Feasibility of Recycling Grey-water in Multi-Storey Buildings in Melbourne

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Location of Melbourne (within Australia)

Water Resources in Melbourne

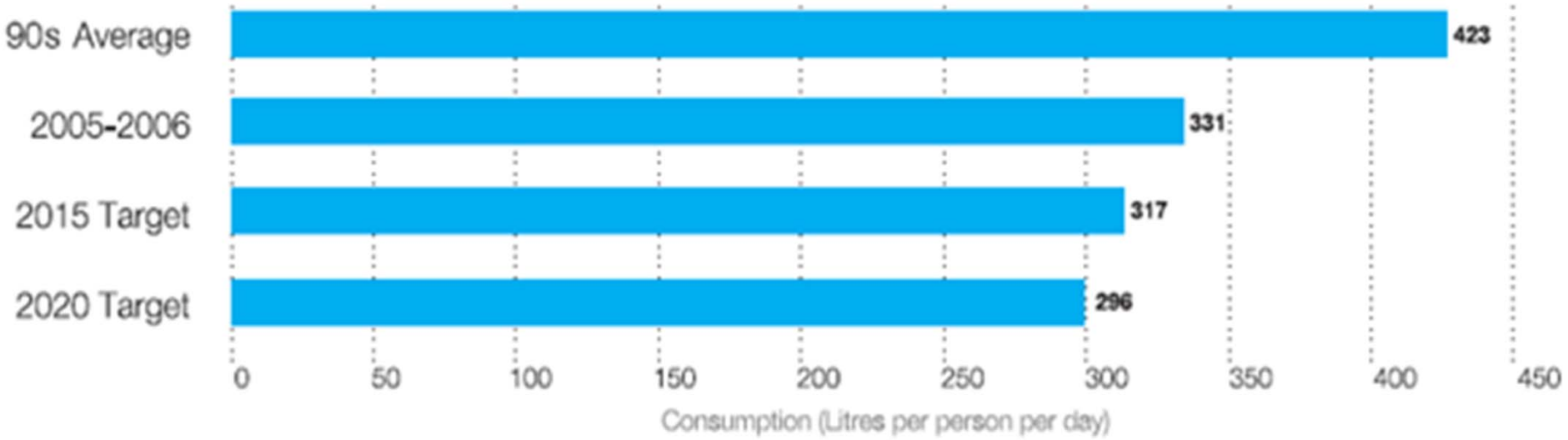
- A temperate climate with warm to hot summers and cool winters
- Temperatures can exceed 40^{o} C in summer
- Annual Average Rainfall 650 mm
- Average evaporation 2-3 m/year
- City water supply mainly depends on the storage reservoirs, contributed by runoff from surrounding catchments
- At present total reservoirs' capacity is 80% full for the first time in 15 years

At times experiences severe drought (i.e. 1998~2009)

Accumulated rainfall (1996 to 2004)

(around State of Victoria)

Per capita water consumption in Melbourne



- Approx. 330 l/capita/day
- One of the highest water consuming cities around the world

Population Increasing

Latest recorded population growth rate is 1.6% per annum

Future population projections:

Population scenarios (millions rounded up)			
Year	Low	Medium	High
2020	3.75	4.08	4.26
2050	3.58	4.60	5.12

Projected change of Inflows (due to climate change) to Melbourne's 4 major dams

Climate Change Scenario	2020	2050
Mild change	- 3 %	- 7 %
Medium change	- 7 %	- 18 %
Severe change	- 11 %	- 35 %

Projected Impact on Water Supply Capacity

Potential Buffer (+ve value) or Shortfall (-ve value) of Systems Yield (in GL/annum)

	No Climate change	Low Climate change	Medium Climate change	High Climate change
2020				
Low population	**66**	**42**	**20**	**-9**
Medium population	**23**	**0**	**-23**	**-52**
High population	**1**	**-23**	**-45**	**-74**
2050				
Low population	**200**	**132**	**70**	**-44**
Medium population	**80**	**12**	**-50**	**-164**
High population	**18**	**-50**	**-112**	**-226**

Government's Initiatives..

- Imposing 'water use restrictions' to reduce water consumptions
- Promoting and providing incentives for water recycling
- A new desalination plant for Melbourne
- Upgrading Melbourne's Eastern Treatment Plant for recycling
- Modernising Victoria's Food Bowl irrigation system to capture lost water from farms

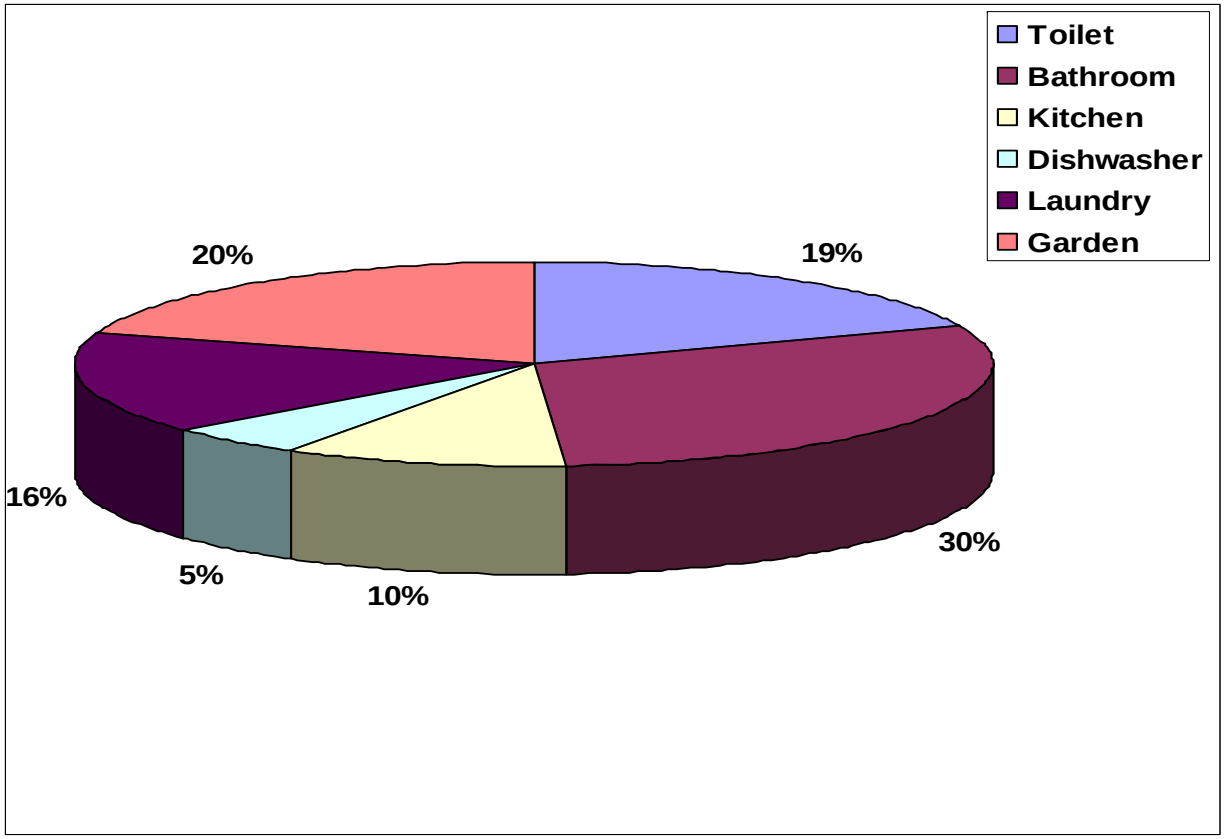
Private Scale Water Recycling

- **Among all the alternative water sources, stormwater harvesting has received the most attention**
- **To date the option of greywater recycling has not got much attention**

The reasons behind it….

- **Users' perception and safety concern**
- **Apparently high initial cost, and**
- **Lack of knowledge regarding actual payback period.**

Melbourne's water uses pattern



- **Greywater from 'bathroom' and 'laundry' (46% of total) can be reused**

Water uses and types of wastewater

Item	Minimum quality required	Wastewater generated	Water use (%)	Water use per unit (L/day)
Toilet	Grey	Black	19	210.5
Bathroom Basin	Fresh	Grey	30	332.4
Kitchen	Fresh	Black	10	110.8
Dishwasher	Fresh	Black	5	55.4
Laundry	Fresh	Grey	16	177.3
Garden	Grey	None	20	221.6

- **As multi-storey buildings do not have reasonable garden, greywater reuse is ONLY considered for 'toilet flushing'**

Three Options Considered

1. **Installing 'water conserving devices' ONLY**
2. **Installing 'greywater recycling' system, and**
3. **Installing both 'water conserving devices' and 'greywater recycling system'**

Assumptions…

1. **Six units per floor and four people in a unit**
2. **Average water demand 277 l/d/person**
3. **Water/sewer charges:**
   - **$2.0/kL for water supply**
   - **$1.60/kL for sewage disposal**

Water Conservation through Water Conserving Devices

- Up to 50% water savings can be achieved through simple Water Conservation Devices






Water Conservation through Water Conserving Devices

Water use sector	Efficient item	Normal item cost ($)	Efficient item cost ($)	Water savings (%)	Water savings per unit (L/day)
Toilet	Dual flash	200	400	50	**105**
Bathroom	Flow restrictor	20	50	40	**133**
Kitchen	Flow restrictor	20	50	40	**44**
Dishwasher	Efficient dishwasher	500	800	30	**17**
Laundry	**Efficient washing machine**	**400**	**800**	**50**	**89**

Costs in Australian Dollars

Water Conservation through Water Conserving Devices

Payback Period:

$$PP_{WC} = \frac{TAC}{AS}$$

Where,

***PP_{WC}* is the payback period for water conserving devices,**

***TAC* is the total additional initial cost for having water efficient devices, and**

***AS* is the annual saving.**

Payback period of water efficient devices ONLY 1.9 years and irrespective of total number of floors in the building.

Greywater Recycling System

- Greywater (46%) Generation Rate –

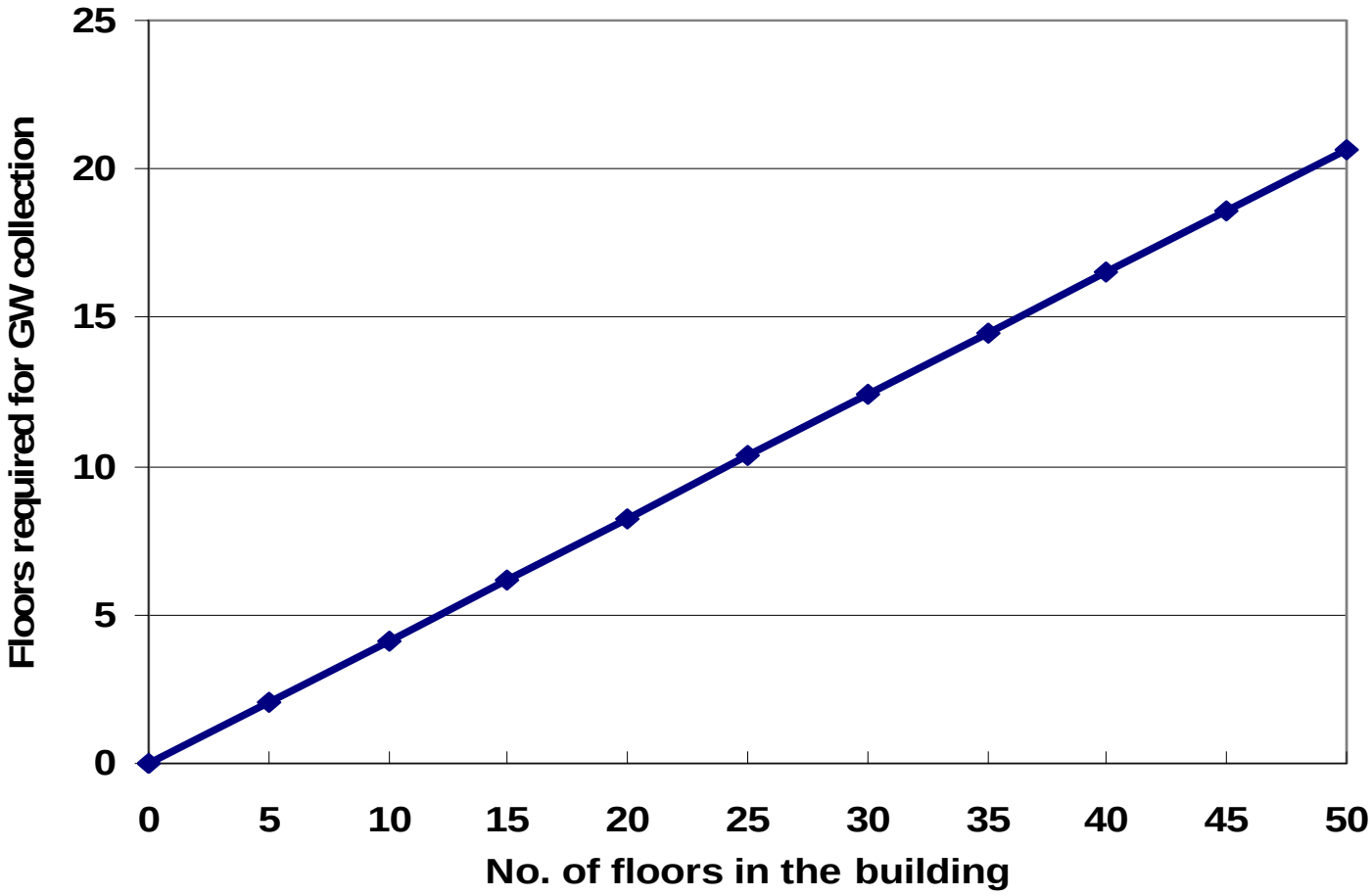
  About 510 l/unit/d

- Demand for Greywater:
  - Toilet Flushing (19%) need

    About 210 l/unit/d

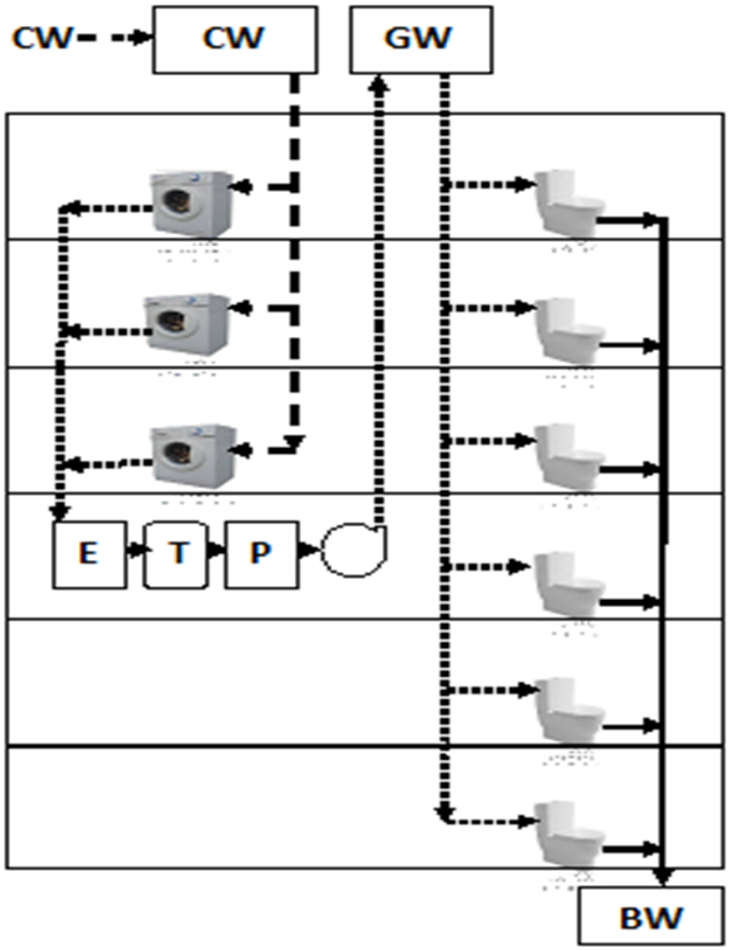
- Greywater generation is much more higher then the greywater need
- Partial recycling from some floors will be enough for the whole building

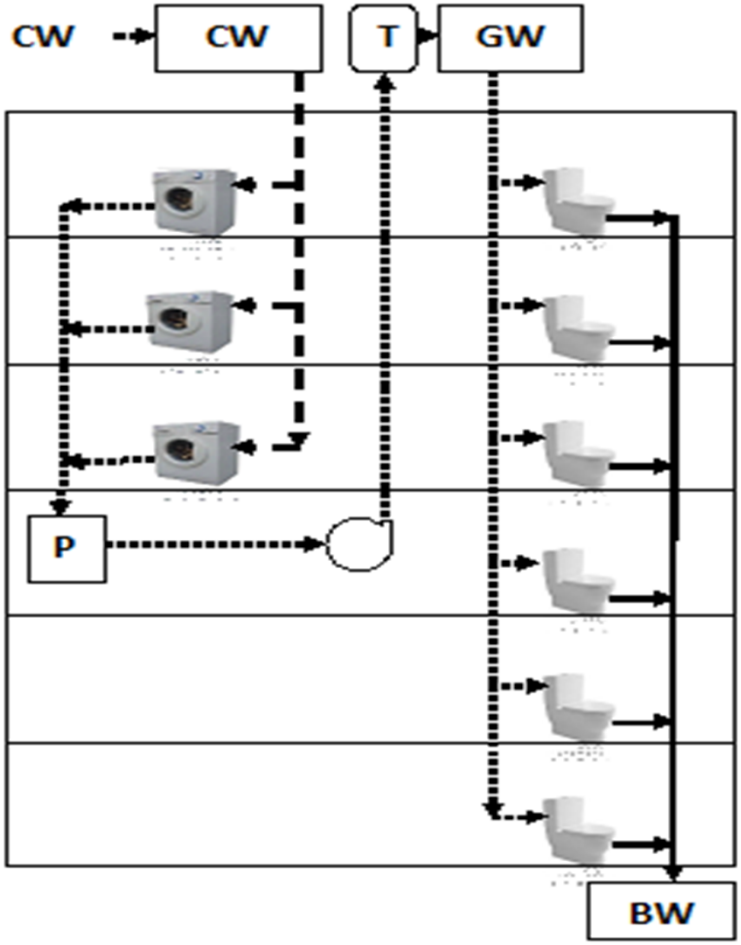
Partial Greywater Recycling



No. of floors required for greywater demand vs. Total number of floors in the building

Location for Partial Grey Water Treatment System – Intermediate or Roof Top to Reduce Pumping Cost





CW=Clean Water; T=Treatment; GW=Greywater; BW=Blackwater; P=Pumping; E=Equalization Tank.

Greywater Recycling: Payback Period

$$PP_{GR} = \frac{TC}{AS - AC}$$

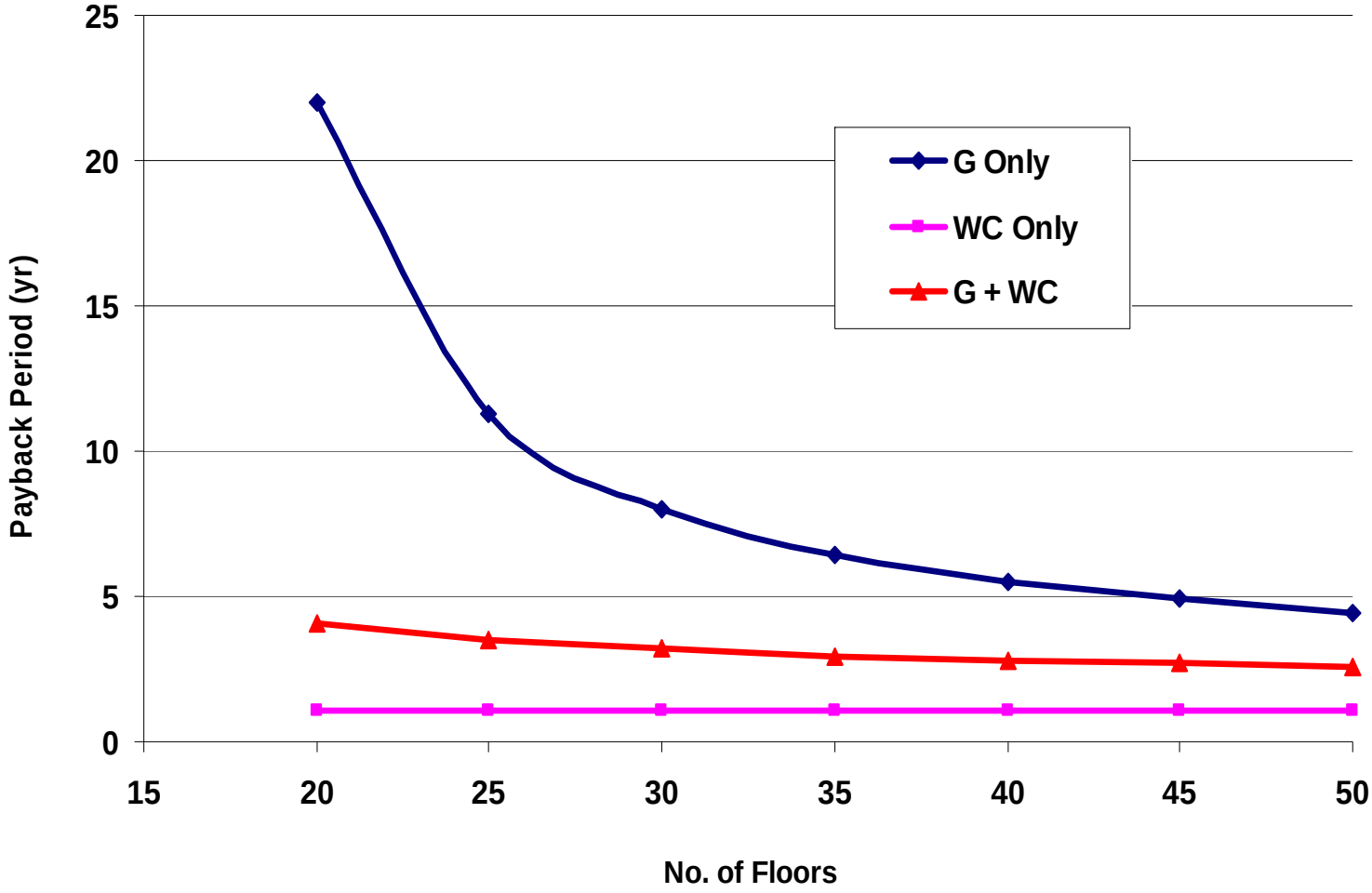
where, PP_{GR} is the payback period for greywater treatment system
TC is the total initial cost
AS is the annual saving and
AC is the annual maintenance/operational costs.

Net present values of the future costs were not considered. This simplification is expected to be compensated through future increases of water and sewerage charges, which were not either considered in this study.

Greywater Recycling: Feasibility

- Due to high initial cost of the system, greywater recycling system would not be feasible for buildings less than 18 floors.
- For a 20 storey building, the payback period is 22 years and decreases sharply with the increase of number of floors.
- For very high number of floors (> 40), an increase in number of floors does not provide a significant decrease in payback period.
- For a floor number of 30, a significantly low payback period of 8 years is achievable.

Combined Greywater Recycling and Water Conserving Devices



G: Greywater recycling; WC: Water Conserving Devices

Combined Greywater Recycling and Water Conserving Devices: Feasibility

- Combined implementation of greywater recycling and water conserving devices is very feasible for multi-storey buildings
- For a 20 storey building, a payback period of only 4.1 years is achievable, and
- For higher number of floors it drops down to 2.8 years.

CONCLUSIONS

- Significant domestic water savings can potentially be achieved from Melbourne multi-storey buildings.
- It is possible to reduce the cost of greywater recycling systems using partial recycling schemes, as a full recycling is not necessary.
- The reported results will vary among the cities/countries depending on the costs of water, power, water-efficient appliances and treatment system as well as maintenance costs.
- However, this study provides a general insight of looking greywater recycling in a positive way.
- The benefits of water conservation and greywater recycling extend beyond the consumers to the concerned water authorities and the environment.