NPS-FW 2020: Suggested Urban Stormwater Management Objectives and Regulation for Freshwater Improvement

November 2023

Introduction

Urban stormwater picks up sediment, microbes, heavy metals, and nutrients along its flow path. Increasing amounts of impervious area in urban development increase stormwater runoff and peak flows and contribute to hydromodification. Receiving water bodies are adversely impacted by receiving environmental contaminants, a reduction in base flows and an increase peak flows, all of which are leading causes of habitat and water quality impairment (Novotny & Olem 1994; Walsh 2000). Suspended matter impacts water ecology by reducing light and water clarity, and non-degradable heavy metals build up over time, accumulating and affecting organism health through bioconcentration and bioaccumulation (Geffard et al. 2007; Hannah 2015; Moss 2014). A wide range of sources contribute to the contamination, such as construction activities, traffic, and wear and tear from roofs and road surfaces, and increased stream bank erosion (Förster 1996; Shamseldin 2011; Zanders 2005).

The National Policy Statement-Freshwater 2020 (NPS-FW) issued by the NZ government sets out objectives and policies detailing how each region is required to change the approach to the management of freshwater to achieve outcomes desired under the National Objective Framework (NOF). There appears to be a lack of attention paid to urban stormwater, which is an important consideration within the NPS-FW under the 'integrated approach' requirements of Policy 3 and Clause 3.5 of the NPS-FW.

Stormwater360 are global experts in urban stormwater and wish to detail some important stressors as well as proposed objectives as solutions for managing the degenerative effects of urban stormwater.

Heavy metals

Heavy metals are potentially toxic and can be transported to freshwater from urban environments via stormwater. Heavy metals are naturally present in the environment, however the concentration in lakes and rivers is exacerbated by human activity. Increases in urban development and industrialisation are a major source of contamination. Human exposure to heavy metals has been linked to damage of the kidney, liver and lungs, the development of different cancers and osteoporosis (Sing et al., 2022). Heavy metal pollution in freshwater has a toxic effect on living organisms and prevents safe Māhanga kai by way of bioconcentration and bioaccumulation.

Building materials such as cooper, unpainted galvanized zincalume and unpainted galvanized iron are significant contributors to heavy metal contamination in urbanised areas. A study of residential, commercial and industrial catchments in Auckland found that roofs contributed more than 75% of the zinc contamination in commercial and industrial areas, and almost 50% of the zinc contamination in residential areas (ARC, 2005). Current rules allow the use of copper roofs in residential developments as permitted activity. William et al. (2016) document that copper roof run off discharges 14,000 µg/L; almost 2000 times the concentration of copper from road (tar felt) run off, 7.6 µg/L.

Stormwater360 suggest that attention is paid to detailing regulation and guidelines for heavy metals in both dissolved and particulate form, as opposed to total concentration. An example of this can be seen in the Washington Technology Assessment Protocol – Ecology (TAPE). The Washington TAPE regulates dissolved metal concentration only, because dissolved metals are harder to remove and more toxic to our freshwater environment. The use of building materials comprising copper and zinc could be regulated in new development i.e., dissolved metal treatment required on site and existing sites with these building materials could be required to retrofit treatment. For example, treatment could be retrofitted to downpipes for the removal of dissolved metals from zincalume roof run off prior to discharging to the stormwater network.

A review of industrial discharge limits is also warranted when looking at international best practice. In California, for example, the Californian Water Board deals with stormwater discharges associated with Industrial Activities under the National Pollutant Discharge Elimination System (NPDES) using a monitoring and trigger level regime. Rather than trying to apply blanket concentration requirements, each industrial site is required to monitor their stormwater discharge for concentrations of contaminants specific to that site. Where an event causes the concentration to go above the agreed trigger level, exceedance response actions are engaged (CWB, 2023).

Gross Pollutants

Gross pollutants can be defined as coarse sediments, litter and debris larger than 5mm in size when used in the context of stormwater. Sediments are defined as inorganic particulates and litter can be defined as anthropogenically derived material including plastics, metals, glass, paper and cloth. Debris can be defined as any organic material such as twigs, leaves, and grass clippings transported by stormwater. While not all gross pollutants are 100% anthropogenic, studies support that human activities are likely responsible for an exponential increase in pollutants when compared to predevelopment conditions (ARC, 2011).

Stormwater360 conducted a study on Waiheke Island to analyse litter loads of various urban land uses using gross pollutant traps (GPTs) over a 12-month period. The GPTs were baskets that sit under the grate of a catchpit. The primary purpose of a GPTs is to remove gross pollutants (>5 mm) washed into the stormwater system before the stormwater enters the receiving waters. Smaller pollutants, such as dirt, chemicals, heavy metals and bacteria are not directly collected by the GPTs; however, some small particles are caught up in the larger items removed, and thus prevented from reaching the receiving water. Urban land uses considered for the study were commercial, recreational, educational, and residential. The sites where litter was greatly concentrated were commercial areas with supermarkets, shops and/or bus stops and recreational areas with some form of commercial establishment. These findings are consistent with a study in Melbourne in 1997, which found commercial areas to generate the highest litter loading (Allison et al., 1997).

Current regional plans do not appear to appear to account for gross pollutants in all high loading areas. For example, there is no regulation on plastic pellets in New Zealand, where countries such as Europe have introduced strict plastic pellet (nurdle) regulations and glitter bans (Guardian, 2023). Stringent gross pollutant control is paramount to combating the global plastic pollution problem being addressed by the United Nations 2024 Global Plastic Pollution Treaty. Incorporating gross pollutant control measures into the NPS-FW 2020 process alongside the global treaty development, expected to be negotiated by March 2024, shows New Zealand's commitment to achieving better global outcomes at the same time as improving our freshwater.

Stormwater360 propose an objective for suitable gross pollutant controls, such as approved GPTs, to be required as part of consent for high loading land use areas.

Emerging contaminants

Microplastics and nanoplastics are of increasing concern. Microplastics can be defined as any plastic less than 5mm in length i.e., smaller than gross pollutants already defined. Nanoplastics can be defined as plastics ranging from 1µm to 100µm in size and as the unintentional byproduct of plastics i.e., from degradation or manufacturing of other plastics (Gigault et al., 2018).

Plastics contain per-and polyfluoroalkyl substances (PFAS) known as "forever chemicals" and can take longer than plastic to break down. Munier (2018) found microplastics can act as a point source of trace metals in coastal ecosystems, and EcoWatch (2023) found hundreds of toxins in recycled plastics. Plastics are entering urban streams, stormwater networks, freshwater bodies, and marine ecosystems and leaching harmful contaminants into our environment.

While stringent gross pollutant measures will help in the reduction of macroplastics (>5mm) entering the receiving environments, micro and nanoplastics also need to be considered to improve the quality of our freshwater. As an example, Symth et al., (2021) from the University of Toronto found that bioretention can reduce the amount of microplastics by over 80%.

Stormwater 360 propose an objective for the identification of emerging contaminants, such as microplastics, nanoplastics and PFAS, with the view of being prepared for faster regulation to protect people and the environment, if required.

Urban Water quality

Additional to chemical contaminants, thermal pollution is an often-overlooked result of increased impervious surface area. Inflow of urban stormwater runoff comes with a thermal load affecting stream temperature (Hathaway et al. 2016; Herb et al. 2008). Especially in cold water ecosystems, a quick increase in temperature and a decrease in dissolved oxygen can be detrimental to stream biota. The warmer temperature of stormwater runoff combined with increased peak flows in urban areas can cause stream temperature spikes which directly affect the persistence of fish by influencing egg development, metabolism, resistance to disease and parasites, migration, spawning habits, and survival (Armour 1991; Beschta et al. 1987; Caissie 2006; Hokanson et al. 1977).

Taking urban contaminants and their effects on the receiving environment into account, Stormwater360 propose an objective on stricter rules for stormwater discharge into the stormwater network and into the receiving body. While the discharge of stormwater remains a permitted activity there is risk in a lack of pollution control measures and maintenance of such, which is unlikely to result in the improvement of freshwater bodies as required under NPS-FW 2020.

Stormwater360 suggest an objective to improve stormwater discharge regulations, particularly from industrial and commercial sites. Improvements in regulation could include:

- Pollution control measures require approval to be installed on new sites and be recorded on a private asset register within the appropriate regulatory body
    - Existing sites are flagged with any existing private assets to be added over time.
- The private asset register is used to ensure the pollution control measures are maintained and the water quality is tested
    - Asset owners are required to submit maintenance receipts or similar in response to automated notification.

  - Asset owners are required to submit testing results showing stormwater discharge is at or below agreed concentrations as stated in the consent, as done for Industrial stormwater discharge in California.
- The register is used to ensure an improvement in the quality of the water being discharged
  - For existing sites, use the current quality as the baseline and work towards improvement, as done for Industrial stormwater discharge in California.
  - Contaminant concentrations should be achievable and be agreed on a site-by-site basis with the view of an improvement over time, as done for Industrial stormwater discharge in California.
- Failure to comply with any of the above results in fines to be invested in stormwater compliance.

Hydrological Mass Balance

Urbanization causes an increase in peak runoff velocity and a decrease in lag time as a result of increased impervious surface area (Ferguson 1998; Leopold 1968). In undeveloped areas, the majority of rainwater is intercepted, evapotranspirated, or infiltrated into the groundwater. Only 15 - 20% of the rainfall volume will move over land as surface runoff. This percentage doubles when impervious surface area increases to 10 - 20%, and increases by more than five times when 75 - 100% of the surface area is impermeable (Arnold & Gibbons 1996). Another example of this phenomenon is a study by Baker (2009), who found that the peak flow of stormwater runoff increased by three times compared to pre-development conditions. The quick channelled discharge in turn causes the baseflows in streams to reduce, as they receive less recharge from groundwater exfiltration (Ferguson & Suckling 1990). The urban hydrograph is therefore characterised by large, sharp peaks, with low baseflow in between.

Current rules do not appear to aim to reduce the amount of discharge or mimic the natural water cycle. It is best practice mimic pre-development conditions in terms of mass balance (volume) and flow rate. This is required to prevent stream bank erosion and habitat destruction, reduce contaminant loading from discharge, and to maintain environmental flows. Attenuation by stormwater retention does not achieve this. The objective can only be achieved by requiring infiltration and water reuse as far as practically possible.

Stormwater360 suggest an objective to include the minimisation of impermeable areas, and on-site retention to encourage hydrological mass balance in the wake of intensive urbanisation and the National Policy Statement on Urban Development 2020.

Operational Stormwater Funding

In addition to charges for non-compliance as mentioned in 'Urban Stormwater Quality' a sustainable way to pay for stormwater treatment and maintenance of stormwater treatment systems is needed. Over time, point source pollution from wastewater and industrial discharges have been addressed but we are still discharging contaminated stormwater.

Like reducing water use by metering or charging for water treatment in homeowner rates, regulatory bodies could apply charges for impervious areas in new developments. Charges could be on a per m^2 per development basis, removed or lessened (credits) when developers use permeable concrete instead of traditional concrete, for example. This type of incentive scheme could help territorial authorities generate income to invest in stormwater asset maintenance and research.

Sustainable stormwater funding models are common across the USA, Canada, and Australia. The following link is guidance for stormwater funding:

https://www.epa.gov/sites/default/files/2015-10/documents/guidance-manual-version-2x-2_0.pdf

Incentive actions would improve the health of urban streams and therefore freshwater bodies across the country, as required under the NPS-FW 2020.

Summary

In summary, Stormwater360 propose the following objectives to be included in Regional Plans to achieve the 'integrated approach' requirements of Policy 3 and Clause 3.5 of the NPS-FW in the context of urban stormwater adversely affecting our freshwater:

- Detailed guidelines and regulations for dissolved heavy metals in place of total metals including:
  - consent for building materials comprising heavy metals such as copper and zinc.
  - bespoke trigger level approach to industrial stormwater discharge limits.

- Requirement for suitable gross pollutant controls, such as approved GPTs, to be installed as part of consent for all high loading land use areas.

- Identification of emerging contaminants, such as micro and nanoplastics and PFAS, with the view of being prepared for faster regulation to protect people and the environment, if required.

- Stricter rules for discharge into the stormwater network or into the receiving body including fines for noncompliance, particularly for commercial and industrial sites.

- Incentive schemes for green infrastructure to aid sustainable urban stormwater management and maintenance.

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