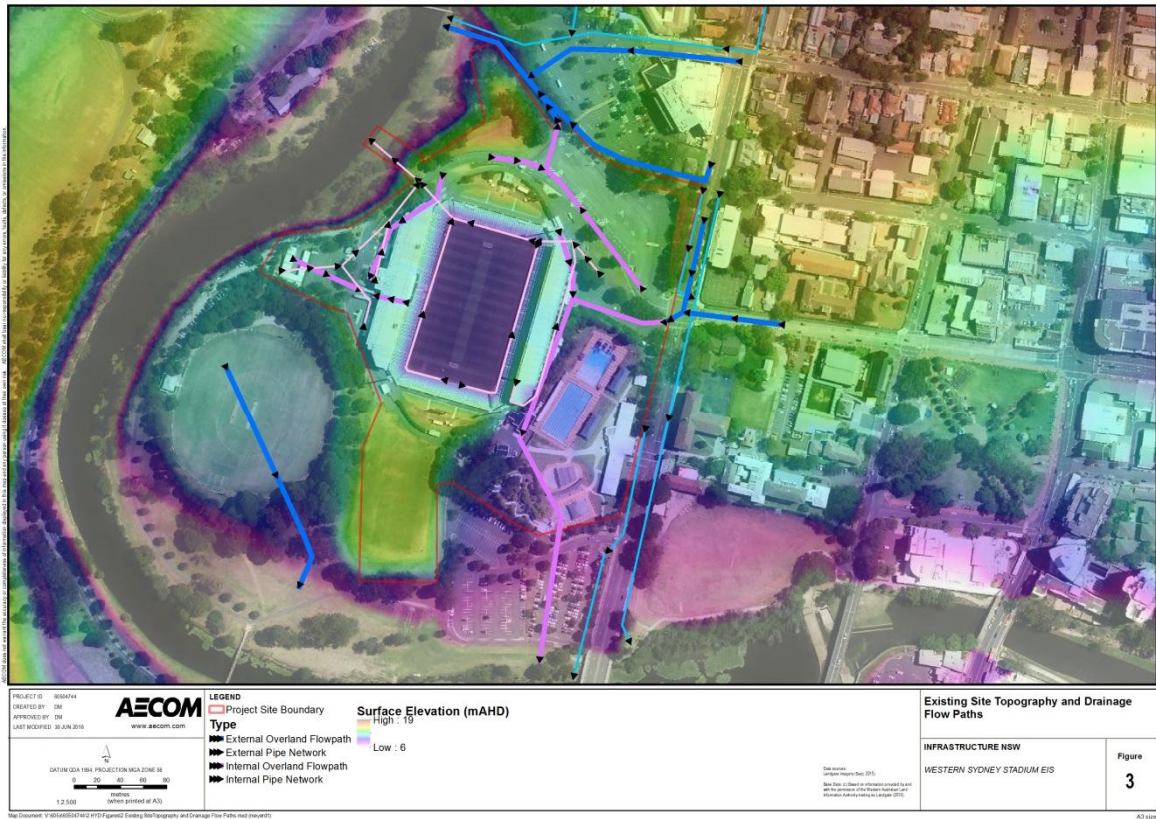


Figure 3 - Existing Site Topography and Drainage Flow Paths

Surface runoff along O'Connell Street, to the north of Grose Street, is conveyed by pipe network west towards the Parramatta River. Runoff from the Leagues Club Carpark likely flows into a swale, along the north-western boundary of the site, and then discharges into the Parramatta River. Runoff from the north-western carpark of the Site also discharges into this swale.

The stadium grass pitch has an elevation of approximately 9 mAHD and is approximately 2 to 4 meters below the surrounding landform. Therefore there is no overland discharge flow path for the stadium playing surface. Any external runoff that enters the playing surface is assumed to slowly infiltrate or be collected and subsequently discharged via the drainage pipe network to the Parramatta River. This network collects runoff from the stadium roofs and discharges to water in a north-easterly direction into the Parramatta River.

3.4 Parramatta River

The Parramatta River conveys runoff from the upstream 103 km² catchment past the eastern and southern side of the Site. The catchment includes Blacktown City, Baulkham Hills, Holroyd City and Parramatta City Councils (Bewsher, 2003).

Since the 1970s, the catchment has undergone flood mitigation works to reduce the flood risk to many parts of the catchment. In 1989 the Upper Parramatta River Catchment Trust was established to provide a cohesive flood mitigation strategy for the four councils, which included a flood inundation model (Bewsher, 2003). This model is currently being updated and is not available for this study. The original 2003 flood study had calculated that during a 100yr ARI event, the north-western area of the Site would be inundated. During a Probable Maximum Flood (PMF), the majority of the Site would be inundated.

3.5 Soil and Groundwater

A geotechnical investigation was conducted 11 July 1984 (Douglas and Partners, 1984) of the stadium area, which included 20 test bores. These bores data indicates that the site general has a top layer of "Filling" material which consists of brown fine sand and silt. The depth varies across the site due to past historical earthwork activities. Below this is a layer of brown Sandy Clay material to a depth of approximately 5 m R.L. Below this level the material consists of silt stone and sand stone.

The bore logs indicate that during construction there was no general presence of groundwater. However, after three weeks, many of the bores along the western side of the existing stadium did exhibit a presence of groundwater at the level equal to the interface of the filling material and the sandy-clay material. This indicates that there is a localised perched groundwater system which likely formed due to the 123 mm rainfall event which occurred two weeks after (26/7/1984) the bore construction (BoM, 2/6/2016).

4.0 Assessment methodology

This assessment has been prepared with the guidance of but not limited to the following documents:

- Parramatta Development Control Plan 2011 (City of Parramatta Council, 2011)
- Floodplain Risk Management Guideline - Practical Consideration of Climate Change (DECC, 2007)
- NSW Floodplain Development Manual (NSW Government, 2005)
- Healthy Catchments Strategy. Sydney Catchment Authority (NSW Government, 2013)
- Western Sydney Stadium - Project Brief (Venues New South Wales, 2016)

Previous studies that have been reviewed that relate to investigation of the site or its surrounding area are:

- Upper Parramatta River Catchment Floodplain Risk Management Study (Bewsher, 2003)
- Urban Growth NSW – Parramatta North Urban Renewal (Hyder, 2014)
- Lower Parramatta River Floodplain Risk - Management Study (SKM, 2005)

In addition to desktop review of previous studies and background information, the following steps were also undertaken in completing the assessment:

- Identification of design objectives for the Project and identification of potential water related risks;
- Quantitative assessment of water related risks and impacts which included:
 - Calculation and estimation of water flows, volumes, intensities, and other required variables;
 - Development of computational models as required; and
- Recommendation of mitigation and management strategies.

4.1 Design Objectives

The Parramatta Council specifies stormwater design objectives for new developments in Section 3 of the *Parramatta Development Control Plan 2011*. However, under the State Environmental Planning Policy 2011, the Site is excluded from development control plans. Nonetheless these objectives have been adopted and expanded for this Project and assessment to aim for maximum sustainable triple bottom line (3BL) benefits to the Site which may not be as prevalent otherwise.

A summary of these design objectives are presented below:

4.1.1 Water Conservation Objectives

- Stormwater to be harvested for reuse from impervious areas and the stadium pitch.
- Achieve a minimum 25% potable water use reduction when compared to a suitable reference case.
- 80% of the pitch irrigation water to be non-potable.
- Include the following WELS rated fixtures & fittings as a minimum: 3 star showerheads (>4.5 but ≤ 6.0 L/min), 6 star taps, 6 star urinals, 4 star toilets, and 6 star dish-washers.

4.1.2 Stormwater Quantity Objectives:

- Minimise the post-development volume and rate of stormwater runoff to equal or less than the pre-development.
- No increase in flood risk to adjoining or downstream properties.
- Minimise flooding.
- Minimise disturbance to existing drainage system.
- Utilise distributed stormwater control and treatment measures.
- Utilise Water Sensitive Urban Design (WSUD) measures.
- Storm water infrastructure to visually integrate with the landscape.

- The site is not flood affected by the 100 year flood envelope but can be affected by the PMF flood envelope.
- Stormwater system designed for a minimum of 100 years ARI where there is no overland flow path or 20yr ARI where an overland flow path is provided.
- Provision of flood evacuation routes from the Stadium and Stadium Precinct.
- Assess the Bureau of Meteorology (BoM) release of the 2013 Intensity Frequency Duration (IFD) design rainfall to the design.

4.1.3 Stormwater Quality Objectives

- Treatment and control measures implemented and used during construction and operation of the stadium.
- Minimise contamination of stormwater.
- Minimise erosion and sedimentation, nutrient and seed dispersal due to stormwater discharge.
- Ensure no adverse environmental impacts on the Parramatta River system.
- The stormwater treatment system must be modelled using MUSIC (or alternative approved software) to demonstrate the system achieves the required pollution reduction loads presented in **Table 2**.

Table 2 Stormwater Treatment Targets for Development

Pollutant	Performance Target Reduction Loads ¹
Gross Pollutants (GP)	90% reduction in the post development mean annual load of total gross pollutant load (greater than 5mm)
Total Suspended Solids (TSS)	85% reduction in the post development mean annual load of Total Suspended Solids (TSS)
Total Phosphorus (TP)	60% reduction in the post development mean annual load of Total Phosphorus (TP)
Total Nitrogen (TN)	45% reduction in the post development mean annual load of Total Nitrogen (TN)
Hydrocarbons, motor oils, oil and grease	No visible oils for flows up to 50% of the one-year ARI peak flow specific for service stations, depots, vehicle body repair workshops, vehicle repair stations, vehicle sales or hire premises, car parks associated with retail premises, places of public worship, tourist and visitor accommodation, registered clubs and pubs

¹ Reductions in loads are relative to the pollution generation from the same development without treatment.

5.0 Assessment Results

5.1 Quantitative assessment of water related risks

The following sections present the modelling calculations that were completed to enable an assessment of the water related risks for the Project (**Section 6.0**) and to enable mitigation strategies to be developed (**Section 7.0**).

5.1.1 Regional flood inundation modelling

The flood inundation modelling of the Parramatta River by Bewsher Consulting Pty Ltd in 2003, determined that portions of the Site may be at risk of flood inundation during a 100yr ARI event. To assess this risk, a flood model was developed which included the surface elevation and stadium location. This model can then be used to revise the flood inundation across the Site for Western Sydney Stadium which may have a different flood envelope than that which was calculated for the conditions in 2003 (**Section 6.2**). This model can also be used to determine if the new stadium would impact the flood risk to external properties (**Section 6.2**).

A two dimensional rain-on-grid TUFLOW model was developed for the Parramatta River Catchment. This model utilised high resolution 1 m gridded LiDAR data of the whole catchment. The model domain was mapped to include Manning's n roughness values depending on land use type i.e. Impervious, Residential, Commercial, Grass Ovals, Heavy Vegetation and River sections. Rainfall infiltrations rates were applied to these mapped land use types.

A 10m gridded model of the entire regional catchment was run for all storm durations for the 100yr ARI event. The critical storm was determined to be the 9 hr event. This produced a peak flow rate at Charles Street Weir of 916 m³/s at a peak flood elevation of 5.5 mAH. This is comparable to modelling investigation by SKM which also calculated a critical storm of 9 hours with a peak flow rate of 847m³/s at a peak flood elevation of 5.4 mAH. Since there is close correlation with the SKM investigation, which has been calibrated to historical events, the model is deemed suitable for used in this assessment. A presentation of the flood inundation for the catchment is provided within **Figure 4**.

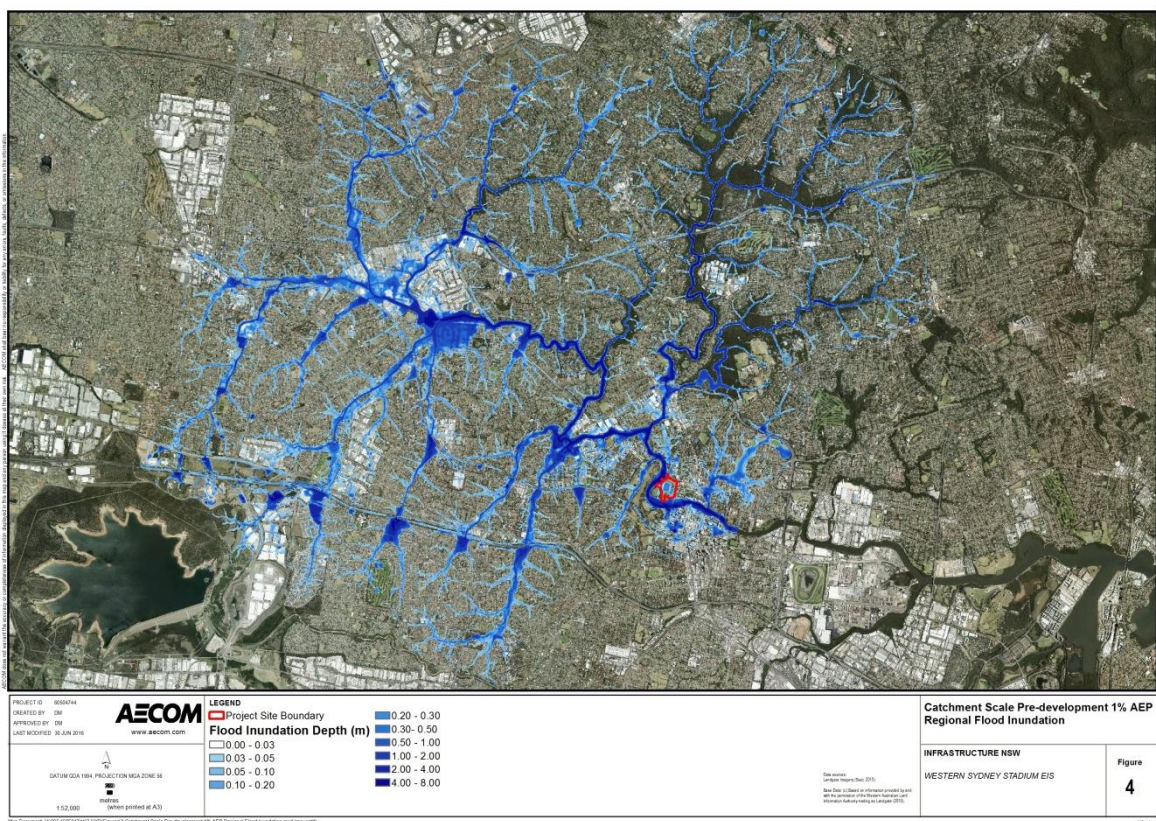


Figure 4 - Catchment Scale Pre-development 1% AEP Regional Flood Inundation

5.1.2 Local flood inundation modelling

5.1.2.1 Pre-developed (existing) Site Conditions

The local flood inundation model was prepared of the immediate site using the regional model for inflows within the Parramatta River. The local flood inundation model had a reduced model domain and an increased model grid resolution to 1.5 m. This enabled increased accuracy and definition in the flood extent. The local flood inundation for the existing Site conditions model is presented in

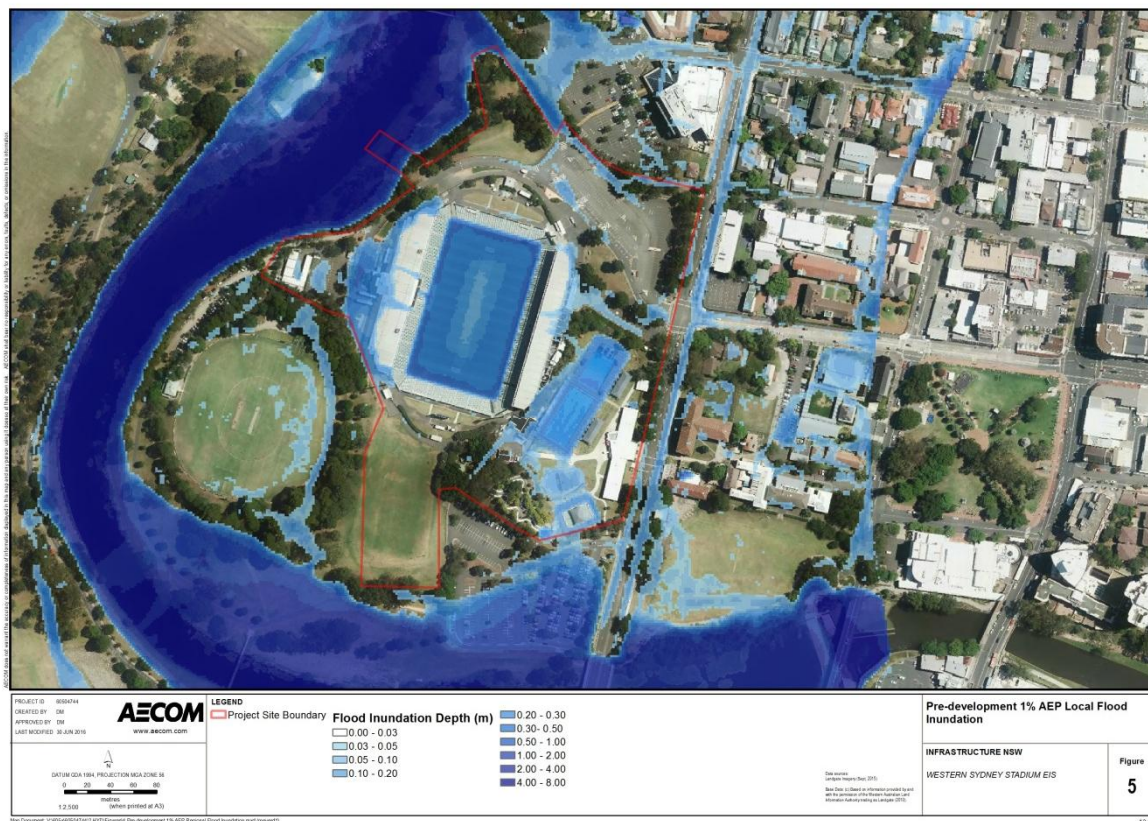


Figure 5 – Pre-development 1% AEP Local Flood Inundation

The results indicate that the flood extent of the Parramatta River does not overlap the existing Site. The minor inundation of the existing Site presented in **Figure 5** is due to excess runoff generated from the Site impervious surfaces and detained within low points in the topography.

5.1.2.2 Post-developed Site Conditions

The design surface levels from the Concept Proposal (31/05/2016) were added to the model digital elevation model (DEM) to generate proposed Site topography as shown in **Figure 6**.

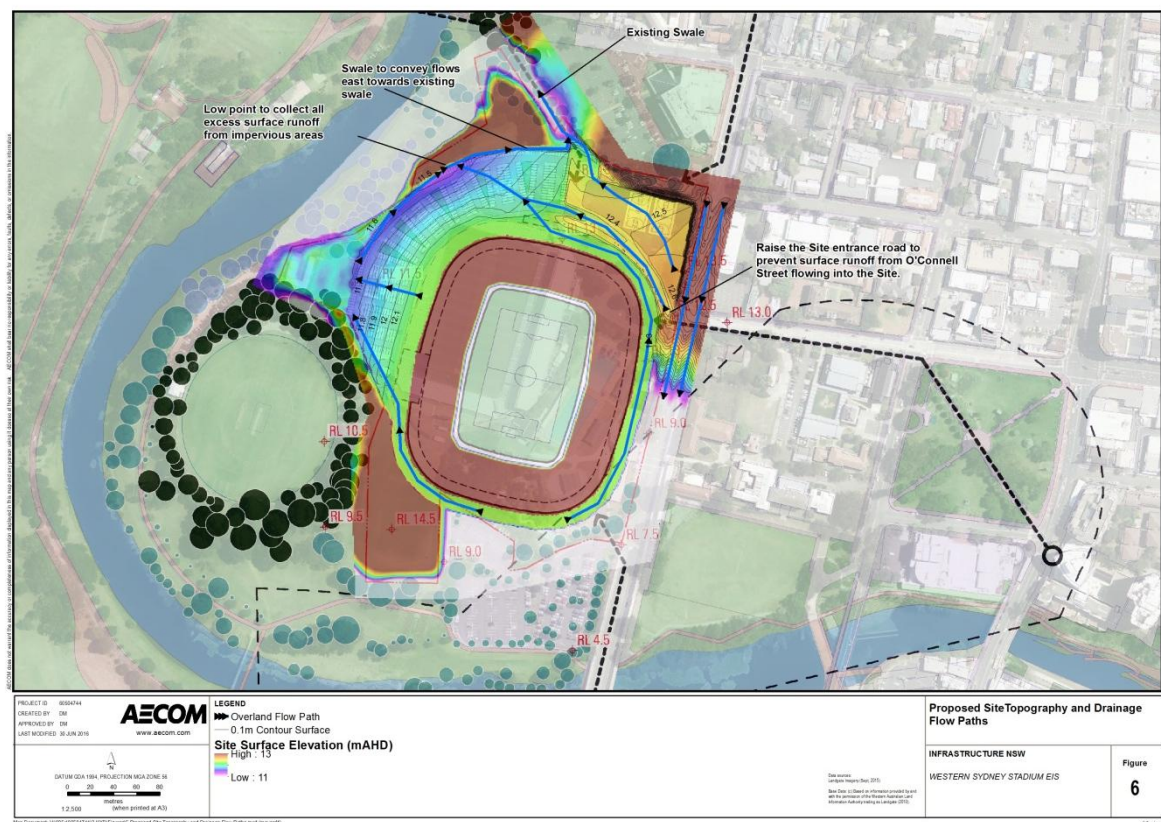


Figure 6 – Proposed Site Topography and Drainage Flow Paths

The local flood inundation model was simulated for the post-developed Site scenario based on the Site topography shown in **Figure 6**. The flood extents of the post-developed Site conditions local flood inundation model are presented in **Figure 7**.

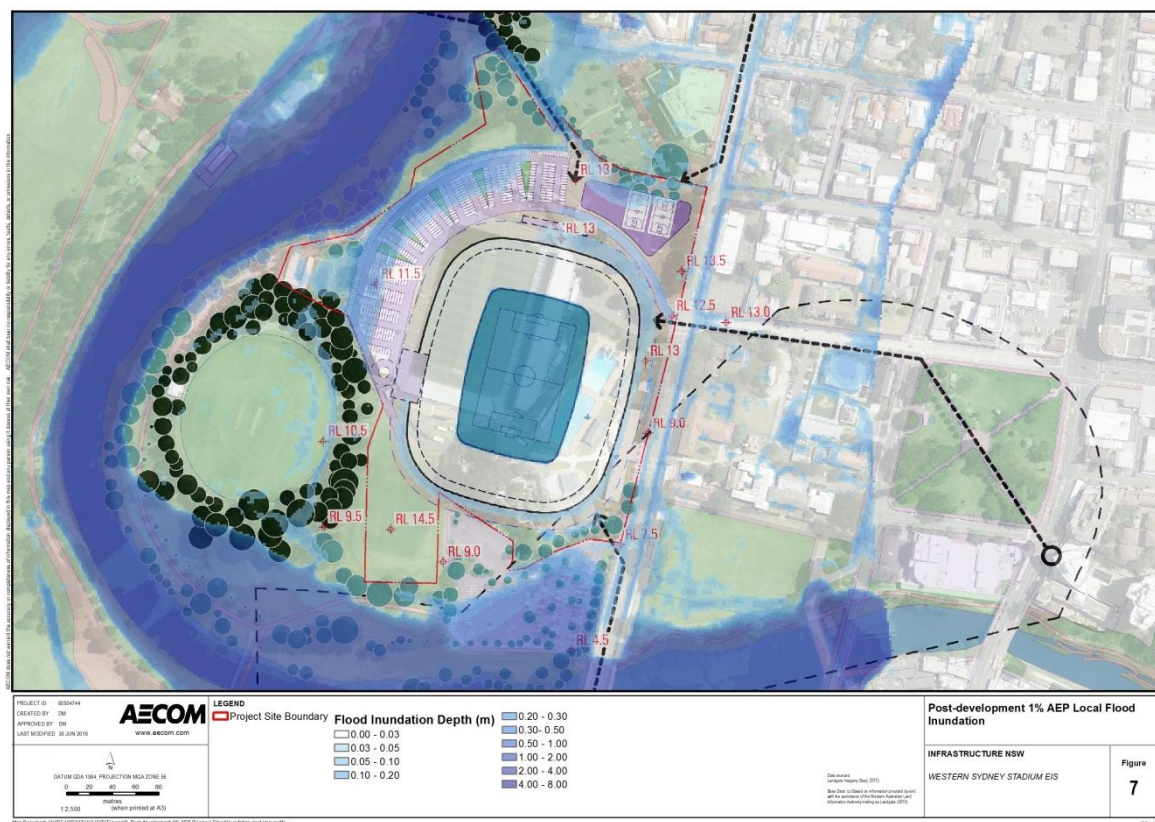


Figure 7 - Post-development 1% AEP Local Flood Inundation

As shown in **Figure 7** the Parramatta River does not overlap the post-developed Site for the 100yr ARI flood event. Therefore the 100 year ARI Parramatta River flood levels are unlikely to impact the Project and the development is subsequently unlikely to have any impact on the flood risk of adjoining properties.

The minor inundation of the Site presented in **Figure 7** is due to excess runoff generated from impervious surfaces within the Site and detained within captive low points in the topography. The excess runoff is proposed to be captured and treated by the site drainage infrastructure and has not been incorporated within this flood model.

5.1.3 Local drainage network modelling

The local drainage reticulation and subsequent hydraulic assessment has been simulated in DRAINS utilising the extended rational method (ERM) hydrological model. The ERM hydrological model within DRAINS incorporates the Rational Method Formula in calculating instantaneous peak stormwater runoff flows with the addition of rainfall hyetographs² to generate volumetric time series stormwater hydrographs³. The ERM model was applied to calculate stormwater runoff flows through and off the Site for the pre and post development scenarios.

Assessment of the as-built information for the Site did not identify all drainage line configurations. The assessment did reveal a single point of discharge, for the main stadium facilities, into Parramatta River. Therefore where drainage line configurations could not be identified, the sub-catchments were assumed to connect into the nearest identified drainage pit or junction and subsequently into the outfall pipe.

The DRAINS model configuration of the pre-developed (existing conditions) drainage system for the stadium facilities is shown in **Figure 8**.

² A distribution of rainfall over time.

³ A graph showing the rate of flow (discharge) versus time.

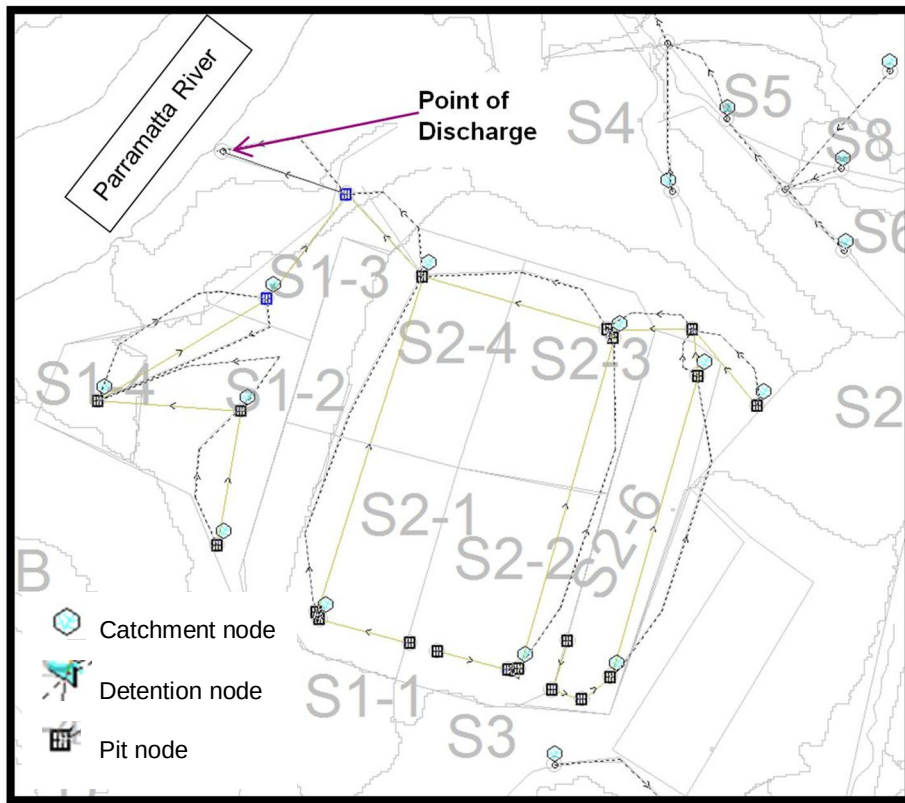


Figure 8 - Pre-Development DRAINS model

The DRAINS model configuration of the post-developed (design conditions) drainage system for the stadium facilities is shown in **Figure 9**.

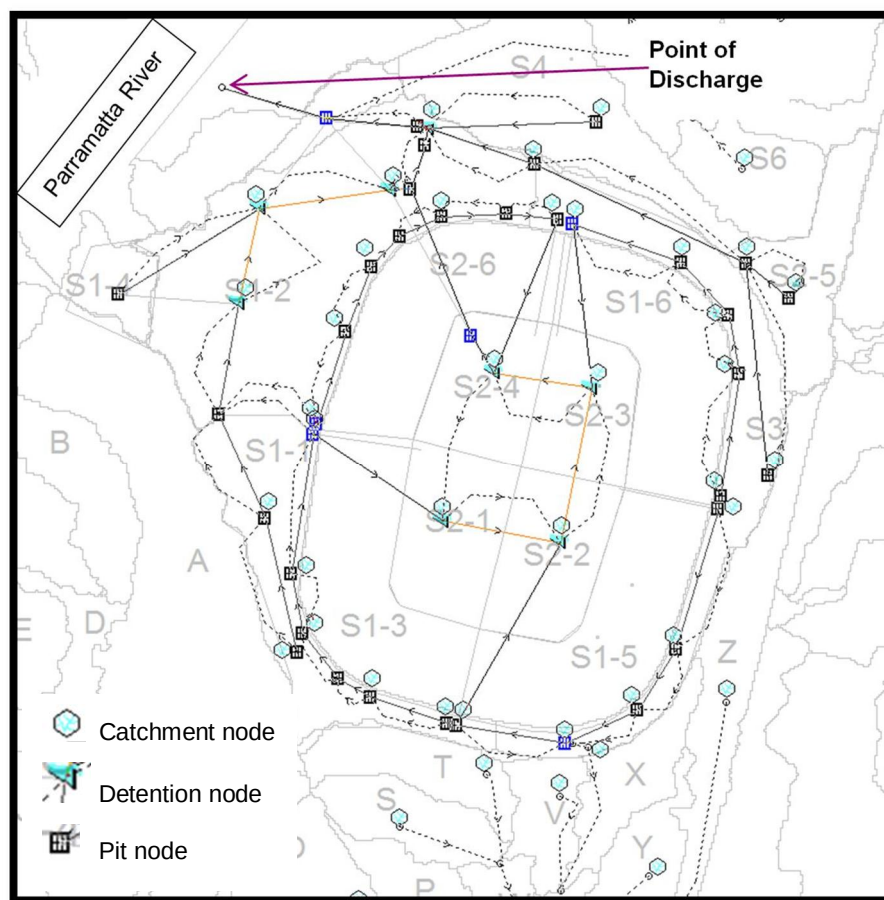


Figure 9 - Post-Development DRAINS model

The ERM method was used to simulate storm durations from five minutes to three hours for the 10 year and 100 year ARI storm events, respectively. Analysis of the DRAINS model results indicates that the 20 minute rainfall duration is the critical duration. The resulting discharge flow rates into Parramatta River are listed in **Table 3** and **Table 4** for the 10 year ARI and 100 year ARI storm events, respectively.

Table 3 - 10 year ARI

Duration	Pre Development Discharge (m ³ /s)	Post Development Discharge (m ³ /s)- Unmitigated
5 minutes	0.743	0.738
10 minutes	0.837	0.985
15 minutes	0.907	1.130
20 minutes	0.930	1.200
25 minutes	0.961	1.230
30 minutes	0.915	1.170
1 hour	0.804	1.130
3 hours	0.612	0.935

Table 4 - 100 year ARI

Duration	Pre Development Discharge (m ³ /s)	Post Development Discharge (m ³ /s)- Unmitigated
5 minutes	1.10	1.31
10 minutes	1.35	1.59
15 minutes	1.38	1.70
20 minutes	1.42	1.75
25 minutes	1.40	1.75
30 minutes	1.37	1.71
1 hour	1.27	1.67
3 hour	0.98	1.49

The results indicate that there is an increase in runoff discharges resulting in the augmentation of the Site characteristics as a result of the proposed development configuration. The increased runoff discharges are primarily attributed to an increase in impervious area coverage across the Site as a result of the Proposal.

5.2 Qualitative assessment of water related risks

5.2.1 Water quality modelling

Stormwater quality modelling has been undertaken for the Proposal using the MUSIC 6.2 software program. MUSIC is widely accepted as the industry standard for WSUD modelling and is used for comparing treatment train effectiveness. Input parameters for source and treatment nodes have been obtained from Sydney Catchment Authority MUSIC modelling manual (NSW Govt, 2012) as well as the NSW MUSIC modelling guidelines (BMT WBM, 2010).

The source nodes in the MUSIC model have been configured based on the DRAINS catchments nodes for both the pre and post development scenarios. The post development scenario incorporates both an unmitigated (no treatment train) and mitigated treatment train scenario. This enables comparison of generated stormwater pollutants based on the change in the rainfall catchment response characteristics of the pre and post development configurations.

Rainfall data has been obtained for the Parramatta North (Masons Drive) Station No: 066124. MUSIC modelling of the Site was analysed for a period of 26 years (1984 – 2010) using a 6 minute time-step period. Average potential evapo-transpiration (PET) data for the Parramatta North station has been adopted.

The pre-developed (existing conditions) site MUSIC model configuration is shown in **Figure 10**.

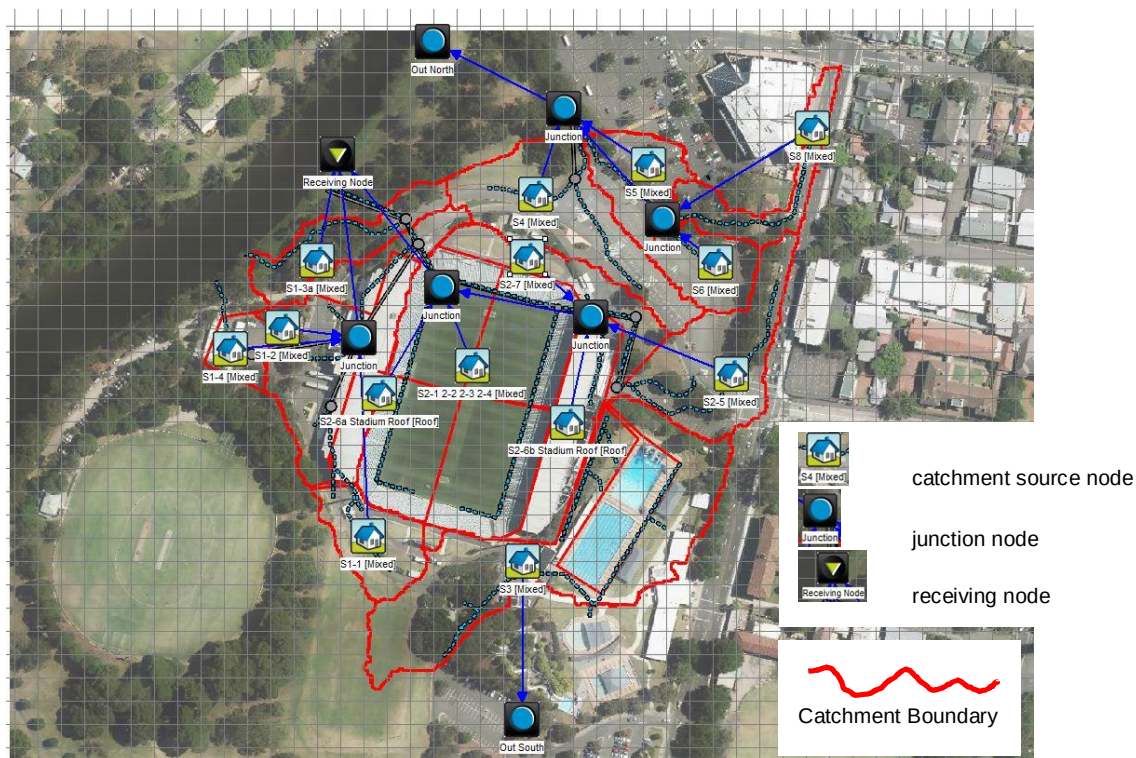


Figure 10 - Pre-Developed (Existing Conditions) MUSIC Model Configuration

The pre-developed stormwater pollutant constituents calculated for the existing main stadium facilities and discharging into Parramatta River are shown in **Figure 11**.

Treatment Train Effectiveness - Receiving Node			
	Sources	Residual Load	% Reduction
Flow (ML/yr)	24.6	24.6	0
Total Suspended Solids (kg/yr)	4270	4270	0
Total Phosphorus (kg/yr)	9.21	9.21	0
Total Nitrogen (kg/yr)	68.2	68.2	0
Gross Pollutants (kg/yr)	697	697	0

Figure 11 - Pre-Developed Stormwater Quality Statistics

The MUSIC model configuration of the post-developed (design conditions) unmitigated stormwater system is shown in **Figure 12**.

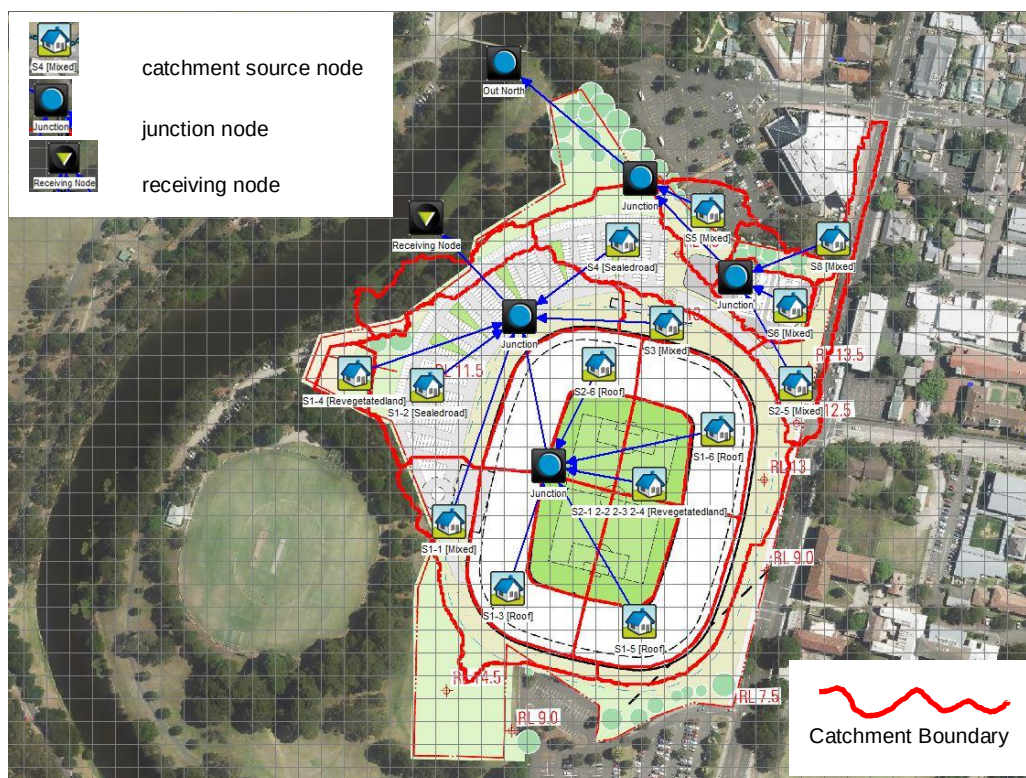


Figure 12 - Unmitigated Post-Developed (Design Conditions) MUSIC Model Configuration

The post-developed unmitigated stormwater pollutant constituents calculated for the Proposal and predicted to discharge into the Parramatta River are shown in **Figure 13**.

	Sources	Residual Load	% Reduction
Flow (ML/yr)	42.6	42.6	0
Total Suspended Solids (kg/yr)	7560	7560	0
Total Phosphorus (kg/yr)	15.2	15.2	0
Total Nitrogen (kg/yr)	101	101	0
Gross Pollutants (kg/yr)	1090	1090	0

Figure 13 - Unmitigated Post-Developed Stormwater Quality Statistics

The increases in stormwater flows and contaminants calculated in the MUSIC model are consistent with the increases identified in the DRAINS stormwater quantity modelling.

The MUSIC model configuration of the post-developed (design conditions) mitigated stormwater system is shown in Figure 14.

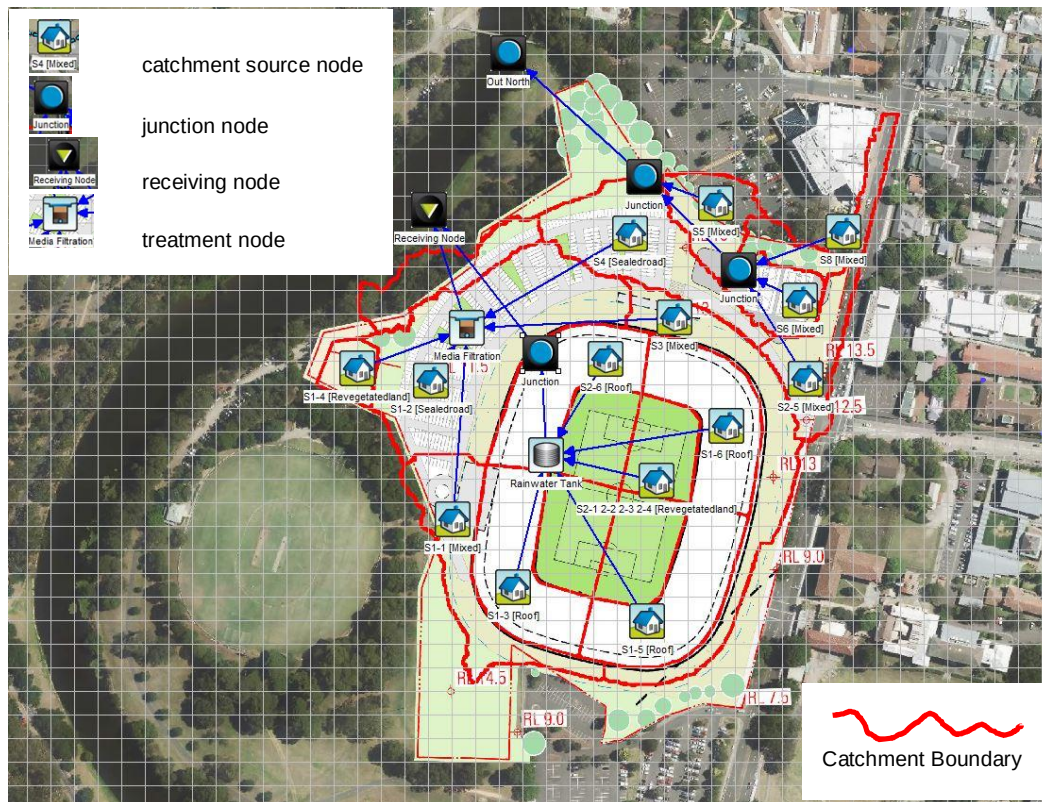


Figure 14 - Mitigated Post-Developed (Design Conditions) MUSIC Model Configuration

The treatment nodes incorporated into this model include a rainwater tank for stormwater harvesting of both the proposed stadium roof and playing field and a media filtration system for the carpark facilities.

The size of the rainwater tank applied to this MUSIC model scenario is referenced from the detention volumes calculated in the DRAINS model (refer to **Section 5.1.3**).

The reuse demand for the rainwater tank system has been modelled under two scenarios:

1. Irrigation water supply demand only of 2,173 kL; and
2. Total stadium facilities water supply demand of 37,175 kL.

The details of these water supply demands are presented in the following **Section 5.2.2**.

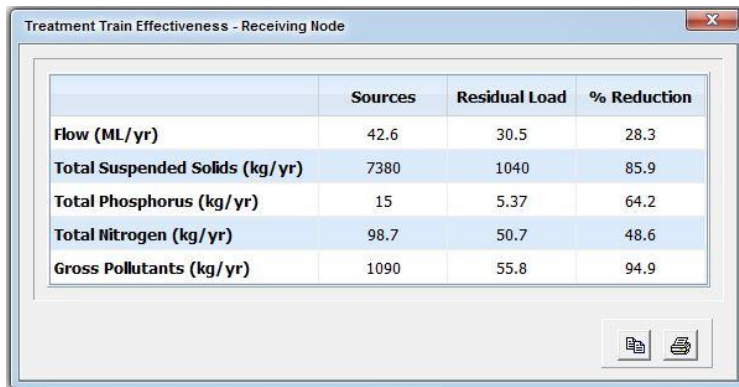
The post-developed mitigated stormwater pollutant constituents calculated for the main stadium facilities for Scenario 1 – irrigation water demand reuse only, discharging from the point of discharge are shown in **Figure 15**.

Treatment Train Effectiveness - Receiving Node			
	Sources	Residual Load	% Reduction
Flow (ML/yr)	42.6	40.2	5.5
Total Suspended Solids (kg/yr)	7380	1160	84.3
Total Phosphorus (kg/yr)	15	6.63	55.8
Total Nitrogen (kg/yr)	98.7	65.6	33.5
Gross Pollutants (kg/yr)	1090	55.8	94.9

Figure 15 - Mitigated Post-Developed Stormwater Quality Statistics – Irrigation Water Demand Reuse Only

As shown in **Figure 15** the stormwater quality objectives (**Table 2**) are not achieved for TSS and TN.

The post-developed mitigated stormwater pollutant constituents calculated for the main stadium facilities for Scenario 2 – total water demand reuse, discharging from the point of discharge are shown in **Figure 16**.



	Sources	Residual Load	% Reduction
Flow (ML/yr)	42.6	30.5	28.3
Total Suspended Solids (kg/yr)	7380	1040	85.9
Total Phosphorus (kg/yr)	15	5.37	64.2
Total Nitrogen (kg/yr)	98.7	50.7	48.6
Gross Pollutants (kg/yr)	1090	55.8	94.9

Figure 16 - Mitigated Post-Developed Stormwater Quality Statistics – Total Water Demand Reuse

As shown in **Figure 16** the stormwater quality management objectives (**Table 2**) can be achieved through a combined WSUD and integrated water cycle management (IWCM) philosophy utilising the maximum volume of non-potable water supplies for reuse. The controls and elements within this philosophy to be adopted in order to achieve the stormwater quality management objectives (**Table 2**) would be presented as part of the detailed design phase of the Project.

5.2.2 Water consumption and conservation modelling

Comprehensive specific use (e.g. irrigation, non-potable, potable) water supply data was not available for the existing stadium facilities. Only historical water bills for 2015 – 2016 were available which provided quarterly water usage and wastewater discharges. This information has been graphically presented in **Figure 17**.

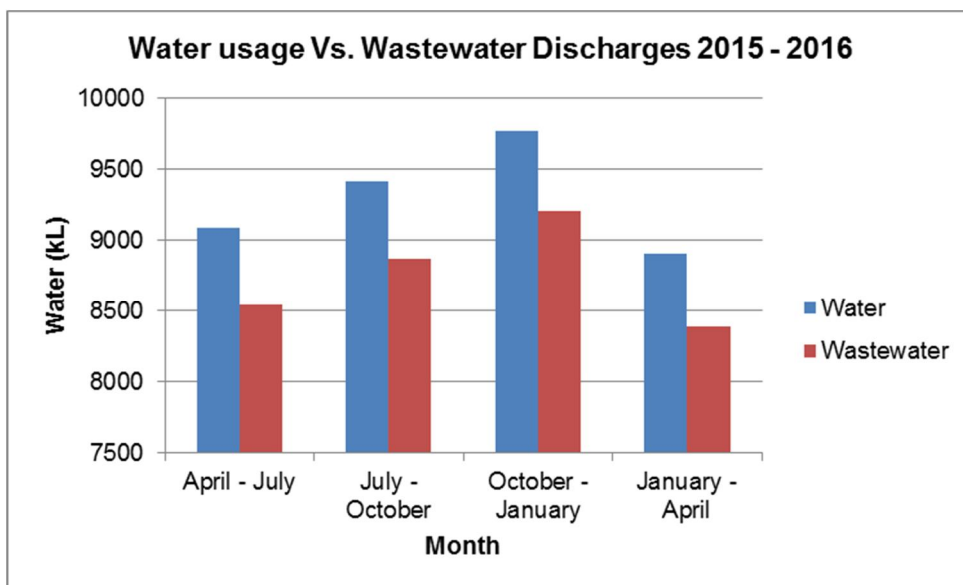


Figure 17 - Parramatta Stadium Water Usage Versus Wastewater Discharge

The total annual water usage for the stadium facilities is calculated at 37,175 kL. We are unable to determine the extent of potable use water supplies. Therefore for the purpose of this assessment we have assumed water for drinking purposes is supplied as bottled water during events and therefore the aforementioned metered water usage is assumed as non-potable.

The water bills have been analysed to estimate water supplied to playing field irrigation. The volumes of water applied to playing field irrigation have been assumed as the difference between the water usage and wastewater discharges. It is assumed the irrigation water supplies drain to the stormwater reticulation system and ultimately drain to the Parramatta River.

Therefore the quarterly playing field irrigation water usage has been estimated as listed in **Table 5**.

Table 5 - Estimated Parramatta Stadium Playing Field Irrigation Water Usage

2015 - 2016	Irrigation Water Usage (kL)
April – July	540
July – October	551
October – January	565
January - April	517

The total annual irrigation water usage is calculated at 2,173 kL.

Whilst MUSIC is not typically applied for water balance modelling, it can be appropriately configured to assess the impact of rainwater tanks on balancing water supplies and demands. Where MUSIC is adopted for this application a daily time step is required; one of which has been adopted for this assessment.

The configuration adopted for the MUSIC model assumes stormwater harvesting of the proposed roof and playing field areas to maximise the stormwater reuse potential and maximise reductions in potable mains supplies. These areas have been combined and assumed to be collected to a central harvesting system.

However, generally where rainwater tanks are included in a particular stormwater strategy the various land types are delineated in the MUSIC model. This is to ensure the pollutant export and treatment processes are appropriately considered. There is generally less TSS and TP exported from just roof areas so rainwater tanks will provide little treatment benefit for these pollutants.

We have also assumed that to maximise sustainable water use, the harvested stormwater would form a primary source for the irrigation water supplies of the playing surface. We would expect that the stormwater harvesting system would incorporate a water treatment system to remove residual chemicals added as part of the irrigation system supplies.

The MUSIC model water balance assessment for the 2,173 kL reuse demand rainwater tank node is shown in **Figure 18**.

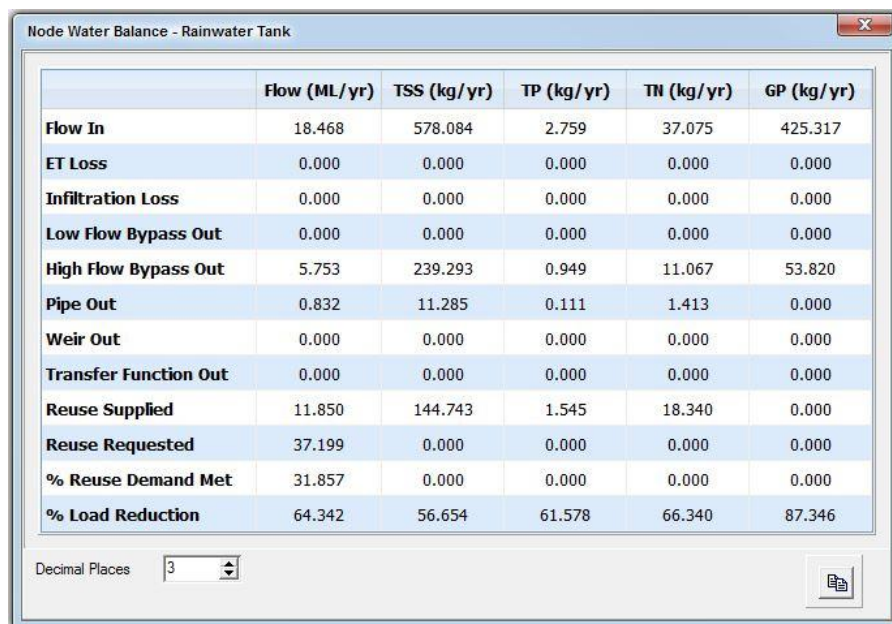
	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	GP (kg/yr)
Flow In	18.468	578.084	2.759	37.075	425.317
ET Loss	0.000	0.000	0.000	0.000	0.000
Infiltration Loss	0.000	0.000	0.000	0.000	0.000
Low Flow Bypass Out	0.000	0.000	0.000	0.000	0.000
High Flow Bypass Out	5.753	239.293	0.949	11.067	53.820
Pipe Out	10.510	131.876	1.377	16.314	0.000
Weir Out	0.000	0.000	0.000	0.000	0.000
Transfer Function Out	0.000	0.000	0.000	0.000	0.000
Reuse Supplied	2.166	26.169	0.282	3.192	0.000
Reuse Requested	2.174	0.000	0.000	0.000	0.000
% Reuse Demand Met	99.601	0.000	0.000	0.000	0.000
% Load Reduction	11.937	35.793	15.707	26.147	87.346

Decimal Places: 3

Figure 18 - 2173 kL Reuse Demand Rainwater Tank Water Balance

As shown in **Figure 18** by utilising stormwater harvesting for only irrigation water supplies, 100% of reuse demands can be met however, as a result there are excess volumes which are discharged from the system. Potable mains supplies would be required to supply the balance of 35,002 kL.

The MUSIC model water balance assessment for the 37,175 kL reuse demand rainwater tank node is shown in **Figure 19**.



	Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	GP (kg/yr)
Flow In	18.468	578.084	2.759	37.075	425.317
ET Loss	0.000	0.000	0.000	0.000	0.000
Infiltration Loss	0.000	0.000	0.000	0.000	0.000
Low Flow Bypass Out	0.000	0.000	0.000	0.000	0.000
High Flow Bypass Out	5.753	239.293	0.949	11.067	53.820
Pipe Out	0.832	11.285	0.111	1.413	0.000
Weir Out	0.000	0.000	0.000	0.000	0.000
Transfer Function Out	0.000	0.000	0.000	0.000	0.000
Reuse Supplied	11.850	144.743	1.545	18.340	0.000
Reuse Requested	37.199	0.000	0.000	0.000	0.000
% Reuse Demand Met	31.857	0.000	0.000	0.000	0.000
% Load Reduction	64.342	56.654	61.578	66.340	87.346

Decimal Places: 3

Figure 19 - 37175 kL Reuse Demand Rainwater Tank Water Balance

As shown in **Figure 19** by utilising stormwater harvesting for total non-potable water supplies, 32% of the reuse demand can be met. This indicates that during the course of the year rainfall alone will not supply all of the reuse (non-potable) demands. Potable mains supplies may still be required but could be reduced by 32% to 25,279 kL.

6.0 Risk and Impact assessment

The following sections provide an assessment of the potential water related risks to the project. These risk are associated with water conservation, stormwater drainage and stormwater quality. The sections provide an assessment of the impact that the indicated risk could have to the project if the identified risk eventuates. The timing for when the risk could occur is provided e.g. during demolition, construction, operation and rainfall events.

An assessment of the significance is provided which is based on the likelihood of occurrence of the identified risk and the impact that the identified risk would have to the project. Recommendations to mitigate the occurrence of the risk are provided in **Section 7.0**.

6.1 Potential Water Conservation Risks and Impacts

Risk A1: The Project may require a large quantity of water which cannot be supplied.

Impact: The irrigation network or facilities cannot operate to full potential.

Occurrence: During operation

Risk Significance: High.

6.2 Potential Stormwater Quantity Risks and Impacts

Risk B1: Post-development discharge rate and volume is greater than the pre-development.

Impact: Potential to increase flood risk to downstream properties.

Occurrence: During large ARI rainfall events, i.e. 100yr ARI.

Risk Significance: Negligible - The size of the Site is small compared to the Parramatta catchment; therefore the runoff from the Site will have negligible impact on the flood risk to downstream (Parramatta River) properties.

Risk B2: Increased flood risk to adjoining properties.

Impact: The new Project may block upstream runoff flow paths through the Site. This could cause upstream flooding of adjoining properties.

Occurrence: During minor and major rainfall events.

Risk Significance: High – The new stadium location has shifted east towards O'Connell Street. This blocks an overland flow path which under existing conditions flows into the site near Victoria Road (refer to **Section 3.3**).

Risk B3: Localised flooding within the project site.

Impact: Water logging of areas causing damage to infrastructure and vegetation. Affect pedestrian access. Mosquito breeding. Reduced visual appeal.

Occurrence: During minor and major rainfall events.

Risk Significance: Medium

Risk B4: The Site is flooded by the Parramatta River.

Impact: Flood waters from the Parramatta River could cause damage to infrastructure, life and the environment.

Occurrence: During extreme rainfall events.

Risk Significance: High – If this risk eventuates, the impact could be high including loss of life.

Risk B5: Underestimate of future rainfall storm intensities

Impact: The rainfall intensities of future rainfall events may increase due to climate change. Revision of *Bureau of Meteorology* Intensity Frequency Duration (IFD) tables may result in increased rainfall intensities. These changes could result in higher runoff and increased risk of flooding.

Occurrence: Future extreme rainfall events.

Risk Significance: High – Increases in rainfall intensity could have significant impact on the effectiveness of the capacity of drainage system.

6.3 Stormwater Quality Risks and Impacts

Risk C1: Stormwater discharged from the Site may contain nutrients and other pollutants.

Impact: The Parramatta River is the receiving water body for any stormwater discharge from the Site. Transportation of nutrients and pollutants to the river could reduce water quality and impact aquatic ecology values.

Occurrence: During frequent rainfall / runoff discharge events

Risk Significance: Low. The single event volume discharge to the river would be a small proportion of the total water within the river (due to significantly larger catchment of the entire upper Parramatta River). It therefore would have a low impact on the river. However, the cumulative impacts of discharges from the Site and all other sites discharging along the entire course of the river could result in a higher impact to the health of the river.

Risk C2: High runoff rates in conveyance corridors could produce scour and sediment transport.

Impact: Concentration of stormwater could cause scour damage. This could produce loss of sediment over time, damage to landscape and reduce water quality in the Parramatta River.

Occurrence: During all rainfall runoff events

Risk Significance: Medium.

Risk C2: Discharge of pollutants in stormwater may occur prior to the construction of the treatment infrastructure.

Impact: Reduce the water quality of the receiving water body (Parramatta River).

Occurrence: During demolition and construction.

Risk Significance: Medium. The discharge of pollutants may be significantly higher than compared to when the treatment infrastructure is installed (during operation).

7.0 Mitigation and management measures

7.1 Conservation Mitigation

Risk A1: The project site may require a large quantity of water which cannot be supplied.

Mitigation Measure: The MUSIC modelling of **Section 5.2.2** indicates that utilising stormwater harvesting for total non-potable water supplies, 32% of the reuse demand can be met.

Residual Risk: Low. Maximising stormwater harvesting opportunities across the entire Site may increase the reuse demand supplies considerably. This would be investigated as part of the detailed design phase for the Project.

7.2 Stormwater Quantity Mitigation

Risk B1: Post-development discharge rate and volume is greater than the pre-development.

Mitigation Measure: The DRAINS modelling indicates that a detention volume of approximately 950 m³ is required to mitigate the 100 year ARI post-development peak discharge flow rate of 1.75 m³/s (for the critical 20 minuted duration event) to the pre-development flow rate of 1.42 m³/s.

Table 6 and **Table 7** lists the detention storage required to mitigate the post-development stormwater flows and volumes to pre-development rates for the 10 year ARI and 100 year ARI events, respectively.

Table 6 - 10 year ARI

Duration	Pre Development Volumetric Discharge (m ³)	Post Development Volumetric Discharge (m ³) Unmitigated	Percentage increase in volumetric discharge
5 minutes	421	662	36%
10 minutes	663	1040	36%
15 minutes	895	1312	32%
20 minutes	999	1722	42%
25 minutes	1086	1900	43%
30 minutes	1480	2670	45%
1 hour	2383	4524	36%
3 hour	3894	7456	48%

Table 7 - 100 year ARI

Duration	Pre Development Volumetric Discharge (m ³)	Post Development Volumetric Discharge (m ³) Unmitigated	Percentage increase in volumetric discharge
5 minutes	602	1100	45%
10 minutes	1022	1695	40%
15 minutes	1269	2119	40%
20 minutes	1499	2451	39%
25 minutes	1638	2760	41%

Duration	Pre Development Volumetric Discharge (m ³)	Post Development Volumetric Discharge (m ³) Unmitigated	Percentage increase in volumetric discharge
30 minutes	1792	3052	41%
1 hour	2470	4288	42%
3 hour	3894	7456	48%

Residual Risk: An increase in the post-development peak discharge from the Site could increase the flood risk to downstream properties; however, incorporating a detention volume of approximately 950 m³ within the Site will maintain the pre-development peak discharge rates. This will mitigate the risk (B1) to a low significance.

Risk B2: Increased flood risk to adjoining properties.

Mitigation Measure: The Project has the potential to change the surface runoff path ways through the Site. If surface runoff from upstream catchments that are conveyed through the existing site are blocked or modified, this may cause upstream flooding of adjoining properties.

The regional flood inundation model of the Parramatta River also includes the immediate residential catchment upstream of the Site (to the north east of the Site). This enables the runoff from the upstream residential area to be calculated to determine if the runoff from the residential area flows into and through the Site.

The modelling indicated that the only flow path through the site is via the entrance to the site at the junction of O'Connell Street and Victoria Road (see **Figure 3**). During large runoff events where the stormwater pipe drainage network along O'Connell Street is exceeded, runoff will flow southwards down O'Connell Street to the Parramatta River and also a proportion of this surface runoff will flow into the Site at the entrance.

It is proposed that the entrance to the Site is raised to provide a gradual height differential of 300 mm between the crest of the entrance and O'Connell Street. This will ensure that during an extreme surface runoff event, the water will be confined to O'Connell Street and will be convey southwards instead of into the Site.

The total peak flow down O'Connell Street (downgrade of Victoria Road intersection) is approximately 0.7m³/s during a 100yr 9h storm event. This road has a gradient of 2.8%. Any increase in the flow down this road due to preventing inflow into the Site is likely to be negligible and will not increase the flood risk to properties along O'Connell Street.

Developments which are located within a floodplain can block the floodwaters and cause a change in the flood extent. This can result in adjacent properties being flooded which were not previously at risk before the construction of the new development.

The Parramatta River flood extent and elevation (The peak water level at the existing pipe discharge location into the river, presented in **Figure 3**, is 9.78 mAHD in both the pre-development and post-development) during a 100yr ARI event is not altered by the development (see comparison between **Figure 5** and **Figure 7**). This is because the proposed development does not encroach on the existing floodplain.

Residual Risk: The lifting of the entrance road to the Site will prevent excessive event runoff into the Site. The increased flow down O'Connell Street due to this modification will have negligible impact on the adjacent properties; therefore the residual risk is low.

The stadium development is not located within the Parramatta River floodplain and therefore the new development does not alter the existing flood extent or elevation. Therefore the residual risk to adjacent properties is low.

Risk B3: Localised flooding within the Site.

Mitigation Measure: The Site could have areas where stormwater runoff is trapped and cannot discharge. This would impact on the function of the Project (i.e. water ponding on the playing surface), damage to infrastructure (prolonged water expose damage) and aesthetics.

The ground surface outside of the proposed stadium will be contoured so that there are no unintended trapped low points. The new hardcourts (north-east region of the Site) will be contoured in a north-west direction towards the existing swale which discharges to the Parramatta River (refer **Figure 6** for proposed post-development flow paths).

All remaining external stadium surfaces will be graded towards a low point on the north-western carpark. Excessive runoff not harvested for reuse, will be treated and discharged into a swale. This swale will convey the runoff in a north-easterly direction into the existing site swale which discharges into the Parramatta River (refer to **Figure 19**).

Localised stormwater volume management within the Site consists of primarily interconnected detention systems and over flow piped networks as conceptualised in **Figure 20**.

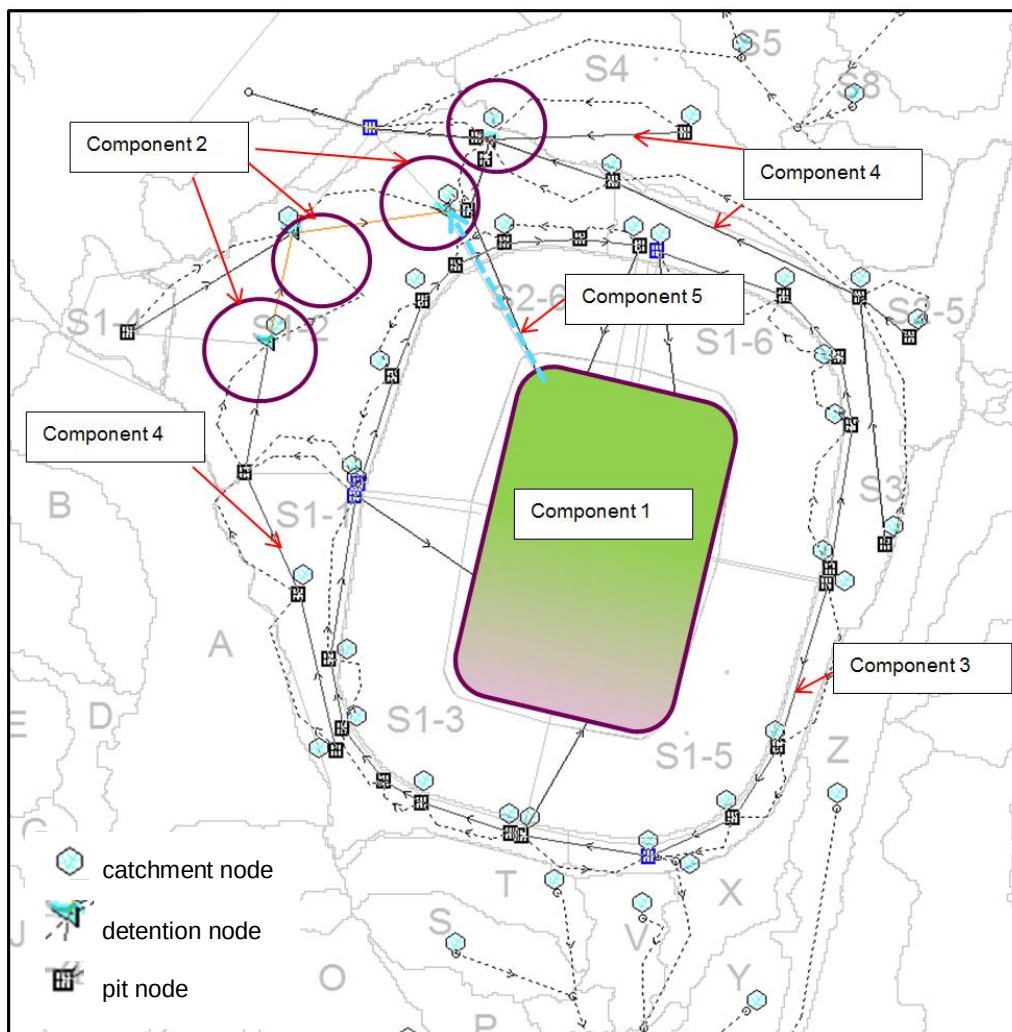


Figure 20 - Localised Site Flooding Mitigation

The main mitigation components of the proposed drainage network incorporate:

- Component 1 - Underground detention system below the playing surface to harvest and detain stormwater and irrigation water inflows.
- Component 2 - Interconnected underground detention system to harvest rainfall runoff from the filtration media of the car park area.
- Component 3 - Conventional piped network around the periphery of the Stadium facilities to collect and convey rainfall from the roof area and discharge into the underground detention tank system.
- Component 4 - Conventional piped network to convey surface runoff from other impervious area around the Site.

- Component 5 - An emergency over flow bypass pipe with a non-return valve to convey excess water build up to the underground tank.

The finished surface level of the playing surface is proposed at approximately 9.0 mAHD. The DRAINS modelling indicates that the maximum water level for a 100 year ARI storm event, 25 minutes critical rainfall duration is less than 8.3 mAHD.

Residual Risk: The Project is proposing to incorporate a number of WSUD and IWCM elements which will significantly reduce at source stormwater runoff flows and volumes. Therefore the residual risk is low.

Risk B4: The Site is flooded by the Parramatta River.

Mitigation Measure: The stadium pitch is at an approximate elevation of 9 m AHD. The peak water level in the Parramatta River adjacent to the north-west boundary of the Site (during a 100yr ARI event) is approximately 9.8m AHD. Due to pitch elevation being lower than the peak flood water, there is a risk of inundation of the pitch and consequential risk to infrastructure, environment and life.

The elevation of the land around the stadium is approximately 12.5 mAHD. This is significantly elevated above the 100yr ARI water level in the Parramatta River and it is unlikely to cause flooding of the pitch via overtopping.

All other areas of the Site are elevated above the 100yr ARI water level.

The pitch will have drainage infrastructure to capture rainfall runoff originating from the pitch and stadium roof, and pipe network to discharge excess water to the Parramatta River. A flow control valve is required to prevent backwater flowing into the stadium pipe network from the Parramatta River.

The flood risk assessment model was only run for the 100yr ARI event. Modelling conducted by Bewsher in 2003 suggest that the PMF flood extent reaches the intersection of O'Connell Street and Victoria Road. This indicates that the PMF water level at this location is approximately 13 mAHD. This location would be an appropriate evacuation route from the stadium to higher ground up O'Connell Street. Alternatively, the stands within the stadium are elevated and would provide separation from the PMF water level.

Residual Risk: The elevation of the Site above the 100yr ARI water level and flow control valve on the pipe network will reduce the risk of flooding of the Site from the Parramatta River. The residual risk is very low for the 100yr ARI design event.

Risk B5: Underestimate of future rainfall storm intensities

Mitigation Measure: There is uncertainty in the calculation of the current design storm rainfall intensities and the future intensities associated with climate change. This uncertainty has been investigated to determine the potential impact on the flood risk to the Site.

The flood risk regional model was simulated using rainfall intensities increased by 30% (DECC, 2007). This modelling indicated that the peak water level for the 100yr ARI event along the north western boundary of the Site will increase from 9.8 mAHD to 10.9 mAHD. This elevation is below the development site ground elevation and therefore this increased flood elevation will not have an impact on the Project (see **Section 5.1.1**).

The BoM has revised the IFD values in 2013. The revised rainfall intensities are approximately 20% lower for the Project Site. Therefore the revised IFD is lower and this would result in less runoff generated than using the original IFD information. The modelling that has been conducted has assumed the original IFD and therefore is more conservative.

Residual Risk: The modelling conducted using the conservative original IFD information and assuming a 30% increase in rainfall intensity did not causing flooding of the Site from the Parramatta River during the 100yr ARI event. Therefore the residual risk from underestimating rainfall intensities is considered to be low.

7.3 Stormwater Quality Mitigation

Risk C1: Stormwater discharged from the Site may contain nutrients and other pollutants.

Mitigation Measure: The Proposal layout and facilities configuration results in an increase in stormwater pollutant constituents. However, by adopting a WSUD and IWCM philosophy for the Site, which incorporates filtration media and rainwater tanks, respectively, stormwater quality treatment target objectives can be achieved.

Residual Risk: The residual impact can be very low if the most appropriate, fit for purpose stormwater management approaches and philosophy are adopted. The modelling indicates that full reuse potential should be targeted in order to achieve stormwater quality treatment target objectives. This is based on the stormwater flows from the stadium roof and playing surface being mitigated by only a rainwater tank system. If only a partial rainwater tank / reuse system is preferred, additional WSUD elements must be incorporated in order to achieve stormwater quality treatment target objectives.

Risk C2: High runoff rates in conveyance corridors could produce scour and sediment transport.

Mitigation Measure: The stormwater management philosophy for the Site should be source-control, ie. managed as close to the source of runoff as practicable. Therefore, the overland flowrates will not be conveying a significant enough volume to generate scour and sediment transport.

Residual Risk: The residual impact is low.

Risk C2: Discharge of pollutants in stormwater may occur prior to the construction of the treatment infrastructure.

Mitigation Measure: During demolition of existing stadium, the ground surface will be significantly modified. Runoff from the disturbed areas has an increased risk of mobilising material such as sediment, construction waste and pollutants. This material could then be conveyed to the Parramatta River.

As part of the Project the design documentation and environmental management plan should incorporate an erosion and sediment control plan.

The erosion and sediment control plan should incorporate extent of works to mitigate erosion and sediment. The extent of works should incorporate, but not limit to, the following activities:

- Maintain all erosion and sediment control devices;
- During the construction of stormwater pits, runoff shall be prevented from entering the pits unless silt fences are erected around pits;
- Minimise disturbance to areas within the site at any one time;
- Protect all material stockpiles from scour and erosion. Do not stockpile in access ways, near drainage pits or in overland flow paths or depressions;
- All soil and water control measures are to be put back in place at the end of each construction working day and modified to best suit Site conditions at that time;
- Control surface water from upstream of the site from entering the disturbed site;
- All construction vehicles shall enter/exit via the dedicated construction entry/exit location;
- All vehicles exiting the site shall be cleaned and inspected before leaving;
- Maintain all on site and relevant stormwater pits and pipes clear of debris and sediment. Inspect stormwater system and clean out after each storm event.
- Clean and maintain all erosion and sediment control devices after each storm event.

The extent of works should incorporate soil management devices such as:

- Silt fences below the Site and across all potential runoff sites;
- Temporary construction vehicle entry/exit and divert runoff to practicable control systems;
- Measures to divert upstream flows into existing stormwater system;
- Sedimentation traps/basins including outlet control and overflows;
- Turf lined swales;
- Straw bale sediment filters;
- Sandbag sediment traps upstream of existing pits;
- Geotextile filter pit surround around all proposed pits as they are constructed;

Upon completion of pavement sand bag kerb inlet sediment traps would be provided around pits and where possible a strip of turf will be maintained on both sides of all roads after the construction of kerbs.

Residual Risk: The aforementioned extent of works, mitigation measures and management devices will reduce the risk of transport of material during frequent rainfall runoff events. During large runoff events the impact will be reduced by the surface contouring and coarse sediment trap; however some discharge of material into the river could occur. The period between demolition and construction of the permanent treatment is approximately 2 years. The residual risk is low for an extreme rainfall event to occur during this time and significant discharge of material off site.

8.0 Conclusion

A summary of the risk and mitigation measures presented in **Sections 4.0, 5.0, 6.0 and 7.0** are summarised in **Table 8**. These proposed mitigation measures will reduced the impact and likelihood of the indicated risks to the project. It is recommended that these measures are further defined in subsequent more detail design of the stadium.

Table 8: Summary of Management and Mitigation of Risk Measures

Risk	Management and Mitigation Measures	Implementation		
		Design	Construction/ Demolition	Operation
The project site may require a large quantity of water which cannot be supplied.	Underground storage will be required to harvest rainfall runoff for re use.	✓		✓
Post-development discharge rate and volume is greater than the pre-development	Underground storage will be required to mitigate discharge rate to its pre development rate or lower	✓		✓
Increased flood risk to adjoining properties	The development is not within the floodplain of the Parramatta River. The entrance road to the Site will be raised to prevent surface runoff into the site.	✓		✓
Localised flooding within the project site	The ground will be contoured to provide an overland flow path to the Parramatta River. Drainage infrastructure to incorporate localised sag point to maximize capture of surface runoff into the piped network,	✓		✓
The project site is flooded by the Parramatta River	The development is not within the floodplain of the Parramatta River. The site is elevated above the 100yr ARI water level. An evacuation route to Victoria Road is available during a PMF.	✓		✓
Underestimate of future rainfall storm intensities	The proposed site is not within the floodplain of the Parramatta River which has been modelled to include a 30% increase in rainfall intensity.	✓		✓
Stormwater discharged from the site may contain nutrients and other pollutants	Fit for purpose WSUD and IWCM will mitigate stormwater pollutants and achieve treatment objectives.	✓		✓
High runoff rates in conveyance corridors could produce scour and sediment transport.	Filtration media will infiltrate surface runoff as close to the source as practicable, reduce surface flow velocities and minimise scouring potential.	✓		✓
Discharge of pollutants in stormwater may occur prior to the construction of the treatment infrastructure	The site will be contoured to reduce discharge from the site. Sediment and silt traps will be used during demolition and construction to reduce the risk of mobilisation of material into the Parramatta River.		✓	

9.0 References

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Appendix A

Stadium Facilities and Demolition Activities

Appendix A Stadium Facilities, Construction and Demolition Activities

A1.0 The Proposal

The Proposal comprises Stage 1 of development for the Project. Specifically, the Proposal includes:

- Concept Proposal for the Western Sydney Stadium, including parking and access facilities, ancillary infrastructure and landscaping
- staged demolition and removal of the existing above ground structures, including the existing stadium and the associated hardstand areas where required (footpaths, roads, car parks etc.).

A1.1 Western Sydney Stadium Concept Proposal

The Western Sydney Stadium Concept Proposal provides for:

- a maximum total Gross Floor Area (GFA) of 60,000-65,000 m² for the stadium development
- a maximum total Gross Floor Area (GFA) of 12,000 m² for community uses
- transport accessibility and parking facilities
- landscaping and public domain elements throughout the Site.

A1.2 Stadium features

The Western Sydney Stadium would provide the following facilities:

- additional seating for approximately 10,000 more spectators via provision of a seating bowl with 30,000 seats, including 27,000 general admission seats 3,000 corporate seats
- five levels of premium box/terrace, function/lounge offerings and a number of suite offerings
- flood lighting and stadium video screen
- additional facilities for team, media, administration and amenity such as changing rooms, media rooms, and food and beverage facilities.

A1.3 Mixed use development

It is anticipated an area of the Site would be zoned for mixed-use development. These would allow for various entertainment and sporting facilities that compliment activities as the stadium site.

A1.4 Parking and access

The Concept Proposal would provide a new at grade car park of 100 – 500 bays to the north and west of the existing stadium. The new car park would be restricted to corporate and VIP use.

Vehicular access to the stadium complex would be provided via the following options:

- a two way vehicular access road via O'Connell Street on the northern side of the Site, with a bus turning circle or 'kiss and ride' drop-off point to the west of the new stadium
- a new one way restricted access ring road from O'Connell St north of the stadium along the western side of the stadium to exit south back on to O'Connell St. This access road would allow staff and player vehicles to enter and exit the Site via O'Connell Street and minimise congestion.

A1.5 Public domain and landscaping

[more information to be provided – not relevant to specialist assessment]

A1.6 Workforce

Workforce at the stadium complex would vary between event and non-event days.

On event days, the in-house stadium co-ordinator would be responsible for overseeing all events held at the new stadium. Up to 1,000 staff (comprising permanent and contract staff) would be required to operate the stadium to provide catering, security, cleaning and customer service functions. However, up to 900 staff may be required

during concert events. Security, police and first aid officers would also be located throughout the stadium on event days.

On non-event days, staffing requirements may vary between ~ five and 100 employees depending on the amount of preparation required for any upcoming events and ongoing maintenance requirements.

A1.7 Hours of Operation

The hours of operation would be consistent with the existing NRL and A-League game times. However, additional games and the potential for music and other entertainment events would be associated with the stadiums increased capacity.

A1.8 Event Schedule

Once operational (projected February 2019), the new Western Sydney Stadium would primarily be used for major sporting events, as well as a range of other non-sporting commercial and community events such as music concerts and fairs. The installation of three tiers of corporate boxes/terraces, function areas and suites would also provide a greater corporate premium offering than the current stadium (KPMG, 2016).

The new stadium is expected to operate as a home stadium for the Parramatta Eels (National Rugby League (NRL)), the Western Sydney Wanderers (A-League soccer) and two additional NRL franchises under the NSW Stadia Strategy objectives for the consolidation of venues. The number of event days are therefore projected to increase substantially at the under the Project (refer to Table A1). An increase in patron attendance to the events is also projected, based on ten year historical growth periods of each sport, with A-league growing at 0.7% and NRL achieving no growth.

Table A1 Event calendar and attendees

	Current event calendar	Projected event calendar under the Project
Event Calendar		
Parramatta Eels	9	10
NRL Team 2	0	10
NRL Team 3	0	10
WS Wanderers	13-14	11-12
Other (e.g. Final Series)	0	1
Total events	22-23	22-23
Attendances		
Parramatta Eels	13,300, no growth	10% uplift, no growth
NRL Team 2	15,900, no growth	10% uplift, no growth
NRL Team 3	11,800, no growth	10% uplift, no growth
WS Wanderers	13,500, 0.7% growth	10% uplift, 0.7%growth
Other (e.g. Final Series)	na	30,000

A2.0 Demolition works

A2.1 Demolition activities

The Demolition works (i.e. Stage 1 works) would be carried out by specialist subcontractors and will involve the following activities within the Demolition works area:

- site establishment to enable the commencement of demolition activities (e.g. closing of existing facilities, installation of perimeter hoardings, fencing and signage and establishment of office compound, installation of sediment and erosion controls)
- waste management activities including the removal of classified waste for offsite disposal and recycling of steel waste

- decommissioning, demolition, dismantling landscaping and/or removal of the existing stadium (Parramatta Stadium), related structures and hard and soft landscaping treatments
- associated civil works
- 'make safe' activities including returning all areas to ground level.

A2.2 Plant and Equipment

The Demolition works would be undertaken in several stages, requiring the following plant/equipment:

- stripping fitout and dismantling of steel structures using two 30 tonne long reach excavators. Works would initially focus on the removal of the internal fitout (including plasterboard walls, ceilings, services and joinery) followed by the roof structure
- demolition of concrete components and stands using up to two 40 tonne excavators with jackhammers, and one long reach excavator or crane. Concrete would be crushed before being transported off site for recycling
- removing stadium lighting poles using one 250-400 tonne crane and boom lifts.

In addition to the above, the following equipment would be used as required:

- up to five small bob-cats
- up to five excavator loading trucks
- up to three water tanks
- re-fuelling tanks

A2.3 Traffic management

During demolition, the majority of vehicles would access directly to the Site from the main access on O'Connell Street. Dismantling of the stadium light towers, demolishing and removing large structures from the stands would require mobile crane access and truck movements around the Site.

A2.4 Hours and duration

Standard construction working hours would apply for the duration of the Demolition works. The hours for demolition would therefore be confined to:

- 7:00 am to 6:00 pm Monday to Friday
- 8:00 am to 1:00 pm on Saturdays
- No work on Sundays or public holidays.

Some night work may be required and would be considered where it may reduce impacts to the public and local community. Work outside standard hours may also occur to complete tasks safely or more efficiently.

If work is required outside standard construction hours, it would be carried out according to the Interim Construction Noise Guideline (DECC 2009). This would include notifying the local community in advance of any work planned to be carried out outside of standard hours.

A2.5 Workforce

The contractor for the Demolition works would determine the size of the workforce, however it is estimated that a maximum of 45 construction and site management personnel would be on site at any one time.

A2.6 Program and schedule

INSW is planning to commence the Demolition works during the second half of 2016. Particular focus will be placed on minimising impact to the operation of the adjoining pool facilities (Parramatta Swimming Centre) over the 2016-2017 summer months. To achieve this requirement, demolition would generally commence on the west stand and progress to the east stand area. This would allow progressive commencement of construction works on the west side of the site once demolition is complete. The Demolition works for the existing stadium and ancillary infrastructure are planned to be completed by March 2017.

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