Structural & Civil Engineering

STORMWATER MANAGEMENT PLAN (WATER SENSITIVE URBAN DESIGN)

Salesian College, Chadstone

Job Reference: 233026

Prepared for: McIldowie Partners

ATTENTION:

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Document Control

Version	Date	Author	
V8	8 May 2024	Daniel Herbert	

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1 Introduction

BCE Design has been engaged by McIldowie Partners to provide a stormwater management strategy report for the proposed upgrade and extension works at Salesian College, Swanson Crescent campus, Chadstone.

This report addresses the Water Sensitive Urban Design response for the proposed works. comprising of the following design elements:

- Addition to and modification to existing School Buildings
- New on-grade carpark.

The report is also intended to satisfy the Stormwater Management Policy (Water Sensitive Urban Design) Clause 22.18-4, and clause 53.18 Stormwater Management in Urban Development.

The purpose of this report is to demonstrate:

- The hydrological and hydraulic analysis supporting the Strategy.
- The indicative drainage conditions of the developed site.
- Compliance with retardation and stormwater treatment requirements.
- Provide stormwater management initiatives for the project during the construction phase of the development.

This report further identifies specific requirements for the stormwater drainage system as required by City of Monash:

- Identification and evaluation of the existing drainage on the site.
- Propose a Legal Point of Discharge (LPOD).
- Present an underground drainage system for minor flows to the proposed LPOD.
- Present measures to improve the stormwater discharge quality from the site in accordance with '*Melbourne Water'* WSUD Guidelines which may include:
    - Reuse tanks.
    - Onsite detention.
    - Onsite treatment.
- Assess the major drainage network catering for the 1 in 100-year (1% AEP) storm event to pass through the development site without causing damage or nuisance to the adjoining lots.
- Assess the minor drainage network catering for the 1 in 10-year (10% AEP) storm event to pass through the development site without causing damage or nuisance to the adjoining lots.

- All areas of the development being drained by means of an underground drainage system to retain a post-development 10% Annual Exceedance Probability storm event for the critical storm duration. Discharge from the site must be limited to an equivalent pre-development flow based on a 1 in 5 Year (20% AEP) storm event for the critical storm duration and be connected to the existing Council's drainage system.

1.1 Project Site

The project site associated with Salesian College, Chadstone is bound by residential dwellings to the east, west and south. The Monash Freeway is to the north. The Campus is accessed via Swanson Crescent to the west.

Figure 1.0: Existing Site – Salesian College Chadstone

1.2 Site Description

The project site is generally sloping towards the Monash Freeway, with the buildings of the campus located on raised platforms. The site is currently occupied by the school building and sports ovals.

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1.3 Development Summary

Address:	Salesian College, Chadstone.
Type:	New school Building and an extension to an existing school building.
Total area:	52,500m^2. (estimated)
Site pervious area:	43,987m^2 (Landscaping).
Site impervious area:	5,778m^2 (Existing Roofs and Pavements),
	8,513m^2 (Existing and proposed Roofs and Pavements),
Buildings:	3 School / Sports type Buildings
	6 School / Sports type Buildings (proposed)

- Extension to the existing Year 8 Building (104m^2).
- New Year 7 Building (1,661m^2).
- Canteen (95m^2).
- Covered Walkway (183m^2).
- Bus Shelter and Bike Shed (251m^2).
- New on-grade carpark (461m^2).
- New pavements and footpaths (1,932m^2).

1.4 Existing and Proposed Drainage System

There is an existing internal drainage network to this site associated with the existing building.

Generally, all concrete and asphalt footpath pavements associated with the retained existing buildings are of a non-permeable nature and fall towards existing drainage points or lawned / garden areas.

Paths surrounding the ‘ovals’ are typically of a permeable nature and fall towards the lawned / garden areas.

The roof drainage associated with the original dwelling will remain in its current condition.

The new roofs associated with the new building and the extension works will be directed towards a new reuse tank, with over-flow discharging onto the existing drainage network. Prior to discharging the to the existing LPOD the new building and associated carpark will discharge via a new gross pollutant trap.

Given the nature of the site and the development, there is a nett change in permeable surfaces vs impermeable surfaces suggesting that some on-site detention would be required for the buildings and pavements associated with the development.

Table 1: Existing Drainage Network Capacities

Road	Pipe Size	Pipe Capacity (m^3/s)
Internal Drainage System	300 dia (1 in 100est.) (1)	0.097 (2)
Swanson Street	375 dia (1 in 100est.) (1)	0.175 (2)
Kerb and Channel	N/A	0.0065 (3)

(1) Pipe capacities are based on Manning's formula and assumed pipe gradients based on provided survey surface data information.

(2) Refer to proposed drainage network associated with overall development.

(3) Typically accepted maximum allowable flow rate for kerb and channel connections.

1.5 Proposed Developed Site

The proposed development site is shown on the layout below. The site will have approximately 8,513m^2, (16.2%) impermeable surfaces. Permeable finishes will be located on Ground floor / surface level will have a total permeable surface area of approximately 43,987m^2,(83.8%).

Conversely, this is comparable to the existing condition with 5,778m^2 (11%) impervious surfaces and 46,722m^2 (89%).

The development will comprise of six (6) school type buildings inclusive of a new covered walkway and open space / landscaping.

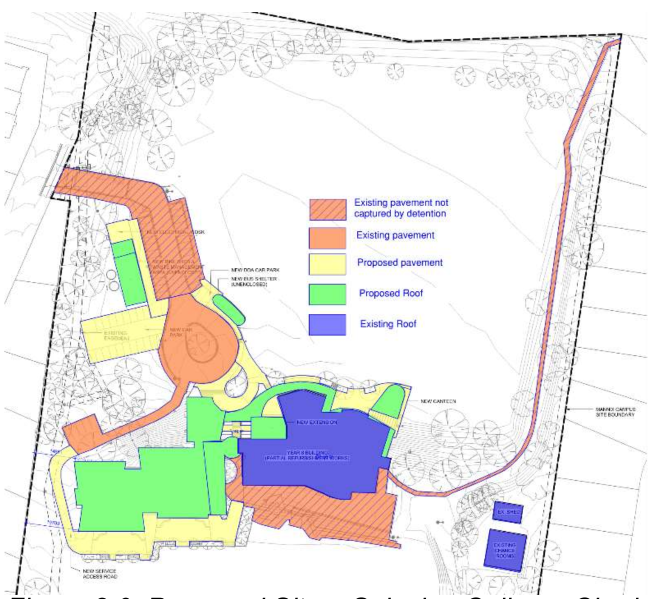


Figure 2.0: Proposed Site – Salesian College, Chadstone

The developed and existing site will grade to the north towards the Monash Freeway. The new carpark will grade west, towards Swanson Crescent.

The developed site will consist of the following drainage components:

- A minor internal drainage system capable of accommodating 10% AEP (1 in 10 Year ARI) peak flow in the form of grated pits, floor wastes and pipe networks.

- A detention system capable of restricting the post development flows to predevelopment flow levels. (Predevelopment flow rates of 1 in 5 year (20% AEP), as post development storage rates of 1 in 10 year (10% AEP).

- A major overland flow drainage system conveying the 1 % AEP (1 in 100 Year ARI) peak flow event.

- An existing legal point of discharge is located on Swanson Crescent.

Additionally, 'Water Sensitive Urban Design' initiatives will be incorporated to treat the stormwater associated with the extension works to the satisfaction of the City of Monash.

'Water Sensitive Urban Design' (WSUD) initiatives may include:

- Onsite retention.
- Onsite detention.
- Gross Pollutant traps and / or Rain Gardens.

We additionally note:

- Proposed measures to enhance stormwater discharge quality from the site in accordance with Melbourne Water WSUD guidelines are utilised in the design.

- A major drainage network catering for the 1% AEP storm event to pass through the development without causing damage or nuisance to adjacent lots.

1.6 Hydrologic and Hydraulic Analysis – Flow Calculations

BCE has utilised the Rational Method to undertake flow calculations to estimate the sizing of the internal drainage network.

The following parameters have been used in the assessment of the proposed development site:

- Tc = 10, Tcs = 7.5, 1 in 5-year storm (5% AEP), Id = 65.2mm/hr

- Tc = 10, Tcs = 7.5, 1 in 10-year storm (10% AEP), Id = 77.2mm/hr

We note, the internal underground drainage network has been designed to support a 10% AEP peak flow event.

We additionally note, the above and below values are consistent with information generally provided by City of Monash. Any flows that exceed this will be via overland flow mechanisms.

Table 2: Tributary Calculation Summary

	Carpark	Y7 Building & Y8 Add.	New Pavements
Catchment size	461 m^2	2,077 m^2	1,471 m^2
Impervious Fraction	0.90	0.900	0.900
Peak Flow 20% AEP	0.0029m^3/s	0.0011m^3/s	0.0045m^3/s
Peak Flow 10% AEP	0.0150m^3/s	0.0653m^3/s	0.048m^3/s

Based on the above assessment onsite detention will be required to ensure predevelopment flows area maintained.

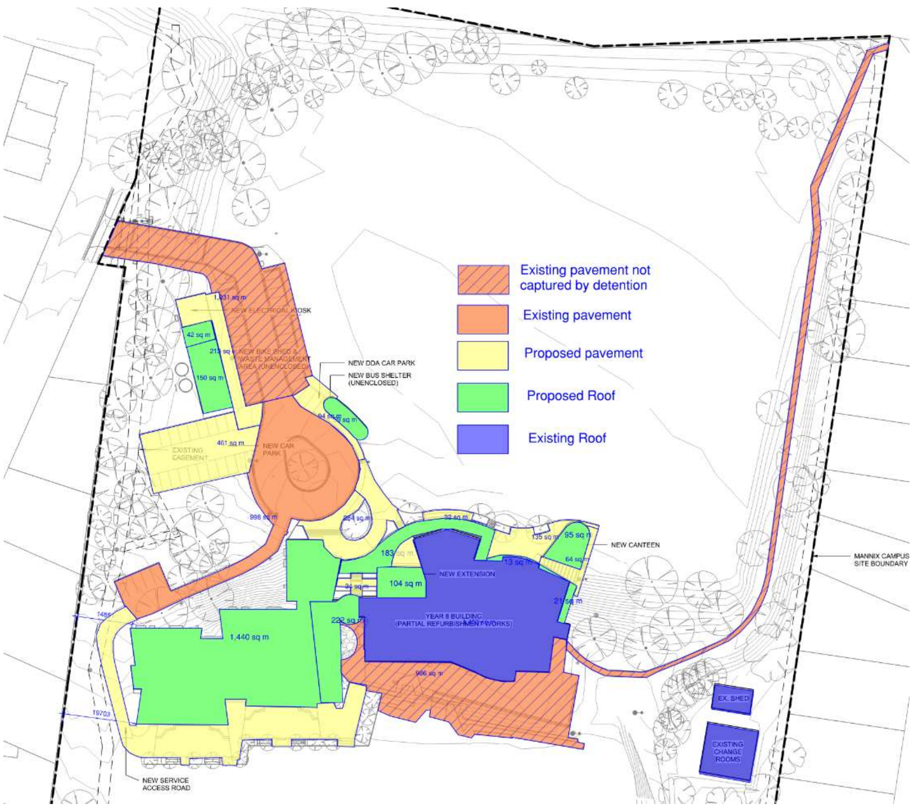


Figure 3: School Building - Catchment Areas

1.7 Minor Drainage Assessment

Approximately 2,077m^2 of the proposed development is roof area, with an additional 251m^2 of additional roof associated with the bike shed and bus shelter, and 1,932m^2 is pavement area associated with the new carpark and paths/ pavement around the proposed school buildings, noting that some of these new pavements are also replacing existing pavements that are to be removed as part of the Year 7 and Year 8 building works (1,453m^2).

Typically, flow from all new roof surfaces will be conveyed via downpipes to and above ground reuse tanks that will overflow to the inground drainage system. These flows will then combine with the existing roofs and ground floor surfaces and pavement minor flows and discharge to the existing LPOD's via the existing internal drainage systems associated with the site.

Additionally, a small portion if the new roof (222m^2) will discharge to a rain garden with a surface area of not less than 5.0m^2 and then overflow for the inground system. The new canopies and roof over the canteen (421m^2), will also discharge to a rain garden with a surface area of not less than 9.0m^2.

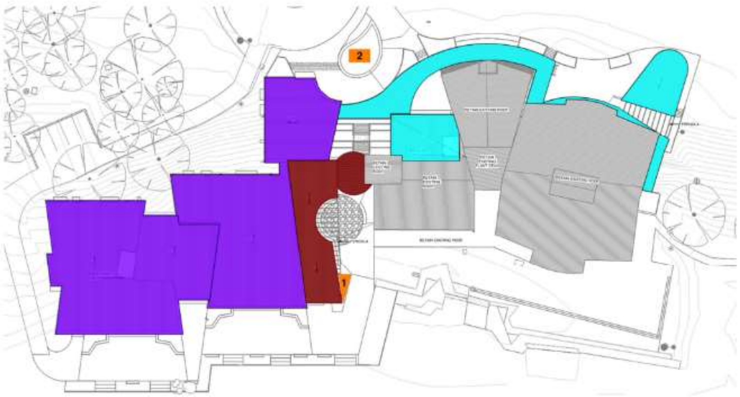


Figure 1: Rainwater harvesting schematic.

(purple)	New Roof to 10,000L rainwater Tank: 1381 m^2 (Rainwater tank location - Architect to confirm location)
(dark red)	New Roof to 5 m^2 raingarden: 222 m^2 ('**1**' Raingarden indicative location only- Architect to confirm location)
(cyan)	New Canopy and Roof to 9 m^2 raingarden: 421 m^2 ('**2**' Raingarden indicative location only- Architect to confirm location)
(orange)	Raingardens' indicative location (indicative location only- Architect to confirm location)

Figure 4: Proposed Rainwater Harvesting Tributary Area's

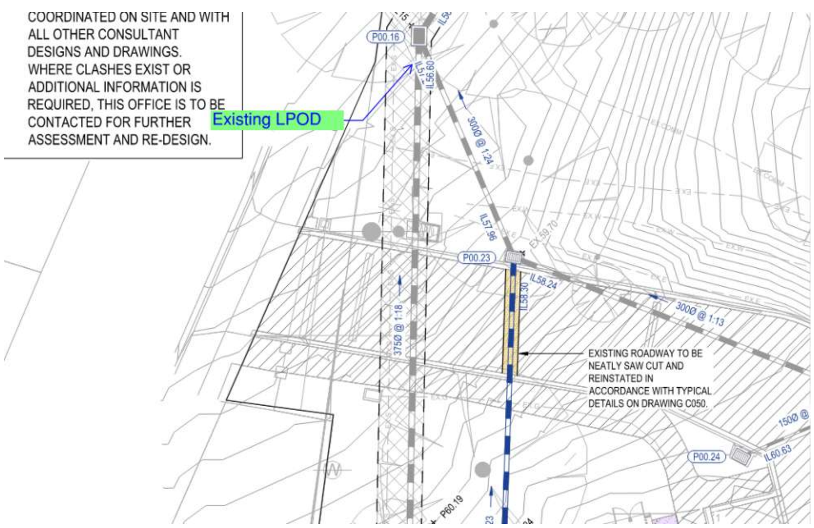


Figure 5: Proposed Legal Point of Discharge

1.8 Major Drainage Assessment

Flows that exceed the 1% AEP storm event will be provided for via overland flow. This typically occurs when roof drainage, downpipe capacity is exceeded in major storm events with overflowing of the subsurface and aerial drainage networks potentially occurring.

Flows that exceed the 1% AEP event will be catered for via overland flow and drained primarily towards the existing oval north of the project site. Residual surface flows from the southern portion of the project will drain south towards the existing southern oval also.

The generally the existing pavements and footpaths are currently draining towards the significant landscaping associated with the site. The existing carparks and road networks drains to the existing internal drainage network

Major event flow paths and discharge points from the site are shown in figure 6.

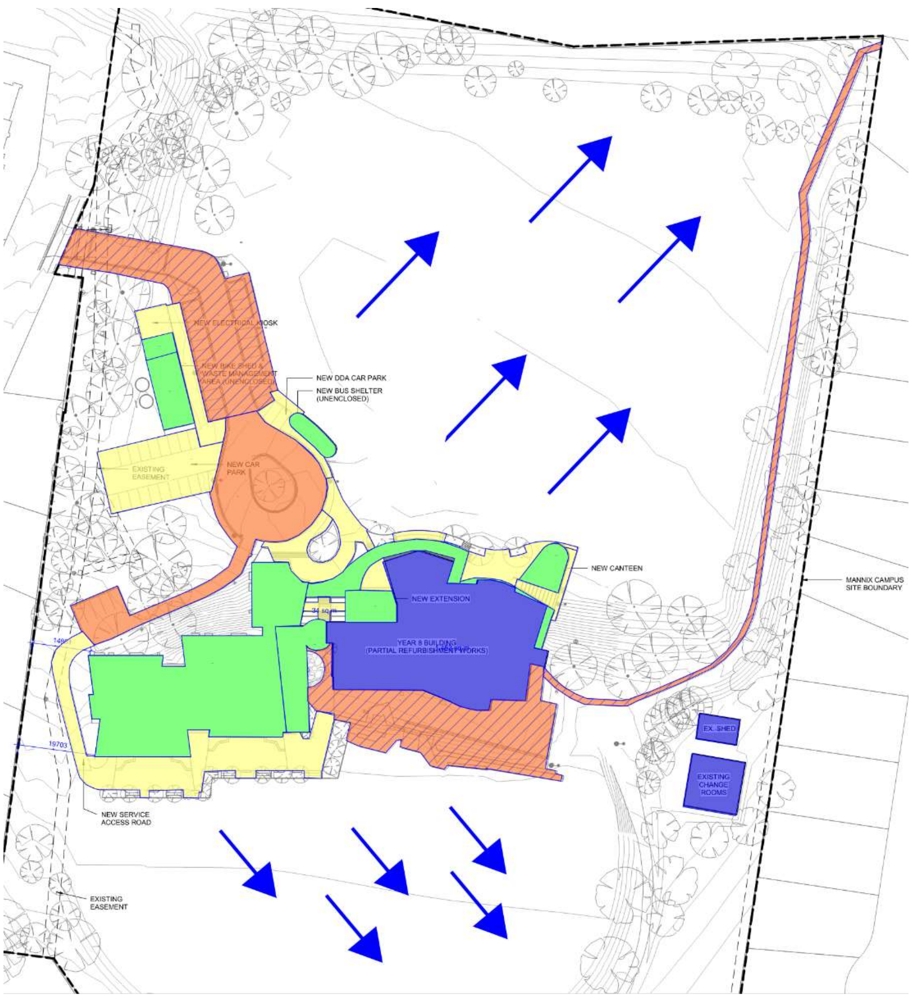


Figure 6: Major overland flow paths

1.9 Stormwater Quality

The improvement of stormwater quality as required by *Melbourne Water WSUD guidelines* Water Sensitive Urban Design (WSUD) treatment initiatives are proposed to reduce pollutants such as suspended solids, gross pollutants, phosphorus, and nitrogen within the projects stormwater network.

Given the nature of proposed building, it is assumed a minimum occupancy of based on:

- Approximately 100 occupants (minimum, noting the maximum occupancy for the Storm Calculation prepared in the SMP).

Potential treatment initiatives include:

- Rainwater harvesting and re-use tanks.
- Gross pollutant traps, Infiltration strips or Rain gardens.

Based on the assessment of the proposed allotments the following treatment initiatives are proposed for each of the allotments to achieve a 103% StormRating.

Table 3: Stormwater Treatment Summary

	Carpark & Pavements	Year 7 Bld. & Y8	Canteen and Canopy
Rainwater tanks	Nil m^3	10.0 m^3	Nil m^3
Raingarden	Gross Pollutant Trap	5.0 m^2	9.0 m^2

As with the retardation of stormwater flows via detention system, treatment initiatives can be achieved using WSUD assets above ground or underground, alongside reuse systems such as rainwater tanks, buffer strips and raingardens. Alternatively, equivalent underground proprietary products could be adopted for the treatment of stormwater discharge prior to entering the local authority drainage system.

1.10 On site detention requirements (OSD)

As per typical City of Monash requirements to mitigate post development flows to the 20% AEP (1 in 5 year) pre-development rate, with connections to the City of Monash Council stormwater infrastructure being limited to 10% AEP (1 in 10 year) storm event.

The Swinburne method was used to determine the combined 20% AEP (1 in 5 year) pre-development flow of 0.0213m^3/s was determined for the overall development. A combined 10% AEP post-development flow was determined to be 0.146m^3/s.

Based on the above, detention is required to restrict the post development flows to predevelopment levels.

Detention tanks / inground pipes will be located between the proposed legal point of discharges and the internal drainage networks for each of the allotments.

The required storage was calculated using the Swinburne Method. (Refer Appendix 2). The estimated pre and post development flows and associated storage are indicated in Table 6 below.

Table 4: Detention Calculation Summary

Parameter	Pre-Development	Post-Development	Detention Volume
Carpark	$0.0029m^3/s$	$0.0150m^3/s$	$6.29m^3$
Year 7 & 8 Building addition	$0.0107m^3/s$	$0.0653m^3/s$	$23.03m^3$
Pavements	$0.0045m^3/s$	$0.0480m^3/s$	$29.80m^3$
Canopy and Canteen	$0.0019m^3/s$	$0.0107m^3/s$	$4.25m^3$
Bus Shelter and Bike Shed	$0.0016m^3/s$	$0.0082m^3/s$	$3.42m^3$

The required onsite detention can be achieved with the application of detention tanks or detention pipes embedded into the internal drainage network

The on-site detention storage will be located adjacent the LPOD where applicable and if structure allows.

1.11 Design Summary

The information contained within this stormwater management plan demonstrates the required stormwater network is sufficient to satisfy City of Monash requirements.

The following summary supports this position:

- Re-use tanks connected to irrigation and toilet flushing with a minimum combined volume of $10.0m^3$.
- All flows up to the 10% AEP event will be catered for via the internal drainage network and discharged to the LPOD at predevelopment rate.
- All flows that exceed 10% AEP event will be catered for via overland flows.
- Stormwater discharge from the site will be retarred via onsite detention, A combined minimum detention volume of $66.79m^3$ will need to be allowed for.
- Flows that exceed the 1% AEP event will be catered for via overland flow and drained primarily towards the existing oval north of the project site. Residual surface flows from the southern portion of the project will drain south towards the existing southern oval also.
- Gross Pollutant traps and Raingardens with a minimum surface area of $14m^2$ to treat stormwater prior to entering the authority drainage system.

2 Stormwater Management Response

2.1 Response Summary

The selected response is to direct all roof rainfall runoff to subterranean rainwater tanks of the development where stormwater will be used for water supply to facility equipment. Final tank sizes will be subject to actual plant requirements.

3 Detailed Response

3.1 Site Layout

Requirement

"To illustrate the position, area draining to treatment measures, and any connection points of the following":

- Harvesting and Reuse Measures, including rainwater tanks.
- Water Quality Treatment Measures may include wetlands, rain gardens and swales.
- Infiltration Measures, including infiltration trenches and porous paving.
- Passive Irrigation Measures, including directing runoff into gardens.

Response

A detailed site layout is provided in Appendix's.

3.2 Proposed Response (Operation Phase)

Requirement

To summarise how the Stormwater Management (Water Sensitive Urban Design Policy) requirements are met. To assess performance via an industry-accepted tool. Outcomes of the policy are listed in Appendix 8.

Response

The proposed development makes use of water harvesting and re-use to meet Water-Sensitive Urban Design (WSUD) initiatives.

- All rainfall on roof new areas is directed to rainwater tanks subject to finalized water supply information from plant operators/ suppliers.
- Rain heads and first flush diverters will be installed to ensure any initial sediment flow, into the rainwater tanks is minimized.
- Selected toilets and garden irrigation will be supplements by harvested rainwater for the rainwater tanks.
- The garden beds which are exposed are considered permeable and allow direct ground infiltration.

3.3 Site Management Plan (Construction Phase)

Requirement

"Details specifying measures aimed at preventing sediment, pollution and litter entering stormwater systems. To advise for preparation of the WSUD site management plan".

Response

Principles from the EPA Environmental Guidelines. These principles and measures are intended to reduce runoff to adjacent properties and reduce erosion. Any waste accumulated during construction, including chemicals and food waste is to be disposed of correctly using best practice measures, described below.

Principles:

- Minimise any disturbance of land.
- Minimise time bare earth is exposed.
- Install features such as rock, vegetation, grass, etc as early as possible.
- Minimise stormwater run-off into and within site.
- Divert stormwater from exposed parts of site.
- Devise solutions for possible peak run-off flows.
- Position earth stockpiles away from run-off pathways.
- Ensure stockpiles have mild slopes (max 1:2 height to radius).

Measures:

The following measures will be implemented as required to achieve the principles listed above.

- **Mesh fabric** to minimise sediment flow, placed at porous fences and gates.
- **Silt fences** to prevent large sediment transport by installation at the base, where the site has a slope steeper than 1:20.
- **Drain filters/sediment traps** to cover pits. Any water pumped from the site must be filtered with this method.
- **Temporary down pipes** to facilitate runoff from the roof to LPOD during construction prior to installation of water tanks.
- **Crushed Rock** to stabilise site and prevent access issues on foot due to mud, as well as stabilise areas subject to heavy vehicle use.
- **Removal of mud on the cross-over and roadway** to contain mud to construction site. Maintained by removing mud from vehicles on site on the day the mud is deposited.
- **Vehicle wash down within site** to remove earth gathered from excavation.
- **Erosion control blankets** to control erosion over mounded earth, especially over any steep slopes.
- **Waste bins** to be provided for personnel as appropriate.
- **Proper disposal of paints and solvents**, to allow safe removal and disposal, separate bins will be used as appropriate.
- **Brick cleaning with acid to be avoided**, particularly on-site.

Additionally, the contractor is required to:

- **Identify and document**, where these measures are to be fitted and how erosion and waste will be managed.
- **Fit tarps on waste bins** each night.
- **Avoid overfilling vehicles** and cover soils being taken offsite.
- **Sweep the site** each day works occurs.
- **Ensure sediment and erosion measures** are operating appropriately via weekly checks and maintenance.

Figure A. Temporary downpipes (image credit: Northumberland Handyman Supplies Pty Ltd)

Figure B. Sediment trap (image credit: ERTEC Environmental Systems)

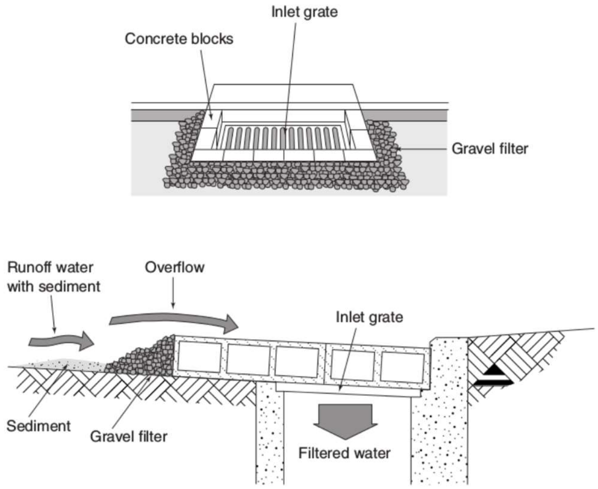


Figure D. Sediment trap (image credit: Delta T Solutions)

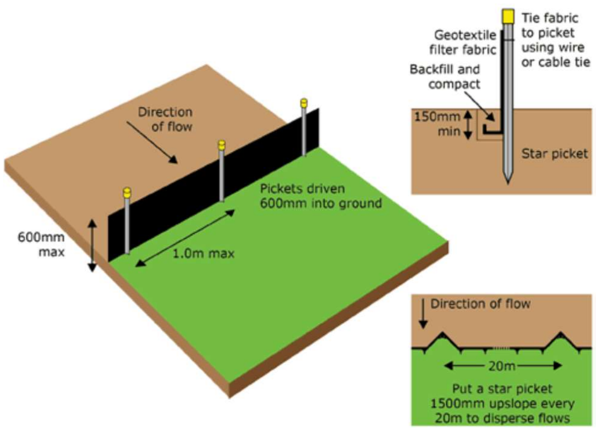


Figure E. Silt fence installation (image credit: Melbourne Water via EPA Victoria 2004, Publication 960 p.30)

Figure F. Silt Fence (image credit: US EPA, 2008)

3.4 Maintenance Plan (Operation Phase)

Requirement

An outline of maintenance and operational measures, which are used to ensure the proper operation of all systems.

Response

Rainwater Harvesting System

1. Roofs are to be regularly checked for debris and leaves. Some pruning may be advised.

2. First flush measures are to be checked and cleaned if appropriate every 3-6 months.

3. Screens are to be inspected every 6 months at inlet and overflow points from the tank.

4. Sludge is to be removed when the colour or smell of the tank output is significantly impacted (sludge on the tank walls is part of the purification process). Generally, this may occur when tank water levels are low.

5. Pumping systems should be checked and maintained according to the manufacturer's specifications.

6. Filters are to be checked and maintained according to the manufacturer's specifications.

7. Implementation of the maintenance schedule is the responsibility of the owner.

References

1. EPA Environmental Guidelines for Major Construction Sites, Victorian Environmental Protection Authority 1996 http://www.epa.vic.gov.au/~/media/Publications/480.pdf

2. Urban Stormwater: Best Practice Environmental Management Guidelines, CSIRO, 1999, http://www.publish.csiro.au/pid/2190.htm

Appendix 1: Assessment of the Existing Stormwater System

Internal Drainage Network

DRAINAGE V5.00 BCE Design Pty Ltd

Summary: **(Drainage Design DD01) Flow in 300mm dia. pipe at 1 in 100 (n=0.013) = 96.70l/s**

Pipe Flow (ARR Book VII Cl 1.6.3)

Diameter (D) =	300	mm
Grade (S) = 1 in	100	
Manning number (n) =	0.013	
$Q = 1.0/n*A*R^{2/3}*S^{1/2}$ =	96.70	l/s

External Drainage Network

DRAINAGE V5.00 BCE Design Pty Ltd

Summary: **(Drainage Design DD01) Flow in 375mm dia. pipe at 1 in 100 (n=0.013) = 175.33l/s**

Pipe Flow (ARR Book VII Cl 1.6.3)

Diameter (D) =	375	mm
Grade (S) = 1 in	100	
Manning number (n) =	0.013	
$Q = 1.0/n*A*R^{2/3}*S^{1/2}$ =	175.33	l/s

Appendix 2: Detention Calculations

School Building

STORMWATER DETENTION V5.05 BCE Design Pty Ltd

Location:	**Melbourne, VIC**
Site:	**2077m² with tc = 10 and tcs = 7.5 mins.**
PSD:	**ARI of 5 years, Underground rectangular tank PSD = 17.72L/s**
Storage:	**ARI of 10 years, Underground rectangular tank volume = 23.04m³**

Design Criteria

Location =	Melbourne, VIC	
Method =	A	(A)RI 2001,A(E)P 2019
PSD average recurrance interval (ARI) =	5	years
Storage average recurrance interval (ARI) =	10	years
Storage method =	U	(A)bove,(P)ipe,(U)nderground,(C)ustom

Site Geometry

Site area (As) =	2077	m²	=	0.2077 Ha
Pre-development coefficient (Cp) =	0.48			
Post development coefficient (Cw) =	0.90			
Total catchment (tc) =	10	minutes		
Upstream catchment to site (tcs) =	7.5	minutes		

Coefficient Calculations

Pre-development

Zone	Area (m²)	C	Area * C
Concrete	485	0.90	437
Roof	0	0.90	0
Gravel	0	0.30	0
Garden	1592	0.35	557
Total	2077	m²	994

Cp = ΣArea*C/Total = 0.478

Post development

Zone	Area (m²)	C	Area * C
Concrete	0	0.90	0
Roof	2077	0.90	1869
Gravel	0	0.30	0
Garden	0	0.17	0
Total	2077	m²	1869

Cw = ΣArea*C/Total = 0.900

Permissible Site Discharge (PSD) (ARI of 5 years)

PSD Intensity (I) =	65.2	mm/hr	For catchment tc = 10 mins.	
Pre-development (Qp = Cp*I*As/0.36) =	18.00	L/s		
Peak post development (Qa = 2*Cw*I*As/0.36) =	67.71	L/s	=(1.039 x I)	Eq. 2.24
Storage method =	U	(A)bove,(P)ipe,(U)nderground,(C)ustom		
Permissible site discharge (Qu = PSD) =	17.719	L/s		

Above ground - Eq 3.8

$0 = PSD^2 - 2*Qa/tc*(0.667*tc*Qp/Qa + 0.75*tc+0.25*tcs)*PSD + 2*Qa*Qp$

Taking x as = PSD and solving

a = 1.0 b = -151.0 c = 2437.2

PSD = $-b\pm\sqrt{b^2-4ac}/(2a)$

PSD = 18.382 L/s

Below ground pipe - Eq 3.3

$Qp = PSD*[1.6*tcs/\{tc*(1-2*PSD/(3*Qa))\}-0.6*tcs^{2.67}/\{tc*(1-2*PSDp/(3*Qa))\}^{2.67}]$

= 18.00

PSD = 18.173 L/s

Below ground rectangular tank - Eq 3.4

$t = tcs/\{tc*(1-2*PSD/(3*Qa))\}$ = 0.908

$Qp = PSD*[0.005-0.455*t+5.228*t^2-1.045*t^3-7.199*t^4+4.519*t^5]$

= 18.00

PSD = 17.719 L/s

School Building

STORMWATER DETENTION V5.05

BCE Design Pty Ltd

Design Storage Capacity (ARI of 10 years)

Above ground (Vs) = [0.5*Qa*td-[(0.875*PSD*td)(1-0.917*PSD/Qa)+(0.427*td*PSD²/Qa)]]*60/10³ m³ — Eq 4.23

Below ground pipe (Vs) = [(0.5*Qa-0.637*PSD+0.089*PSD²/Qa)*td]*60/10³ m³ — Eq 4.8

Below ground rect. tank (Vs) = [(0.5*Qa-0.572*PSD+0.048*PSD²/Qa)*td]*60/10³ m³ — Eq 4.13

td (mins)	I (mm/hr)	Qa (L/s)	Above Vs (m³)	Pipe Vs (m³)	B/G Vs (m³)
5	103.3	107.3			13.09
11	73.9	76.7			18.76
15	63.5	65.9			20.75
18	57.8	60.0			21.72
21	53.2	55.2			22.37
24	49.4	51.3			22.78
27	46.2	48.0			22.99
31	42.7	44.4			23.03
34	40.5	42.0			22.92
37	38.5	40.0			22.70

Table 1 - Storage as function of time for ARI of 10 years

Type	td (mins)	I (mm/hr)	Qa (L/s)	Vs (m³)
Above				
Pipe				
B/ground	29.7	43.8	45.5	**23.04**

Table 2 - Storage requirements for ARI of 10 years

Frequency of operation of Above Ground storage

Qop2 = 0.75 Cl 2.4.5.1

Qp2 =Qop2*Qp1 (where Qp1=PSD) = 13.79 L/s at which time above ground storage occurs

I = 360*Qp2/(2*Cw*As*10³) = 13.3 mm/h — Eq 4.24

Period of Storage

Time to Fill:

Above ground (tf) = td*(1-0.92*PSD/Qa) — Eq 4.27

Below ground pipe (tf) = td*(1-2*PSD/(3*Qa)) — Eq 3.2

Below ground rect. tank (tf) = td*(1-2*PSD/(3*Qa)) — Eq 3.2

Time to empty:

Above ground (te) = (Vs+0.33*PSD²*td/Qa*60/10³)*(1.14/PSD)*(10³/60) — Eq 4.28

Below ground pipe (te) = 1.464/PSD*(Vs+0.333*PSD²*td/Qa*60/10³)*(10³/60) — Eq 4.32

Below ground rect. tank (te) = 2.653/PSD*(Vs+0.333*PSD²*td/Qa*60/10³)*(10³/60) — Eq 4.36

Storage period (Ps = tf + te) — Eq 4.26

Type	td (mins)	Qa (L/s)	Vs (L/s)	tf (mins)	te (mins)	Ps (mins)
Above						
Pipe						
B/ground	29.7	45.5	23.0	22.0	67.7	89.7

Table 3 - Period of Storage requirements for ARI of 10 years

Carpark

STORMWATER DETENTION V5.05

BCE Design Pty Ltd

Location: Melbourne, VIC
Site: 461m² with tc = 10 and tcs = 7.5 mins.
PSD: ARI of 5 years, Underground rectangular tank PSD = 2.91L/s
Storage: ARI of 10 years, Underground rectangular tank volume = 6.29m³

Design Criteria

Location = Melbourne, VIC
Method = A (A)RI 2001,A(E)P 2019
PSD average recurrance interval (ARI) = 5 years
Storage average recurrance interval (ARI) = 10 years

Storage method = U (A)bove,(P)ipe,(U)nderground,(C)ustom

Site Geometry

Site area (As) = 461 m² = 0.0461 Ha
Pre-development coefficient (Cp) = 0.35
Post development coefficient (Cw) = 0.90

Total catchment (tc) = 10 minutes
Upstream catchment to site (tcs) = 7.5 minutes

Coefficient Calculations

Pre-development

Zone	Area (m²)	C	Area * C
Concrete	461	0.35	161
Roof	0	0.90	0
Gravel	0	0.30	0
Garden	0	0.17	0
Total	461 m²		161

Cp = ΣArea*C/Total = 0.350

Post development

Zone	Area (m²)	C	Area * C
Concrete	0	0.90	0
Roof	461	0.90	415
Gravel	0	0.30	0
Garden	0	0.17	0
Total	461 m²		415

Cw = ΣArea*C/Total = 0.900

Permissible Site Discharge (PSD) (ARI of 5 years)

PSD Intensity (I) = 65.2 mm/hr For catchment tc = 10 mins.
Pre-development (Qp = Cp*I*As/0.36) = 2.92 L/s
Peak post development (Qa = 2*Cw*I*As/0.36) = 15.03 L/s =(0.231 x I) Eq. 2.24

Storage method = U (A)bove,(P)ipe,(U)nderground,(C)ustom
Permissible site discharge (Qu = PSD) = 2.911 L/s

Above ground - Eq 3.8

0 = PSD² - 2*Qa/tc*(0.667*tc*Qp/Qa + 0.75*tc+0.25*tcs)*PSD + 2*Qa*Qp
Taking x as = PSD and solving
a = 1.0 b = -32.1 c = 87.8
PSD = -b±√(b²-4ac)/(2a)
PSD = 3.023 L/s

Below ground pipe - Eq 3.3

Qp = PSD*[1.6*tcs/{tc*(1-2*PSD/(3*Qa))}-0.6*tcs^2.67/{tc*(1-2*PSDp/(3*Qa))}^2.67]
= 2.92
PSD = 2.992 L/s

Below ground rectangular tank - Eq 3.4

t =tcs/(tc*(1-2*PSD/(3*Qa))) = 0.861
Qp = PSD*[0.005-0.455*t+5.228*t²-1.045*t³-7.199*t⁴+4.519*t⁵]
= 2.92
PSD = 2.911 L/s

Carpark

STORMWATER DETENTION V5.05 BCE Design Pty Ltd

Design Storage Capacity (ARI of 10 years)

Above ground (Vs) = $[0.5*Qa*td-[(0.875*PSD*td)(1-0.917*PSD/Qa)+(0.427*td*PSD^2/Qa)]]*60/10^3$ m³ — Eq 4.23

Below ground pipe (Vs) = $[(0.5*Qa-0.637*PSD+0.089*PSD^2/Qa)*td]*60/10^3$ m³ — Eq 4.8

Below ground rect. tank (Vs) = $[(0.5*Qa-0.572*PSD+0.048*PSD^2/Qa)*td]*60/10^3$ m³ — Eq 4.13

td (mins)	I (mm/hr)	Qa (L/s)	Above Vs (m³)	Pipe Vs (m³)	B/G Vs (m³)
5	103.3	23.8			3.08
15	63.5	14.6			5.11
20	54.6	12.6			5.59
25	48.3	11.1			5.91
30	43.5	10.0			6.11
34	40.5	9.3			6.21
39	37.3	8.6			6.27
44	34.7	8.0			6.29
49	32.4	7.5			6.26
54	30.6	7.0			6.20

Table 1 - Storage as function of time for ARI of 10 years

Type	td (mins)	I (mm/hr)	Qa (L/s)	Vs (m³)
Above				
Pipe				
B/ground	43.2	35.1	8.1	**6.29**

Table 2 - Storage requirements for ARI of 10 years

Frequency of operation of Above Ground storage

Qop2 = 0.75 Cl 2.4.5.1

Qp2 =Qop2*Qp1 (where Qp1=PSD) = 2.27 L/s at which time above ground storage occurs

I = $360*Qp2/(2*Cw*As*10^3)$ = 9.8 mm/h — Eq 4.24

Period of Storage

Time to Fill:

Above ground (tf) = td*(1-0.92*PSD/Qa) — Eq 4.27

Below ground pipe (tf) = td*(1-2*PSD/(3*Qa)) — Eq 3.2

Below ground rect. tank (tf) = td*(1-2*PSD/(3*Qa)) — Eq 3.2

Time to empty:

Above ground (te) = $(Vs+0.33*PSD^2*td/Qa*60/10^3)*(1.14/PSD)*(10^3/60)$ — Eq 4.28

Below ground pipe (te) = $1.464/PSD*(Vs+0.333*PSD^2*td/Qa*60/10^3)*(10^3/60)$ — Eq 4.32

Below ground rect. tank (te) = $2.653/PSD*(Vs+0.333*PSD^2*td/Qa*60/10^3)*(10^3/60)$ — Eq 4.36

Storage period (Ps = tf + te) — Eq 4.26

Type	td (mins)	Qa (L/s)	Vs (L/s)	tf (mins)	te (mins)	Ps (mins)
Above						
Pipe						
B/ground	43.2	8.1	6.3	32.8	109.2	142.1

Table 3 - Period of Storage requirements for ARI of 10 years

Canteen and Canopy

STORMWATER DETENTION V5.05 BCE Design Pty Ltd

Location:	**Melbourne, VIC**
Site:	**312m² with tc = 10 and tcs = 7.5 mins.**
PSD:	**ARI of 5 years, Underground rectangular tank PSD = 1.97L/s**
Storage:	**ARI of 10 years, Underground rectangular tank volume = 4.25m³**

Design Criteria

Location = Melbourne, VIC
Method = A (A)RI 2001,A(E)P 2019
PSD average recurrance interval (ARI) = 5 years
Storage average recurrance interval (ARI) = 10 years

Storage method = U (A)bove,(P)ipe,(U)nderground,(C)ustom

Site Geometry

Site area (As) = 312 m² = 0.0312 Ha
Pre-development coefficient (Cp) = 0.35
Post development coefficient (Cw) = 0.90

Total catchment (tc) = 10 minutes
Upstream catchment to site (tcs) = 7.5 minutes

Coefficient Calculations

Pre-development

Zone	Area (m²)	C	Area * C
Concrete	312	0.35	109
Roof	0	0.90	0
Gravel	0	0.30	0
Garden	0	0.17	0
Total	312	m²	109

Cp = ΣArea*C/Total = 0.350

Post development

Zone	Area (m²)	C	Area * C
Concrete	0	0.90	0
Roof	312	0.90	281
Gravel	0	0.30	0
Garden	0	0.17	0
Total	312	m²	281

Cw = ΣArea*C/Total = 0.900

Permissible Site Discharge (PSD) (ARI of 5 years)

PSD Intensity (I) = 65.2 mm/hr For catchment tc = 10 mins.
Pre-development (Qp = Cp*I*As/0.36) = 1.98 L/s
Peak post development (Qa = 2*Cw*I*As/0.36) = 10.17 L/s =(0.156 x I) Eq. 2.24

Storage method = U (A)bove,(P)ipe,(U)nderground,(C)ustom
Permissible site discharge (Qu = PSD) = 1.970 L/s

Above ground - Eq 3.8

0 = PSD² - 2*Qa/tc*(0.667*tc*Qp/Qa + 0.75*tc+0.25*tcs)*PSD + 2*Qa*Qp
Taking x as = PSD and solving
a = 1.0 b = -21.7 c = 40.2
PSD = -b±√(b²-4ac)/(2a)
PSD = 2.046 L/s

Below ground pipe - Eq 3.3

Qp = PSD*[1.6*tcs/{tc*(1-2*PSD/(3*Qa))}-0.6*tcs^2.67/{tc*(1-2*PSDp/(3*Qa))}^2.67]
= 1.98
PSD = 2.025 L/s

Below ground rectangular tank - Eq 3.4

t =tcs/(tc*(1-2*PSD/(3*Qa))) = 0.861
Qp = PSD*[0.005-0.455*t+5.228*t²-1.045*t³-7.199*t⁴+4.519*t⁵]
= 1.98
PSD = 1.970 L/s

Canteen and Canopy

STORMWATER DETENTION V5.05
BCE Design Pty Ltd

Design Storage Capacity (ARI of 10 years)

Above ground (Vs) = $[0.5*Qa*td-[(0.875*PSD*td)(1-0.917*PSD/Qa)+(0.427*td*PSD^2/Qa)]]*60/10^3$ m³ Eq 4.23

Below ground pipe (Vs) = $[(0.5*Qa-0.637*PSD+0.089*PSD^2/Qa)*td]*60/10^3$ m³ Eq 4.8

Below ground rect. tank (Vs) = $[(0.5*Qa-0.572*PSD+0.048*PSD^2/Qa)*td]*60/10^3$ m³ Eq 4.13

td (mins)	I (mm/hr)	Qa (L/s)	Above Vs (m^3)	Pipe Vs (m^3)	B/G Vs (m^3)
5	103.3	16.1			2.08
15	63.5	9.9			3.46
20	54.6	8.5			3.79
25	48.3	7.5			4.00
30	43.5	6.8			4.13
34	40.5	6.3			4.20
39	37.3	5.8			4.24
44	34.7	5.4			4.25
49	32.4	5.1			4.24
54	30.6	4.8			4.20

Table 1 - Storage as function of time for ARI of 10 years

Type	td (mins)	I (mm/hr)	Qa (L/s)	Vs (m^3)
Above				
Pipe				
B/ground	43.2	35.1	5.5	**4.25**

Table 2 - Storage requirements for ARI of 10 years

Frequency of operation of Above Ground storage

Qop2 = 0.75 Cl 2.4.5.1

Qp2 =Qop2*Qp1 (where Qp1=PSD) = 1.53 L/s at which time above ground storage occurs

I = $360*Qp2/(2*Cw*As*10^3)$ = 9.8 mm/h Eq 4.24

Period of Storage

Time to Fill:

Above ground (tf) = td*(1-0.92*PSD/Qa) Eq 4.27

Below ground pipe (tf) = td*(1-2*PSD/(3*Qa)) Eq 3.2

Below ground rect. tank (tf) = td*(1-2*PSD/(3*Qa)) Eq 3.2

Time to empty:

Above ground (te) = $(Vs+0.33*PSD^2*td/Qa*60/10^3)*(1.14/PSD)*(10^3/60)$ Eq 4.28

Below ground pipe (te) = $1.464/PSD*(Vs+0.333*PSD^2*td/Qa*60/10^3)*(10^3/60)$ Eq 4.32

Below ground rect. tank (te) = $2.653/PSD*(Vs+0.333*PSD^2*td/Qa*60/10^3)*(10^3/60)$ Eq 4.36

Storage period (Ps = tf + te) Eq 4.26

Type	td (mins)	Qa (L/s)	Vs (L/s)	tf (mins)	te (mins)	Ps (mins)
Above						
Pipe						
B/ground	43.2	5.5	4.3	32.8	109.2	142.1

Bike and Bus Shelter

STORMWATER DETENTION V5.05

BCE Design Pty Ltd

Location: **Melbourne, VIC**
Site: **251m² with tc = 10 and tcs = 7.5 mins.**
PSD: **ARI of 5 years, Underground rectangular tank PSD = 1.58L/s**
Storage: **ARI of 10 years, Underground rectangular tank volume = 3.42m³**

Design Criteria

Location = Melbourne, VIC
Method = A (A)RI 2001,A(E)P 2019
PSD average recurrance interval (ARI) = 5 years
Storage average recurrance interval (ARI) = 10 years

Storage method = U (A)bove,(P)ipe,(U)nderground,(C)ustom

Site Geometry

Site area (As) = 251 m² = 0.0251 Ha
Pre-development coefficient (Cp) = 0.35
Post development coefficient (Cw) = 0.90

Total catchment (tc) = 10 minutes
Upstream catchment to site (tcs) = 7.5 minutes

Coefficient Calculations

Pre-development

Zone	Area (m²)	C	Area * C
Concrete	251	0.35	88
Roof	0	0.90	0
Gravel	0	0.30	0
Garden	0	0.17	0
Total	251 m²		88

Cp = ΣArea*C/Total = 0.350

Post development

Zone	Area (m²)	C	Area * C
Concrete	0	0.90	0
Roof	251	0.90	226
Gravel	0	0.30	0
Garden	0	0.17	0
Total	251 m²		226

Cw = ΣArea*C/Total = 0.900

Permissible Site Discharge (PSD) (ARI of 5 years)

PSD Intensity (I) = 65.2 mm/hr For catchment tc = 10 mins.
Pre-development (Qp = Cp*I*As/0.36) = 1.59 L/s
Peak post development (Qa = 2*Cw*I*As/0.36) = 8.18 L/s =(0.126 x I) Eq. 2.24

Storage method = U (A)bove,(P)ipe,(U)nderground,(C)ustom
Permissible site discharge (Qu = PSD) = 1.585 L/s

Above ground - Eq 3.8

0 = PSD² - 2*Qa/tc*(0.667*tc*Qp/Qa + 0.75*tc+0.25*tcs)*PSD + 2*Qa*Qp
Taking x as = PSD and solving
a = 1.0 b = -17.5 c = 26.0
PSD = -b±√(b²-4ac)/(2a)
PSD = 1.646 L/s

Below ground pipe - Eq 3.3

Qp = PSD*[1.6*tcs/{tc*(1-2*PSD/(3*Qa))}-0.6*tcs$^{2.67}$/{tc*(1-2*PSDp/(3*Qa))}$^{2.67}$]
= 1.59
PSD = 1.629 L/s

Below ground rectangular tank - Eq 3.4

t =tcs/(tc*(1-2*PSD/(3*Qa))) = 0.861
Qp = PSD*[0.005-0.455*t+5.228*t²-1.045*t³-7.199*t⁴+4.519*t⁵]
= 1.59
PSD = 1.585 L/s

STORMWATER DETENTION V5.05 BCE Design Pty Ltd

Design Storage Capacity (ARI of 10 years)

Above ground (Vs) = [0.5*Qa*td-[(0.875*PSD*td)(1-0.917*PSD/Qa)+(0.427*td*PSD²/Qa)]]*60/10³ m³ Eq 4.23
Below ground pipe (Vs) = [(0.5*Qa-0.637*PSD+0.089*PSD²/Qa)*td]*60/10³ m³ Eq 4.8
Below ground rect. tank (Vs) = [(0.5*Qa-0.572*PSD+0.048*PSD²/Qa)*td]*60/10³ m³ Eq 4.13

td (mins)	I (mm/hr)	Qa (L/s)	Above Vs (m³)	Pipe Vs (m³)	B/G Vs (m³)
5	103.3	13.0			1.68
15	63.5	8.0			2.78
20	54.6	6.9			3.05
25	48.3	6.1			3.22
30	43.5	5.5			3.32
34	40.5	5.1			3.38
39	37.3	4.7			3.41
44	34.7	4.4			3.42
49	32.4	4.1			3.41
54	30.6	3.8			3.38

Table 1 - Storage as function of time for ARI of 10 years

Type	td (mins)	I (mm/hr)	Qa (L/s)	Vs (m³)
Above				
Pipe				
B/ground	43.2	35.1	4.4	**3.42**

Table 2 - Storage requirements for ARI of 10 years

Frequency of operation of Above Ground storage

Qop2 = 0.75 Cl 2.4.5.1
Qp2 =Qop2*Qp1 (where Qp1=PSD) = 1.23 L/s at which time above ground storage occurs
I = 360*Qp2/(2*Cw*As*10³) = 9.8 mm/h Eq 4.24

Period of Storage

Time to Fill:

Above ground (tf) = td*(1-0.92*PSD/Qa) Eq 4.27
Below ground pipe (tf) = td*(1-2*PSD/(3*Qa)) Eq 3.2
Below ground rect. tank (tf) = td*(1-2*PSD/(3*Qa)) Eq 3.2

Time to empty:

Above ground (te) = (Vs+0.33*PSD²*td/Qa*60/10³)*(1.14/PSD)*(10³/60) Eq 4.28
Below ground pipe (te) = 1.464/PSD*(Vs+0.333*PSD²*td/Qa*60/10³)*(10³/60) Eq 4.32
Below ground rect. tank (te) = 2.653/PSD*(Vs+0.333*PSD²*td/Qa*60/10³)*(10³/60) Eq 4.36

Storage period (Ps = tf + te) Eq 4.26

Type	td (mins)	Qa (L/s)	Vs (L/s)	tf (mins)	te (mins)	Ps (mins)
Above						
Pipe						
B/ground	43.2	4.4	3.4	32.8	109.2	142.1

Table 3 - Period of Storage requirements for ARI of 10 years

Pavements

STORMWATER DETENTION V5.05 BCE Design Pty Ltd

Location: **Melbourne, VIC**
Site: **1471m² with tc = 10 and tcs = 7.5 mins.**
PSD: **ARI of 5 years, Underground rectangular tank PSD = 4.60L/s**
Storage: **ARI of 10 years, Underground rectangular tank volume = 29.80m³**

Design Criteria

Location = Melbourne, VIC
Method = A (A)RI 2001,A(E)P 2019
PSD average recurrance interval (ARI) = 5 years
Storage average recurrance interval (ARI) = 10 years

Storage method = U (A)bove,(P)ipe,(U)nderground,(C)ustom

Site Geometry

Site area (As) = 1471 m² = 0.1471 Ha
Pre-development coefficient (Cp) = 0.17
Post development coefficient (Cw) = 0.90

Total catchment (tc) = 10 minutes
Upstream catchment to site (tcs) = 7.5 minutes

Coefficient Calculations

Pre-development

Zone	Area (m²)	C	Area * C
Concrete	0	0.90	0
Roof	0	0.90	0
Gravel	0	0.30	0
Garden	1471	0.17	250
Total	1471	m²	250

Cp = ΣArea*C/Total = 0.170

Post development

Zone	Area (m²)	C	Area * C
Concrete	1471	0.90	1324
Roof	0	0.90	0
Gravel	0	0.30	0
Garden	0	0.17	0
Total	1471	m²	1324

Cw = ΣArea*C/Total = 0.900

Permissible Site Discharge (PSD) (ARI of 5 years)

PSD Intensity (I) = 65.2 mm/hr For catchment tc = 10 mins.
Pre-development (Qp = Cp*I*As/0.36) = 4.53 L/s
Peak post development (Qa = 2*Cw*I*As/0.36) = 47.95 L/s =(0.736 x I) Eq. 2.24

Storage method = U (A)bove,(P)ipe,(U)nderground,(C)ustom
Permissible site discharge (Qu = PSD) = 4.601 L/s

Above ground - Eq 3.8

$0 = PSD^2 - 2*Qa/tc*(0.667*tc*Qp/Qa + 0.75*tc+0.25*tcs)*PSD + 2*Qa*Qp$
Taking x as = PSD and solving
a = 1.0 b = -96.0 c = 434.4
$PSD = -b\pm\sqrt{b^2-4ac}/(2a)$
PSD = 4.763 L/s

Below ground pipe - Eq 3.3

$Qp = PSD*[1.6*tcs/\{tc*(1-2*PSD/(3*Qa))\}-0.6*tcs^{2.67}/\{tc*(1-2*PSDp/(3*Qa))\}^{2.67}]$
= 4.53
PSD = 4.763 L/s

Below ground rectangular tank - Eq 3.4

t =tcs/(tc*(1-2*PSD/(3*Qa))) = 0.801
$Qp = PSD*[0.005-0.455*t+5.228*t^2-1.045*t^3-7.199*t^4+4.519*t^5]$
= 4.53
PSD = 4.601 L/s

Pavements

STORMWATER DETENTION V5.05 BCE Design Pty Ltd

Design Storage Capacity (ARI of 10 years)

Above ground (Vs) = $[0.5*Qa*td-[(0.875*PSD*td)(1-0.917*PSD/Qa)+(0.427*td*PSD^2/Qa)]]*60/10^3\ m^3$ Eq 4.23
Below ground pipe (Vs) = $[(0.5*Qa-0.637*PSD+0.089*PSD^2/Qa)*td]*60/10^3\ m^3$ Eq 4.8
Below ground rect. tank (Vs) = $[(0.5*Qa-0.572*PSD+0.048*PSD^2/Qa)*td]*60/10^3\ m^3$ Eq 4.13

td (mins)	I (mm/hr)	Qa (L/s)	Above Vs (m^3)	Pipe Vs (m^3)	B/G Vs (m^3)
5	103.3	76.0			10.61
29	44.4	32.7			23.88
41	36.2	26.6			26.35
53	30.9	22.7			27.92
66	26.9	19.8			28.95
78	24.1	17.7			29.47
90	22.0	16.2			29.74
102	20.2	14.9			29.80
114	18.8	13.8			29.71
126	17.6	12.9			29.50

Table 1 - Storage as function of time for ARI of 10 years

Type	td (mins)	I (mm/hr)	Qa (L/s)	Vs (m^3)
Above				
Pipe				
B/ground	101.1	20.3	15.0	**29.80**

Table 2 - Storage requirements for ARI of 10 years

Frequency of operation of Above Ground storage

Qop2 = 0.75 Cl 2.4.5.1
Qp2 =Qop2*Qp1 (where Qp1=PSD) = 3.57 L/s at which time above ground storage occurs
$I = 360*Qp2/(2*Cw*As*10^3)$ = 4.9 mm/h Eq 4.24

Period of Storage

Time to Fill:

Above ground (tf) = td*(1-0.92*PSD/Qa) Eq 4.27
Below ground pipe (tf) = td*(1-2*PSD/(3*Qa)) Eq 3.2
Below ground rect. tank (tf) = td*(1-2*PSD/(3*Qa)) Eq 3.2

Time to empty:

Above ground (te) = $(Vs+0.33*PSD^2*td/Qa*60/10^3)*(1.14/PSD)*(10^3/60)$ Eq 4.28
Below ground pipe (te) = $1.464/PSD*(Vs+0.333*PSD^2*td/Qa*60/10^3)*(10^3/60)$ Eq 4.32
Below ground rect. tank (te) = $2.653/PSD*(Vs+0.333*PSD^2*td/Qa*60/10^3)*(10^3/60)$ Eq 4.36

Storage period (Ps = tf + te) Eq 4.26

Type	td (mins)	Qa (L/s)	Vs (L/s)	tf (mins)	te (mins)	Ps (mins)
Above						
Pipe						
B/ground	101.1	15.0	29.8	80.4	313.9	394.3

Table 3 - Period of Storage requirements for ARI of 10 years

Appendix 3: Storm Report

STORM Rating Report

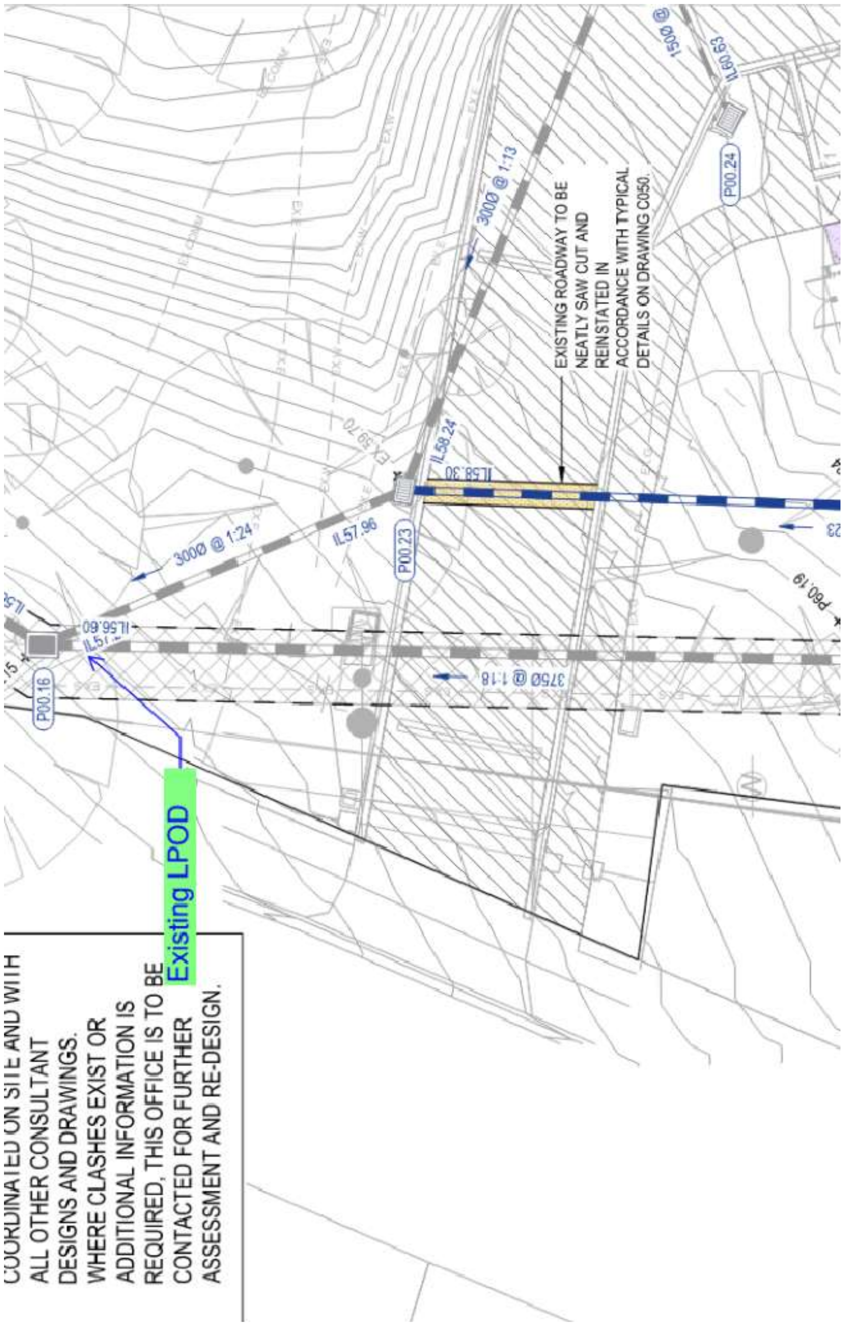
Melbourne Water

TransactionID:	0
Municipality:	MONASH
Rainfall Station:	MONASH
Address:	2B Swanson Cres
	Chadstone
	VIC 3148
Assessor:	NJM Design
Development Type:	Other
Allotment Site (m2):	2,024.00
STORM Rating %:	103

Description	Impervious Area (m2)	Treatment Type	Treatment Area/Volume (m2 or L)	Occupants / Number Of Bedrooms	Treatment %	Tank Water Supply Reliability (%)
Roof to RWT	1,381.00	Rainwater Tank	10,000.00	100	91.00	47.00
Roof to Raingarden 2	421.00	Raingarden 100mm	9.00	0	128.70	0.00
Roof to Raingarden 1	222.00	Raingarden 100mm	5.00	0	129.25	0.00

Stormwater Treatment Objective – Relative Measure (STORM) was developed by Melbourne Water to simplify the analysis of stormwater treatment methods within a development. The calculator assesses Water Sensitive Urban Design (WSUD) measures on project sites and delivers a percentage result, determining whether best practice targets have been achieved. A score of 100% or higher means the treatment features meet all objectives.

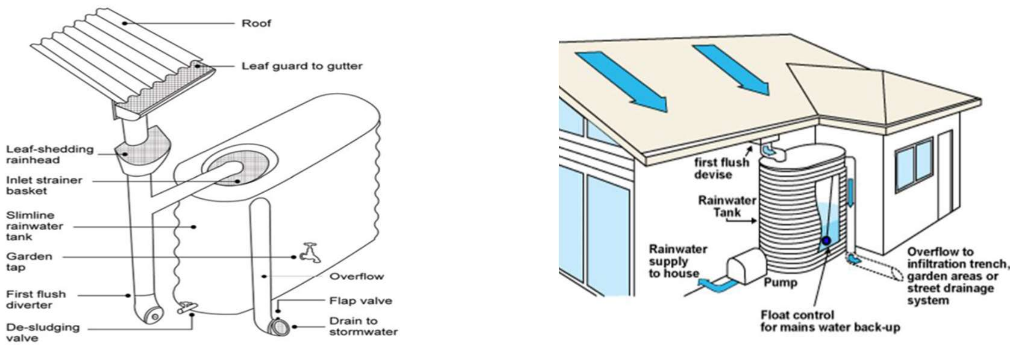
Appendix 4: Legal Point of Discharge


EXISTING ROADWAY TO BE NEATLY SAW CUT AND REINSTATED IN ACCORDANCE WITH TYPICAL DETAILS ON DRAWING C050.
300Ø @ 1:13
300Ø @ 1:24
375Ø @ 1:18
150Ø @
IL58.24
IL58.30
IL57.96
IL56.60
IL60.63
P00.23
P00.24
P00.16
P60.19
Existing LPOD
COORDINATED ON SITE AND WITH ALL OTHER CONSULTANT DESIGNS AND DRAWINGS. WHERE CLASHES EXIST OR ADDITIONAL INFORMATION IS REQUIRED, THIS OFFICE IS TO BE CONTACTED FOR FURTHER ASSESSMENT AND RE-DESIGN.

Appendix 5: Technical Measure Explained

Rainwater Harvesting

Downpipes are used to transport rainwater from the rood to the rainwater tanks. These tanks can be used to provide a flow detention capacity, storage for reuse, and to treat rainwater via particle settlement. Purposes for re-use generally include irrigation, laundry and toilet services and showers.



Components of a rainwater harvesting system. Source: BlueScope Steel

Rainwater Filtration

The requirements of filtration depend on the use for the tank water. Therefore, different treatment measures are required to meet certain uses. These relationships are shown in the tables below.

Required Quality					Filter			
End use	Clear	Odourless	Low in dissolved solids	No human pathogens, toxins. heavy metals	**Fixture/ Use**	Tannin filter if tannin from trees expected	Sediment filter (e.g.: 20 micron)	Sub 1-micron absolute filter
Garden/Lawn irrigation					**Irrigation & outdoor**			
Toilet services	✓	✓			**Hot water system**	✓	✓	
Clothes washing	✓	✓			**Toilet / Washing machine**	✓		
Showering	✓	✓	✓		**Drinking water outlets cold**	✓	✓	✓
Drinking	✓	✓	✓	✓				

General considerations:

- Tank systems can be at a number of different levels of complexity. The simplest tank system is where downpipes flow directly into the top of a water tank as shown above. If a number of downpipes from around the building are collecting water for the same tank that is aboveground, a charged pipe system may be required, where water sits in the downpipes to the level of the top of the tank, and the water level stays balanced.

- Rainwater tank systems may be wet (charged) or dry. Charged systems are where the pipes from the gutter run down the wall and underground, then up into the tank. If there are long runs of pipe underground which remain full of water, they are wet systems. If the pipe network runs directly from the gutter into the tank, such that the pipes drain out the water when rainfall stops, they are dry systems.

- Aperture screens of 1mm should be included on all openings to prevent mosquito breeding.

- A first flush device should be installed into the system initially, which will divert the initial 1 or 2 minutes of runoff from the roof to minimize pollutants.

- Connection from the tank to toilets (or other regularly used end-uses) is often done to allow the tanks to be used up regularly. This ensures the tank is able to collect new rainfall water.

- Tank to mains switches, which diverts water supply from water storage tanks to mains must be installed, in the event the water storage tanks are empty. Automated and manual switches is often recommended (to account for the event of automatic switch failure).

a)

b)

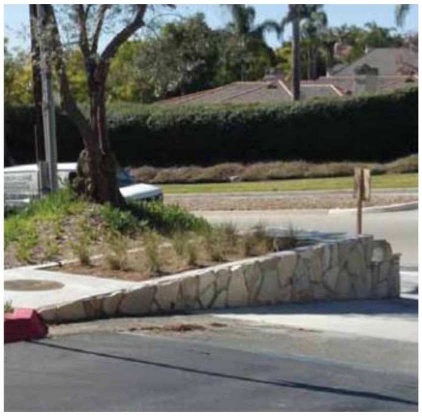
c)

d)

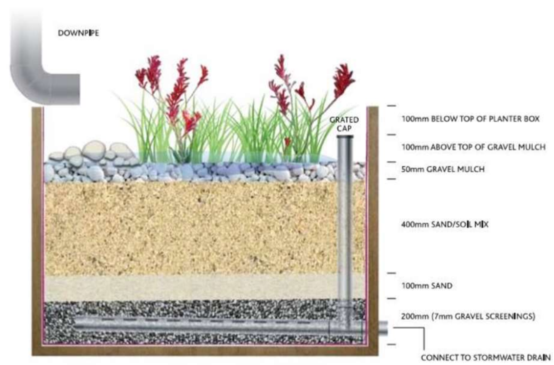
Types of rainwater tanks a) slime line; b) storage walls; c) underground tanks; d) modular
Sources: www.yourhome.gov.au/water/rainwater www.freshwater.com.au

Planting



SPEL BASIN – Modular bio-retention basin SPEL BASIN – Modular bio-retention basin

Examples of in-ground and planter box rain garden systems. Sources: Melbourne Water, LID Consulting