



Water sensitive urban design

Carbon costs of WSUD and conventional drainage

Introduction

Excessive greenhouse gas emissions are the primary cause of global warming. Adapting existing processes to be more carbon neutral is an essential step in Australia's commitment to address climate change.

Water Sensitive Urban Design (WSUD) has several known benefits to both the community and the surrounding environment including, but not limited to, reducing water usage, increasing biodiversity, and improving social amenity.

The carbon costs of WSUD can be compared to existing practices by calculating the Global Warming Potential (GWP) of each element. Knowing the different carbon cost of urban form elements is key to making an informed choice when designing urban areas.

Comparing WSUD elements to conventional drainage elements

The carbon cost and GWP for following WSUD solutions can be estimated and compared to conventional drainage system (Figure 1):

- Soak wells
- Tree pits
- Rain gardens
- Permeable paving
- Vegetated swales
- Living streams
- Bioretention pits

GWP refers to the heating effects of emissions relative to carbon dioxide. The larger the number, the greater the heating effect. Reducing GWP, and consequently carbon emissions, is key to addressing global warming.

For GWP analysis, the carbon contribution of the complete product life cycle is considered. For example, a soak well's GWP includes manufacturing the concrete, transporting the product to site, excavating the area required, installation, and replacement at its end of life.

Product Stage > Construction Stage > Use Stage > End-of-life Stage

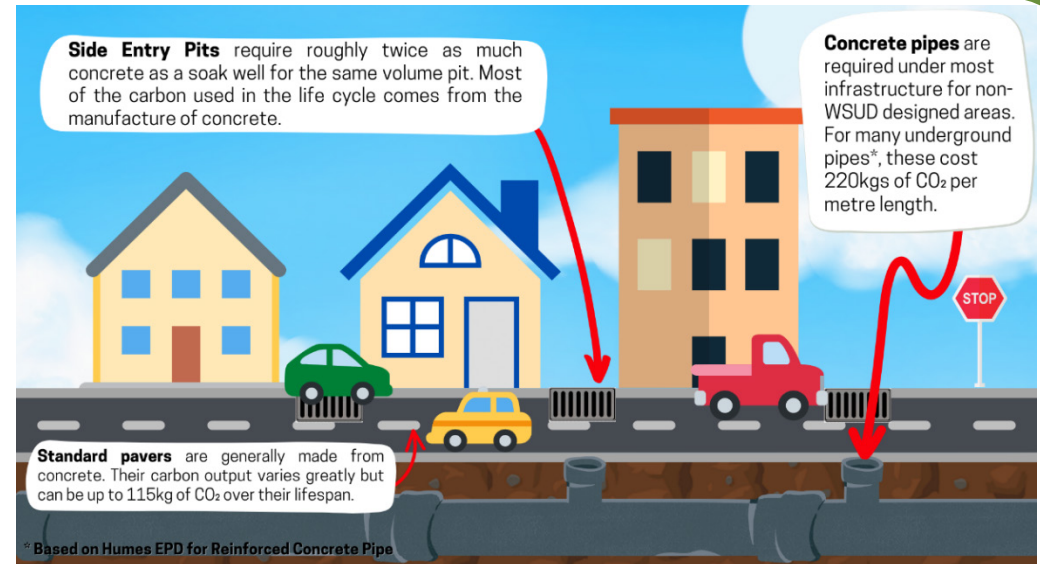


Figure 1: Conventional drainage design

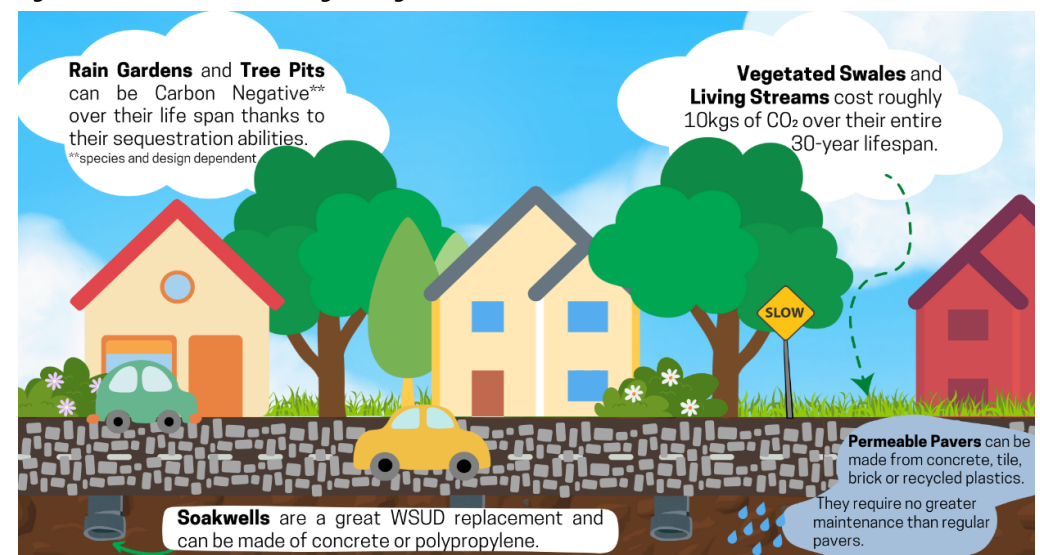


Figure 2: Water sensitive drainage design



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Example study

To quantify the effect WSUD can have on the carbon emissions of a singular street, a theoretical street was analysed prior to and after the 'installation' of WSUD. The GWP for a 30-year life of each design was then compared. Table 1 suggests that the GWP of a WSUD street may be an order of magnitude less than using conventional drainage systems.

The following values are based on a street roughly 800m long with a 10m wide road/ paved area. For simplicity of considering a singular street, sumps, living streams and bioretention pits were discounted.

Table 1: Estimated GWP of conventional drainage design compared to water sensitive drainage

Traditional Street		WSUD Street	
Pipe length required (m):	640	Raingarden area (m ²):	125
GWP pipe (kg):	141,651	GWP rain gardens (kg):	-1,575
Paved area (m ²):	8,000	# Tree pits:	50
GWP paving (kg):	488,000	GWP tree pits (kg):	-7,500
Side entry pits required:	12	# soak wells:	12
GWP side entry pits (kg):	8,256	GWP soak wells (kg):	4,643
		Permeable paved area (m ²):	8,000
		GWP paving (kg):	72,800
Total GWP (tonnes CO₂)	638	Total GWP (tonnes CO₂)	68

Assumptions

Please note, this factsheet is a high-level analysis for comparative purposes only. Figures from this fact sheet should not be used for planning, budgeting, or reporting purposes.

Life cycle assessment is dependent on time frame. This assessment considered a life cycle of 30 years. Accordingly, the carbon costs will vary when considering a different period due to the sequestration performance of plants, as trees are most effective at sequestering carbon once they reach maturity.

The assessment also made assumptions about the products used and WSUD element design. For example, tree pit carbon cost is dependent on tree species. While many species are recommended by local governments, the London Plane and Eucalyptus trees were mainly used to calculate a carbon cost, as these are often the species of choice. The key difference is the trees' ability to sequester carbon. Additionally, most studies on carbon sequestration by plants have occurred in the USA. Thus, local climate will impact field results. Concrete piping was based on the Humes' specification of a DN750, Class 4 pipe with RRJ joining, manufactured in Perth. The carbon cost of the pipe varies dependent on the size and joining of the pipe.

Table 2: Values used in the example study

Design Type	Asset	Carbon Cost (kg CO ₂)	Unit
Traditional	Concrete Pipe	221.33	m-1
	Pavement	61	m-2
	Side Entry Pit	687.98	per pit
WSUD	Soak well	386.92	per well
	Tree Pit	-150	per pit
	Rain Garden	-12.6	m-2
	Permeable Paver	9.1	m-2
	Vegetated Swale	10.53	m-2
	Living Stream	10.53	m-2
	Bioretention Pit	-20.5	m-2

References

Humes. (2020). Environmental Product Declaration.

Kavehei, E., Iram, N., Rashti, M. R., Jenkins, G. A., Lemckert, C., & Adame, M. F. (2021). Greenhouse Gas emissions from stormwater bioretention basins. *Ecological Engineering*, 159(0925-8574), 106-120. doi:https://doi.org/10.1016/j.ecoleng.2020.106120.

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