

UNSW

KENSINGTON CAMPUS

2025

STORMWATER STRATEGY

MASTER PLAN

(July 2017)



**UNSW KENSINGTON
CAMPUS 2025**

STORMWATER STRATEGY

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1 INTRODUCTION

In 1997, a stormwater management study was carried out by Ove Arup & Partners for the UNSW Kensington Campus. In 2005, ANA Technical Services updated the 1997 study to include substantial alterations to the Campus' stormwater catchments from 1997 through to 2005.. The 2005 document was approved by Randwick City Council and formed the 'Campus 2020 Master Plan - Stormwater Strategy', prior to this document.

UNSW, with the assistance of Kustom Engineering Pty Ltd undertook a complete review of the new stormwater master plan through to 2025. Kustom's main objective is to review the existing 2005 Operational Stormwater documents, and to update the plans and models to reflect the current state (as at 2016) of redevelopment over the past 11 years at the Campus, and to identify deficiencies in the existing stormwater network.

The existing Operation Stormwater documents included:

- UNSW Kensington Campus DRAINS Model by Kustom Engineering 2015 (DRAINS Model);
- UNSW Kensington Campus 2020 Master Plan – Stormwater Strategy (by ANA Technical Services 2005);
- Stormwater diversion structures drawing (1:1000 scale @ AO); and
- Stormwater catchment plan (1:1000 scale drawing @ AO).

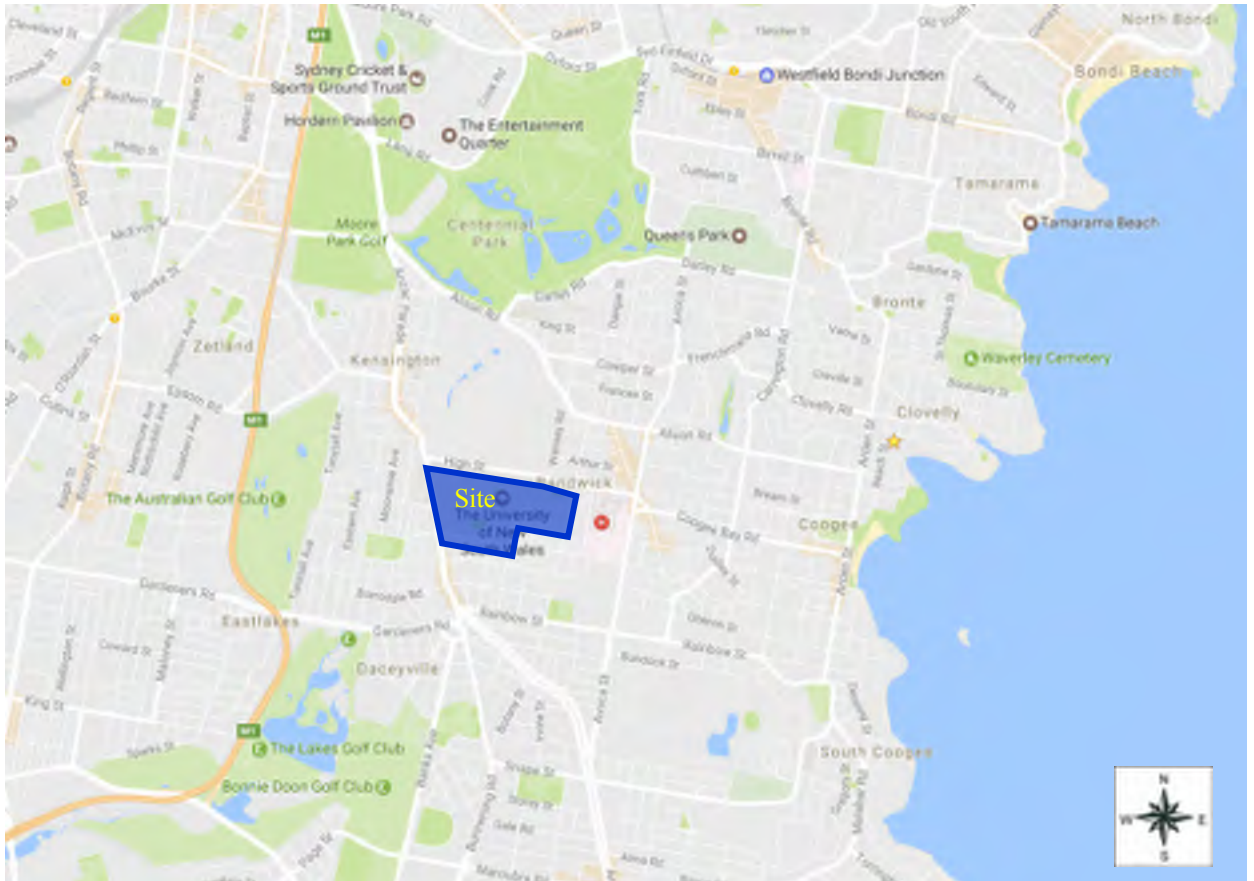


Figure 1 – UNSW Kensington Campus Location

2 OVERVIEW

The Campus stormwater network covers three (3) primary catchment zones, with each containing complex arrangements of drainage structures such as detention basins, percolation infiltration systems, diversion structures, and piped flow paths under buildings. With ongoing redevelopment over the Campus, UNSW have to ensure conditions are not made worse for Council, as each of these zones can also influence downstream flooding within Council's catchments. The three zones surrounding the Campus include Anzac Pde – North, Anzac Pde – South, and Botany St to the east.

Kensington campus stormwater drainage is to be managed in accordance with this strategy masterplan document, as agreed by UNSW and Randwick City Council. This document outlines the Stormwater Strategy to be adopted by both the University and the Council for stormwater engineering on existing and future development. It sets out the design parameters and development constraints for each of several catchments and sub-catchments within the site.

A key stormwater system at the Campus is a large grassed detention basin (which also includes a recharge facility for the Botany Sands Aquifer), known as the Village Green, which is located at the south-western corner and captures approximately 60% of the Campus' piped catchments, and approximately 54% of overland flows. Since its inception in 1996, the Village Green has played a key role in reducing peak stormwater discharge from the Campus by operating as a combined detention basin and percolation recharge system.

While the Campus is located at the high point of three (3) surrounding catchments, there is a trapped sag point within Barker St, to the south, that has been confirmed by survey and modelling to overflow into Campus grounds during large storm events.

Should a rare storm event occur, such as the 1 in 100 year ARI (otherwise known as the 1% AEP), the storage capacity of the Village Green is currently expected to be exceeded (Figure 2) where flows will pass over a weir located at the south-eastern edge of the Village Green, and then overflow westward down Southern Drive. Once reaching the lower part of the Campus, between the New College Village and Warrane College, the overflows will reach a trapped sag point and eventually reach the level of 26.50 m AHD before being conveyed out to Anzac Parade.

The remaining smaller catchments of the Campus that do not drain into the Village Green consist of typical piped stormwater networks and overland flow paths that discharge out from the Campus to surrounding Council roads and drainage systems.

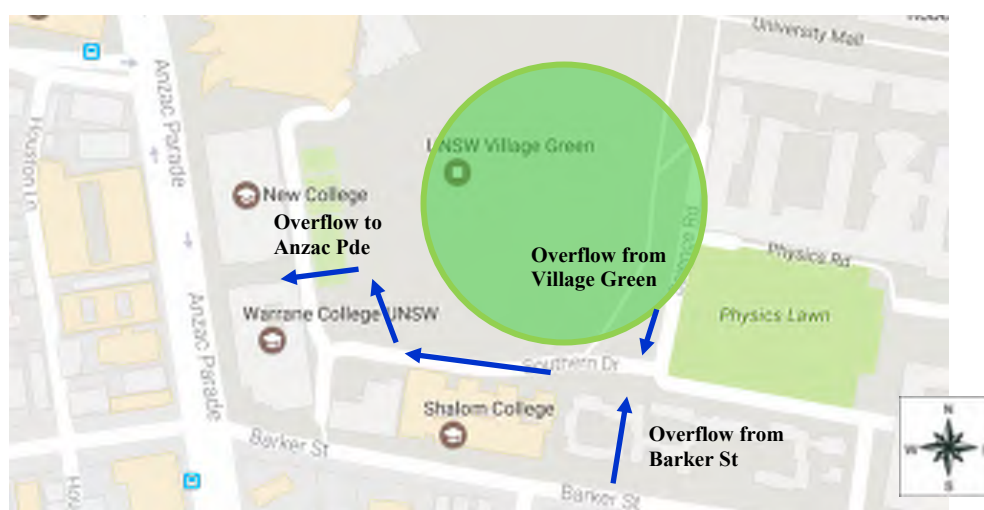


Figure 2 – UNSW Kensington Campus Location

The stormwater discharge quality off the Kensington Campus is high due to the various management practices undertaken by UNSW, these include:

- Daily removal of waste and leaf litter across the campus.
- Regular grating and pit cleaning.
- Gross pollutant trap installations and regular maintenance.
- Control of sewerage system overflow.
- Absence of significant dirty trades activities on the site.
- Absence of exposed clay soil areas due to stabilising landscape practices.

Stormwater detention and percolation into the aquifer substantially reduces discharge to Anzac Parade, thus ameliorating flooding in surrounding Council streets, particularly Barker St. and Anzac Pde, where flooding has been particularly severe for both small and large storm events.

Some catchments outside the detention basin are restricted in their use due to retained local depressions functioning as small detention basins, and existing pervious areas allowing percolation into the aquifer rather than increasing discharge to an already overloaded receiving system. In these areas, formal underground and surface drainage is low capacity, allowing water to surface as nuisance local flooding for all but the smallest of storm events.

Within most catchments there are artificial diversion structures positioned to direct overland flows away from buildings and towards their design discharge points. These are to be retained to protect development from extreme storm occurrences.

3 REFERENCED DOCUMENTS

This Strategy shall be read in conjunction with the following documents:

1. Letter of Agreement between Randwick City Council and University of New South Wales.
2. UNSW Drawing No FME-K-H015 – Catchment Management Plan
3. UNSW Drawing No FME-K-H016 – Diversion Structures Plan
4. Drains model prepared by Kustom Engineering (UNSW_CAMPUS_DRAINS_Model_[V101].drm)

4 COUNCIL AND OTHER CONSENT AUTHORITY DEVELOPMENT PROCESSING

All stormwater engineering is to comply with this Campus 2025 Master Plan Stormwater Strategy for all proposed developments within the UNSW Kensington Campus site lodged with Council (or other consent authority). This Strategy will be updated by UNSW as new developments further restrict development or site constraints.

5 BASIS OF MANAGEMENT STRATEGIES

The 2005 Study describes the history of catchment management strategies between UNSW and Council, and how the planning of the Village Green detention basin in 1996 formed the basis of the first Stormwater Strategy.

As the Campus drainage influences flooding in three (3) separate Council stormwater catchments, the 2005 Study identified changes to the catchment zones. This masterplan document incorporates development changes of operation within the Campus to 2017 and clarifies areas of the stormwater operation that is believed to have been incorrect.

6 CATCHMENT MANAGEMENT STRATEGIES

There are multiple catchment areas on campus, each of which have their own physical differences from soil types to discharge point restrictions depending on Council drain capacities. These catchments have been further divided into sub-catchments where their final discharge may affect more than one Council drainage catchment.

6.1 Diversion Structures

To ensure overland flow is diverted to the appropriate catchment or sub-catchment area, diversion structures such as walls, steps, surcharge pits, oversized stormwater pipes, road humps, burms, embankments, kerbs, road depressions and open drains have been designed and constructed. Most of these were designed integrally with Council-approved developments and substitute for natural overland flow paths, which have been interrupted by building development.

These must be retained for the life of the Campus, or replacement management strategies engineered to take their place. Otherwise building flooding will occur. For a description of each of these, refer to UNSW Drawing No FME-K-H016.

6.2 Percolation Cambers and Trenches Design

In locations outside the Village Green detention catchment, to mitigate flow rates from new developments, percolation to the Botany Sands Aquifer can be adopted for a major proportion of the Campus, as nominated in the Future Development clauses for the various drainage Areas. Design shall comply with Randwick City Council's Private Stormwater Policy. To assist in achieving compliance, the following design criteria may be adopted:

Design percolation rate for sizing percolation areas:	750mm per hour ($k = 0.2L/m^2/sec$) for natural sand (Based on percolation of natural sands at the Village Green and other regional testing. This allows for a 50% blockage factor). A higher rate could be achieved by site-specific testing.
Default percolation area sizing for areas < 100m ² :	1m ² per 20 m ² roof area. Storage volume required 1m ³ per 20 m ² roof area.
Percolation area cleaning & maintenance:	Provision shall be made for cleaning & maintenance. (e.g. This could include grassed area over open cell units such as Atlantis Cells being permanently reserved for open space; structural storage tank under concrete slab with two manholes for access and ventilation)
Sediment & silt arrester pit:	As per Council details.

6.3 Detention Storage Depth

Maximum depth of basin storage shall be 300mm maximum (except for the Village Green Detention Basin).

6.4 Area A

6.4.1 Description and Constraints

This catchment area is 19.56ha and comprises all areas draining directly to the Village Green Detention Basin. It includes areas encompassed by and including the following buildings and precincts: Botany St Parking Station H26, Mathews F23, Clancy Auditorium C24, Lowy Cancer Research Centre, Chancellery C22, Library Lawn, Morven Brown C20, Basser College (Part) C17, Basser Steps, Phillip Baxter College (Part) D18, Quadrangle Lawn, Alumni Lawn, SEB (under construction), Hilmer Building E10, Law Building F8, Applied Science F10, Sam Cracknell H8, Webster G14, Village Green, Old Main Building K15, K17, Willis Annex J18, and Civil Engineering H20. Area 'A' is bounded in part by Willis Street, Oval Lane and High Street.

The original agreement details are:

'No overland flows from this portion of the Campus will be discharged into the RCC area for rainfall events up to and including the 100yr ARI storm event'.

6.4.2 Overland Flow Paths

Significant 100yr ARI overland flow paths (OFP) have been established throughout this area in 1996 and 2005.

Library Road OFP

The major OFP follows the roadway system: Chancellery Walk, Library Rd, under Library Stage 2 (previous roadway now through a 600mm pipe), south along Library Rd to the Mall, west along Library Rd, south along Engineering Rd, west along Physics Rd, swale in Physics Lawn, across depression in Science Rd to the Village Green detention basin. At various locations along these routes, artificial high and low points and barriers have been constructed to contain the overland flow within the OFP.

Such locations are: Low point east side of Library Stage 2, barrier wall and raised paving at west end of Goodsell building, swale in concrete paving in Mall below Scientia building, raised pavement at east end of Burrows Lane, pavement high point in Engineering Rd below Physics Rd and depression in Science Rd. Pavement levels at these locations are permanently fixed and should dictate any future development levels. The University Mall acts as a secondary overland flow path.

Burrows Lane OFP

A secondary OFP is down Burrows Lane and under the Red Centre undercroft adjacent to Newton building. Roadway levels in the vicinity of Physics Courtyard must be maintained lower than the courtyard and the Red Centre breezeway to contain stormwater within Burrows Lane. A wall has been constructed to divert overland flow away from the doorway leading to the Red Centre basement due to previous flooding. The low point east of Newton must be retained to prevent storm flows flooding Old Main and Newton buildings.

College Road OFP

The major OFP in the north east corner of the Campus follows: Basser Steps, Quadrangle Lawn detention basin, College Rd, Alumni Lawn, Hilmer Building, under Law building and University Mall in 1050mm pipe to Village Green detention basin. To capture this water and divert it into the pipeline, diversion structures and kerb inlet pits with 100% blockage factor are positioned in College and Union Roads. In particular, overland flow is diverted away from the Applied Science and Law loading dock entry to prevent them flooding. Union Rd boundary is raised at the western end to prevent any escape of water to the Roundhouse and University Mall.

6.4.3 Village Green Detention Basin

This receives all storm flows up to 100yr ARI from Area 'A' by formal underground drainage and overland flow. Survey has confirmed that the Village Green would begin surcharging at a level of 26.93 m AHD over the weir located at the south-eastern section of the Village Green, near the intersection of Science Rd and Southern Drive. A maximum water level of 27.20 m AHD is estimated before secondary overflow would occur at the western section of the Village Green near the Basketball Court / Cricket Nets. The water surface area is approximately 19,300m² and the calculated storage volume is 13,000 m³.

After the Village Green surcharges over the weir at 26.93 m AHD, both the Village Green flows, and overflows entering from Barker St, will dam up behind a road speed hump (listed as a diversion structure) to a level of 26.83 m AHD before overflowing down Southern Drive. The level at which water can divert to/from the Campus through Barker St is 26.50 m AHD.

6.4.4 Quality Management

A basic gross pollutant trap and separate CDS Technology unit is incorporated into the discharge orifice plate pit. It traps sediment and other significant rubbish prior to discharge. The CDS unit is sized for the 3 month ARI with bypass for all storm flows. The CDS unit removes rubbish prior to water entering the percolation chamber in order to reduce its maintenance period. They also remove solids and residual oils from the first flush of storm flow.

6.4.5 Discharge Flow Rate Control

The outlet of the Village Green OSD system is controlled via an internal weir followed by three orifices cut into a plate on the outlet pipe. Three orifices have been modelled at 2x 300 mm dia. and 1x 450 mm dia. The modelled configuration of the system appears to achieve a significant delay before stormwater begins to pass over the weir. A discharge of 1.12 m³/s is observed to enter the pipe during the peak of a 2 hr, 100 year ARI storm.

The results of the modelling have revealed that an additional 2.24 m³/s of peak surcharge entering the Campus from Barker Street that was not previously considered, some of which is ponding high enough over the 'hump' to enter the Village Green.

6.4.6 Percolation Chamber

To capture an optimum volume of stormwater for harvesting, a 1.3ML underground storage is located under the Village Green playing field. This is an open frame polyethylene box wrapped with geotextile (Atlantis Tank Module System) and laid directly onto the excavated sand bed. With a design average percolation rate of 900mm/hour, it is likely that 90% of annual rainfall within the catchment will be able to be directed to the aquifer. Only intense storms of long duration will cause discharge to Council drainage. Expected average annual aquifer recharge rate is 180ML. Water levels within the chamber are constantly monitored by the campus wide BMS. From this information, actual volumetric recharge will be calculated and graphed. As the rate of recharge decreases, it will be possible to determine a maintenance period for the sand bed below the chamber. Expected scheduled maintenance is 25 years and will be carried out by removing the Tank Module, regenerating the sand layer and reinstalling the Module.

6.4.7 Future Development

Area A does not drain directly to any RCC catchment area. Stormwater run-off from any new development within this catchment up to the 100yr ARI storm must be connected to the Village Green Detention Basin. The existing Sub-detention basins and diversion structures must be retained. Further percolation trenches shall not be installed within this Area A as a substitute for required measures in other Areas.

6.5 Area B1

6.5.1 Council Receiving Catchment

Overland flow drains to Area C3 via Area D2, and onward to RCC Anzac Pde (North) catchment.

(Note that much of the original Area B (now B1) transferred to Area A with construction of the Law building and associated diversion of overland flows to Village Green. This resulted in the 1.9ha reduction in storm flows to the Anzac Pde North catchment. This more than offsets any increase in flow caused by 100yr ARI overland flow without detention outside Area A.)

6.5.2 Description and Constraints

Area B1 is 0.85ha and comprises areas draining directly to the Village Green by pipe flows only for storms up to 5yr ARI, and to Anzac Pde. for larger storms. It includes areas encompassed by and including the following buildings and precincts: Goldstein Hall D16, Goldstein College C & B 16 and C15.

The original agreement details are:

'No overland flows from this portion of the campus will be discharged into the RCC area for rainfall events up to and including the 5yr ARI storm event. Pipe flows are directed to the detention basin.'

6.5.3 Future Development

Future development must ensure that the above flow conditions are not altered. Piped flows must not be upgraded to carry more than the 5yr ARI to avoid overloading the Village Green detention basin. Flows between 5yr and 20yr ARI overflow via piped drainage to High Street kerb. All flows drain to Anzac Pde North catchment. Where practical, storm flows could be reduced by including percolation chambers / trenches or detention tanks.

6.6 Area B2

6.6.1 Council Receiving Catchment

Flows between 5yr and 20yr ARI overflow via piped drainage to High Street kerb. All flows drain to Anzac Pde North catchment.

6.6.2 Description and Constraints

Area B2 comprises areas draining directly to the Village Green by pipe flows only for storms up to 5yr ARI, and to High Street for larger storms. It comprises the Morven Brown car park and has an area of 0.50ha.

The original agreement details are:

'No overland flows from this portion of the campus will be discharged into the RCC area for rainfall events up to and including the 5yr ARI storm event. Pipe flows are directed to the detention basin.'

6.6.3 Future Development

Future development must ensure that the above flow conditions are not altered. Piped flows must not be upgraded to carry more than the 5yr ARI to avoid overloading the Village Green detention basin. For flows between 5yr and 20yr ARI, these shall be diverted to Council kerb and gutter via buried pipelines.

6.7 Area B3

6.7.1 Council Receiving Catchment

Flows between 5yr and 20yr ARI overflow via piped drainage to Barker Street kerb. All flows drain to Anzac Pde South catchment.

6.7.2 Description and Constraints

Area B3 comprises areas draining directly to the Village Green by pipe flows only for storms up to 5yr ARI, and to Barker Street for larger storms. It comprises Barker Street car park N18 and Rupert Myers M15, and has an area of 1.32ha.

The original agreement details are:

'No overland flows from this portion of the campus will be discharged into the RCC area for rainfall events up to and including the 5yr ARI storm event. Pipe flows are directed to the detention basin.'

6.7.3 Future Development

Future development must ensure that the above flow conditions are not altered. Piped flows must not be upgraded to carry more than the 5yr ARI to avoid overloading the Village Green detention basin. For flows between 5yr and 20yr ARI, these shall be diverted to Council drainage in Barker St via buried pipelines.

6.8 Area C1 and C2

6.8.1 Council Receiving Catchment

Flows between 5 and 20yr ARI are piped to Council drainage. 100yr ARI flows discharge to Anzac Pde South catchment.

6.8.2 Description and Constraints

This catchment Area C1 is 2.01 ha and Area C2 is 3.28 ha and comprises areas draining directly to Council piped drainage only, for storms up to 5yr ARI, and overland to Anzac Pde and Barker via piped flow to kerb and gutter for storms up to 20yr ARI. It includes areas encompassed by and including the following buildings and precincts, Squarehouse E4, Roundhouse E8, Blockhouse G8, University Mall, New College L6, Warrane College M7, Kindergarten N8, Shalom College N9, Barker Apartments N14, Village Green embankments and Physics Lawn.

'Area C1' drains via pipe to Barker St, while 'Area C2' drains via pipe to Anzac Pde. 20 year ARI and 100 year ARI discharge from 'Area C1' will reach the Barker St sag point and eventually overflow back into the Campus through the gap in Shalom College and Barker Street Apartments as discussed previously. Both 'Area C1' and 'Area C2' will eventually contribute to the Anzac Pde South catchment.

Where necessary, to prevent piped drainage from surcharging off site for storms up to 5yr ARI, it will be necessary to construct percolation trenches for roof areas.

The original agreement details are:

'No overland flows from this portion of the campus will be discharged into RCC area for rainfall events up to and including the 5yr ARI storm event. Pipe flows will discharge directly to RCC drainage.'

6.8.3 Overland Flow Paths and Detention

In the event that the Village Green surcharges over the weir at 26.93 m AHD, both the Village Green flows, and overflows entering from Barker St will dam up behind a road speed hump (listed as a diversion structure) to a level of 26.83 m AHD before overflowing down Southern Drive. The level at which water can divert to/from the Campus through Barker St is 26.50 m AHD.

6.8.4 Quality Management

It is proposed that sometime into the future as discharge quality requirements become more onerous, a GPT will be installed on the piped discharge from this area into the 1050mm pipe located on the boundary of Anzac Pde.

6.8.5 Future Development

Future development must ensure that the above flow conditions are not altered. Roof drainage shall be directed to percolation trenches. Flows between 5 and 20yr ARI shall be diverted via piped drainage to Council kerb.

6.9 Area C3

6.9.1 Council Receiving Catchment

Flows between 5 and 20yr ARI are piped to Council drainage. 100yr ARI flows discharge to Anzac Pde North catchment.

6.9.2 Description and Constraints

This catchment area is 1.90ha and comprises areas draining directly to Council piped drainage only, for storms up to 5yr ARI, and to Anzac Pde North and High Street via piped flow to kerb and gutter for storms up to 20yr ARI. It includes areas encompassed by and including the following buildings and precincts: D7, B8, C8, D8, International House, Squash Courts & Swimming Pool B4 and Pool Lawn.

Where necessary, to prevent piped drainage from surcharging off site for storms up to 5yr ARI, it will be necessary to construct percolation trenches for roof areas.

The original agreement details are:

'No overland flows from this portion of the campus will be discharged into RCC area for rainfall events up to and including the 5yr ARI storm event. Pipe flows will discharge directly to RCC drainage', however RCC will not permit sheet overland flow across footpaths.

6.9.3 *Overland Flow Paths and Detention*

Significant 100yr ARI overland flow paths (OFF) have been established in this area in 1996.

6.9.4 *International Road Detention*

The trapped sag point located in International Road, otherwise later referred to as 'Area F5', consists of low lying pavement with a high kerb on the west side (nominally 300mm) preventing overland flow toward Anzac Parade. Since portions of the existing Roundhouse building back onto International Road and have floor levels lower than the height of the high kerb diversion structure, these areas of the Roundhouse have experienced frequent nuisance flooding.

As part of the proposed SEB re-development project, adjustments have been carried out to the sag pit arrangement in International Road, retaining the functionality of the sag pits and incorporating OSD and percolation as part of the future building construction. The outcome results in a reduction of nuisance flooding at the Roundhouse and improves pedestrian safety with the proposed College Mall walk.

6.9.5 *First Avenue West OFF & Detention*

To assist in preventing overland flow to Anzac Pde from storms less than 5yr ARI; a detention basin has been incorporated into First Avenue West at its low point between the Square House and the Unigym. The existing levels along International Rd must be retained to contain surcharging from low point pits outside the Swimming Pool. The overland flow path from this detention is west to Anzac Pde between the Square house plant room and the retaining wall. Without this flow path being maintained at its existing spillway level of RL 27.67 approx., flooding of the whole of the precinct would occur.

6.9.6 *Future Development*

Future development must ensure that the above flow conditions are not altered. Roof drainage shall be directed to percolation trenches for up to 5yr ARI flows. Flows between 5 and 20yr ARI shall be diverted via piped drainage to Council kerb.

6.10 Area D1

6.10.1 *Council Receiving Catchment*

Flows to 20yr ARI are piped to Council drainage. 100yr ARI flows discharge to Anzac Pde South catchment.

6.10.2 *Description and Constraints*

This catchment area is 4.39ha and comprises areas draining directly to Council piped drainage, with roof water being directed to percolation trenches to Council standard requirements. It includes areas encompassed by and including the following buildings and precincts: Tyree H6, UNSW Global L5, Western Campus including NIDA and perimeter landscaping. For any new development in this area roof water shall be directed to a percolation trench designed for 20yr ARI, with overflow to existing drainage.

The original agreement details are:

This portion of the campus will discharge to High St, Anzac Pde, Day Ave, Houston Ln or Barker St without maximum discharge restrictions. For future developments undertaken in this area, the UNSW will direct roofwater firstly to the ground via infiltration, with overflows to the existing pipe system.'

6.10.3 *Overland Flow Path*

Development conditions for the L5 building required diversion drainage to be constructed. A 900mm pipe diverts water into the UNSW 1050mm pipeline in front of New College, over which Randwick Council has an Easement for Drainage. UNSW maintains this common drainage pipeline within the easement.

6.10.4 *On-site Detention*

Development conditions for the NIDA building at the Western Campus required that a detention tank be constructed prior to discharge to Council drainage. This is located at the southwestern corner of the NIDA site.

6.10.5 *Future Development*

Future development must ensure that the above flow conditions are not altered. Roof drainage shall be directed to percolation trenches designed for 20yr ARI. Other flows up to 20yr ARI shall be diverted via piped drainage to Council kerb.

6.11 Area D2

6.11.1 *Council Receiving Catchment*

Flows to 20yr ARI are piped to Council drainage. 100yr ARI flows discharge to Anzac Pde North catchment.

6.11.2 *Description and Constraints*

This catchment area is 2.00ha and comprises areas draining directly to Council piped drainage, with roof water being directed to percolation trenches to Council standard requirements. It includes areas encompassed by and including the following buildings and precincts: UNSW Village and perimeter landscaping north of Grid E and west of Grid 17. For any new development in this area roof water shall be directed to a percolation trench designed for 20yr ARI, with overflow to existing drainage.

The original agreement details are:

'This portion of the campus will discharge to High St, Anzac Pde, Day Ave, Houston Ln or Barker St without maximum discharge restrictions. For future developments undertaken in this area, the UNSW will direct roofwater firstly to the ground via infiltration, with overflows to the existing pipe system.'

6.11.3 *Overland Flow Path*

Goldstein College OFP

A high-level pit discharge pipe from the infiltration system in Goldstein College C16 courtyard discharges to Fig Tree Lane roadway. It was installed in 2003 to prevent flooding of C16 and B16 buildings.

6.11.4 *Future Development*

Future development must ensure that the above flow conditions are not altered. Roof drainage shall be directed to percolation trenches designed for 20yr ARI. Other flows up to 20yr ARI shall be diverted via piped drainage to Council kerb.

6.12 Area D3

6.12.1 *Council Receiving Catchment*

Flows to 20yr ARI are piped to Council kerb and gutter in High Street. 100yr ARI flows discharge to Anzac Pde North catchment.

6.12.2 *Description and Constraints*

This catchment area is 0.92ha and comprises areas draining directly to Council kerb and gutter. It includes areas encompassed by and including the following buildings and precincts: The Kensington Colleges (TKC) and landscaping north of Chancellery Lawn.

6.12.3 Future Development

Flows up to 20yr ARI shall be diverted via piped drainage to Council kerb in High Street. 100yr ARI flow discharges to Anzac Pde North catchment.

6.13 Area E

6.13.1 Council Receiving Catchment

Area E1' All flows discharge to Botany St catchment (2.18ha).

'Area E2' Flows to 5 year ARI are piped to the Village Green. All other flows discharge to Botany St catchment (0.17ha).

6.13.2 Description and Constraints

This catchment area is 2.35ha and comprises areas draining east to Council piped drainage. It includes areas encompassed by and including the following buildings and precincts: Wallace Wurth C27, Biological Sciences D26, Samuels F25 and AGSM G27.

A OSD tank is located in the breezeway between Wallace Wurth & Bio Science. An additional OSD tank has been incorporated within the road, Gate 11 Entry for the Bio Science precinct upgrade works. Both OSD structures have been designed for the 20Yr ARI in accordance with Council's requirements.

6.13.3 Quality Management

A GPT has been installed on the piped discharge from this area prior to discharge to Council stormwater in Oval Lane.

6.13.4 Future Development

Randwick Council requires this area to be treated separately to other parts of the campus by having Council's full detention requirements applied to any new or replacement buildings and hard surfaces. All site discharge up to the 20yr ARI shall be via pipelines to Council drainage. Roof water must not be drained to Area A to avoid overloading the Village Green detention basin.

6.14 Area F1

This Area comprises the Village Green detention basin as previously described in Area A.

6.14.1 Future Development

This detention basin is at capacity and cannot receive stormwater flows other than those described in Areas A and B above. It is unlikely that there is sufficient space to increase its capacity by raising the spillway levels and embankments. Planting of large trees such as figs and eucalypts is not permitted on the inside, top or outside of the embankments, as they are likely to cause the embankment to fail during a design storm. The percolation chamber must be maintained to allow the design percolation rate, otherwise the detention basin capacity will be compromised.

6.15 Area F2

Percolation Chamber receiving all stormwater from the Village Green detention basin catchment Area A. This is sized to provide 1,000m² percolation area to recharge the Botany Sands Aquifer from which the campus bores extract water as a source of non-potable water. This system was installed to offset any requirement for provision of rainwater tanks under Council's Rainwater Tank Policy and to provide additional detention volume to offset previous expansion of the 100yr ARI catchment.

6.15.1 Future Development

This chamber shall be retained and maintained indefinitely.

6.16 Area F3

Percolation / detention tank receiving roof water from NIDA building.

6.16.1 Future Development

This tank shall be retained either in its existing state or replaced elsewhere to comply with current Council requirements. No water shall be discharged to Anzac Parade drainage system, including kerb discharge.

6.17 Area F4

Area F4 is a stormwater surcharge depression comprising First Avenue West, part of Swimming Pool Lawn and landscaping west of International House, covering a total area of 0.38ha.

Grated road pits surcharge during larger storms to flood the area until the hydraulic gradient in the receiving stormwater drainage lowers, allowing the area to drain away.

6.17.1 Future Development

The area covered by the surcharge must be retained in its present form. Road and green area levels must not be raised unless other design strategies are employed to contain the surcharge volume.

6.18 Area F5

Area F5 is a stormwater surcharge depression comprising part of International Road outside International House, covering a total area of 0.05ha. The overland flow path is directed via pipe drainage to Anzac Parade South to improve pedestrian safety with the proposed College Mall walk. As part of the proposed SEB re-development project, adjustments have been carried out to the sag pit arrangement in International Road, retaining the functionality of the sag pits.

6.18.1 Future Development

The area covered by Area F5 must be retained in its new present form and road levels must not be raised. The future construction of SEB building and/or precinct redevelopment must incorporate OSD and percolation in accordance with the design criteria established in the 2005 Study 'Section 5.2 Percolation Chambers and Trenches Design', guided by the Randwick City Council's Private Stormwater Policy.

6.19 Area F6

This is an in-formal detention basin covering the Quadrangle Lawn and part of College Road. It drains to a pit in College Rd located at the north west corner of the lawn. This area is controlled by the outlet pipe.

6.19.1 Description and Constraints

This detention basin was constructed prior to construction of the Village Green detention basin and has since been incorporated into the design of the Village Green basin.

The original agreement details are:

'This portion of the campus has already had the existing RCC on-site detention restriction applied to it. Therefore, the existing discharge standards would be maintained. If redevelopment of any of this portion occurs, it will be necessary to maintain or rebuild a detention facility to ensure the existing maximum discharge is maintained, or alter the Village Green detention basin to accommodate these changes'.

6.19.2 Future Development

Any future re-development in this area must incorporate a detention basin in accordance with RCC requirements.

6.20 Area F7

Percolation trenches receiving roof water from Colombo House. This is sized at 1m³ per 20m² roof area to Council's standard requirement.

6.20.1 Future Development

These trenches shall be retained either in their existing state or replaced elsewhere within the same catchment area to comply with the above design requirement.

6.21 Area F8

This is a formal detention located in the basement floor of the multi-storey Botany Street Car Park. It drains to a screened pit located at its northern face and containing a flow restricting orifice plate.

6.21.1 Description and Constraints

Prior to construction of the Village Green detention basin this detention basin was constructed and hence incorporated into the design of the Village Green basin.

The original agreement details are:

'This portion of the campus has already had the existing RCC on-site detention restriction applied to it. Therefore, the existing discharge standards would be maintained. If redevelopment of any of this portion occurs, it will be necessary to maintain or rebuild a detention facility to ensure the existing maximum discharge is maintained, or alter the Village Green detention basin to accommodate these changes'.

6.21.2 Future Development

This detention basin must be retained or replaced elsewhere, as the Village Green detention is insufficient to take its place. No development is permitted in this area unless it incorporates a replacement detention tank of equal volume.

6.22 Area F9

This is a formal detention located in the basement floor of the multi-storey Barker Street Car Park. It drains to a screened pit located near its western face and containing a flow restricting orifice plate.

6.22.1 Description and Constraints

Prior to construction of the Village Green detention basin this detention basin was constructed and hence incorporated into the design of the Village Green basin.

The original agreement details are:

'This portion of the campus has already had the existing RCC on-site detention restriction applied to it. Therefore, the existing discharge standards would be maintained. If redevelopment of any of this portion occurs, it will be necessary to maintain or rebuild a detention facility to ensure the existing maximum discharge is maintained, or alter the Village Green detention basin to accommodate these changes'.

6.22.2 Future Development

This detention basin must be retained or replaced elsewhere, as the Village Green detention is insufficient to take its place. No development is permitted in this area unless it incorporates a replacement detention tank of equal volume.

6.23 Area F10 – The Kensington Colleges (TKC) OSD 1

6.23.1 Description and Constraints

20 year ARI detention basin for The Kensington Colleges development, discharging into piped drainage out to High Street, to be maintained and permanently retained in some form of equal capacity.

6.23.2 *Future Development*

This detention basin must be retained or replaced elsewhere, within the same catchment area to comply with the design requirement.

6.24 Area F11 – The Kensington Colleges OSD 2

6.24.1 *Description and Constraints*

5 yr ARI detention basin for The Kensington Colleges development, discharging into 5 yr ARI pipe to Village Green, to be maintained and permanently retained in some form of equal capacity.

6.24.2 *Future Development*

This detention basin must be retained or replaced elsewhere, within the same catchment area to comply with the design requirement.

6.25 Area F12 – Wallace Wurth OSD

6.25.1 *Description and Constraints*

20 yr ARI detention basin for the Wallace Wurth development, discharging into pipe system out to Botany Street, to be maintained and permanently retained in some form of equal capacity.

6.25.2 *Future Development*

This detention basin must be retained or replaced elsewhere, within the same catchment area to comply with the design requirement.

6.26 Area F13 – Bio Sciences Redevelopment OSD in Library Rd

6.26.1 *Description and Constraints*

20 yr ARI detention basin for the Bio Sciences Redevelopment, discharging into pipe system out to Botany Street, to be maintained and permanently retained in some form of equal capacity.

6.26.2 *Future Development*

This detention basin must be retained or replaced elsewhere, within the same catchment area to comply with the design requirement.

7 Lower Campus Re-Development and Temporary Roundhouse

UNSW Australia (UNSW) is currently redeveloping part of the lower Kensington Campus. This includes refurbishment of the Roundhouse and Squarehouse, and extension of College Walk. During refurbishment works to the Roundhouse, UNSW has constructed a temporary facility to support student activities over the Village Green, known as the Village Green Temporary Pavilions (VGTP). The VGTP includes the erection of a temporary elevated deck structure with associated entry ramps, facilities and tent structures.

As the Village Green receives a significant portion of the Kensington Campus stormwater flows, Kustom modelled the potential flood level impacts within the Village Green due to the VGTP. Modelling confirmed that due to the elevated nature of the proposed temporary structure, there would be negligible flood impacts expected within the Village Green. As such, the temporary construction, and subsequent removal of the VGTP following completion of Roundhouse re-development works, should not be considered within the 2025 Stormwater Masterplan.

8 UNSW Kensington Campus DRAINS Model

8.1 DRAINS Model Configuration

A model of the piped drainage system and corresponding overland flow was developed using the DRAINS software (currently Version 2016.14 – 4 December 2016). The DRAINS configuration follows ARR1987 methods and includes utilising ILSAX hydrology, a soil type parameter of 3, an Antecedent Moisture Condition (AMC) of 3.5, paved and supplementary area depression storages of 1 mm and 1 mm respectively, and 5 mm for grassed areas. Areas of high infiltration / recharge have been modelled separately.

Design rainfall patterns were developed for the Campus's location from Bureau of Meteorology procedures utilising 1987 IFD's for the 5 year, 10 year, 20 year, 50 year and 100 year ARI events. Storm durations of 5 minutes to 4.5 hours were modelled, with the 45 minute, 1.5 hour and 2 hour storm durations being determined as the critical storm events.

The DRAINS model includes an up to date status of the Site's stormwater drainage network (Jan 2017), and also includes any approved stormwater drainage works associated with planned future works in the lower campus as discussed in Section 7.

A custom DRAINS Database was developed for the Campus configured by the types of pits and overflow routes inspected. The model geometry consists of over 2050 nodes representing pits, junctions or down pipes, over 1100 sub-catchments, almost 2000 pipes and over 800 overflow routes.

Any stormwater modelling undertaken on campus for current or future projects is to incorporate the data of this model. An extract of the model can be requested from UNSW Facilities Management.

8.2 Minimum DRAINS Modelling Requirements and Specifications for New Design and Construct Projects

During modelling, utilise the latest version of DRAINS Premium Hydraulics with all available modules as required, to analyse the existing drainage network. Unless advise otherwise, it is proposed that hydrological modelling will be carried out using ILSAX hydrology.

All open channel hydraulic modelling is to be carried out using DRAINS Premium Hydraulics, complementing the detailed catchment and drainage network input information.

All pits, pipes, overland flow paths, and open channel hydraulics will be assessed individually to ensure that each is modelled in DRAINS to accurately reflect the provided survey data. This will include splitting of flows into multiple complex overland flow routes where necessary utilising the unsteady state capabilities of the DRAINS Premium Hydraulics. Pit pressure loss coefficients will also be determined individually based on their hydraulic and geometric attributes in accordance with the Missouri Charts.

Minimum Modelling Requirements:

- DRAINS Version: The minimum version to be utilised when modelling is the current version at the date of commencing modelling. If during the modelling process a critical DRAINS updated is released, then the newest version must be utilised.
- All final models must be completed utilising the 'Premium Hydraulic Model' License
- Accepted Hydrological models: ILSAX
- Paved & supplementary area depression storages: 1 mm
- Grassed area depression storages: 5 mm
- Soil Type: 3
- Antecedent Moisture Condition (AMC): 3.5
- Minimum 50% pit blockages for sag pits

- Minimum 0% pit blockages for on-grade pits
- Ideal minimum pit freeboard: 150 mm
- Ideal minimum fall across pits: 30 mm

8.3 Changes to Australian Rainfall and Runoff

It should be noted that in late November 2016 Australian Rainfall and Runoff has been officially released. Although the full publication is not complete, prescribed stormwater modelling methods have been revised. Some of the key changes include revisions to loss models, expanded number of rainfall hyetographs per duration (from only 1 pattern in 1987, now to 10 in 2016), updated Intensity Frequency Durations (IFDs) based on a more extensive data base with more than 30 years of additional rainfall data and extra rainfall stations being included since the 1987 IFDs.

At present software providers, such as Watercom – developer of DRAINS, are waiting on the release of pre-burst rainfall loss information for shorter duration storms below 1 hour – which at present, no methods or guidance has been provided. As the shorter duration storms below 1 hour are often critical in urban stormwater drainage modelling, UNSW require that all works adopt the ARR 2016 procedures.

9 UNSW Kensington Campus Summary of Catchments, Systems and Structures

Table 1 – UNSW Kensington Campus Sub-Catchments

Location	Sub Catchment Area (ha)	Discharge Summary
Area A	19.56 ha	All stormwater run-off to Village Green Detention Basin Areas F1, F2, F6, F8 & F9 and diversion structures are to be retained
Area B1	8.48 ha	5 yr ARI to Village Green Detention Basin via piped drainage 5 yr to 20 yr ARI to Council kerb via piped drainage 100 yr ARI to Anzac Pde North Council catchment Retain diversion structures
Area B2	5.12 ha	5 yr ARI to Village Green Detention Basin via piped drainage 20 yr ARI to High St kerb via piped drainage 100 yr ARI to Anzac Pde North Council catchment
Area B3	1.33 ha	5 yr ARI to Village Green Detention Basin via piped drainage 20 yr ARI to Barker St kerb via piped drainage 100 yr ARI to Anzac Pde South Council catchment
Area C1	2.01 ha	5 yr ARI roof drainage to percolation trench 20 yr ARI to Barker St kerb via piped drainage 100 yr ARI to Anzac Pde South Council catchment via Southern Drive Retain detention basin F9
Area C2	3.28 ha	5 yr ARI roof drainage to percolation trench 20 yr ARI to Anzac Pde South kerb via piped drainage 100 yr ARI to Anzac Pde South Council catchment Retain diversion structures
Area C3	1.73 ha	5 yr ARI roof drainage to percolation trench 20 yr ARI to Anzac Pde South kerb via piped drainage 100 yr ARI to Anzac Pde North Council catchment Retain detention basins F4 & F5 and diversion structures
Area D1	3.29 ha	20 yr ARI roof drainage to percolation trench with overflows to existing piped drainage 100 yr ARI to Anzac Pde South Council catchment Retain detention basin F3 and diversion structures
Area D2	2.19 ha	20 yr ARI roof drainage to percolation trench with overflows to Council kerb or existing piped drainage 100 yr ARI to Anzac Pde North Council catchment Retain detention basin F7 and diversion structures
Area D3	0.93 ha	20 yr ARI to Council kerb via piped drainage Discharges to Anzac Pde North Council catchment
Area E1	2.18 ha	Drains to Botany St Catchment All developments require full detention to Council standard requirements
Area E2	1.73 ha	5 yr ARI to Village Green Detention Basin via piped drainage 5 yr to 20 yr ARI to Council kerb via piped drainage 100 yr ARI to Anzac Pde North Council catchment All developments require full detention to Council standard requirements

Table 2 – UNSW Kensington Campus Detention Basin & Percolation Systems

Location	Detention Basin & Percolation Systems
Area F1	Village Green detention basin. All bank profiles and levels are protected. Banks can be raised, but not lowered. To be maintained and permanently retained.
Area F2	Percolation chamber serving Village Green detention catchment, to be maintained and permanently retained.
Area F3	Percolation / detention tank serving NIDA roof water discharge, to be maintained and permanently retained in some form.
Area F4	5 yr ARI surcharge basin for stormwater surcharge pits in First Avenue West. Encroaches onto Swimming Pool Lawn. Must be maintained, and retained in some form.
Area F5	5 yr ARI surcharge basin for stormwater surcharge pits in International Road. Must be retained in some form.
Area F6	Quadrangle Lawn detention basin with discharge orifice plate pit in College Road. College Road is raised below pit to retain overland flow. Must be maintained and retained in some form of equal capacity, as Village Green detention volume cannot be safely increased.
Area F7	Percolation trench serving Goldstein roof water discharge, to be maintained and permanently retained in some form of equal capacity.
Area F8	Upper Campus Car Park detention basin with discharge orifice pit in ground floor. Must be maintained and permanently retained, as Village Green detention volume cannot be safely increased.
Area F9	Barker Street Car Park detention basin with discharge orifice pit in ground floor. Must be maintained and permanently retained, as Village Green detention volume cannot be safely increased.
Area F10	20 yr ARI detention basin for the The Kensington Colleges development, discharging into piped drainage out to High Street, to be maintained and permanently retained in some form of equal capacity.
Area F11	5 yr ARI detention basin for the The Kensington Colleges development, discharging into 5 yr ARI pipe to Village Green, to be maintained and permanently retained in some form of equal capacity.
Area F12	20 yr ARI detention basin for the Wallace Worth development, discharging into pipe system out to Botany Street, to be maintained and permanently retained in some form of equal capacity.
Area F13	20 yr ARI detention basin for the Bio Sciences Redevelopment, discharging into pipe system out to Botany Street, to be maintained and permanently retained in some form of equal capacity.

Table 3 – UNSW Kensington Campus Diversion Structures

Diversion Structure Number	Diversion Structure Description
1	Kerb Inlet pits and oversized pipe with surcharge outlet in Library Rd at Goodsell, originally sized for 100 yr ARI. Constructed when overland flow path cut off by Infill of Library breezeway. Current modelling indicated potential overland flow to commence from storms of 20 yr ARI and greater.
2	Pavement levels west of Goodsell raised and Red Wall constructed to divert 100 yr ARI & prevent flooding of Electrical Engineering.
3	Pavement depressed to stop overland flow discharge down Mall.
4	Unorthodox steps at building entry to prevent flooding of Electrical Engineering.
5	Depression in centre of road to retain overland flow.
6	Brick wall and raised pavement levels in Burroughs Lane to divert flow down Engineering Rd.
7	Levels in Engineering Rd raised to divert flow down Physics Rd.
8	Overland flow open drain with depression in Science Rd to take surcharge from in-ground pipeline which has been designed to surcharge in the 100 yr ARI storm.
9	Village Green overflow weir crest to divert overflow to 'raised hump' in Southern Drive, before diverting overflow down to lower Southern Drive. Level must be retained at 26.93 m AHD.
10	Village Green embankment must be at least 27.32 m AHD.
11	Brick wall around recreation area. Top of wall must be at least 27.27 m AHD.
12	Pavement level at crest in road access to Village Green must be at least 27.27 m AHD to prevent Village Green detention overflow to Anzac Pde.
13	Oversized kerb entry and pipe crossing to provide for overland flow path in to UNSW / Council 1100 mm stormwater pipe.
14	Culvert under building between Newton & Red Centre to take 100 yr ARI overland flow surcharge from Burroughs Lane. Must be kept open and clear of debris and services.
15	Depression in Mall pavement above steps to divert overland flow into Village Green and to prevent flow discharging to Anzac Pde.
16	College Rd levels locally raised to bund Quadrangle detention basin.
17	Fig Tree Lane levels locally graded to divert overland flow from Goldstein Courtyard area to Quadrangle Detention Basin F5. This reduces flow to High St.
18	Pipe through wall to allow surcharge to High St from percolation trenches.
19	High capacity inlet pits in College Rd & Union Rd to capture overland flow into the oversized pipe under Law Building. Hence kerbs must be continuous and kerb inlet pits retained.
20	Hilmer Building (E10) (previously Material Science carpark) and Union Rd banded to prevent flooding of Union Rd and Applied Science loading dock. Kerbs must be continuous and raised vehicle crossings and kerb inlets must be retained.
21	Union Rd west banded to prevent escape of overland flow to Mall and Round house precinct. Kerbs and raised road edge levels must be continuous and inlet pits retained.
22	A College Mall walk is proposed as part of Lower Campus redevelopment. Previous overland flows that may exceed the detention capacity of F5 and discharge overland through the Round House are now piped between the Law Building (F8) and Blockhouse (G6) into an existing 825 mm dia. pipe to Anzac Pde. Additional OSD and percolation is required for future developments in this catchment.

Diversion Structure Number	Diversion Structure Description
23	Brick retaining wall and 2.4 m wide floodway constructed to divert overland flow past Square House plant room to Anzac Pde.
24	Ground levels raised to form diversion bank to prevent floodwaters discharging to Anzac Pde South Council catchments.
25	Laneway between Barker Apartments and Shalom College is an overland flow path taking discharge from Barker Street into the Campus to locally raised hump in Southern Drive. Ground levels must be retained. Brick wall along Shalom College boundary must be retained.

10 Modelling Outcomes & Hazard Assessment

10.1 Overview of DRAINS Model Results

The DRAINS Model indicates that as a whole, the UNSW Campus stormwater system is generally safe during storm events from 1 year ARI through to 100 year ARI if the system is maintained and operating unobstructed. Although typical design requirements associated with common street drainage are not always met (i.e 150 mm pit freeboard and no pit surcharge during 5 to 10 year ARI storms), most overland flow paths can be classified as safe for pedestrians and vehicular stability.

A significant change between the results of the DRAINS Model in this study, and the results of the 2005 Study is that originally operation of the Village Green was expected to fully contain a 100 year ARI storm event without surcharge, while the actual operation, in the current configuration, results in 100 year ARI surcharge.

A two key differences between the models are:

- Barker St is now modelled to overflow **into** the Campus (as has been confirmed through survey and shown in other 2D recent studies); and
- The Village Green overflow crest level is presently 26.93 m AHD, while the 2005 Study has the level at 27.17 m AHD.

As the two key differences are closely related, the current operation of the lower crest level enables a portion of the overland flows from Barker St to now enter the Village green from storms of 20 year ARI and larger, instead of surcharging down Southern Dr.

Due to the additional volume of flow from Barker St entering the Village Green, the Village Green's capacity is reached (26.93 m AHD) during the 100 year ARI, with excess flows being conveyed down Southern Dr. The modelled peak overland flow down Southern Dr is estimated at 0.65 m³/s during a 100 year ARI storm event.

While adjusting the DRAINS Model with the higher crest level to confirm that there would be no surcharge from the Village Green during a 100 year ARI storm event, the modelled peak overland flow rate down Southern Dr, as a direct result of Barker St, is estimated to be 1.08 m³/s.

Although the current crest level is lower than that previously required in the Stormwater Master Plan, the current operation provides an overall improvement to overland flows down Southern Dr. It is recommended to retain the current operation of the Village Green with the lower crest level of 26.93 m AHD unless drainage upgrades can be carried out in the sag point of Barker St to improve inlet capacity. A 50 mm increase to the hump level (from 26.83 to 26.88 m AHD) would improve surcharge down Southern Dr from Barker St overflows.

Expanding the focus to the overall UNSW Campus, there are other locations of overland flow paths flagged in the DRAINS Model as potentially being unsafe. These have been listed in Section 6.2. and include overland flow paths that may be unsafe for pedestrians, vehicles, or where water may enter a building. To understand the potential hazard level of the unsafe conditions, below is a simplified Hazard Level table to classify the potential Consequence of the hazard compared with the Urgency to have the hazard addressed.

Table 4 – Hazard Level Table

Hazard Level		Consequence		
		Low (L)	Medium (M)	High (H)
Urgency	1	Yellow	Orange	Orange
	2	Yellow	Orange	Red
	3	Orange	Red	Red

Low – Low risk to life, possible pedestrian and vehicle instability, or possible flood ingress to the building with minimal damage / cost expected;

Medium – Pedestrian and vehicles unstable, with possible risk to life, or flood ingress to the building with damage and cost expected;

High – All pedestrian and vehicle unstable with high risk to life, or significant flood damage / cost to the building is expected;

Urgency

1 – Not urgent, consider addressing during future remediation or upgrade works;

2 – Should be completed in the near future, possibly as part of planned maintenance;

3 – Urgent, should be addressed as a priority item, either due to high risk or due to anticipated ease / low cost of rectification;

10.2 Areas of Concern During 10 Year ARI and 100 Year ARI Storm Events

Following are areas of concern flagged by the DRAINS Model where possible flooding or hydraulic hazards may occur during storm events of 10 year to 100 year ARI. The relevant node or link reference has been included in brackets for cross referencing purposes with the DRAINS Model.

Note that while the best attempt has been made at modelling the entire UNSW Kensington Campus with the DRAINS Model, and analysing the results, it could be possible that other isolated flooding issues and hazards may exist that are not reflected in the DRAINS Model. Table 5 has been prepared to provide UNSW with an initial list of known and modelled flood issues that should be continuously updated as new data or records of issues become available. UNSW should also review and make final judgement on the level of hazard level and urgency for each issue to be addressed.

Table 5 – UNSW Kensington Campus Stormwater Hazards & Issues

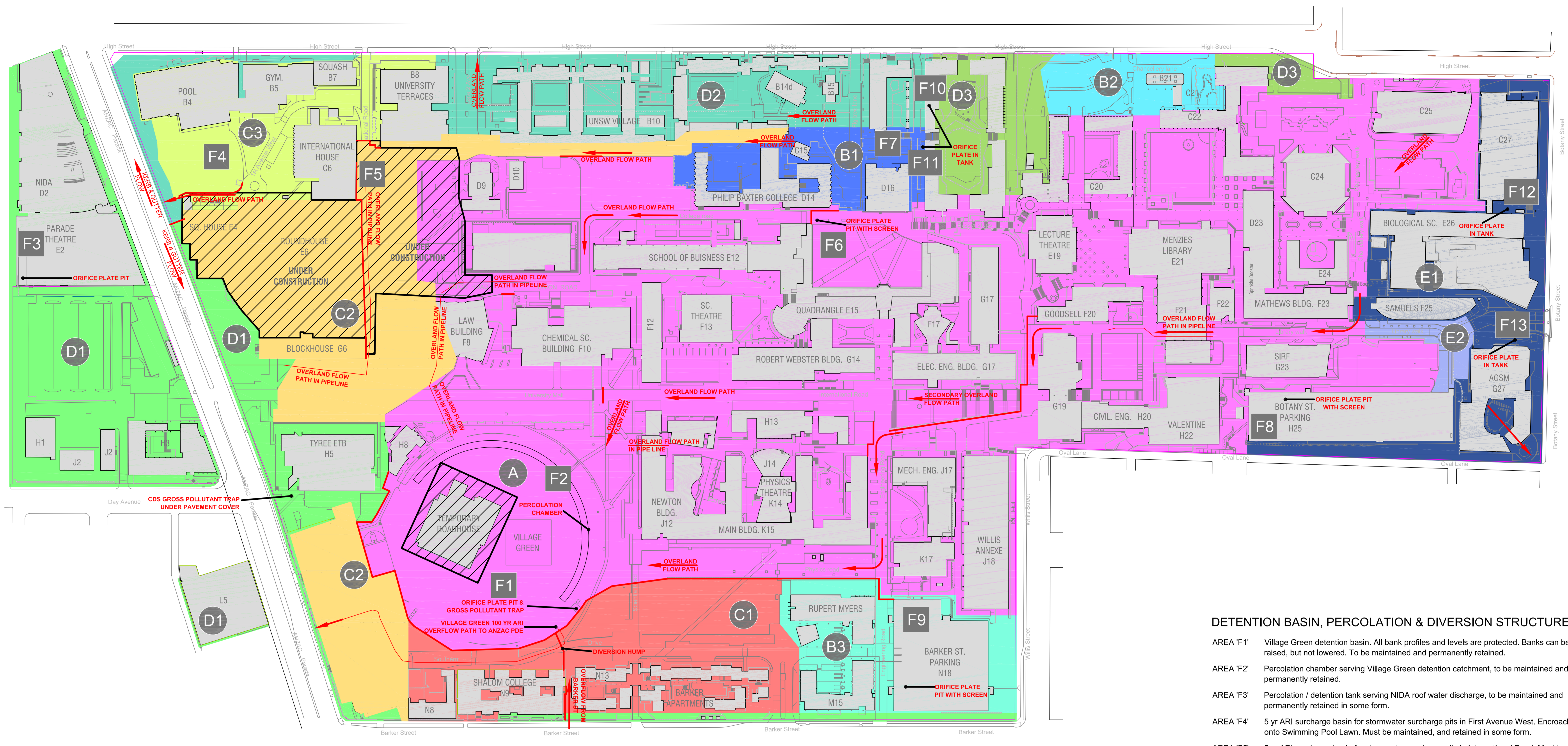
Location	Issue / Hazard & ARI Event	Hazard Level	Comment / Recommendation
Village Green (BasinVGn)	Possible reduction in hydraulic conductivity resulting in reduced effectiveness of Village Green as a detention basin during 50+ year ARI storms	L3	<p>Although the Village Green is utilised as a playing field, its other purpose is capturing and reducing peak stormwater discharge from the Campus by operating as a combined detention basin and percolation recharge system.</p> <p>The Village Green appears to be operating satisfactorily, however, UNSW needs to update the Geotech testing to confirm that fouling of the sand substrate has not occurred overtime, as can happen with infiltration systems in contact with un-treated stormwater. If the infiltration rate is reduced, it is unlikely to result in significant consequences during a 10 year ARI due to the available storage capacity. However, during larger events, the Village Green is likely to result in earlier surcharge, possibly during a 50 year ARI storm instead of the modelled 100 year ARI storm.</p>
	Surcharge during 100 year ARI storm events to Southern Drive leading to unsafe conditions	H1	<p>Under the current operation, the Village Green is expected to exceed full capacity during a 100 year ARI and surcharge out to Southern Drive. There are no direct recommendations to upgrade the capacity or alter the operation of the Village Green. As already noted in the Stormwater Plan documentation, it is important that future developments located in a catchment that discharge into the Village Green (Areas A, B & E2) should incorporate an onsite detention system, and where feasible consider reducing peak discharge flowrates to less than existing conditions to improve the Village Green operation.</p> <p>This reduction may help reduce the level of surcharge during 100 year ARI events, offset possible reductions in infiltration capacity, provide a safety net for potential deficiencies or blockages that may occur over the site, or cater for perceived increase of flows associated with future Climate Change.</p> <p>The required level of reduction should be determined and advised by UNSW Faculty Management case by case. Although it would add cost to an individual project, a cost benefit analysis should be undertaken comparing expected alternate costs to implement similar stormwater improvements elsewhere on the Campus.</p>
	Level of brick wall around recreation area lower than required, which could result overland flow from Village Green in rare events exceeding 100 year ARI storm events	L1	<p>The master plan nominates the brick wall around recreation area to have a minimum top of wall least at 27.32 m AHD. Survey has placed the brick wall around the recreation area approximately 50 mm below this level, with a minimum wall level surveyed at 27.27 m AHD.</p> <p>The operation of the basin during a 100 year ARI storm event is not expected to reach a level of 27.27 m AHD. Increasing the wall by 50 mm would provide a very small</p>

			additional freeboard to a detention basin and should only be considered if future works are to be carried out to the wall.
	Significant ponding water (~500 mm during 10 year ARI & ~800 mm to 900mm during 100 year ARI) that may lead to drowning	H3	Persons have been observed entering the basin during past storm events to exercise in the ponded water. As this could pose a high risk to life, particularly if flood levels are still increasing, it is recommended that appropriate flood signage be erected near all entry points to the Village Green to warn people not to enter during or shortly after storm events until flood water is no longer present.
Units at N13, between Shalom college & Barker Apartments (oHBX010)	Possible flooding into ground floor units at N13 from internal courtyard during 10+ year ARI storms	L1	It is understood that this area is a private location not under management of UNSW. Possible ingress of water into units is expected to results in minimal damage.
Barker St, between Shalom college & Barker Apartments (oBarkerStHump)	Overland flows entering the UNSW Campus from Barker Street between Shalom College & Barker Apartments from 5 year ARI storm events.	M3	<p>The Barker St drainage pipe to Anzac Pde is expected to be at capacity during the 5 year ARI storm. Beyond this, flows will enter the UNSW Campus through the gap in Shalom College and Barker Street Apartments.</p> <p>During the 10 year ARI storm, flow depths of nominally 200 mm are expected that may lead to some pedestrian and vehicle instability.</p> <p>Due to the capacity of the Barker Street drainage being a Council asset, it is unlikely that UNSW can address this issue directly.</p> <p>During the 100 year ARI storm, larger flow depths of nominally 350 mm to 400 mm are expected that would cause pedestrian and vehicle instability, and pose a risk to life.</p> <p>Without the ability to address the issue directly in Barker St, it is recommended that signage is added to warn about risk of flood path during heavy storm events and that access to the direct flow path between the buildings remains restricted.</p>
Burroughs Lane (oBCA110)	Modelled surcharge from grated pit in Burroughs Lane during 10 year ARI storms and greater, leading to increase of overland flows towards north side of Newton Bld J12 and diversion structure 14	M2	<p>The DRAINS Model indicates that the grated pit (BCA110) located in Burroughs Lane, north west of the Physics Theatre (J14) is leading to surcharge pressure relief in the pipe line. This adds significant flows to the culvert under the building between Newton and Red Centre (diversion structure 14).</p> <p>A possible solution could be to seal off the pit to retain pipe flows underground, however, further modelling is required to confirm possible impacts elsewhere in side lines due to possible reductions in capacity of the side lines pipes.</p>

Physics Theatre (oGBB080)	Possible flooding into Physics Theatre leading to damage during 100 year ARI storm	M1	Modelling demonstrates possible overland flows to enter the eastern side Physics Theatre entry during a 100 year ARI storm due to the trapped sag point nature for the entry. Flooding is likely to result in some damage. Unless local ground adjustments or diversions can be easily constructed to increase protection, it is recommended to address this hazard during future redevelopment of the building.
Building G27, near Botany Street (oBCR020)	Flooding into Bld G27 through north-western entry during 20 year ARI storm leading to damage	M2	Modelling demonstrates overland flows do enter the Bld G27 from storms 20 year ARI and larger. Flooding will result in some damage. Unless local ground adjustments or diversions can be easily constructed to increase protection, it is recommended to address this hazard during future redevelopment of the building. A possible diversion that may relieve overland flooding is to modify the speed hump north of this location, in Library, by cutting a channel at least 300 mm wide along the gutter to allow overland flows to discharge out to Botany St.
Southern side of Electrical G17 Building	Chance of Flooding into Electrical Engineering Building (G17) from University Mall Walk	L3	Past storm events have resulted in observed flooding into the southern side of the Electrical Engineering Building (G17). It is difficult to confirm overland flow entry into the building due to the flat nature of the University Mall, and limited survey detail. However, as past events have led to nuisance flooding, it is recommended that these issues be addressed as part of the Electrical Engineering Building refurbishment works.
Warrane College M7	Flooding of Warrane College leading to damage and potential risk to life	H1	Once Barker St and/or Village Green overland flows pass down Southern Dr and reach the trapped sag point between the New College Village and Warrane College, the lower level of Warrane College (believed to be a gym) will be inundated prior to overflows reaching the level of 26.50 m AHD before being conveyed out to Anzac Pde. Due to the expected difficulty of altering the stormwater drainage system in this area, it is recommended, as a minimum, that an evacuation policy is available for this building. The policy should ensure that a clear unobstructed evacuation route is available from any location on the lower level to a high level. It would be unsafe for persons to attempt to evacuate into the flooded laneway.
	Flooding of laneway between New College Village and Warrane College leading to vehicular damage and potential risk to life	H1	Continuing from above, vehicles commonly park in this laneway. As this location experience one of the greatest depths of flood in the Campus during a 100 year ARI storm event, it is recommended that adequate flood warning signage is erected to notify pedestrians and drivers that this area is a major overland flow path during large storm events.

College Road (oECI010, oDEB010)	Hydraulic Hazard along College Road during 100 year ARI event that may lead to vehicle and pedestrian instability	L1	There is a Low to Medium Hydraulic Hazard along College Road where the Velocity Depth product (VxD) slightly exceeds 0.4 with a gutter flow depth up to 200mm deep at 2.8 m/s. Due to the overall low risk, this issue could be addressed if future works were to occur on the north side of the School of Business up to the Quadrangle.
Chancellery Walk (BGA050, oBFG060, oBGA080)	Hydraulic Hazard along Chancellery Walk during 100 year ARI event that may lead to pedestrian instability	L1	There is a Low Hydraulic Hazard along Chancellery Walk where overland flows may reach up to 200mm in depth. Due to the overall low risk, this issue could potentially be addressed with OSD if future works were to occur with building C24 (Sir John Clancy Auditorium / Faculty Management), Lowy Cancer Research Centre C25, and the Michael Birt Lawn – all of which contribute to the overland flows.
School Of Business North-East E12 loading dock (oECG010)	Flooding into School Of Business North-East E12 Loading Dock leading to possible damage during load dock entry door into building, and risk to transformers	L1	The DRAINS Model indicates that possible surcharging may occur from a pit located in the loading dock, caused from the pipe draining the Quadrangle Lawn down College Rd. Diversion structure 16 and detention 'Area F6' indicate that the Quadrangle contains a pit with an orifice plate and screen to function as detention. During recent inspections, UNSW have not been able to confirm the existence of this detention facility other than the observed mound (16). As a result, the DRAINS Model currently does not include any detention modelling structure at this location. If previous records indicate flooding has occurred at this loading dock, then it is recommended to attempt to find and confirm the operation of detention 'Area F6' and update the DRAINS Model as required. It should be noted that there appears to be transformers within this loading dock on raised floors. It is unlikely that the surcharge would reach the floor levels of the transformer in events up to 100 year ARI storms.
Building F21 (oFrom Bld F21)	Overland flow entering Building F21 from Library Rd during 20 year ARI storm leading to possible pedestrian instability and damage	M1	Diversion structure 1 nominates that there are kerb Inlet pits and an oversized pipe with surcharge outlet in Library Rd at Goodsell, originally sized for 100 yr ARI when the overland flow path was cut off by the Infill of Library breezeway. The Current DRAINS Model indicates that overland flow is likely to commence from storms of 20 yr ARI and greater through the breezeway that may lead to pedestrian instability and likely some damage to adjoining rooms off the breezeway. Due to the overall medium risk, temporary measures may be considered through the breezeway such as cutting a grated flow path through the breezeway that would allow the conveyance of water, otherwise this issue should be addressed properly if future works were to occur in this area.

<p>Chemical Sciences (F10) loading dock from Union Rd</p>	<p>Possible flooding into Chemical Sciences (F10) basement loading dock from Union Rd during 100 year ARI storm</p>	<p>H2</p>	<p>As part of the recent Hilmer Building E10 construction, modifications were made to College Rd drainage and Union Rd. The DRAINS Model indicates that the constructed system should be able to safely convey the 100 year ARI discharge within the pipe without entering the Chemical Sciences (F10) basement loading dock. A visual inspection of the area causes slight concern that the hump constructed in Union Rd may potentially direct overland flows down the loading dock ramp if the sag pit located nominally 20 meters upstream were to become blocked. Due to the importance of infrastructure within the lower Chemical Sciences building that would be significantly damaged, it is recommended that detailed work as executed survey be reviewed to confirm if overland flows would pass over the hump or down into the loading dock.</p>
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DETENTION BASIN, PERCOLATION & DIVERSION STRUCTURES

- AREA 'F1' Village Green detention basin. All bank profiles and levels are protected. Banks can be raised, but not lowered. To be maintained and permanently retained.
- AREA 'F2' Percolation chamber serving Village Green detention catchment, to be maintained and permanently retained.
- AREA 'F3' Percolation / detention tank serving NIDA roof water discharge, to be maintained and permanently retained in some form.
- AREA 'F4' 5 yr ARI surcharge basin for stormwater surcharge pits in First Avenue West. Encroaches onto Swimming Pool Lawn. Must be maintained, and retained in some form.
- AREA 'F5' 5 yr ARI surcharge basin for stormwater surcharge pits in International Road. Must be retained in some form.
- AREA 'F6' Quadrangle Lawn detention basin with discharge orifice plate pit in College Road. College Road is raised below pit to retain overland flow. Must be maintained and retained in some form of equal capacity, as Village Green detention volume cannot be safely increased.
- AREA 'F7' Percolation trench serving Goldstein roof water discharge, to be maintained and permanently retained in some form of equal capacity.
- AREA 'F8' Upper Campus Car Park detention basin with discharge orifice pit in ground floor. Must be maintained and permanently retained, as Village Green detention volume cannot be safely increased.
- AREA 'F9' Barker Street Car Park detention basin with discharge orifice pit in ground floor. Must be maintained and permanently retained, as Village Green detention volume cannot be safely increased.
- AREA 'F10' 20 yr ARI detention basin for the The Kensington Colleges development, discharging into piped drainage out to High Street, to be maintained and permanently retained in some form of equal capacity.
- AREA 'F11' 5 yr ARI detention basin for the The Kensington Colleges development, discharging into 5 yr ARI pipe to Village Green, to be maintained and permanently retained in some form of equal capacity.
- AREA 'F12' 20 yr ARI detention basin for the Wallace Worth development, discharging into pipe system out to Botany Street, to be maintained and permanently retained in some form of equal capacity.
- AREA 'F13' 20 yr ARI detention basin for the Bio Sciences Redevelopment, discharging into pipe system out to Botany Street, to be maintained and permanently retained in some form of equal capacity.

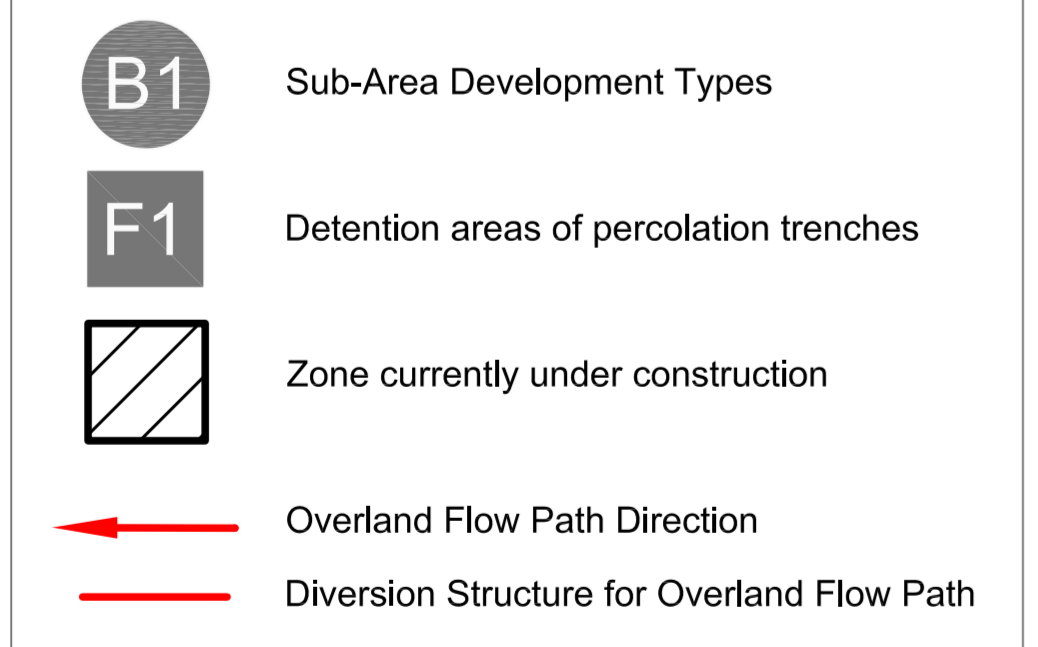
MAIN AREA GROUP CHARACTERISTICS

- AREA 'A' 100 yr ARI to Village Green Detention Basin
- AREAS 'B' 5 yr ARI to Village Green Detention Basin; 100 yr ARI to Council street drainage
- AREAS 'C' 5 yr ARI to Village Green Detention Basin; 100 yr ARI to Council street drainage
- AREAS 'D' 20 yr ARI to percolation trench; 100 yr ARI to Council street drainage
- AREAS 'E' Requires full detention
- AREAS 'F' Detention basins & diversion structures to be retained

SUB-AREA DEVELOPMENT CONSTRAINTS

- AREA 'A' All stormwater run-off to Village Green Detention Basin
- AREAS 'B1' Areas F1, F2, F6, F8 & F9 and diversion structures are to be retained
- AREA 'B2' 5 yr ARI to Village Green Detention Basin via piped drainage
- AREA 'B3' 5 yr ARI to Village Green Detention Basin via piped drainage
- AREA 'C1' 5 yr ARI roof drainage to percolation trench
- AREA 'C2' 5 yr ARI roof drainage to percolation trench
- AREA 'C3' 5 yr ARI roof drainage to percolation trench
- AREA 'D1' 20 yr ARI roof drainage to percolation trench with overflows to existing piped drainage
- AREA 'D2' 20 yr ARI roof drainage to percolation trench with overflows to Council kerb or existing piped drainage
- AREA 'D3' 20 yr ARI to Council kerb via piped drainage
- AREA 'E1' Drains to Botany St Catchment
- AREA 'E2' 5 yr ARI to Village Green Detention Basin via piped drainage

LEGEND



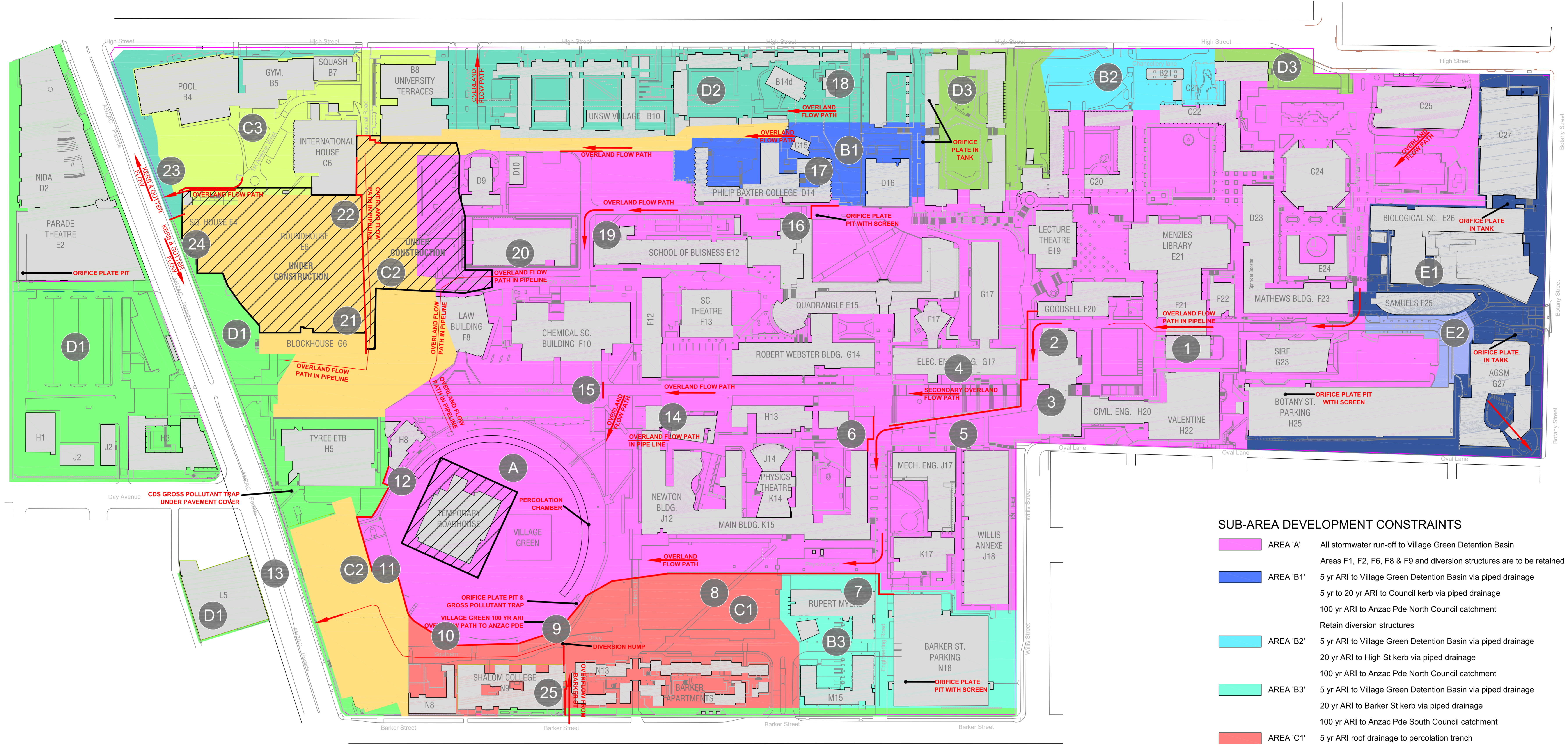
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SITE SERVICES

Created 03.07.2017	Updated 03.07.2017	Campus KENSINGTON	Building No. ALL
Drawn B.KUS	Approved C.Pelosi	Project STORMWATER MASTER PLAN 2025	Sheet No. 1 OF 1
Discipline HYD	Scale N.T.S	Title STORMWATER CATCHMENT PLAN	Revision A
CAD Reference	Drawing No. FME-K-H015	Revision	A

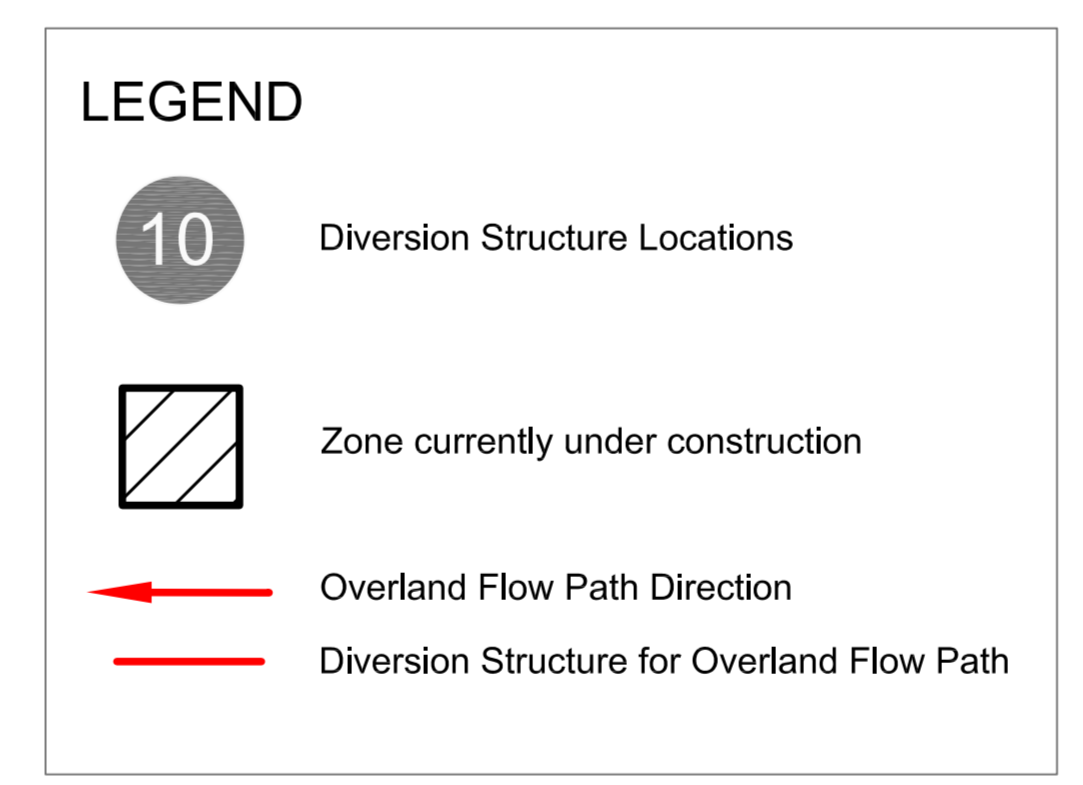


SUB-AREA DEVELOPMENT CONSTRAINTS

AREA 'A'	All stormwater run-off to Village Green Detention Basin Areas F1, F2, F6, F8 & F9 and diversion structures are to be retained
AREA 'B1'	5 yr ARI to Village Green Detention Basin via piped drainage 5 yr to 20 yr ARI to Council kerb via piped drainage 100 yr ARI to Anzac Pde North Council catchment Retain diversion structures
AREA 'B2'	5 yr ARI to Village Green Detention Basin via piped drainage 20 yr ARI to High St kerb via piped drainage 100 yr ARI to Anzac Pde North Council catchment Retain diversion structures
AREA 'B3'	5 yr ARI to Village Green Detention Basin via piped drainage 20 yr ARI to Barker St kerb via piped drainage 100 yr ARI to Anzac Pde South Council catchment Retain diversion structures
AREA 'C1'	5 yr ARI roof drainage to percolation trench 20 yr ARI to Barker St kerb via piped drainage 100 yr ARI to Anzac Pde South Council catchment via Southern Drive Retain detention basin F9
AREA 'C2'	5 yr ARI roof drainage to percolation trench 20 yr ARI to Anzac Pde South kerb via piped drainage 100 yr ARI to Anzac Pde South Council catchment Retain diversion structures
AREA 'C3'	5 yr ARI roof drainage to percolation trench 20 yr ARI to Anzac Pde South kerb via piped drainage 100 yr ARI to Anzac Pde North Council catchment Retain detention basins F4 & F5 and diversion structures
AREA 'D1'	20 yr ARI roof drainage to percolation trench with overflows to existing piped drainage 100 yr ARI to Anzac Pde South Council catchment Retain detention basin F3 and diversion structures
AREA 'D2'	20 yr ARI roof drainage to percolation trench with overflows to Council kerb or existing piped drainage 100 yr ARI to Anzac Pde North Council catchment Retain detention basin F7 and diversion structures
AREA 'D3'	20 yr ARI to Council kerb via piped drainage Discharges to Anzac Pde North Council catchment
AREA 'E1'	Drains to Botany St Catchment All developments require full detention to Council standard requirements
AREA 'E2'	5 yr ARI to Village Green Detention Basin via piped drainage 5 yr to 20 yr ARI to Council kerb via piped drainage 100 yr ARI to Anzac Pde North Council catchment All developments require full detention to Council standard requirements

DIVERSION STRUCTURES DESCRIPTION

- Kerb Inlet pits and oversized pipe with surcharge outlet in Library Rd at Goodsell, originally sized for 100 yr ARI. Constructed when overland flow path cut off by Infill of Library breezeway. Current modelling indicates overland flow to commence from storms of 20 yr ARI and greater.
- Pavement levels west of Goodsell raised and Red Wall constructed to divert 100 yr ARI & prevent flooding of Electrical Engineering.
- Pavement depressed to stop overland flow discharge down Mall.
- Unorthodox steps at building entry to prevent flooding of Electrical Engineering.
- Depression in centre of road to retain overland flow.
- Brick wall and raised pavement levels in Burroughs Lane to divert flow down Engineering Rd.
- Levels in Engineering Rd raised to divert flow down Physics Rd.
- Overland flow open drain with depression in Science Rd to take surcharge from in-ground pipeline which has been designed to surcharge in the 100 yr ARI storm.
- Village Green overflow weir crest to discharge overflow to 'raised hump' in Southern Dr. Ponding flows will overtop the hump and continue westward down Southern Drive until reaching a trapped depression between New College (L6) and Warrane College (M7). Level must be retained at 26.93 m AHD.
- Village Green embankment must be at least 27.32 m AHD.
- Brick wall around recreation area. Top of wall must be at least 27.32 m AHD.
- Pavement level at crest in road access to Village Green must be at least 27.27 m AHD to prevent Village Green detention overflow to Anzac Pde.
- Oversized kerb entry and pipe crossing to provide for overland flow path in to UNSW / Council 1100 mm stormwater pipe.
- Culvert under building between Newton & Red Centre to take 100 yr ARI overland flow surcharge from Burroughs Lane. Must be kept open and clear of debris and services.
- Depression in Mall pavement above steps to divert overland flow into Village Green and to prevent flow discharging to Anzac Pde.
- College Rd levels locally raised to bund Quadrangle detention basin.
- Fig Tree Lane levels locally graded to divert overland flow from Goldstein Courtyard area to Quadrangle Detention Basin F5. This reduces flow to High St.
- Pipe through wall to allow surcharge to High St from percolation trenches.
- High capacity inlet pits in College Rd and Union Rd to capture overland flow into the oversized pipe under Law Building. Hence kerbs must be continuous and kerb inlet pits retained.
- Hilmer Building (E10) (previously the Material Science carpark) and Union Rd banded to prevent flooding of Union Rd and Applied Science loading dock. Kerbs must be continuous and raised vehicle crossings and kerb inlets must be retained.
- Union Rd west banded to prevent escape of overland flow to Mall and Round house precinct. Kerbs and raised road edge levels must be continuous and inlet pits retained.
- A Collage Mall walk is proposed as part of teh Lower Campus redevelopment. Previous overland flows that exceed the detention capacity of F5 and discharge overland through the Round House are now piped between the Law Building (F8) and Blockhouse (G6) into an existing 825 mm dia. pipe to Anzac Pde. Additional OSD and percolation is required for future developments in this catchment.
- Brick retaining wall and 2.4 m wide floodway constructed to divert overland flow past Square House plant room to Anzac Pde.
- Ground levels raised to form diversion bank to prevent floodwaters discharging to Anzac Pde South Council catchments.
- Laneway between Barker Apartments and Shalom College is an overland flow path taking discharge from Barker St into the Campus to locally raised hump in Southern Drive. Ground levels must be retained. Brick wall along Shalom College boundary must be retained.



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CAD Reference 	Drawing No. FME-K-H016	Revision 	