Characterisation of Accumulated Sediments in Kerb Side Infiltration Pits

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Highlights

- Kerb side inlet and infiltration pit can be used to harvest road runoff.
- Kerb side infiltration pits plays key role to attenuate sediments and pollutants at the point of source.
- Accumulated sediments contain heavy metals (As, Mn, Ni, Pb).

Introduction

Drainage infrastructure has traditionally been designed to prevent flooding by rapidly discharging stormwater to receiving waters. With increasing urbanization, stormwater can cause problems due to increased flows and pollution. The TREENET Inlet system (Figure 1) is an emerging street scale stormwater harvesting device designed to reduce urban runoff volumes and contaminant loads. The inlet system is the gravity-fed excavated pits, retrofitted into existing kerbs or can be installed during construction of new kerbs. A small infiltration pit or 'leaky well' soak the harvested stormwater into the soil to provide passive irrigation to the street trees (Johnson et al. 2016).

The wet and dry deposition of material (for example, sediments, organic material or petroleum products) on impervious/pervious surfaces can wash out during rain events. These pollutants entered into infiltration systems with stormwater. The infiltration systems treat stormwater pollutants by various processes, including mechanical filtration, biological and chemical (Feng et al. 2012). The mechanical filtration process includes sedimentation, adsorption and sorption of pollutants (Feng et al. 2012). The sedimentation of pollutants (for example, heavy metals and aromatic hydrocarbons) is accumulated in the infiltration systems in each storm event. However, there is no data on the quality of accumulated sediment in leaky well systems.

This study investigated and characterised the sediments captured at the base of leaky wells at the study site. Further research is required to investigate the potential benefits of these systems to treat stormwater in the urban environment.

Methodology

Study area and infiltration system installations

The research study site is located in Eynesbury Avenue, Kingswood, South Australia, approximately 5.6 km south of Adelaide, the capital city of South Australia. Eynesbury Avenue is a residential street with detached homes. The street has paved footpaths and nature strips along each side of the road with 150 mm (standard height) high kerbs and gutters. Adelaide's climate has been described as the Mediterranean; receive an average annual rainfall of approximately is 450 – 550 mm per year, the bulk of which falls during winter. Typically, winters in Adelaide are cool and summer are hot with low humidity.

Total 28 TREENET inlet systems were installed in a residential street in between July and November 2014. TREENET inlet systems comprise of two zones: capture zone (kerb side inlet) and infiltration zone (leaky well infiltration pit). The kerb side inlets were cast into concrete kerbs using a foamwork (ref). The inlet faceplate then connected to the infiltration zone using pvc stormwater pipe. The leaky wells fabricated using pvc pipe (220 mm diameter and 1000 mm height) with endcap at the bottom (Figure 1). The fabricated wells were installed in the excavated pit (440 mm diameter and 1000 mm depth) and filled with filter media. Total seven wells were backfilled with gravel, water treatment solid (WTS), sandy loam and native clay at random locations, basically one system between two trees.

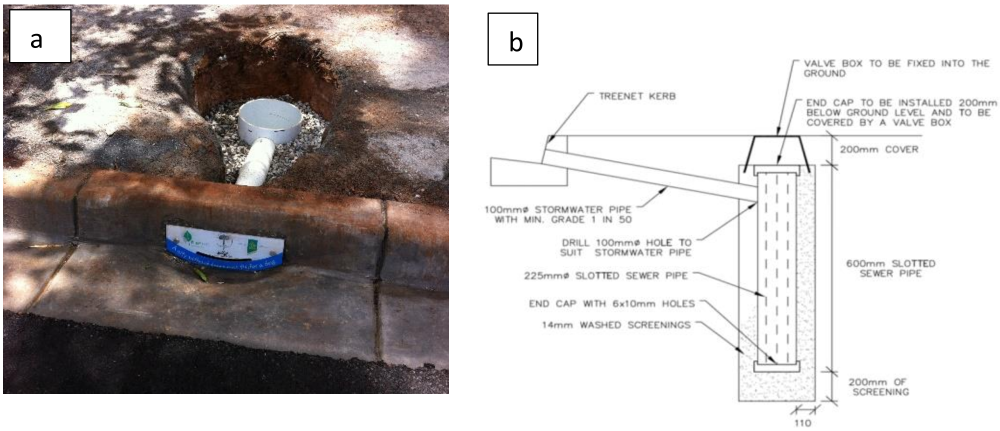

Figure 1 (a) Photograph of TREENET inlet coupled and leaky well at construction stage; (b) Diagram of leaky well

Sediment collection and analysis

After four years of operation, the accumulated sediments were collected from each type of filter media well having the same catchment area wells and made 4 composite samples (Figure 2). The samples were analysed at Nata Credited laboratory for heavy metals (arsenic (As), lead (Pb), nickel (Ni) and manganese (Mn)) concentrations.

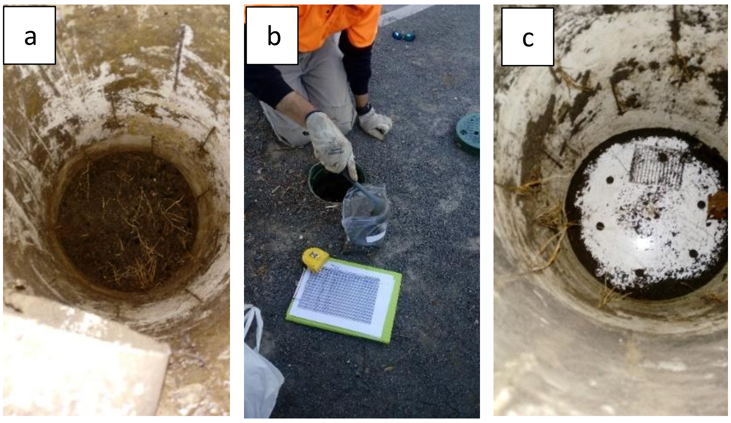

Figure 2: Photographs of (a) accumulated sediments in leaky well; (b) sediment collection; (c) cleaned wells

Results and discussion

After four years of operations, approximately 4 to 7 kg of the sediment mass were collected from the base of the leaky well. It is revealed that the accumulated sediment is a source of heavy metal (Figure 3). The pollutants (heavy metals) vary with land use (for example industry, agriculture or residential site) and proximity to use (Ying and Sansalone 2010). It was noted that the sediment also contained organic matter which may be due to dry leaves of a street tree or roots of trees. The results of this study provided important proof of concept for the application leaky well systems for the removal of sediments and pollutants from the urban catchment. However, due to prolonged saturation of sediment may impact the surrounding soil and groundwater (Appleyard 1993).

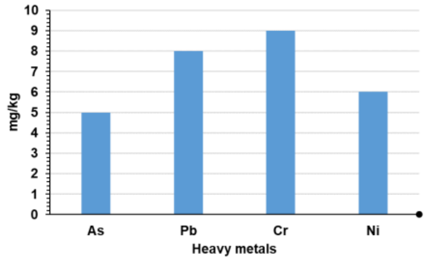

Figure 3 Heavy metal concentration in accumulated sediment at the base of leaky well

Conclusions and future work

The relative accumulation of sediments indicated that the leaky well may be an efficient trap for sediments and pollutants. The regular collection and maintenance of leaky well may enhance the function of filter media and increase the life of infiltration systems.
In the future,

- the heavy metal accumulation at various catchment types should be investigated to determine the effectiveness of kerb side leaky wells.
- It would be useful to investigate the impact of cleaning (sediment removal) on the infiltration rate and life cycle of the system.
- The physical characterisation of the sediment should be investigated to understand the source of sediments.

References

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