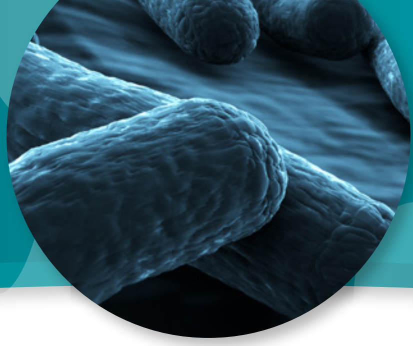
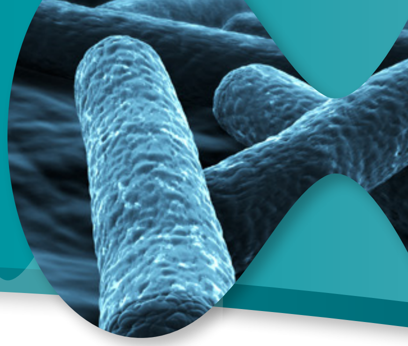
CRC for
Water Sensitive Cities





How clean is raw stormwater? Understanding the hazards

Research shows that raw stormwater is likely to contain chemical, microbial and toxicological contaminants. By understanding and quantifying these risks, we can design better and safer stormwater harvesting schemes.

The research project

Water Sensitive Cities embrace and value all water sources including stormwater runoff, which is now commonly used for non-potable water purposes (such as irrigation and third pipe household use), and beginning to be used for potable reuse (such as Singapore and NSW's Blackman's Swamp scheme).

Understanding the quality of stormwater before it is treated is a key first step in planning a stormwater harvesting scheme. It will influence decisions about end use, treatment trains and risk management.

More specifically, the presence of chemical and microbial contaminants in raw stormwater represents a potential risk to public health if the stormwater is reused without the appropriate treatment and barriers.

Research by the CRC for Water Sensitive Cities provides the first database of stormwater quality from a range of catchments across Australia. As a conservative approach to identify contaminants of greatest risk, the study compared the chemical, microbial and toxicological characteristics of raw stormwater with the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Augmentation of Drinking Water Supplies (2008).

The database can be used in a stormwater harvesting risk assessment to predict the quality of raw stormwater and to understand the catchment hazards that underlie this. The results show that untreated stormwater commonly contains metals, pesticides, pharmaceuticals, endocrine disrupting chemicals, industrial chemicals, and pathogens.

Metals

Metals such as lead, nickel, cadmium and mercury often occur in stormwater at concentrations well above public health standards.

Pesticides

Herbicides, including diuron, MCPA, 2,4-D, simazine and triclopyr were found in >50% of stormwater samples in the research. Concentrations of pesticides in stormwater were generally low, with <10% of the samples exceeding public health standards.

The composition of pesticides in stormwater was found to vary significantly between catchments suggesting that a catchment specific approach to managing pesticides is required when planning stormwater treatment and harvesting systems.

Pharmaceuticals

Stormwater is likely to contain commonly used pharmaceuticals such as caffeine, acesulfame-K (artificial sweetener), paracetamol and salicylic acid. With the exception of caffeine, the concentrations of all other pharmaceuticals were below public health standards in the research samples.

Whilst the majority of pharmaceuticals are not a human health risk, they may indicate sewage ingress into stormwater systems, and therefore may be surrogate indicators of microbial risk.

Endocrine disrupting chemicals

Endocrine disrupting chemicals, including steroidal hormones, are generally absent or found in low concentrations in stormwater. Mestranol, an active ingredient in contraceptive pills, was detected during the research and exceeded public health standards in nearly a third of samples.

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Industrial chemicals

Industrial compounds associated with polycarbonate plastics and epoxy resins were frequently detected in raw stormwater, although the concentrations were well below the public health standards. The distribution of industrial chemicals suggests that catchment characteristics such as land use and point sources have a large influence.

Pathogens

Pathogens found in stormwater suggest that sewage contamination is common. A broad suite of pathogens were detected across Australia (see figure below). All samples contained high concentrations of faecal indicator bacteria *Enterococci* spp. and *Escherichia coli (E. coli)* with the concentrations frequently exceeding public health standards.

The prevalence of microbial markers (e.g. human polyomavirus and adenovirus) together with chemical markers (e.g. paracetamol and caffeine) provides further indication that sewage (not animals) is the source of this contamination. The detection of *Campylobacter* and *Salmonella enterica* suggests a strong likelihood of the presence of other pathogens (Cryptosporidium and enteric virus) based on evidence of human faecal contamination.

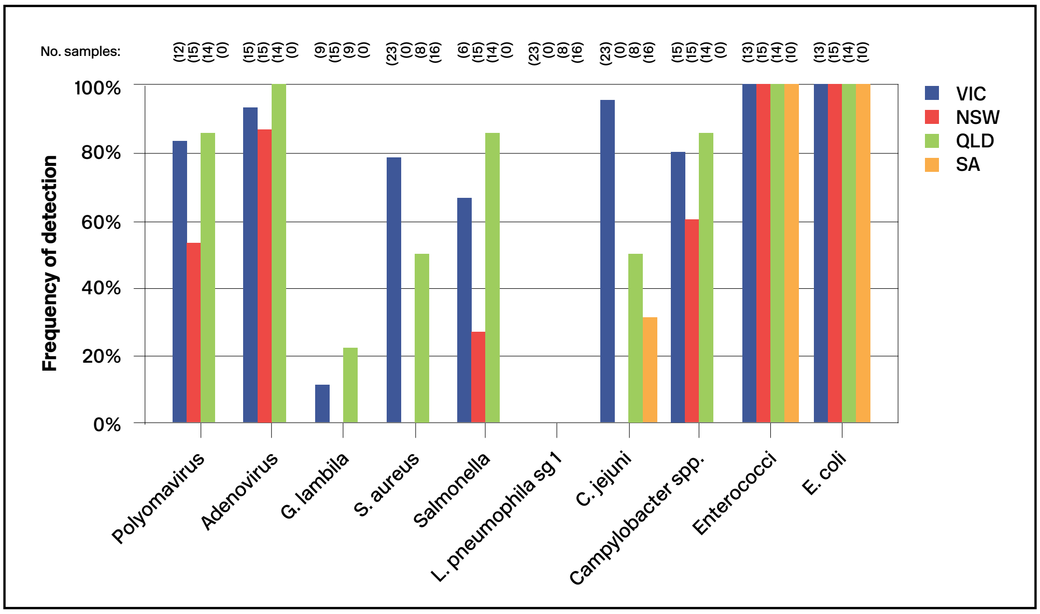
High variability was observed in the adenovirus, polyomavirus and *Salmonella enterica* numbers in both the inter- and intra-event periods. The wide spread prevalence of human specific faecal markers along with human adenovirus and polyomavirus in the water samples collected between storms suggests that sources other than sewage, such as point sources and sediments, may act as reservoir for pathogens.

Stormwater treatment

It is recommended that all stormwater be treated prior to use. Stormwater treatment technologies should be selected to produce fit-for-purpose water supplies and must consider methods to reduce risks associated with stormwater contaminants.

The widespread detection of sewage in raw stormwater indicates that this contamination risk should be assumed for all stormwater harvesting schemes. An integrated stormwater management approach to control faecal contamination is required which may involve controlling the sources of contamination such as sewage leakage, elimination of cross connections or treatment after collection (e.g. by wetlands to allow natural attenuation or other engineered solutions) prior to discharge into surface water or stormwater harvesting.

Stormwater treatment systems associated with harvesting schemes require a case-by-case validation to determine the treatment efficacy for removal of pathogens. Options for managing pathogens include chlorination and UV treatment as well as emerging biofiltration technologies.



Further reading

Gernjak, W., Lampard, J. and Tang, J.Y.M (2017) Characterisation of chemical hazards in stormwater. Melbourne, Australia: CRC for Water Sensitive Cities.

Lampard J, Sidhu, J, Aguiló-Barceló M, Larsen E, Gernjak W. (2017) Microbial quality of untreated stormwater in Australian catchments: human health perspectives. Melbourne, Australia: CRC for Water Sensitive Cities.

Lampard, J., Chapman, H., Roiko, A., Stratton, H. and D.T. McCarthy. Pathogenic bacteria in stormwater runoff: Factors influencing presence and potential human health risks. CRC for Water Sensitive Cities note.

Lampard, J. (2014) Chemical and microbial properties of stormwater: considerations of reuse. Paper presented at Water Sensitive Cities Conference 2014.

Lampard, J., Tang, J., Black, J., Aguiló-Barceló, M., Sidhu, J. and W. Gernjak (2015) Human health hazards in Australian urban stormwater runoff. Paper presented at 2nd Water Sensitive Cities Conference 2015.

Sidhu, J., Gernjak, W. and S. Toze. (2012) Health Risk Assessment of Urban Stormwater. Urban Water Security Research Alliance Technical Report No. 102.

Further information

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