Structural
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Kambala Sports Precinct SSDA Stormwater Management Plan

Kambala Sports, Wellbeing and Senior Learning Precinct, Rose Bay

Prepared for Carmichael Tompkins Property Group / 20 July 2020

191896

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1.0 EXECUTIVE SUMMARY

The purpose of this stormwater management plan report is to identify the potential for diversion of the stormwater pipes and easement across the Kambala School (existing site), address the relevant Secretary's Environmental Assessment Requirements SEARS and design the proposed stormwater system for the proposed sports precinct development for the Kambala School in Rose Bay, NSW.

The stormwater system assessment analysis was completed using DRAINS software for the 1% Annual Exceedance Probability (AEP) flood event.

Results confirm that significant overflow would occur on New South Head Road during 1% AEP flood event (1 in 100-year event) of about 10.7 m^3/s.

To maintain the stormwater system capacity under the proposed building, we propose increasing the pipe size and relocating the easement.

Across the Kambala School, it is recommended to upgrade existing 450mm pipe to 750mm (refer to Figure 9).

The increased pipe capacity will allow the proposed development to be built over the stormwater system without affecting the performance of the stormwater system or the overland flow capacity through the site.

Design stormwater quantity and quality measures for the proposed sports precinct development on site to suit Council's specifications and requirements.

Diversion of south-eastern easement pipe entering the site from the east to be diverted away from the new building structure as to prevent impact to the existing stormwater system.

The relevant civil SEARs items addressed in this report and the civil drawings are listed in the below table.

SEARs Item	*DESCRIPTION*	*Report Reference*
2. Policies	Address the relevant planning provisions, goals and strategic planning objectives	The stormwater design (quantity and quality) is in accordance with Council's requirements outlined in Woollahra Development Control Plan 2015. Council's requirements are referenced and addressed in the proposed design. Refer to Section 7 of this report.
16. Drainage	· Detail measures to minimise operational water quality impacts on surface waters and groundwater. · Stormwater plans detailing the proposed methods of drainage without impacting on the downstream properties.	The stormwater design achieves the required water quality targets outlined in the DCP. Refer to Section 7 of this report and civil drawings.
17. Flooding	· Identify flood risk on-site (detailing the most recent flood studies for the project area) and consideration of any relevant provisions of the NSW Floodplain Development Manual (DIPNR, 2005), including the potential effects of climate change, sea level rise and an increase in rainfall intensity. If there is a material flood risk, include design solutions for mitigation.	The most recent flood study is referenced in section 4 of this report. It is noted that the existing overland flow on New South Head Road is assumed to remain on the road and bypass the site in Section 5 of this report. The potential effects have been addressed in Section 7.3 of this report.
19. Sediment, Erosion and Dust Controls	Detail measures and procedures to minimise and manage the generation and off-site transmission of sediment, dust and fine particles.	The sediment, erosion and dust controls are outlined in civil drawing C02.

2.0 Introduction

The site is located at 794 -796 New South Head Road, Rose Bay and is part of the Kambala School, which is under jurisdiction of the Woollahra Municipal Council. Kambala School site is bounded by Bayview Hill Rd to the north, New South Head Rd to the east and south and Tivoli Ave to the west. The topography of the site naturally falls towards the Tivoli Avenue and then Rose Bay which are located in the south west of the site (refer to Figure 1 and Figure 2). Elevation across the site varies from 50m AHD at the northeast to around 30m AHD at the southwest. Figure 2 shows surface elevations around the site.

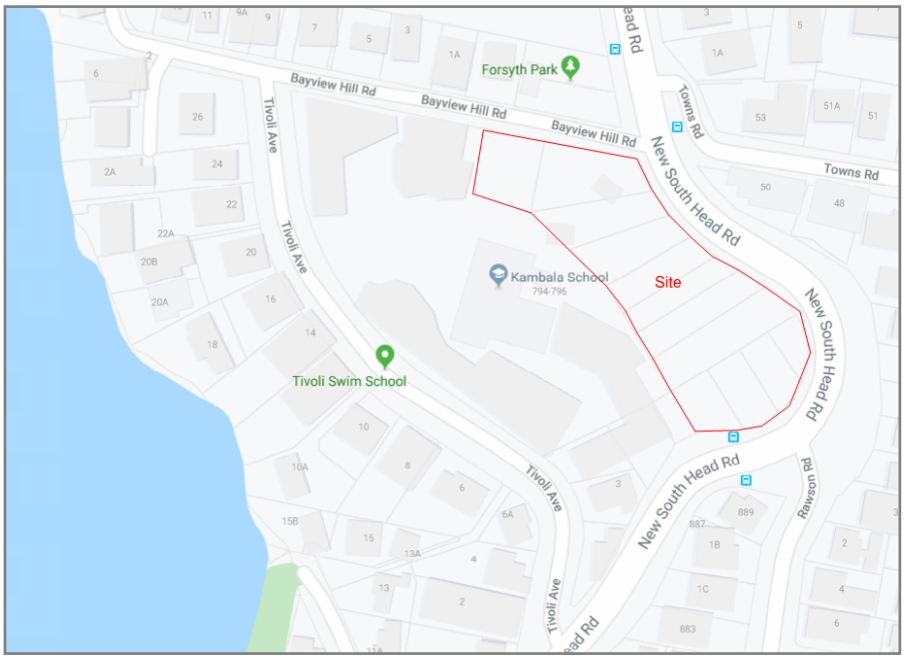

Figure 1. Locality Plan (Source: Google Maps)

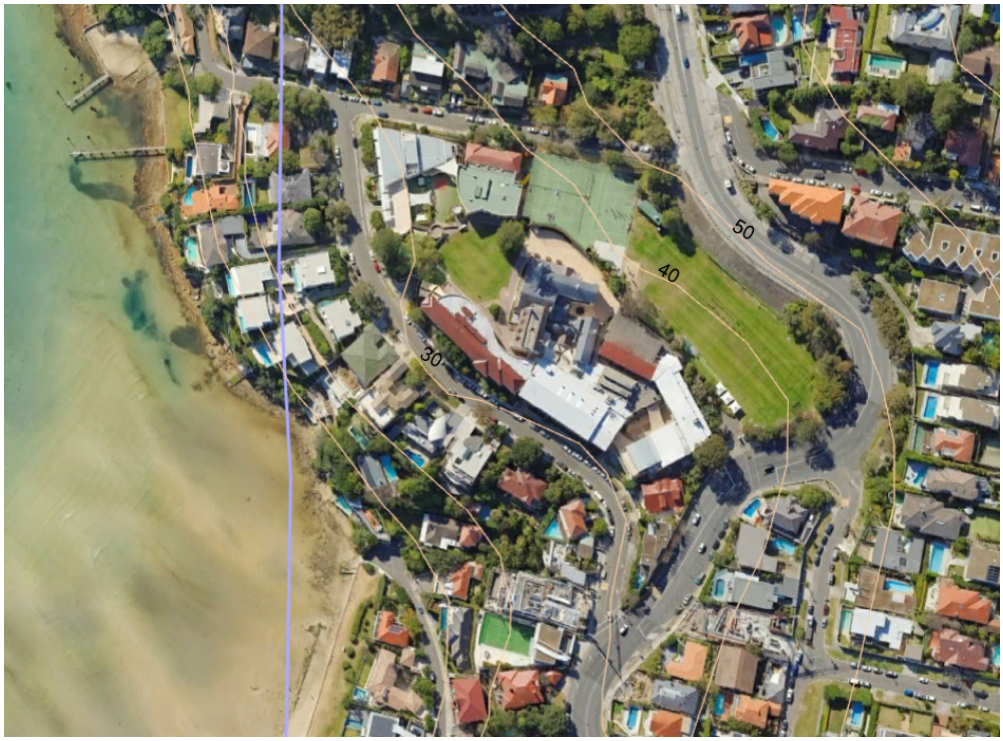

Figure 2. Site Topography around the Kambala School (Source: Google Earth with adding NSW Globe Contours)

The site area is approximately 8,900 m^2 and the development will involve converting the grassed area into sports courts and learning facilities while maintaining the integrity of the New South Head Road batter. Refer to Figures below for the architectural drawings. Refer to the architectural drawings by AJ+C and civil drawings by TTW for more details.

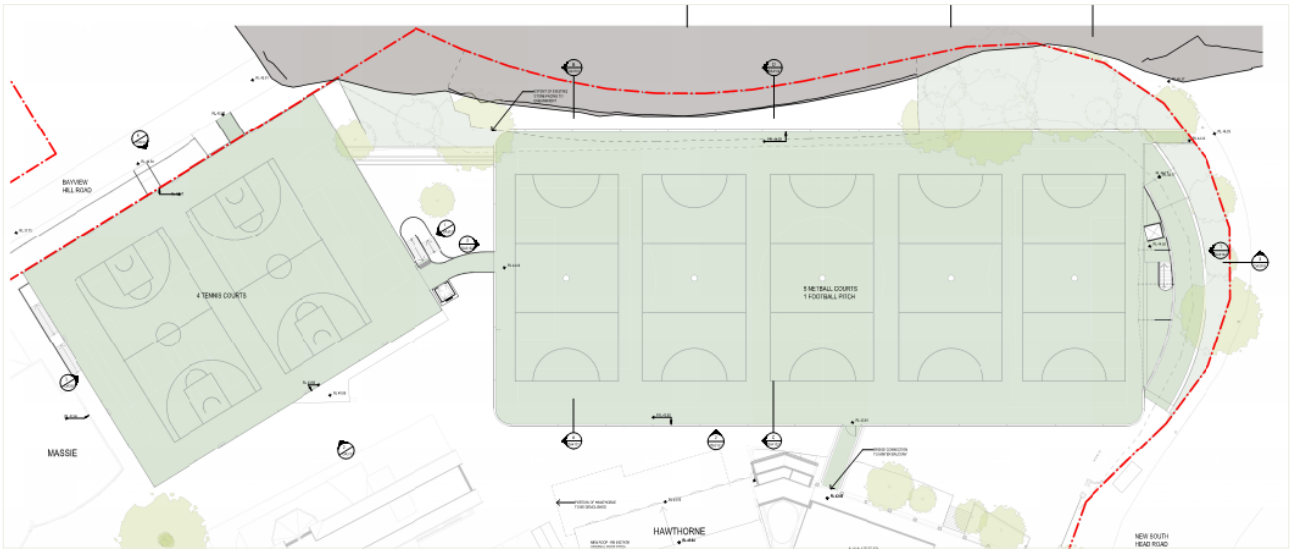

Figure 3 Level 3 Architectural Drawing by AJ+C

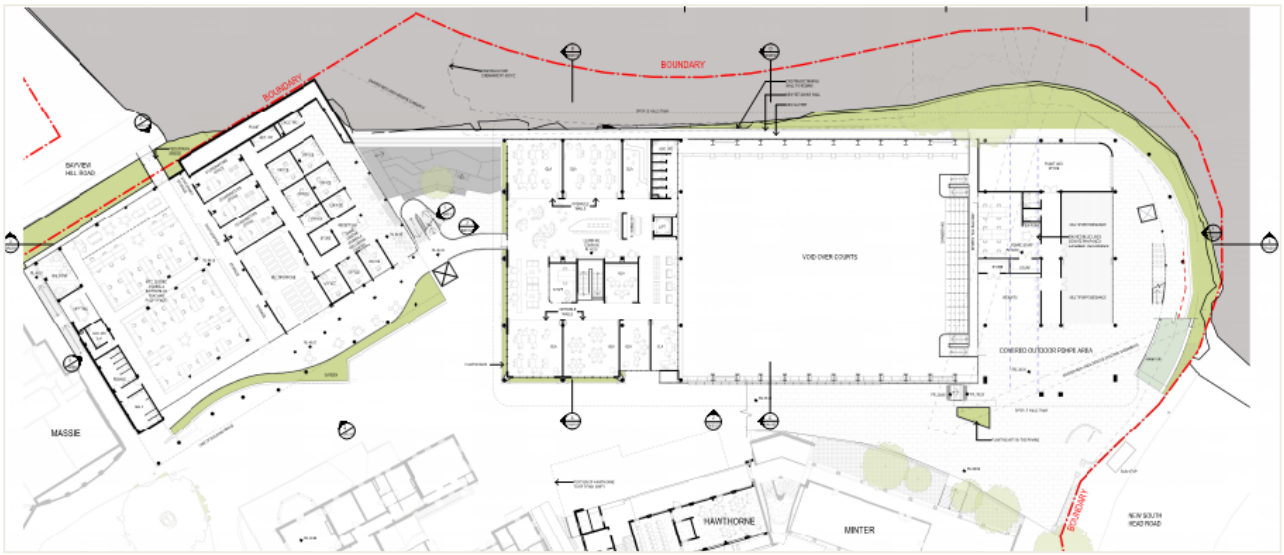

Figure 4 Level 2 Architectural Drawing by AJ+C

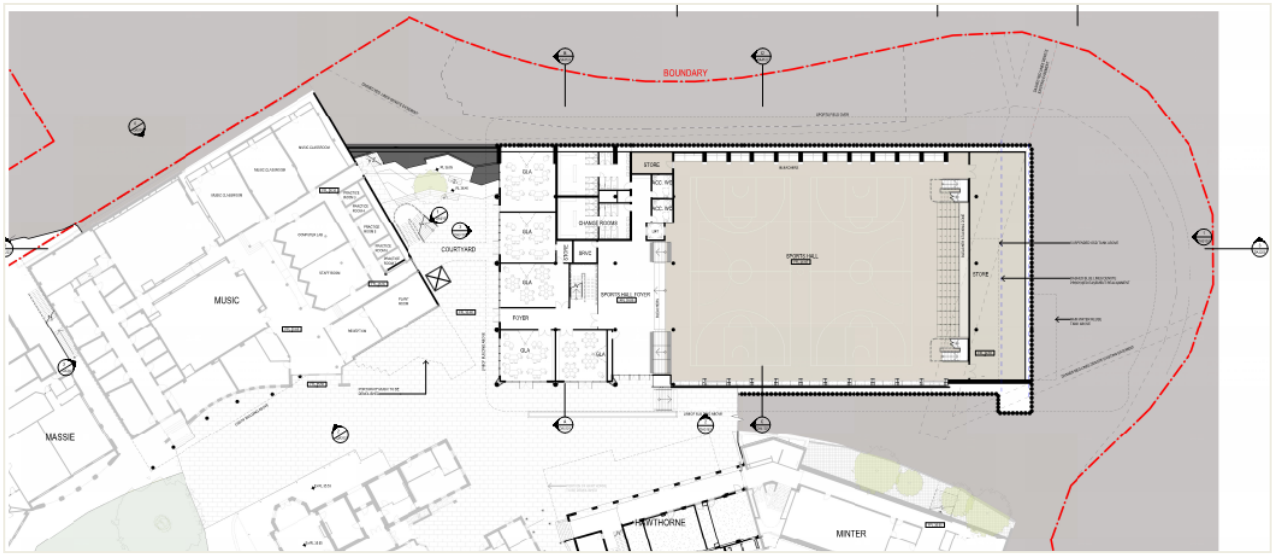

Figure 5 Level 1 Architectural Drawing by AJ+C

3.0 Overall Catchments

The upstream catchment area for the existing pipe system was estimated using NSW Globe Contours Information. The total upstream catchment area is about 28.1-hectares (ha). The overall catchment falls from the north-east to the south-west and into the Rose Bay. The study area sub catchments are shown in Figure 6.

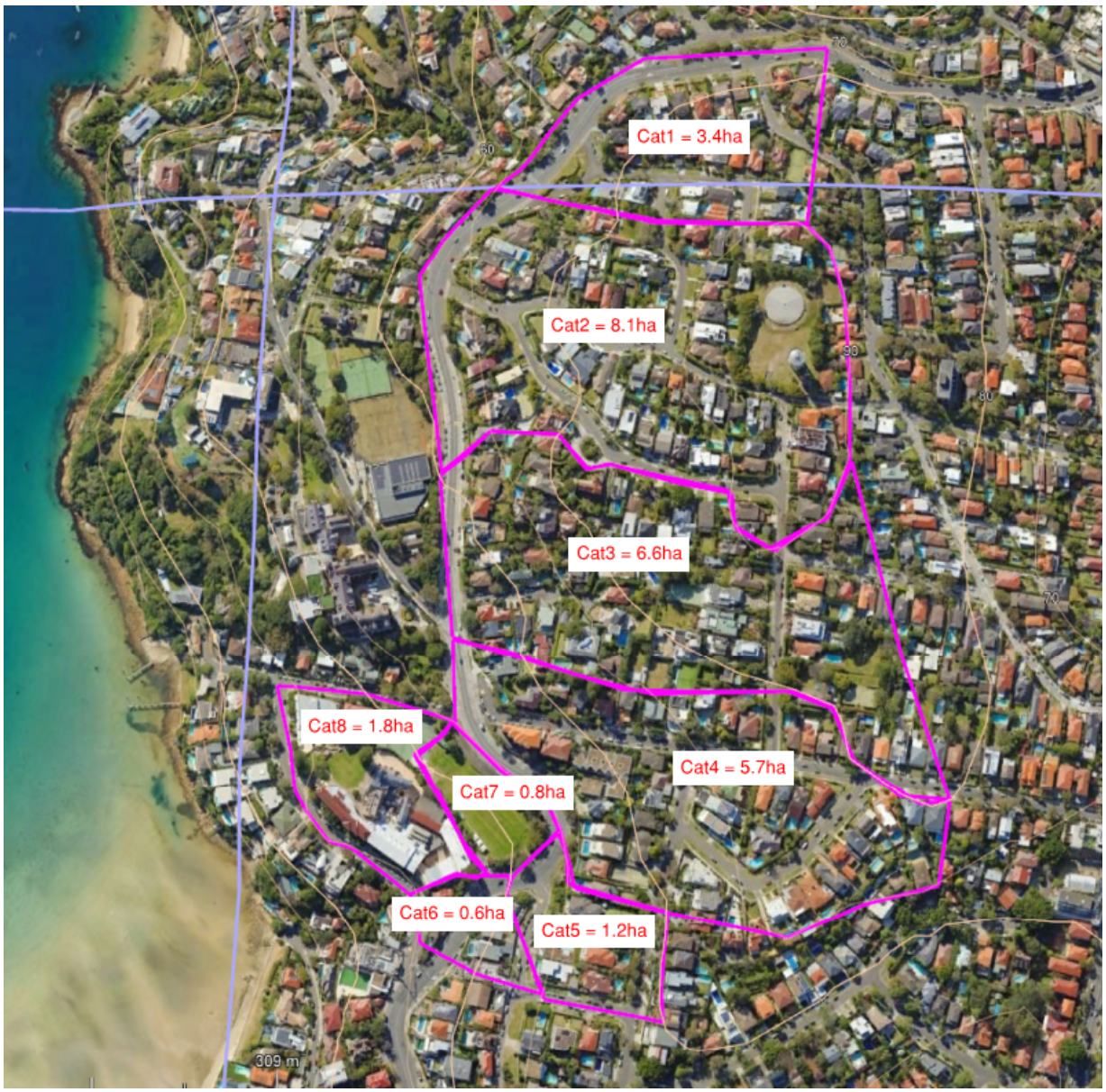

Figure 6. Upstream sub catchments (Source: Google Earth and NSW Globe Contours)

4.0 Available Information

4.1 Existing Overall Stormwater System

There is an existing stormwater system based on Woollahra Municipal Council records "https://www.woollahra.nsw.gov.au/environment/water_and_coast/our_projects/floodplain_management/rose_bay_catchment_flood_study".

The maps of the existing stormwater system around the site are extracted from council records under the "*Rose Bay Catchment Flood Study*" and are shown in Figures 7 and 8.

Detailed stormwater system information including pipe size, pipe inlet and outlet locations, pipe length, pipe upstream and downstream invert elevations, pit type and pits surface elevations are required to be included in the stormwater system in the DRAINS model.

Refer to Figures 7 and 8 below, which show the approximate location and types of the existing pits and pipes used to develop the DRAINS model.

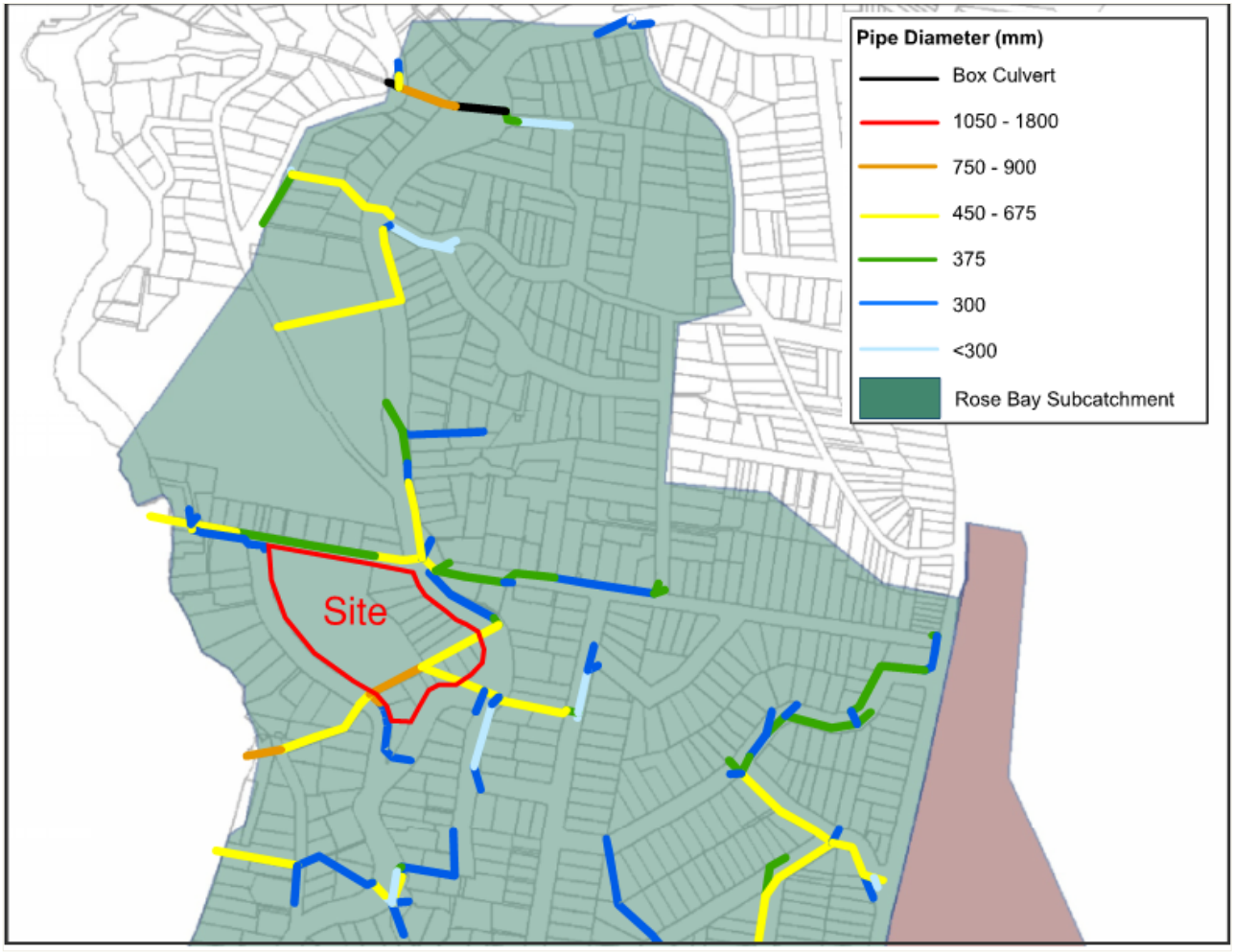

Figure 7 Existing Pipe Network

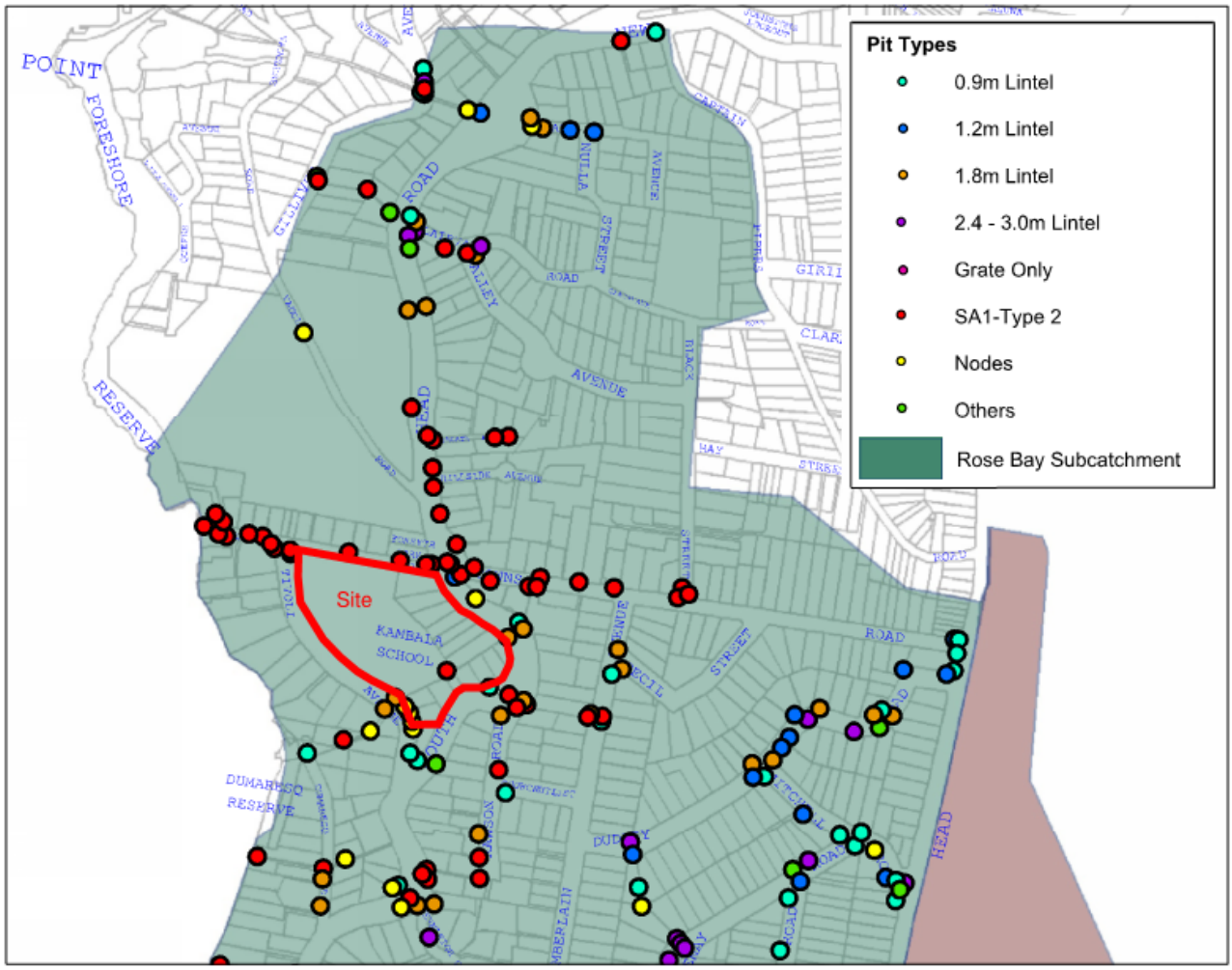

Figure 8 Existing Pits

5.0 Overall DRAINS Model

5.1 Overall DRAINS Model Description

In this study, DRAINS software was used to model the existing stormwater system. In the DRAINS Software, Initial Loss/Continuing Loss model (i.e., IL/CL model) were selected as the hydrology model as it is recommended in Chapter 3 of Book 5 of Australian Rainfall & Runoff,2019 (ARR,2019).

In the ARR 2019 data hub, the below values were proposed as the Storm IL and CL for rural area in this region:

IL= 28.0mm

CL= 1.6mm/hr

The ARR2019 in Book 5 Section 3.5.3.2.1 recommended to adopt 60% to 80% of the recommended rural ILs for urban area.

In this study, 70% of the above initial loss were adopted for this site (ILs=19.6mm).

Loss values for the impervious area of the study area were assumed based on the ARR 2019 guidelines. Accordingly, the following values were used in the DRAINS model:

IL= 2.0mm

CL=1.0mm/hr

The main characteristics of the upstream sub catchments including the pervious and impervious area are shown in Table 1.

Table 1 Overall DRAINS model for Existing Condition Sub Catchment Areas

Sub Catchment ID	Area (ha)	Effective Impervious Area (%)	Remaining Impervious Area (%)	Pervious Area (%)
Cat1	3.4	80	10	10
Cat2	8.1	80	10	10
Cat3	6.6	80	10	10
Cat4	5.7	80	10	10
Cat5	1.2	80	10	10
Cat6	0.6	80	10	10
Cat7	0.8	5	5	90
Cat8	1.8	80	10	10
Total	28.1	80	10	10

The study area Temporal Pattern (TP) information was obtained from data.arr-software.org (ARR Data Hub) website. The Intensity Frequency Duration (IFD) design rainfall depths were obtained from www.bom.gov.au website. The IFDs design rainfalls are represented in Appendix A.

As mentioned previously, all the required information is not available for the existing stormwater pits and pipes,

the approximate location and size of the stormwater system were considered based on the available information in Figure 7 and Figure 8.

A site visit was also conducted on 10th January 2020 to have an overview of the stormwater system location, size and overflow paths.

To develop the base DRAINS model some assumptions have been undertaken including:

Surface elevation at pit locations was roughly assumed based on the NSW Globe contours information;

20% blockage was assumed for all the pits included in the model;

Invert elevation at upstream and downstream of each pipe included in the model was roughly assumed based on the NSW Globe contours information and available pipe size information;

The box culvert size located near Ray Avenue was assumed to be 1200mm by 700mm based on our site inspection; and

Based on our site inspection, it was assumed that the overflow of the New South Head Rd at the Bayview Hill Rd junction, totally remains on the New South Head Road and would bypass the Kambala School. In Appendix C, two photos of our site inspection that show the Bayview Hill Rd and New South Head Rd junction and existing batter are presented.

Figure 9 represents the pipes included in the Overall DRAINS model.

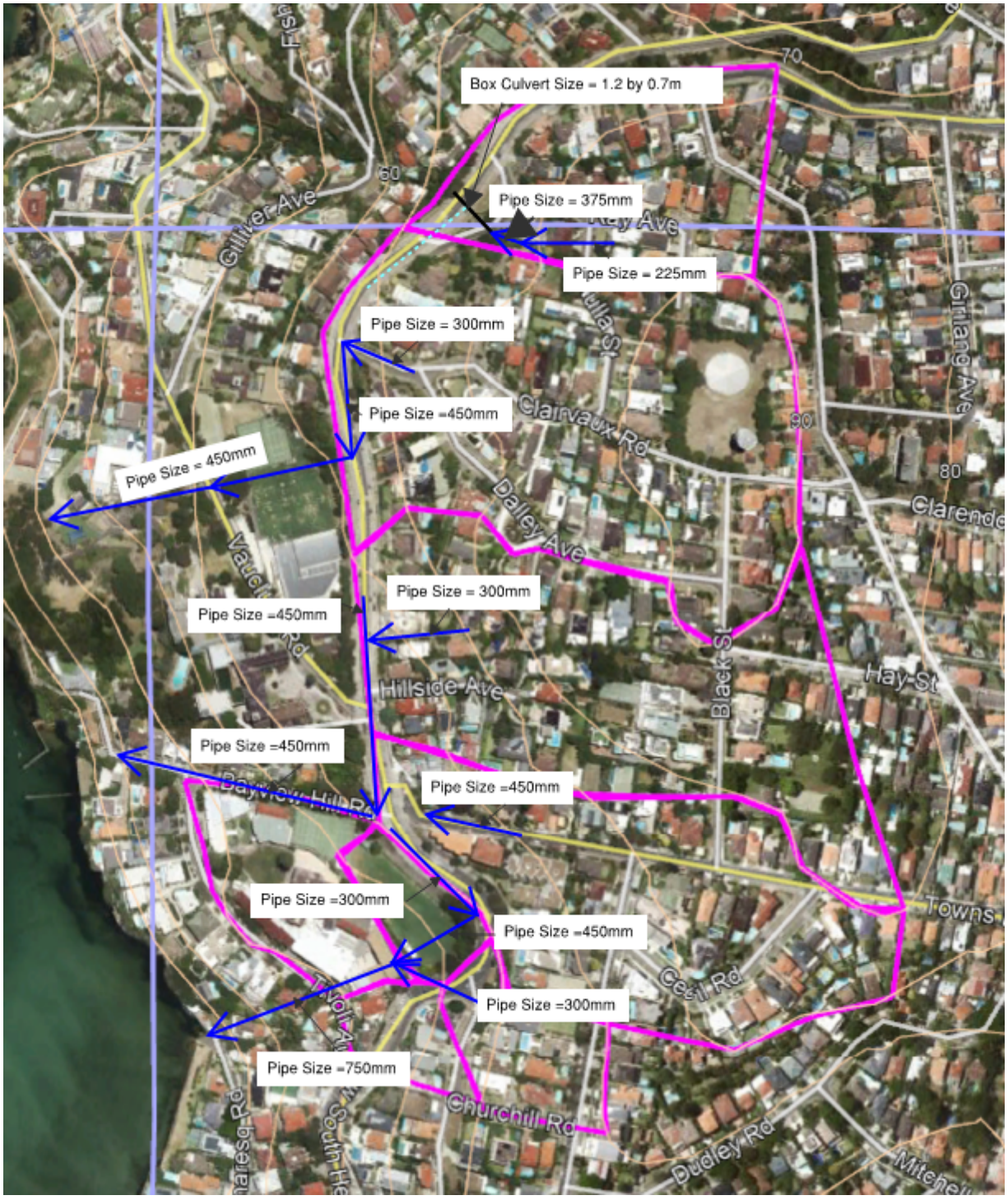

Figure 9 Main Stormwater System included in the DRAINS Model

6.0 Overall DRAINS Model Results

6.1 Existing Condition

The obtained information from ARR 2019 (TP) and BOM web site (IFDs) were used in the developed DRAINS model to simulate storms for 1% AEP event with durations 5, 10,15, 20, 25, 30, 45 and 60 minutes. The results are presented in Table 2, and Figure 10 & 11.

Results indicate that during 1% AEP event maximum overflow 9.9 m^3/s would remain on New South Head Road.

Table 2. Generated DRAINS peak 1% AEP event flows

Sub catchment ID	Q_{max} (m^3/s)	Critical Storm Duration (minutes)
Cat1	2.2	5
Cat2	5.1	5
Cat3	4.1	5
Cat4	3.6	5
Cat5	0.8	5
Cat6	0.4	5
Cat7	0.5	10
Cat8	0.7	5

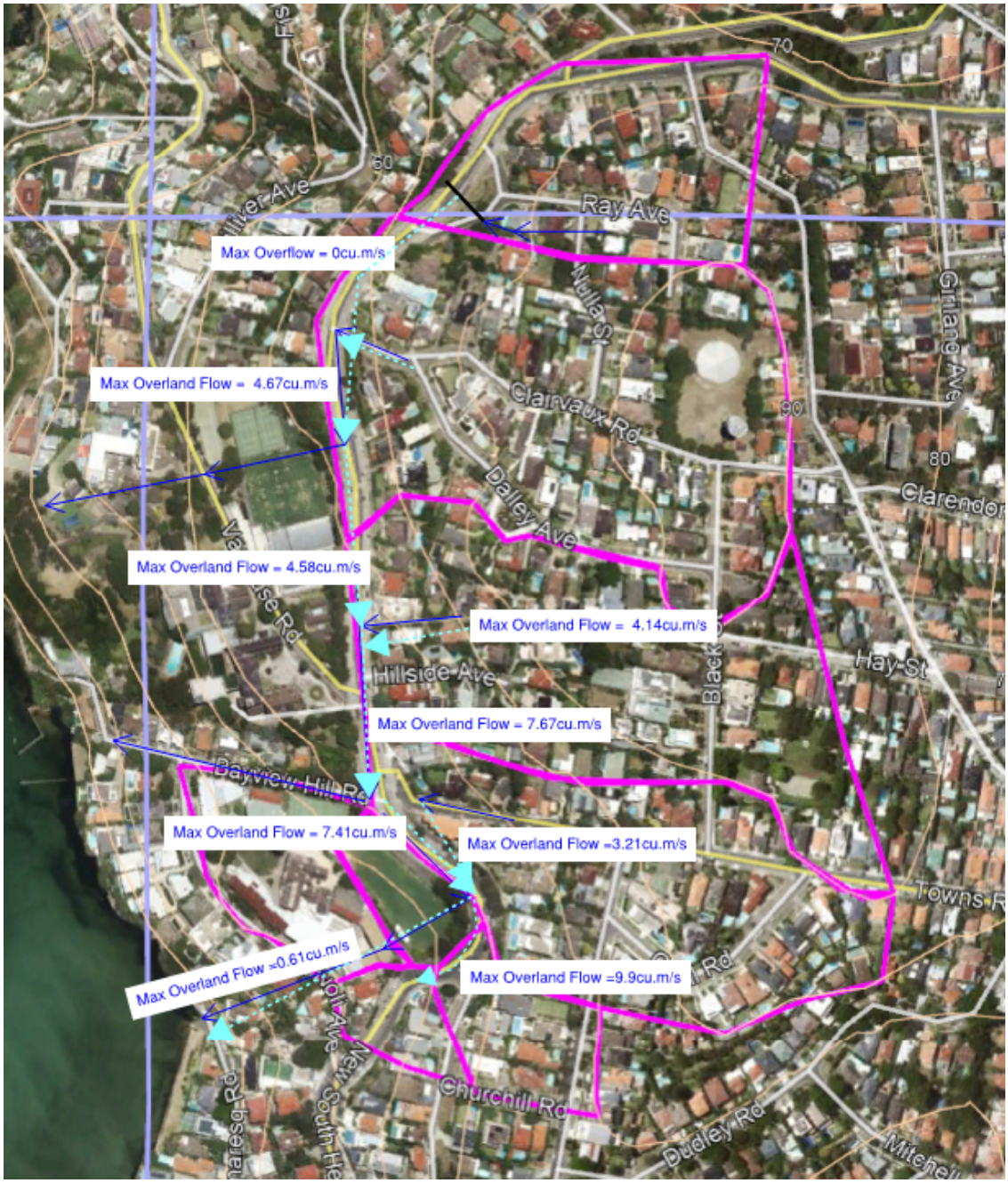

Figure 10 Maximum overland Flow generated by DRAINS Model for 1% AEP Event in Existing Condition

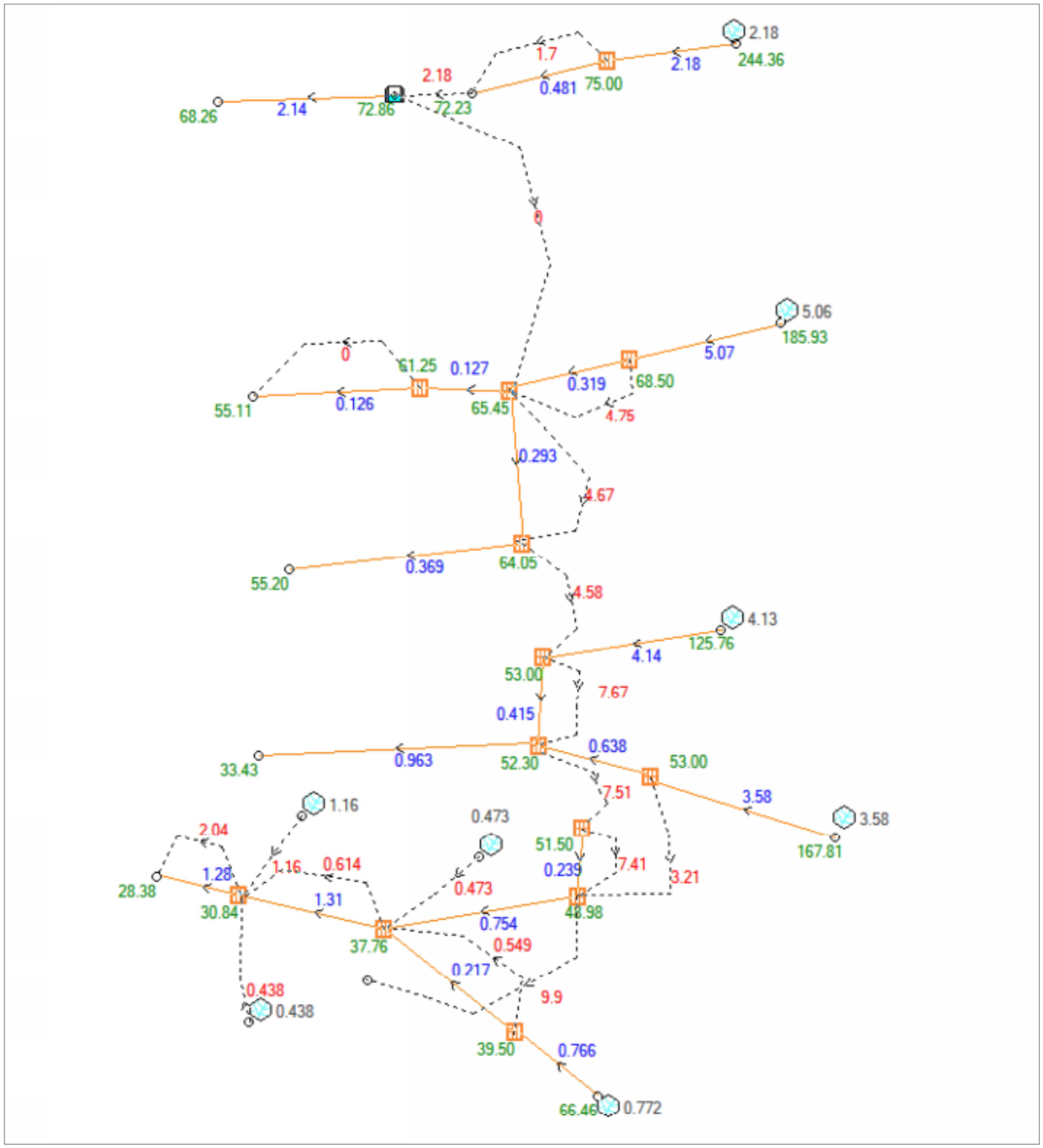

Figure 11 DRAINS Model Results for 1% AEP Event in Existing Condition

6.2 Post - Development Condition

In post-development condition the impervious and pervious area of the sub catchment 7 will be changed. In this condition, 95% impervious area and 5% pervious area were assumed for this sub catchment. Therefore, in post-development condition maximum flow produced by sub catchment would be 0.549 m^3/s (generated flow in existing condition in this sub catchment is 0.473 m^3/s.

In post-development condition by upgrading the existing pipe from 450mm to 750mm, the pipe transfers 0.86 m^3/s compare to 0.754 m^3/s in existing condition. Negligible changes are predicted for flood behaviour during the 1% AEP event.

7.0 Stormwater Requirements

7.1 Proposed Development Stormwater Quantity

7.1.1 Pit and Pipe Stormwater System

The proposed stormwater drainage is designed to have no impact on downstream properties as per SEARS requirement Clause 16.

The proposed pit and pipe system are designed for storm events up to and including the 1 in 20year ARI storm event as per Council's development control plan- Woollahra DCP 2015 – Chapter E2 Stormwater and Flood Risk Management – E2.2.5, which states that the proposed pipes be designed to cater for storm events up to and including the 1 in 20year ARI storm event where an overland flow path is available. Refer to Figure 12 below.

C4 Where an overland flow system is available, the drainage system is designed to cater to a minimum 1 in 20 ARI event; and the drainage system, in combination with the overland flow system, is designed to cater to a minimum 1 in 100 ARI event.

Figure 12 Stormwater pipe requirements

Overland flow paths are provided, which cater for all storm events above the 1 in 20year ARI storm event up to and including the 1 in 100year ARI storm event.

7.1.2 On-Site Detention (OSD) Requirements

The site is required to provide an on-site detention (OSD) to meet Council's requirements to limit the flow discharged from the site as stated in Council's development control plan – Woollahra DCP 2015 Chapter E2 Stormwater and Flood Risk Management – E2.2.4 On site detention (OSD) of stormwater. Refer to Figure 13 below.

OSD requirements per 1,000m² of the total site area		
Permissible site discharge (l/s)	Minimum site storage requirements (m³)	ARI (year)
24	4	1 in 2
34	20	1 in 100

Figure 13 OSD requirements

The proposed development is split into two catchments due to the natural site grade which falls in two directions, south-west and south-east corners of the site.

Catchment 1, with an area of approximately 0.64ha, is the eastern side of the site, which generally falls towards the south-east of the site Catchment 2, with an area of approximately 0.25ha, is the western side of the site, which generally falls towards the south-west of the site. Refer to Figure 14 below.

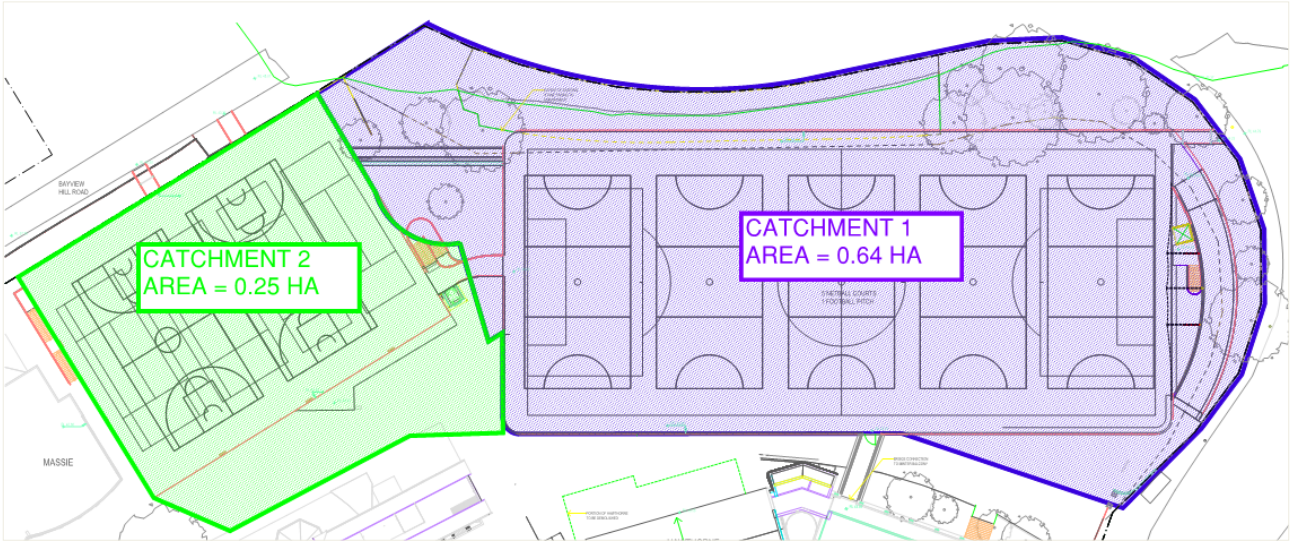

Figure 14 Proposed Catchment Breakdown

Therefore, two on-site detention tanks are designed to provide storage of stormwater runoff from each of the catchments. To meet Council's requirements each of the OSD tanks were designed to limit the flow to 34 l/s per 1,000 m^2 and to provide storage of 20 m^3 per 1,000 m^2 for the 1 in 100year ARI storm event.

- **Catchment 1:** The proposed OSD is to limit the flow to 217 l/s and provide a minimum storage of 128m3. Refer to civil drawings C05 and C08 for details.
- **Catchment 2:** The proposed OSD is to limit the flow to 85 l/s and provide a minimum storage of 50m3. Refer to civil drawings C05 and C08 for details.

Catchment 1 OSD will discharge into the new easement pit 4 in easement diversion in the south-eastern side of the site. Catchment 2 OSD will discharge into the existing school's stormwater system in the south-west corner of the site. Refer to the stormwater plan in Appendix B and civil drawing C05.

In Catchment 1, the stormwater runoff from the batter south of New South Head has an approximate area of 0.1 ha, which will be carried via a proposed strip drain concrete channel (0.9m wide x 0.6m deep). The strip drain has 225mm pipe connections at equal intervals to the suspended 375mm pipe behind the shoring wall draining to easement pit 2 and bypasses the OSD. Refer to Figure 15 below. Refer to civil drawing C05 and the architectural plans.

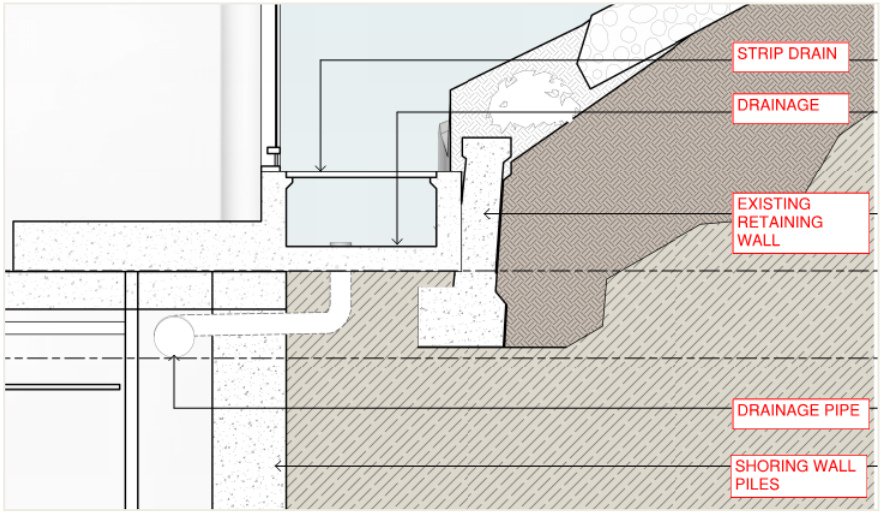

Figure 15 Sketch of section through proposed strip drain from Architectural Plans

7.2 Proposed Development Stormwater Quality

The site is proposed to undergo water quality treatment measures to meet Council's water quality targets as stated in Council's DCP E2.2.3 Stormwater treatment. Refer to Figure 16 below.

Water quality targets

C7 Water quality measures are installed that meet the following environmental targets for stormwater runoff leaving the site:

a) 90% removal of gross pollutants (> 5mm);

b) 85% removal of total suspended solids;

c) 65% removal of total phosphorous; and

d) 45% removal of total nitrogen.

Figure 16 Water quality targets

7.2.1 MUSIC Model

The site will be treated through proposed water quality treatment devices, which are a reuse rainwater tank, storm sacks and hydrosystems to remove litter and reduce pollutants to meet Council's pollutant removal targets. A MUSIC model was setup to determine the water quality devices required to achieve the targets.

Each catchment is modelled in MUSIC to have an 95% impervious area and is treated separately.

Based on the MUSIC model results, each catchment requires the following treatment devices:

- **Catchment 1:**

  100KL Re-use RWT and 1 x Stormsack and 1 x HydroSystem 1500/4 by SPEL or equivalent

- **Catchment 2:**

  2 x Stormsacks and 1 x Hydrosystem 1000 by SPEL or equivalent

The proposed treatment trains are shown below in the MUSIC model layout. Refer to Figure 17.

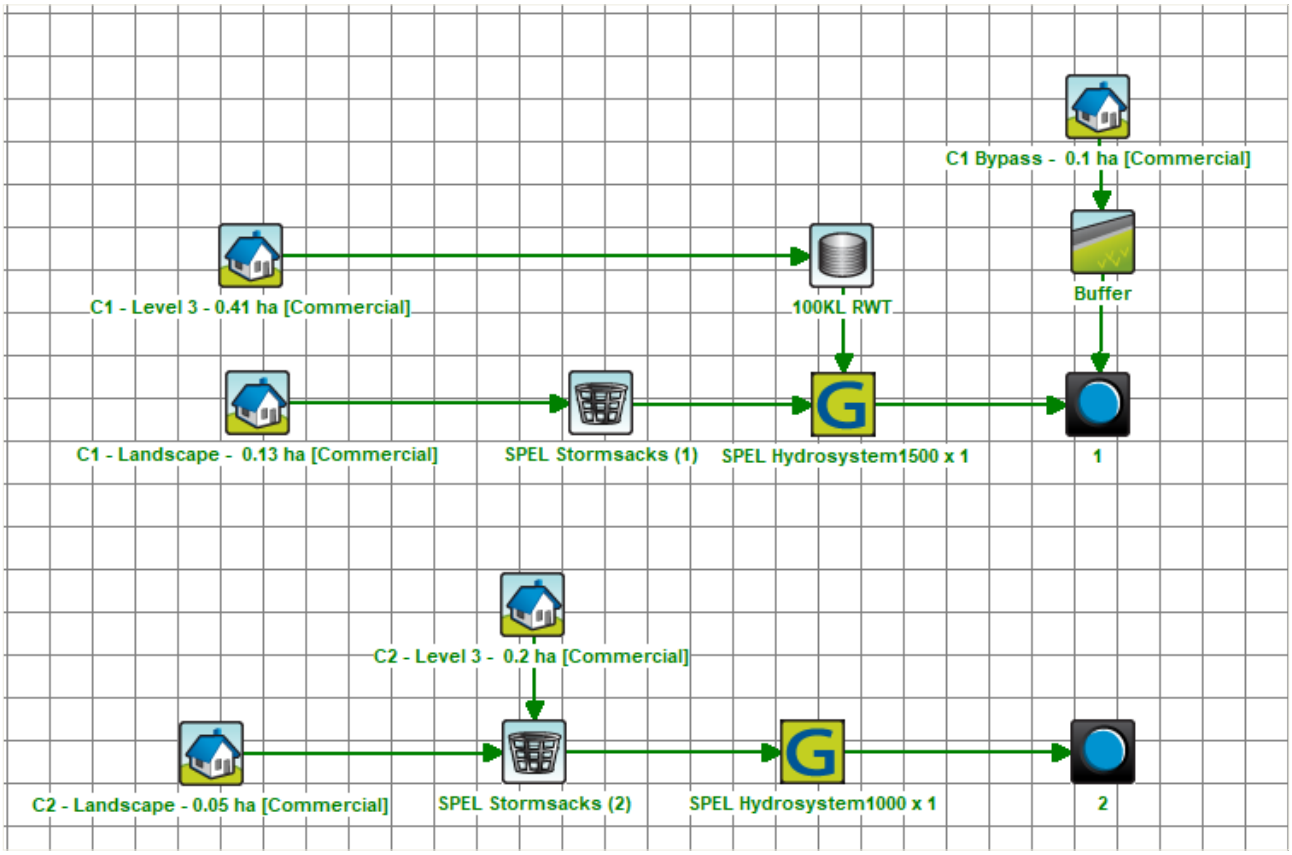

Figure 17 MUSIC model layout

The proposed water quality measures are incorporated in the stormwater plan. Refer to Civil Drawings C05 and C10 for details.

7.2.2 MUSIC Model Results

The proposed water quality treatment meets Council's water quality targets. Refer to Table 3 below.

Table 3. Pollutant Reduction Comparison

Pollutant Type	Catchment 1 MUSIC Results	Catchment 2 MUSIC Results	WCC WQ Targets
Total Suspended Solids - TSS	*85.8%*	*89.8%*	*85%*
Total Phosphorus - TP	*73.8%*	*76.3%*	*65%*
Total Nitrogen - TN	*51.1%*	*65.2%*	*45%*
Gross Pollutants - GP	*91.4%*	*99.3%*	*90%*

7.3 Climate Change Impact

Climate change is expected to have an adverse impact on rainfall intensities, which have the potential to have significant impact on flood behaviour at specific locations. Climate change projections in NSW are generated from the NSW and ACT Regional Climate Modelling (NARCliM) project.

The NARCliM projections for total rainfall for the Sydney Metropolitan Region is a decrease in spring and winter, and an increase in autumn and summer. The NARCliM projections for extreme rainfall are that both rainfall intensities and the frequency of extreme events will increase.

Current predictions for extreme rainfall are that peak rainfall intensity is likely to increase by up to 10%, however sensitivity analysis using an increase in peak rainfall of up to 30% has been adopted in accordance with Council's Flood Study.

Stormwater modelling has been completed to allow for possible impacts of climate change for the proposed development, with the impact of increased rainfall of 10%, 20% and 30%. The impacts of climate change do not have a significant increase in flooding within or adjacent to the development site. Refer to table 4 below.

Scenario	1% AEP Overland Flow (m^3/s)	Overland Flow Depth (mm)
Proposed Scenario	**0.549**	**0.24**
Proposed Climate Change Scenario with 10% increase in rainfall	**0.605**	**0.24**
Proposed Climate Change Scenario with 20% increase in rainfall	**0.660**	**0.25**
Proposed Climate Change Scenario with 30% increase in rainfall	**0.715**	**0.26**

Table 4. Comparison of 1% AEP Overland Flow for Existing, Proposed and Climate Change Scenarios

8.0 South-Eastern Easement Pipe Diversion

It is recommended that the existing easement entering the site from the east be diverted away from the proposed building footprint. This is to ensure the building structure causes no impact on the new easement stormwater pipe. The proposed diversion of the 450mm pipe is from new pit 3 to new pit 4 to new pit 5, which then connects to existing easement pit 6 via a 750mm pipe. The proposed easement pipe diversion is as shown below in Figure 18.

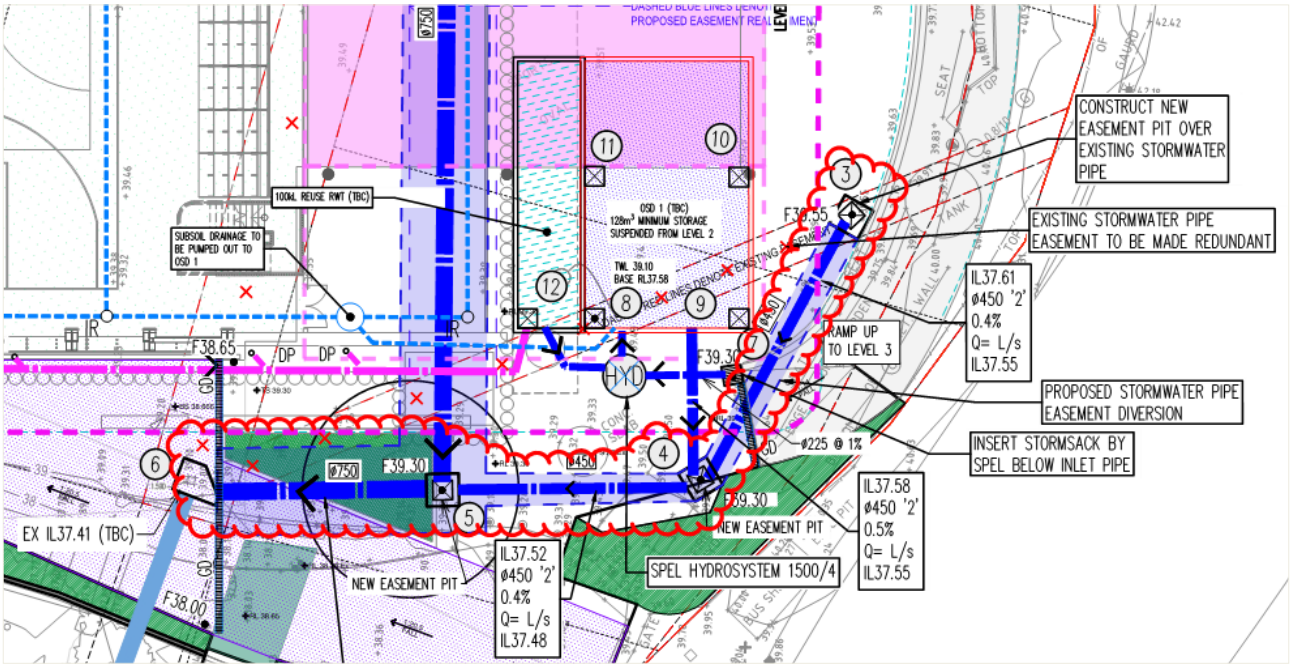

Figure 18 Proposed south-eastern easement pipe diversion

9.0 Conclusion and Recommendations

- The proposed northern pipe diversion allows the proposed sports hall and classroom precinct to be completed without any impact on the existing stormwater system.
- It is recommended to upgrade existing pipe located on the site from 450mm to 750mm to allow building over this line.
- For more accurate results, detailed survey information is required to develop more reliable DRAINS model.
- The proposed development is intended to have two on-site detention tanks and the above-mentioned water quality devices to meet Council's stormwater quantity and quality requirements. Refer to civil drawings for details.
- It is recommended that the south-eastern easement pipe be diverted as shown in Figure 18 above. The proposed eastern pipe diversion allows the proposed building to be completed without any impact on the existing stormwater system.

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Technical Director

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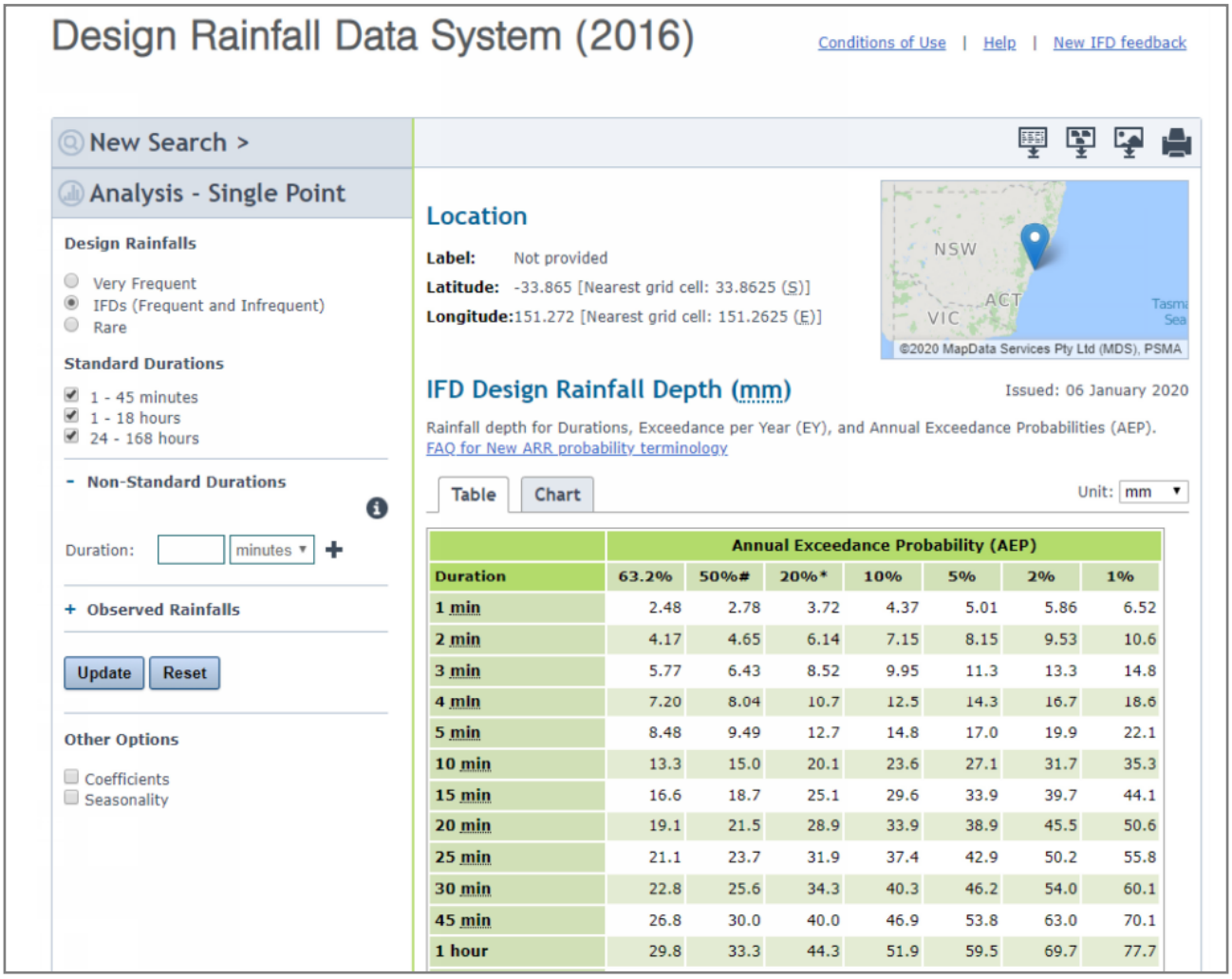
Appendix A

BOM IFD DATA



Design Rainfall Data System (2016)

Conditions of Use | Help | New IFD feedback

New Search >

Analysis - Single Point

Design Rainfalls

- Very Frequent
- IFDs (Frequent and Infrequent)
- Rare

Standard Durations

- 1 - 45 minutes
- 1 - 18 hours
- 24 - 168 hours

- Non-Standard Durations

Duration: minutes +

+ Observed Rainfalls

Update Reset

Other Options

- Coefficients
- Seasonality

Location

Label: Not provided

Latitude: -33.865 [Nearest grid cell: 33.8625 (S)]

Longitude: 151.272 [Nearest grid cell: 151.2625 (E)]

IFD Design Rainfall Depth (mm)

Issued: 06 January 2020

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart

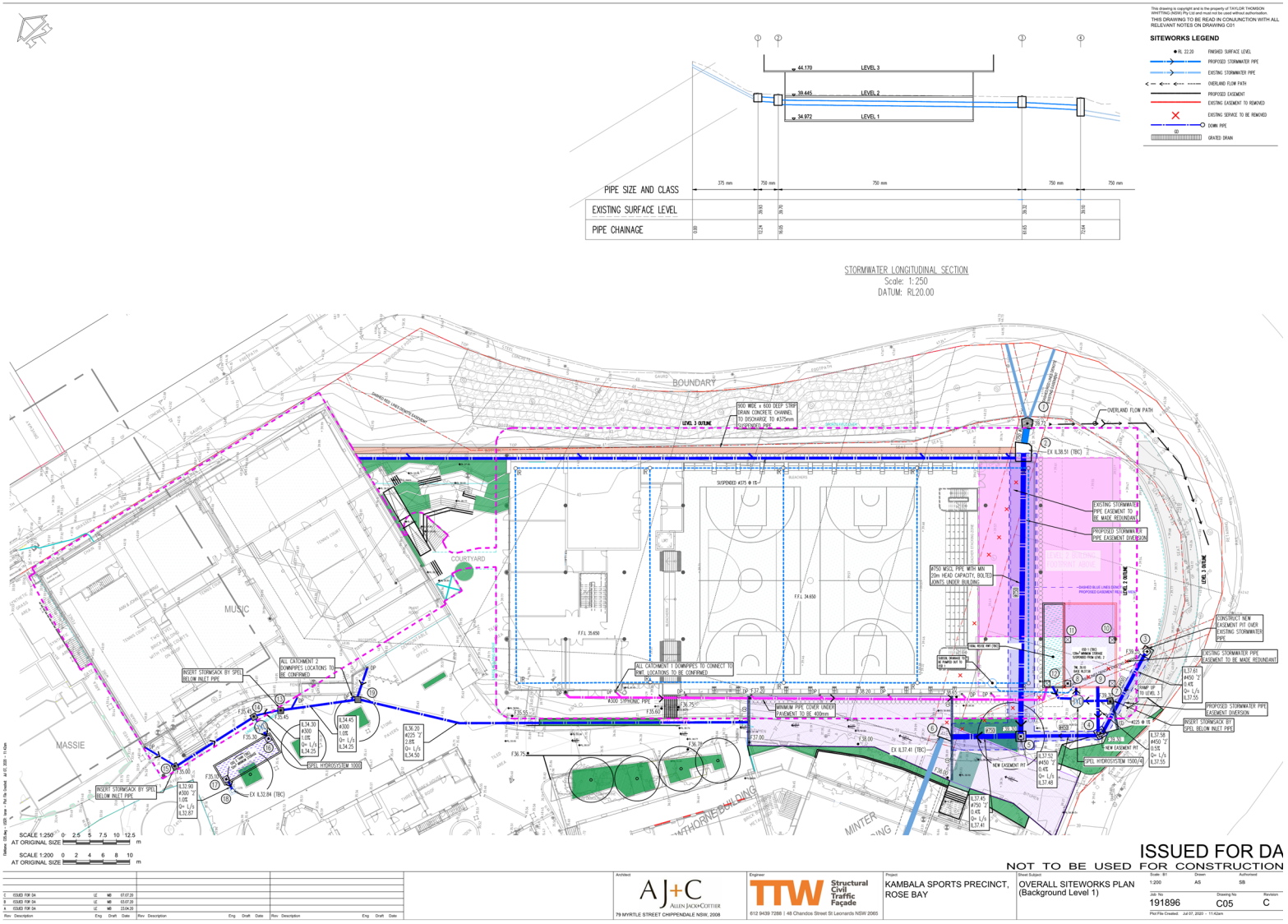
Unit: mm

	Annual Exceedance Probability (AEP)						
Duration	63.2%	50%#	20%*	10%	5%	2%	1%
1 min	2.48	2.78	3.72	4.37	5.01	5.86	6.52
2 min	4.17	4.65	6.14	7.15	8.15	9.53	10.6
3 min	5.77	6.43	8.52	9.95	11.3	13.3	14.8
4 min	7.20	8.04	10.7	12.5	14.3	16.7	18.6
5 min	8.48	9.49	12.7	14.8	17.0	19.9	22.1
10 min	13.3	15.0	20.1	23.6	27.1	31.7	35.3
15 min	16.6	18.7	25.1	29.6	33.9	39.7	44.1
20 min	19.1	21.5	28.9	33.9	38.9	45.5	50.6
25 min	21.1	23.7	31.9	37.4	42.9	50.2	55.8
30 min	22.8	25.6	34.3	40.3	46.2	54.0	60.1
45 min	26.8	30.0	40.0	46.9	53.8	63.0	70.1
1 hour	29.8	33.3	44.3	51.9	59.5	69.7	77.7

Note:
 # The 50% AEP IFD does not correspond to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.

** The 20% AEP IFD does not correspond to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.*

Appendix B



Appendix C

Photo of Bayview Hill Road and New South Head Road Junction