Design of stormwater harvesting system at Syndal South Primary School

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Report prepared by

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Summary

This proposal outlines an approach to harvest runoff from all roofs and paved areas within Syndal South Primary School using a new stormwater filtration and storage system, developed by Ecosmart Water Solutions. The volume of water treated and collected will meet 69% of demand for toilet flushing and irrigation at the school.

The system will be used as demonstration site for a novel Australian water saving technology. The performance of the system will be monitored by Monash University which will support further advancements of the technology.

1. Syndal South Primary School

Site

Figure 1 shows an aerial photo of the school, with roof areas and paved areas clearly marked.

Figure 1 : Site and catchment area

2. Stormwater harvesting design

Water harvesting

Currently runoff from roof 6 (R6, see figure 1) is collected and stored in a 27.5 m^3 tank. Roof 5 (R5, see figure 1) is also connected to a small tank for the irrigation a small garden (a tank is already installed).

Runoff from all paved areas and the other schools buildings is currently connected, via a series of stomwater pits, to a traditional stormwater drainage system. It is proposed that this water be intercepted by installing a new stormwater pit and directed to the Ecosmart Water Solutions system. Peak flows from very large storms will bypass the system and flow into the existing stormwater pipes. The captured stormwater will be treated to remove pollutants (such as sediment, heavy metals and microorganisms), before being stored in large tanks ready for reuse.

Water distribution

To supply water for indoor use (toilet flushing), a dual reticulation system has to be installed; a new plumbing system to bring the harvested water from the store to the toilets without interfering with the existing plumbing that supplies the potable water to toilet (or any other) taps in the school. The pipes of the new system have to be clearly marked (in purple) and any cross-connection must be avoided by using certified plumbers.

An automatic irrigation system will be installed for irrigation of the sports oval. However smart irrigation is to be practiced (the irrigation on demand and only when it is necessary), which will bring large water savings.

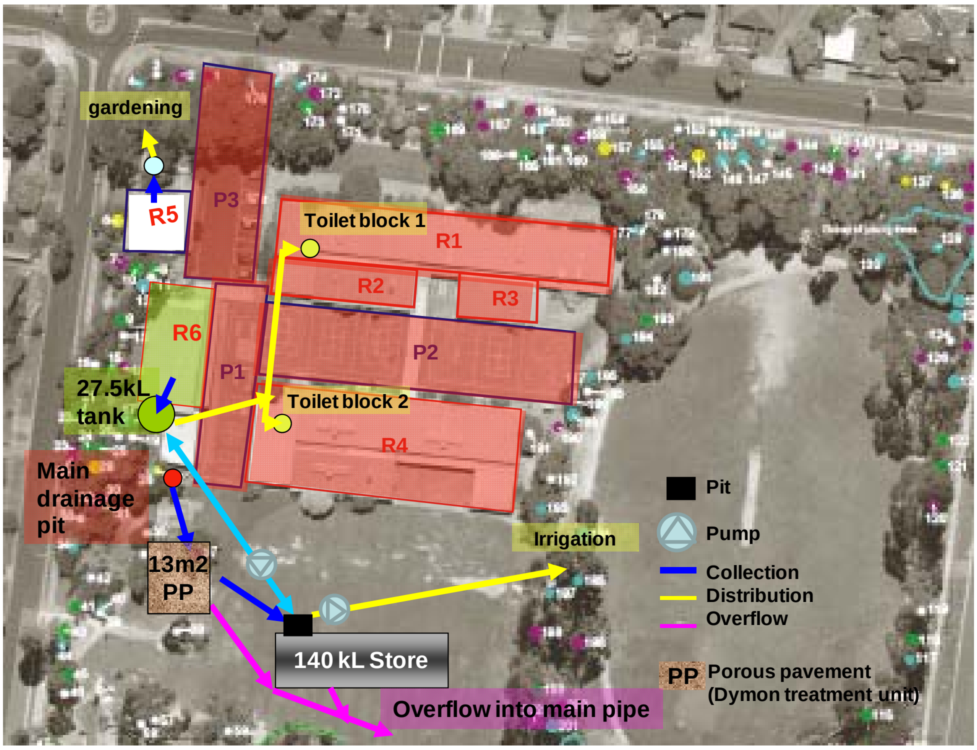


Figure 2 : Outline of Final Scenario

3. System performance : method and analysis

Surface area

Table 1 presents the sizes of the surfaces from which the water will be harvested (Fig 1 shows these areas). The school roofs cover area of 2548 m^2 (0.256 ha), while paved areas that could be used for harvesting cover 2061 m2 (0.21ha). In total water can be harvested from **0.46 ha**.

Table 1 : surface area

Roof areas [m^2]		Paved areas [m^2]	
R1	737	P1	930
R2	261	P2	400
R3	160	P3	731
R4	1060		
R5	105		
R6	225		
Sub-Total	**2548**		**2061**
TOTAL [m^2]			**4609**

Demand

Water will be used for toilet flushing and irrigation, while any overflow from the system will be directed to the wetland. The monthly volume of each of the demand types is presented in Table 2.

Table 2 : Toilet and irrigation demand patterns and magnitudes.

- Indoor use - Toilets			***- Outdoor use - Irrigation***		
Yearly = 570 m^3/year			**Yearly = 1020 m^3/year**		
Month	[% of year]	[m^3/month]	Month	[% of year]	[m^3/month]
Jan	1	6	Jan	22	224
Feb	9	51	Feb	22	224
March	9	51	March	11	112
April	9	51	April	6	61
May	9	51	May	0	0
June	9	51	June	0	0
July	9	51	July	0	0
Aug	9	51	Aug	0	0
Sept	9	51	Sept	0	0
Oct	9	51	Oct	6	61
Nov	9	51	Nov	11	112
Dec	9	51	Dec	22	224

Modelling method

One software tool has been used in the design (developed by Monash researchers):Reuse Analyses Tool (RAT).

Ten years of continuous rainfall data (recorded at Melbourne station between June 1998 and June 2007) were used for the calculations. Selection of this recent period ensures that the analysis takes into account the impact of drought and climate change.

4. System Performances : results

Filter size

The size of the porous pavement can be determined using the percentage of runoff treated. **Error! Reference source not found.** shows the percentage of runoff treated relative to the area of porous pavement.

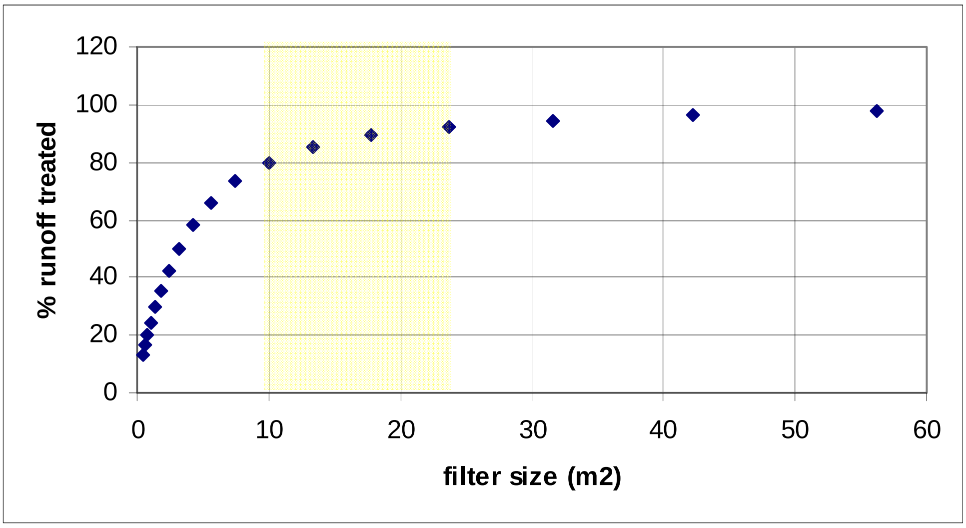


Figure 3 : percentage of runoff treated relative to area of porous pavement

For each added square metre of pavement, the gain becomes smaller, with gains becoming very small for areas of over 10 m^2 in size. The optimal store should be somewhere between 10 and 22 m^2. Considering site constraints, a porous pavement filter of **13 m^2** was chosen which will treat 84 % of the stormwater runoff.

Volume of storage tank

Error! Reference source not found. shows the volumetric reliability (percentage of annual demand supplied) relative to the volume of tank.

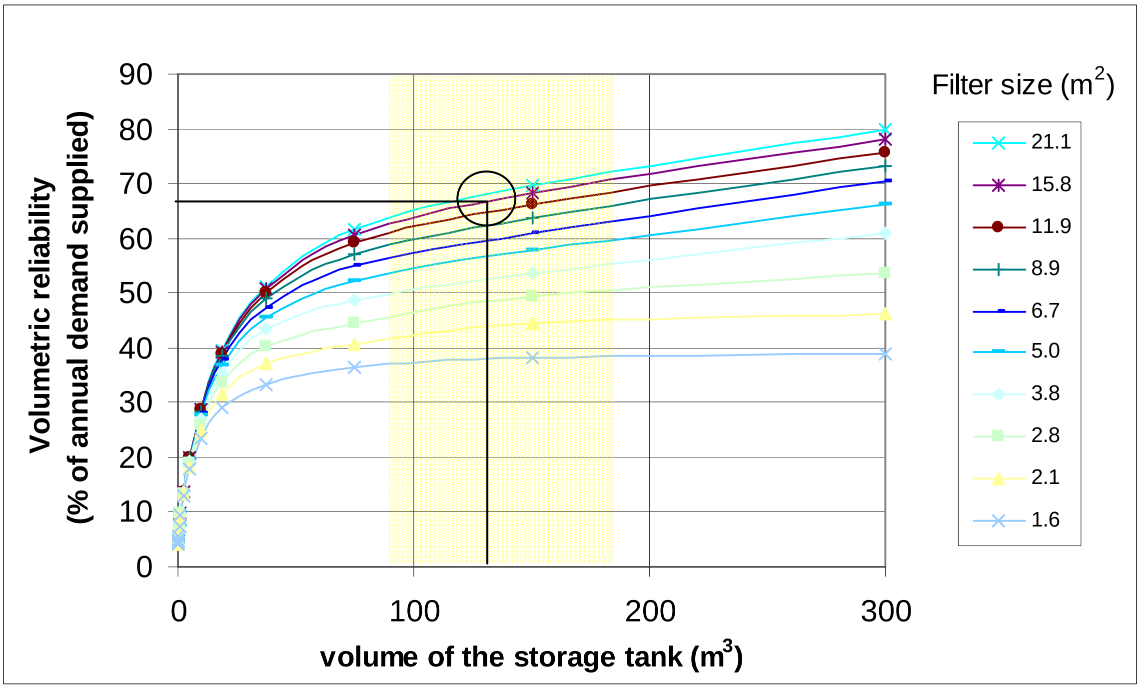


Figure 4 : volumetric reliability relative to volume of storage tank, for several values of filter size

The predicted performance modelled by RAT (details shown in Appendix I) shows that the optimal tank size should be between 90 and 180 m^3. A tank of **144 m^3** was chosen, which, with a filter size of 13m^2, **supplies 69% of the demand.**

Preliminary design of this scenario is summarised in Table 3.

Table 3: Preliminary design.

Design Parameter		**Simulated values**
Demand	Annual water demand (irrigation + toilet flushing) (m^3)	1590
	Catchment area (m^2)	4504
Filter	Surface area (covered by Permapave porous paving) (m^2)	12.55
Tank	Volume (m^3)	144
Efficiency		
Volumetric reliability (%)		69

5. Detailed design

Treatment unit

The treatment unit (Figure 6) consists of Permapave® (porous pavement pavers) placed over the top of filter media, specifically designed to remove the key pollutants from stormwater (e.g. microorganisms, heavy metals and PAHs).

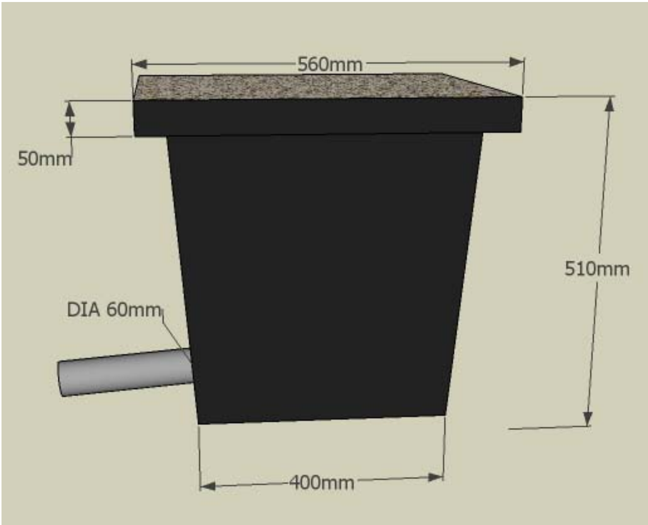


Figure 5 : Treatment unit : stormwater pit containing Permapave and filter media

System

A detailed map of the system is available in Appendix 1.

It is proposed to install the pavers in the form of a path (figure 7). The area will be wet only during storm events, while it will be used by children and staff during dry weather.

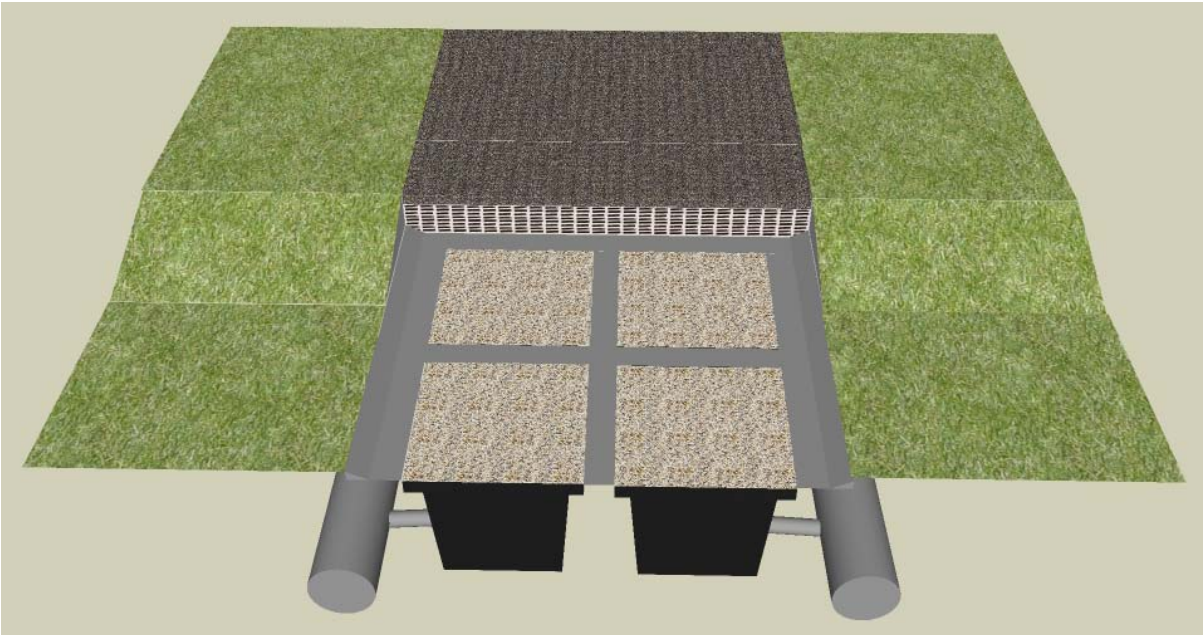
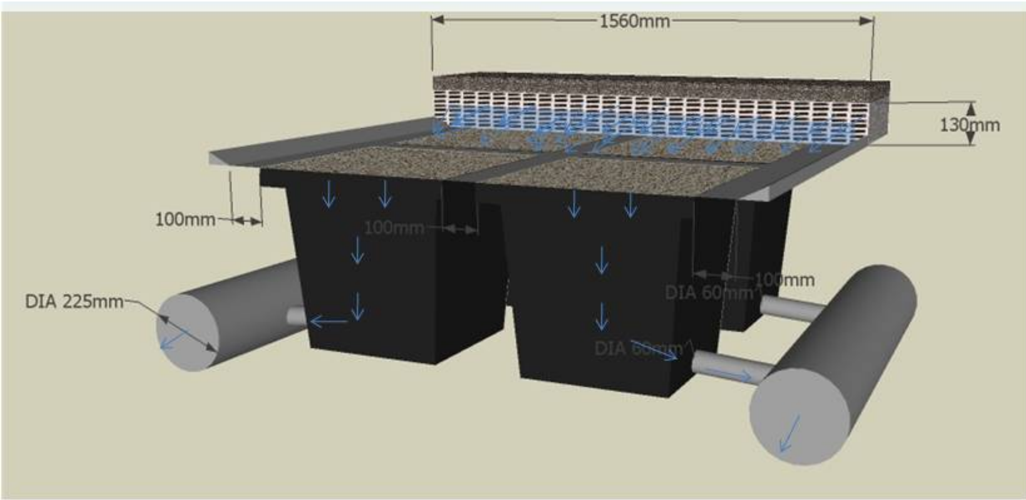


Figure 6 : Proposed design of water treatment system

The water harvested from roofs and paved_areas is directed into a main pit, before being distributed, via 9 pipes, to the treatment system.

Figure 7 describes the flow of water through the system.



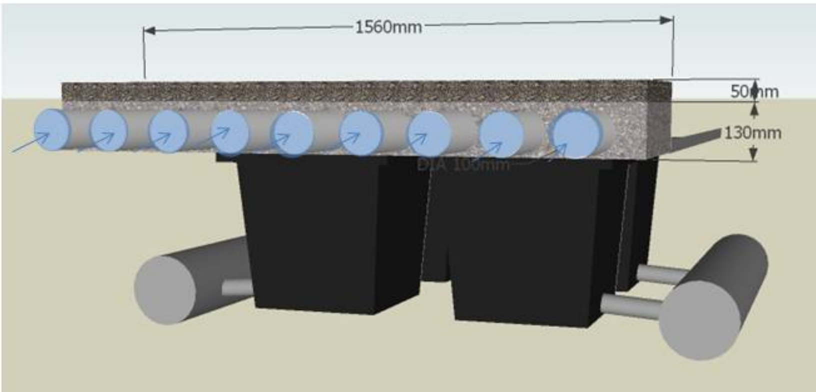


Figure 7 : Inlet detail of the system – Zoom 2

6. Benefits

The main benefits are the following:

- ***Water savings***: The system will harvest ***1 Ml of water per year.*** It is estimated that the school will reduce its mains water use to around 0.5 ML/year, while still irrigating its sports oval and maintaining a healthy wetland ecosystem.

- ***Stormwater pollution reduction***: the system will reduce pollution loads into Scotchmen's Creek and Port Philip Bay. Pollutants such as sediment, nutrients, heavy metals, pathogens and hydrocarbons will be captured by the system. Currently, Melbourne Water (MW) spends on average $15 million per year to treat stormwater around Melbourne, so this system will present a part of the MW overall solution.

- ***Environmental flow benefits***: the system will reduce peak flows and volumes of elevated inflows into Scotchmen's Creek and therefore help to maintain health of its ecosystem.

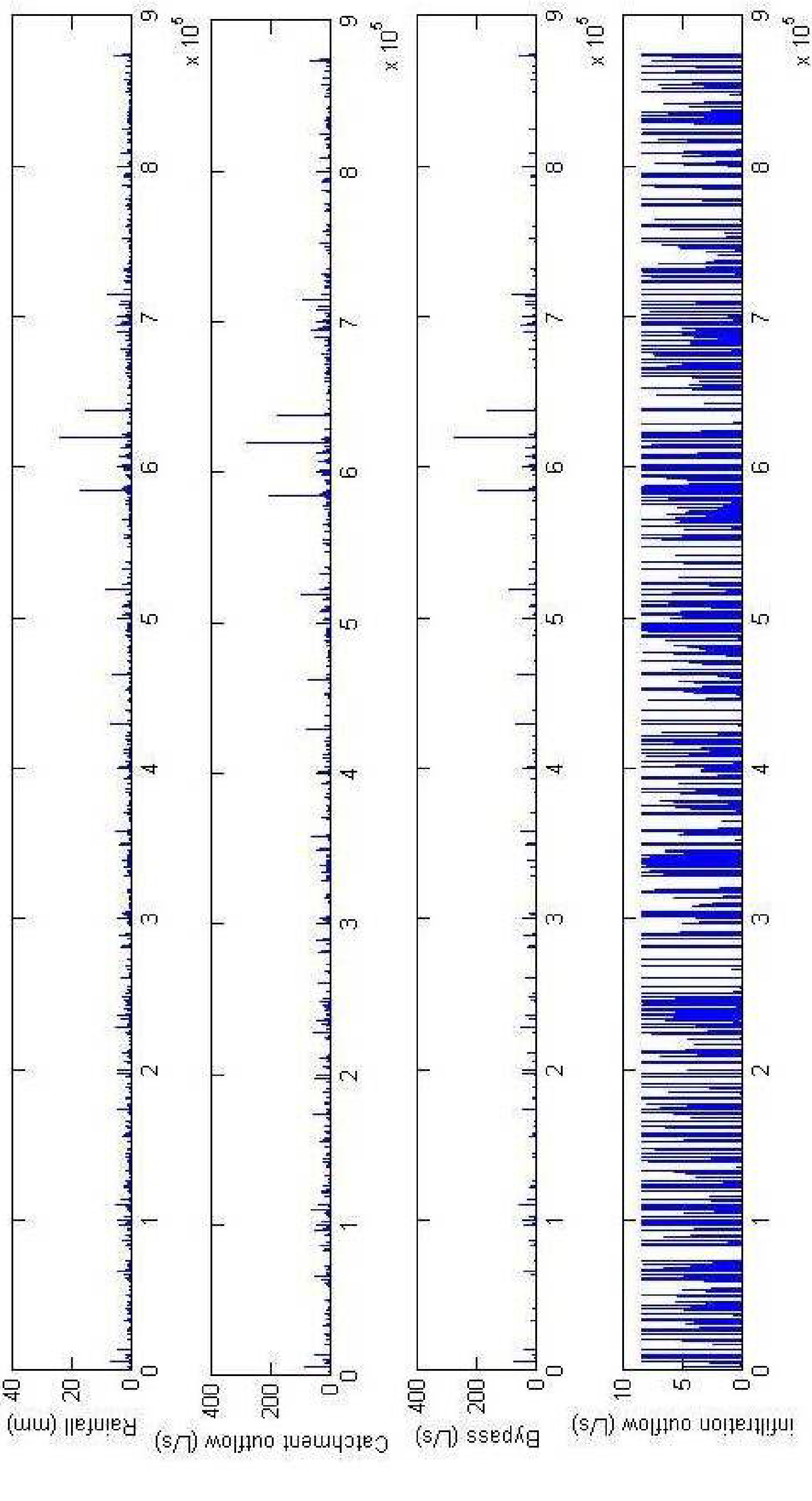
- ***Flood protection benefits***: the area immediately downstream of the school has been earmarked by the local council as requiring investigation into flood protection. This system will help reduce peak flows and flooding.

7. References

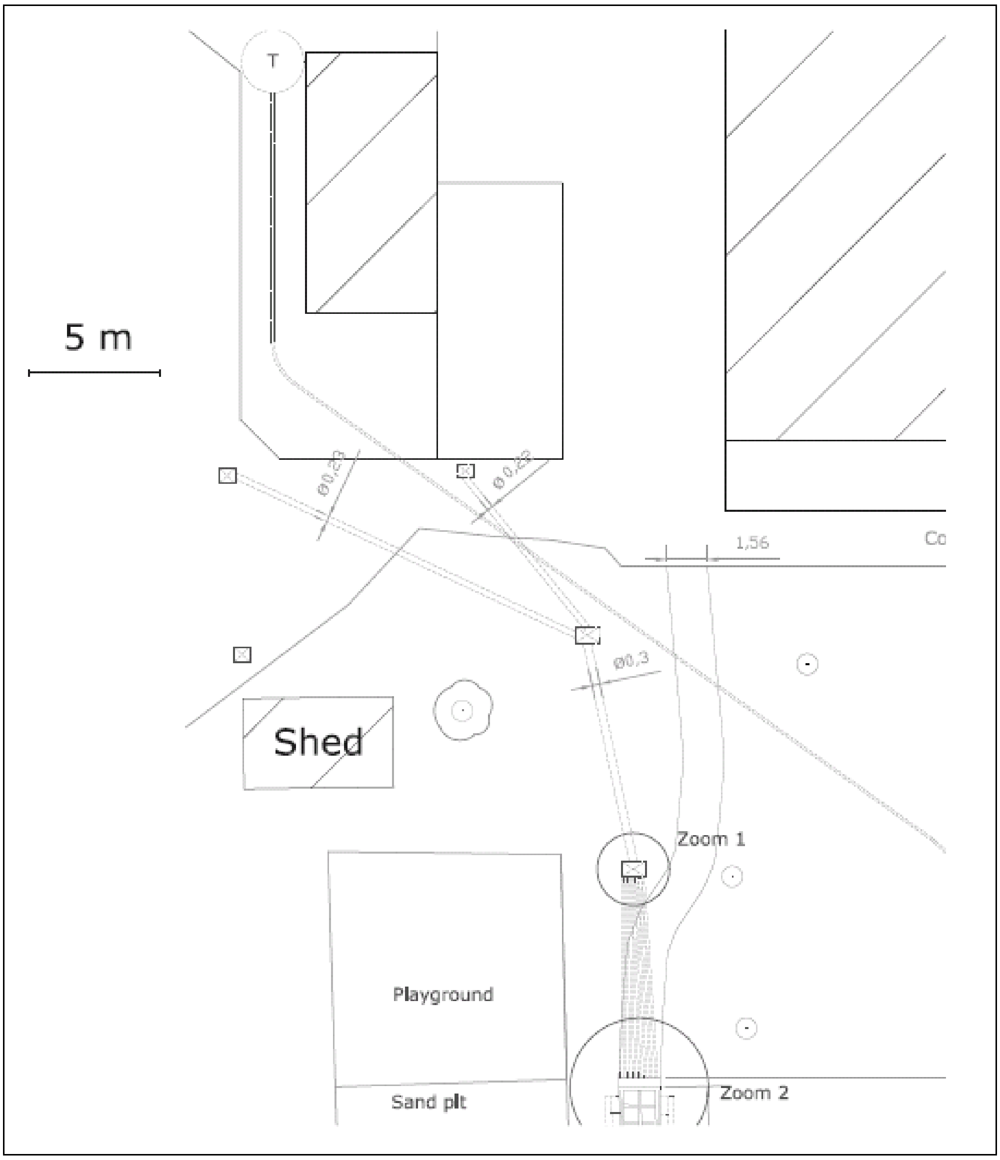
Mitchell, V.G., Deletic, A., Fletcher, T.D., Hatt, B., D.T. McCarthy (2007) Achieving Multiple Benefits from Urban Stormwater Harvesting, *Water Science and Technology*, 55(4) 135-144

Mitchell, V.G., Deletic, A., Fletcher, T.D., McCarthy D.T. (2007) Urban stormwater harvesting - sensitivity of a storage behaviour model- Monash University, Institute for Sustainable Water Resources.

Appendix 1: 10 year RAT performance simulation



Appendix 2: Beginning of the path



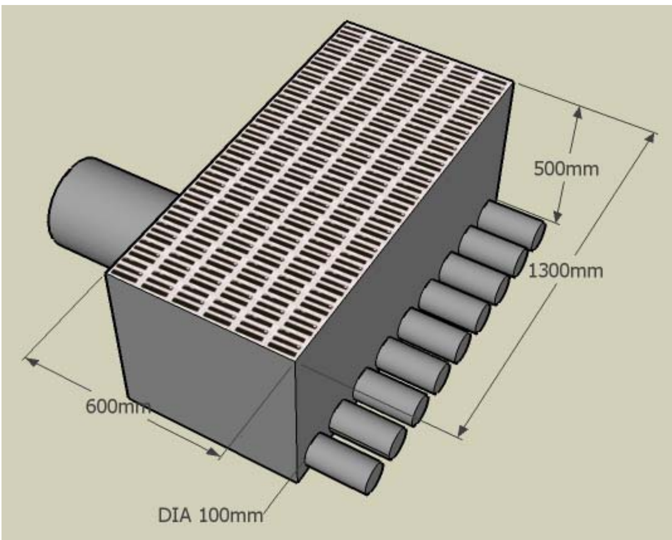
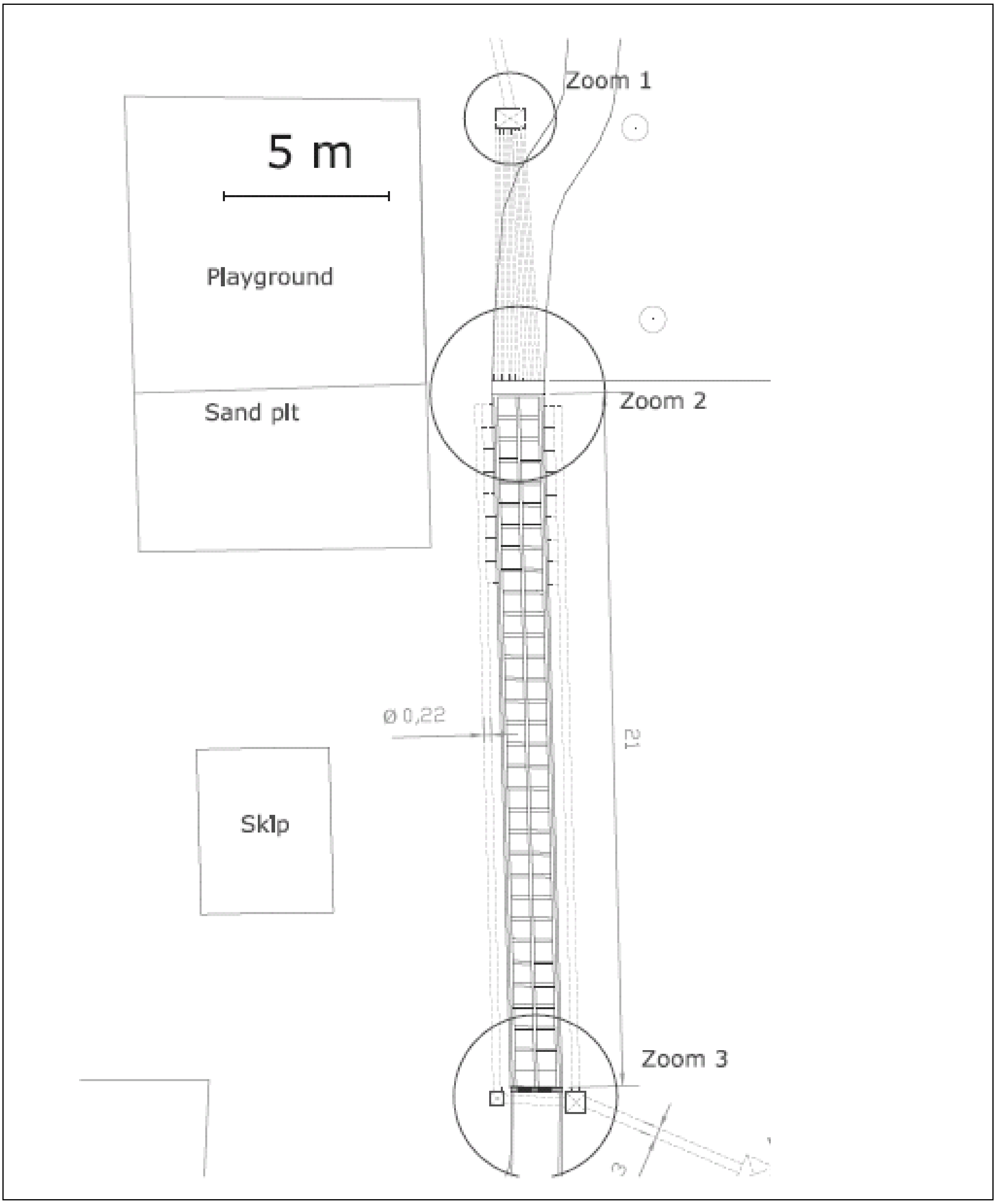


Figure 8 : distribution pit – Zoom 1

Appendix 3: System



Appendix 4: Detail and cross-sections of the system

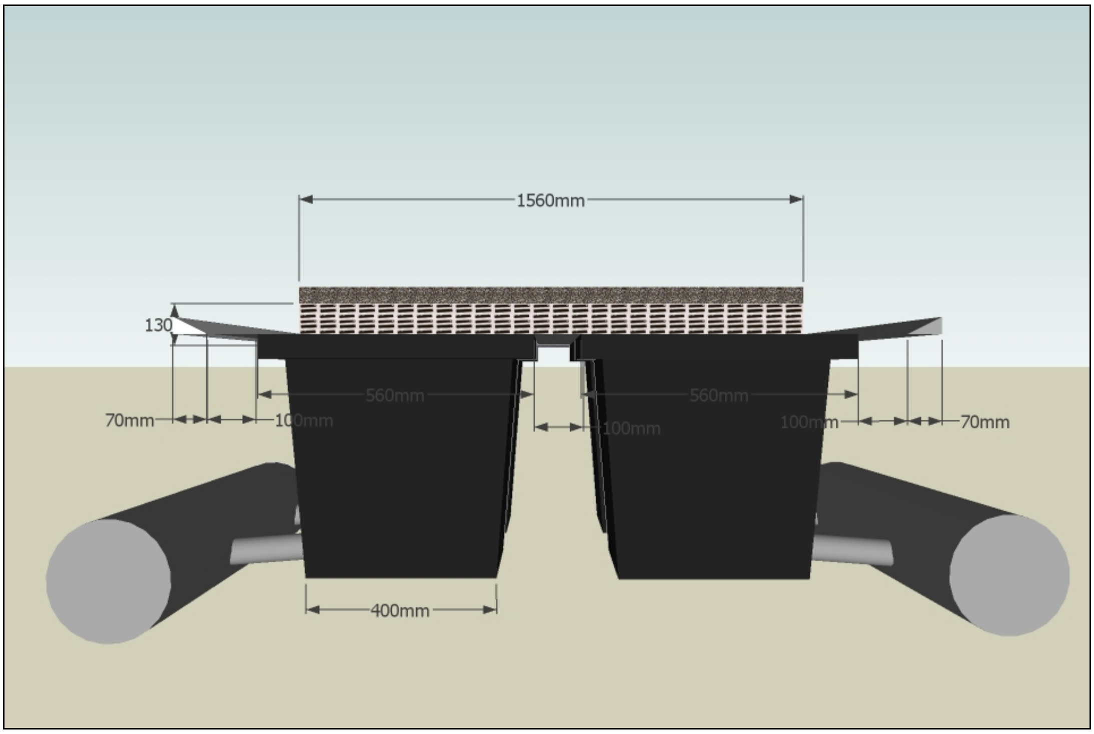


Figure 9 : Cross-section of the filtration system- Zoom 2

<u>Note:</u> Camber on concrete in between filter units and small angles on concrete bordering path to direct water into units. (Figure 10)

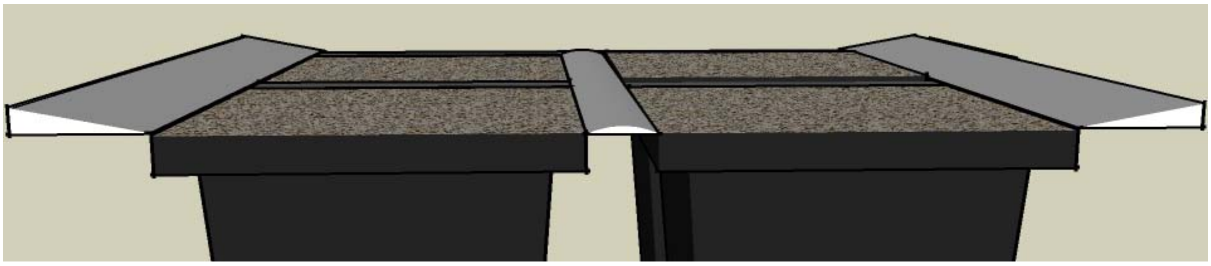


Figure 10 : detail of surface

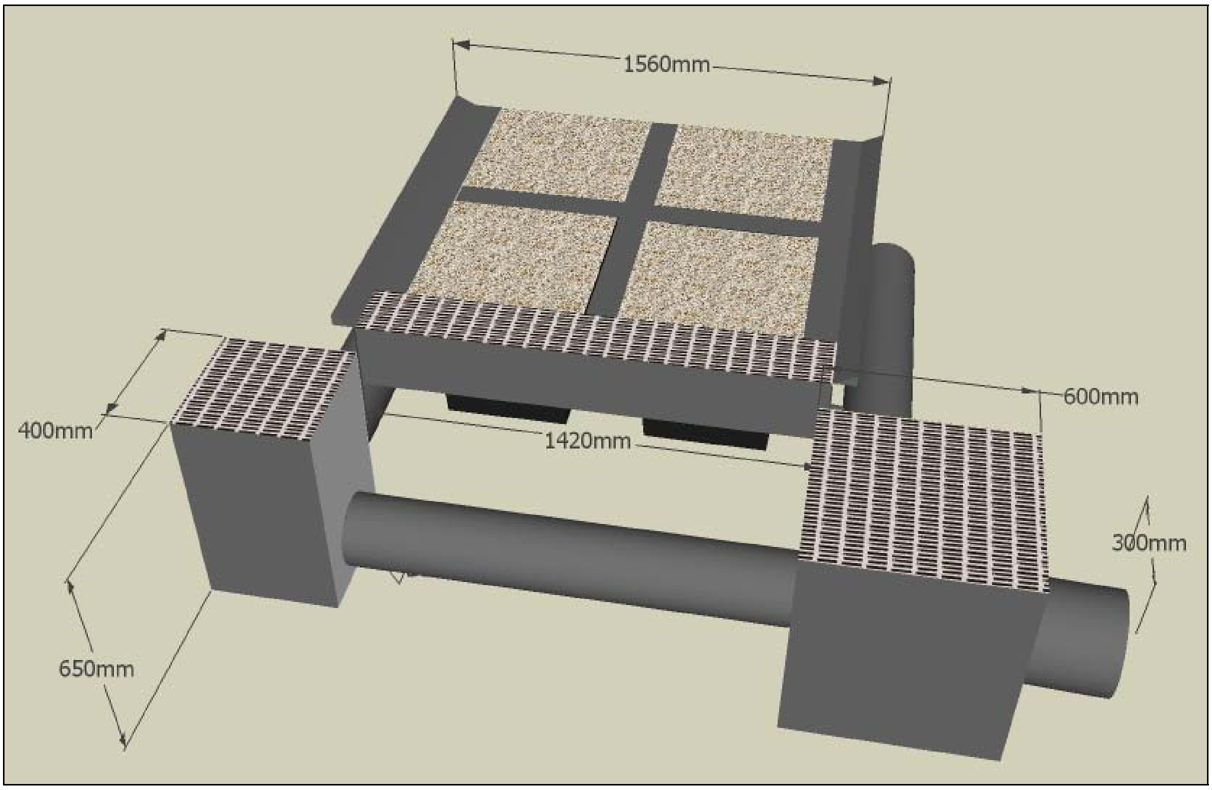


Figure 11 : End of the filtration system - Zoom 3

Appendix 4: Tank