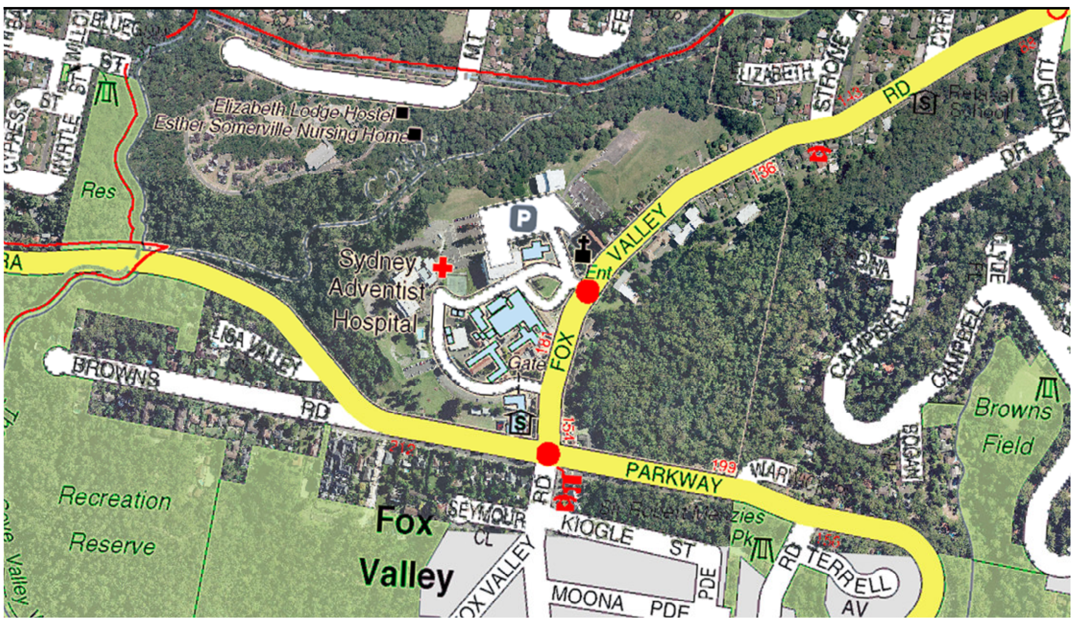
Johnson Property Group

Wahroonga Estate Flooding and Stormwater Master Plan



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1 Introduction

1.1 Background

Johnson Property Group (JPG) is proposing to redevelop a 65 ha site of the Australian Conference Association Wahroonga Estate to accommodate the expansion of the Sydney Adventist Hospital together with the provision of new educational and community facilities, residential dwellings and a village centre. The new estate will be known as the Wahroonga Estate and it is located at the intersection of Fox Valley Road and the Comenarra Parkway, Wahroonga (Figure1).

To facilitate the proposed development planning process, Hyder Consulting has been commissioned to prepare this Stormwater Management Master Plan (SMMP) for the proposed development. This SMMP includes:

- Integrated water cycle management strategy, which demonstrates the means and adequacy of managing stormwater within the site in accordance with Ku-ring-gai Council's Water Management Development Control Plan (DCP 47).
- location and sizing of flood detention ponds to mitigation potential adverse flood impacts on neighbouring property;
- water quality controls to mitigate potential adverse impacts of stormwater pollutant loads from the proposed development on receiving waters; and
- general comment on related flooding and stormwater issues to be addressed at detailed deign.

1.2 Data base

The following information has been used in the process of carrying out this SMMP.

- Survey of the main waterways within and adjacent to the site by Mepstead & Associates Surveyor's & Development Consultants (drawing number 3826DET1, dated 14/11/2003)
- Ku-ring-gai Council Water Management Development Control Plan – DCP 47.
- Site inspection during the course of this study of catchment and waterway conditions.

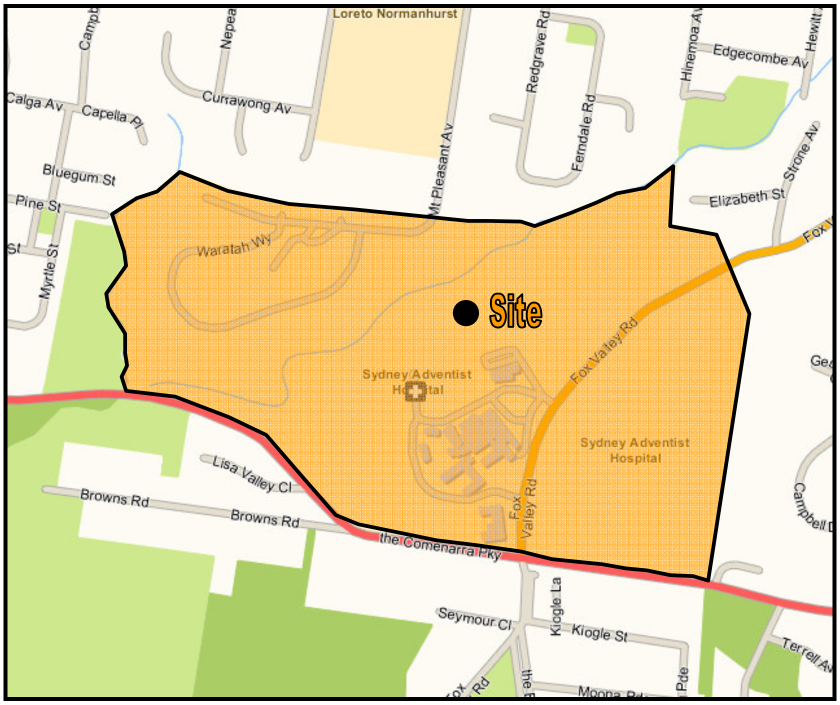

Figure 1: Site Location

2 Integrated Water Cycle Management Strategy

2.1 Objectives

Water Sensitive Urban Design (WSUD) principles are incorporated into the stormwater infrastructure and landscape design of the proposed development in order to control flooding, stormwater pollution and conserve water on the site.

2.1.1 Stormwater quality

A treatment train approach is adopted to capture and treat stormwater flows from regular rainfall events to the following stormwater reduction targets set by Council's DCP 47:

- 70% reduction in the average annual gross pollutants load.
- 80% reduction in the average annual total suspended solids (TSS) load.
- 45% reduction in the average annual total phosphorus (TP) load.
- 45% reduction in the average annual total nitrogen (TN) load.

2.1.2 Flood control

The principles of on-site detention for flood control according to Ku-ring-gai Council's DCP 47 requirements are adopted to control the rate of stormwater runoff and reduce peak discharges during storm events and thus minimise flood events and pressure on the downstream stormwater infrastructure.

Kuringai Council have advised that they have no recorded flood study of the area from which to predict flood levels, but also that they have no records of flooding in the area.

The site is characterised by topography containing deep, well defined creek valleys. As these riparian corridors are largely retained and the proposed development occurs on the ridges and areas elevated above these deep creek valleys, flooding is unlikely to provide a constraint on development.

2.1.3 Water conservation

In relation to water conservation on the site, Council's DCP sets mandatory rainwater tank requirements for the various development types within the site, with BASIX requirements as a minimum for the residential types of developments. Stormwater harvesting and/or sewer mining would be used to irrigate public open space where possible.

2.2 Proposed management measures

A number of WSUD management measures can be incorporated at the development site to meet the above objectives such as rainwater tanks, detention basins, rain gardens, wetlands and ponds. These measures vary in their effectiveness in meeting the different water cycle objectives and some could serve multiple of these objectives. A number of water cycle management options were developed and evaluated using mathematical modelling and the optimum suite of WSUD measures is then selected. The results of this investigation are presented in the following sections of this report.

3 On Site Detention

To minimise the adverse impact of a development on downstream properties and drainage systems, On Site Detention (OSD) is enforced by Ku-ring-gai council. Also mandatory to the site is the use of rainwater tanks which in some cases could reduce the OSD storage requirements.

According to the Water Management Development Control Plan 47 (DCP 47) the minimum storage volume and permissible site discharge (PSD) are calculated in accordance to the catchment location.

3.1 Catchment Description

The site drains to two main catchments areas, Coups Creek and Fox Valley with the dividing crest along Fox Valley Road. The area of the site to the west of Fox Valley Road drains to Coups Creek, which runs south leaving the site through a culvert crossing Comenarra Parkway. The area of the site to the east of Fox Valley Road drains to the Fox Valley Catchment. Only a small area at the south of the site discharges to the Lane Cove River catchment.

The permissible site discharge and the minimum OSD volume requirements for the three catchments located within the site are based on DCP 47 and are summarized in Table 1 below:

Table 1 – Catchment permissible site discharge and storage volume

Catchment Area	Permitted Site Discharge (l/s/ha)	Equivalent Minimum OSD Storage Volume (m^3/ha)
Coups Creek (CC)	132	325
Fox Valley (FV1)	129	332
Lane Cove River (LC)	166	241

To facilitate effective on-site stormwater management, the site was subdivided into sub-catchments as shown in Drawing SKC007. The sub-catchments areas were used to calculate the OSD volume requirements for each sub-catchment.

3.2 Land Use

The land use of each precinct was determined based on an area map developed by Urbis (figure 2) and further grouped into different development types according to Ku-ring-gai Council's DCP 47. These are summarised in Table 2 below.

The site is classified to be in Location Type B according to DCP 47 as it drains to natural water bodies that either traverse or are located immediately adjacent to the site. Council's DCP 47 requires that stormwater investigations would adopt a maximum impervious area determined based on the development type as follows:

- Development Types 1-5 — 60% of the area
- Development Type 6 — 100% of the area
- Development Type 7 — determined on merit
- Paved Areas — 100% of the area

Table 2 – Land use for the proposed development

Precinct	Land Uses	Development Types
Mount Pleasant	House, Town House, Apartment and Retirement	3 / 4 / 5
Central	Hospital, Church, Educational, Commercial, House, Hostel, Apartment	3 / 5 / 6
Fox Valley	Commercial, House, Apartment	3 / 5 / 6
Environmental Living	House, Town House, Apartment	3 / 4 / 5

Precincts Central and Fox Valley are described by Urbis as commercial and residential. As the impervious area for each use is different, it was considered an equivalent impervious area based on the area of each use.

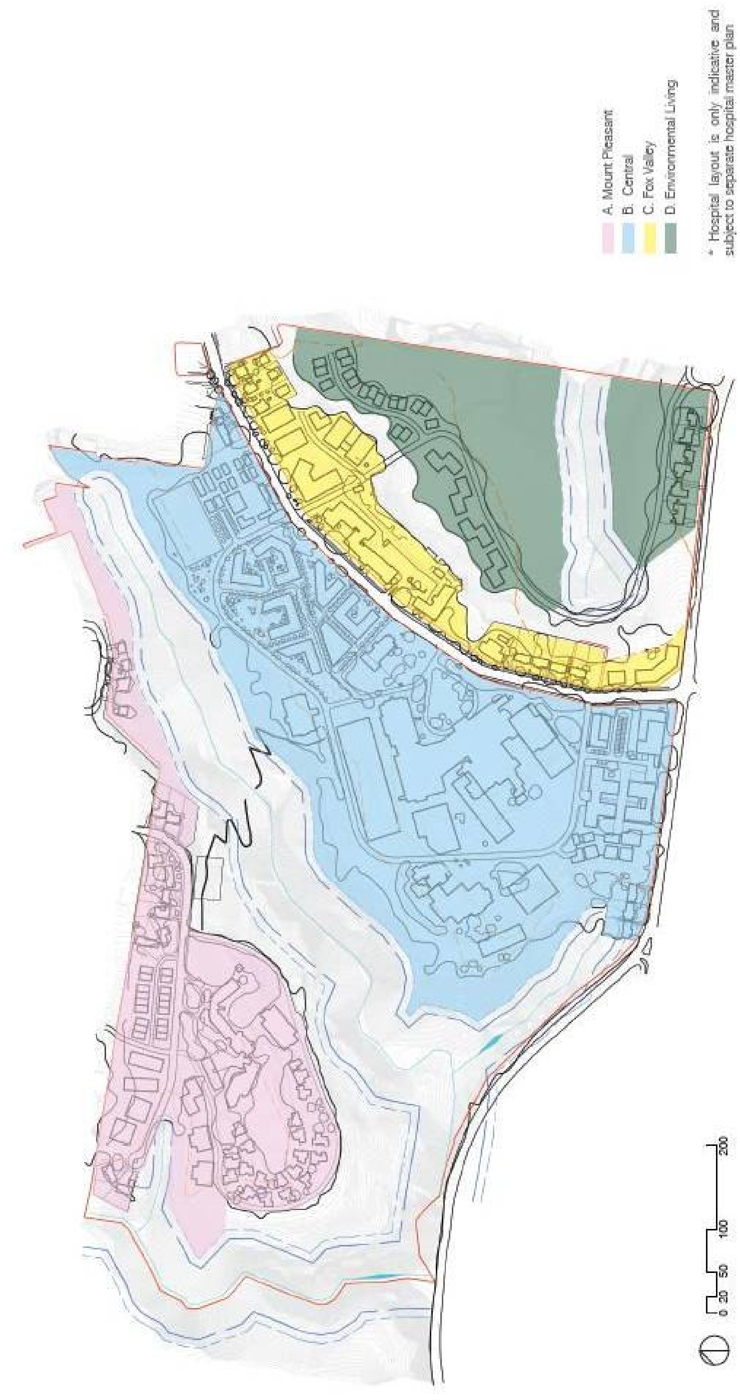

Figure 2: Site Precinct Plan

3.3 OSD Storage Volumes

The volume of each detention basin was calculated based on the minimum OSD storage volume required for each subcatchment based on the total impervious area, and increased by 20% to allow for growth of the vegetation as required by DCP47. Some subcatchments included parts of different precincts. In such cases, an equivalent percentage of impervious area was calculated.

DCP 47 allows a deduction of a percentage of the provided rainwater tank storage from the OSD storage requirements, provided that peak outflows from the subject site do not coincide with the peak flow for the catchment as a whole. DCP 47 indicates that generally, in lower areas of the catchment, it maybe preferable to allow most of the stormwater to leave the site immediately, and thus the rainwater tank storage reduction of the OSD storage requirements would be applicable. DCP 47 also sets an upper limit for the deduction of the rainwater tank storage, which is 50% of the OSD storage requirements for development types 4, 5 and 6 (with less than 9 units) and 25% of the OSD storage requirements for development types 5 and 6 (with more than 9 units).

While the majority of the proposed development site is located in the lower reaches of Coups Creek catchment, which could qualify the site to claim rainwater tank volume deduction from the OSD storage requirements, we have assumed no such deduction for the Stormwater Master Plan of the proposed development because Council could require additional investigation in order to claim such deduction. We have calculated however, for comparative reasons, the savings in the required OSD storage if such deduction was approved by Council. Summary of these calculations are presented in Table 3 below.

An above ground OSD basin complying with DCP 47 requirements was assumed for most of subcatchments within the site with a typical cross section shown in Drawing SKC009. However, this assumption was not practical for some of the subcatchments being either of small area or of no area available for locating the OSD basin. Such subcatchments were assumed to manage their OSD requirements on the site during development application stage and not as part of this Master Plan stage.

Table 3 – Subcatchment OSD volume requirements

Subcatchment	Catchment	Total area (ha)	Rainwater tank vol. requirements (m^3)	OSD volume requirements[1] (m^3)	OSD volume requirements[2] (m^3)	OSD Basin footprint[1] (m2)	OSD Basin footprint[2] (m2)
1	CC	1.16	35	271	236	n/a	n/a
2	CC	4.30	148	1006	858	2000	1855
3	CC	2.67	106	625	519	1785	1525
4	CC	5.03	210	1177	967	2545	2200
5	CC	3.86	174	903	729	2150	1925
6	CC	0.80	36	187	151	745	695
7	CC	3.10	140	725	585	1570	1335
8	LC	2.34	106	406	305	n/a	n/a
9	FV1	2.96	112	811	699	1850	1710
10	FV1	4.10	161	1078	917	2430	2135
11	FV1	2.17	107	493	386	1405	1220
12	FV1	0.83	23	198	175	n/a	n/a
13	CC	0.26	10	60	50	n/a	n/a
14	CC	0.41	19	96	77	n/a	n/a

Notes:

1) Without considering rainwater tank requirements.
2) Rainwater tank requirements are subtracted from OSD volume requirements according to DCP 47.

4 Stormwater Quality & Water Conservation

4.1 MUSIC model set-up

MUSIC software was used to develop a long-term stormwater quality simulation model for the site to evaluate the potential water quality impact from the proposed development and assess the performance of the proposed mitigation measures.

Daily rainfall and evapotranspiration data, from January 1, 1968 to January 1, 2008 were obtained from the SILO services of the Bureau of Meteorology. This information represents the best interpolated data specific to the site (Latitude -33.70, Longitude 151.10). Based on this data, Yearly average rainfall for this site was 1140 mm/year while average annual evapotranspiration was 1408 mm/yr. The Potential evapotranspiration values were calculated using the FAO Penman-Monteith formula.

MUSIC was used to estimate the long-term average annual stormwater volume and expected pollutant loads for TSS, TP and TN generated by the site. MUSIC is then used to conceptually simulate the performance of a group of proposed stormwater treatment measures (treatment train) to assess whether the proposed WSUD strategy would meet the set stormwater reduction targets stated earlier.

Sub-catchment characteristics

The site has been divided into sub-catchments with impervious percentages similar to the configuration used for calculating OSD storage volume requirements.

Rainfall-runoff modelling parameters

The MUSIC model default rainfall-runoff modelling parameters for Sydney were adopted for this site and are presented in Appendix A, Table A1. Sensitivity analysis for the model indicated the following runoff coefficient results for the various degrees of catchment urbanisation:

- Runoff coefficient of 0.09 for 0% imperviousness
- Runoff coefficient of 0.20 for 15% imperviousness
- Runoff coefficient of 0.63 for 70% imperviousness

Stormwater pollutant characteristics

The default pollutant load relationships for urban catchments in MUSIC were adopted for this site. These were based on a comprehensive review of stormwater quality in urban catchments undertaken by Duncan (1999). Constant mean event concentrations for the various pollutants were used as follows:

- 158 mg/L for TSS

- 0.355 mg/L for TP
- 2.63 mg/L for TN

4.2 Proposed stormwater treatment measures

The proposed stormwater management strategy for the site includes a variety of stormwater treatment measures acting as a treatment train to achieve the set pollutant reduction targets. The proposed stormwater treatment measures act as a WSUD framework for the whole site and thus the development of individual stages within the site's precincts according to the proposed strategy would contribute to the cumulative attainment of the site's pollutant reduction targets. The proposed stormwater management strategy for the site includes the treatment measures described below.

Rainwater Tanks

Ku-ring-gai Council's DCP 47 sets mandatory rainwater tank requirements for the various development types within the site, with BASIX requirements as a minimum for the residential types of developments. Accordingly, rainwater tank storage volumes were calculated for the various subcatchments based on the following requirements:

Development type	Description	Adopted min. tank storage volume (m^3)	Minimum use of rainwater and comments
Types 3 & 4	Single dwelling and dual occupancy	4000 L per lot.	As determined by BASIX. Assumed for toilet flushing and garden irrigation
Type 5	Multi-unit development	1000 L per unit.	As determined by BASIX. Assumed for toilet flushing and garden irrigation
Type 6	Business, commercial and retail	1000 L per m^2 of floor space.	No current BASIX requirement. Assumed for toilet flushing and garden irrigation.

The landuse and density assumptions for the proposed development, which were used to calculate the rainwater tank volume requirements, are presented in Table 4 below.

Table 4 – Landuse and density assumptions for the proposed development and rainwater tank volume requirements

	No. of Units	No. of Town houses	No. of Houses	Commercial area[1] (m^2)	Rooms	irrigation demand (kL/year)[2]	Toilet flushing demand (kL/day)[3]	Rainwater tank vol (kL)
Mount Pleasant	119	20	14	0	145	2594	10.0	370
Central	360	0	7	2000	343	4283	24.8	751
Fox Valley	88	0	10	16000	0	1246	18.9	288
Environmental Living	72	16	9	0	0	1273	4.1	148
Totals						**9397**	**57.8**	**1557**

Notes

1) Rainwater tank volume provision was assumed only to new commercial areas in the site.
2) Average irrigation demands for units = 17.7 L/day, for townhouses = 33.9 L/day and for houses = 186.1 L/day based on unpublished data from the BASIX project.
3) Average toilet flushing demands for units = 38.6 L/day, for townhouses = 47.6 L/day and for houses = 61.3 L/day based on unpublished data from the BASIX project. For commercial areas, toilet flushing demand was assumed to be 30% of 1.13 kL/m^2/year, which is the benchmarked water consumption for office and public buildings

Gross Pollutant Traps

A Gross pollutant Trap (GPT) is a treatment device designed to capture coarse sediment, trash and vegetation matter carried in stormwater. The capture rate for different gross pollutant trap devices can vary depending on the type of device installed. It was found that other pollutants such as TSS, TP and TN are carried in gross pollutants and removal of the gross pollutants would lead to some removal of the other pollutants. Walker et al (1999) investigated the efficiency of CDS GPT in treating TSS, TN and TP and found the following relationships, which was adopted in the MUSIC model for the site:

- $Y = 0.2787 X + 27.231$ for TSS > 75 mg/L
- $Y = 0.641 X + 0.1273$ for TP > 0.5 mg/L

Where Y is the downstream pollutant concentration (mg/L) and X is the upstream pollutant concentration (mg/L).

The study also found that for TN, the removal within the CDS device was erratic during storm events, with a constant removal of approximately 13% during dry weather flow condition. An average value for the wet and dry scenario was assumed thus, TN was set to be reduced by 6% in the MUSIC model.

Rain gardens (Bio-retention systems)

Rain gardens are basin-style bio-retention systems, which promote the filtration of stormwater through a prescribed sub-surface filter medium. Runoff ponds in the provided storage area at the surface of the system, percolates through the filter media and then collected by sub-surface drains and discharged to the downstream stormwater infrastructure.

The MUSIC model was used to investigate the effectiveness of using a variety of stormwater treatment measures such as rain gardens, ponds and wetlands to be fitted into the base of the OSD basin for a trial subcatchment. The results, which are shown in Table 5 below indicate that rain gardens provided the most effective treatment system to meet the pollutant reduction targets for the site. The filter area of the rain garden system was then varied to reach the optimum configuration that meets the required treatment targets. It was found that providing 50% of the rain garden area for filtration purposes was the optimum configuration. An HDPE liner may be used to prevent infiltration of the collected stormwater into the surrounding soil due to salinity constrains (subject to geotechnical investigation). A typical detail of a rain garden incorporated into the OSD basin is shown in Drawing SKC009.

The common parameters for the rain garden systems used in the MUSIC model for the site are presented in Appendix A Table A2.