

LESSONS ON GREEN INFRASTRUCTURE MANAGEMENT AND WATER REFORM OPPORTUNITIES

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ABSTRACT

Water sensitive design (WSD) and the associated use of green infrastructure (GI) is an emerging stormwater management practice in the Wellington region. Wellington Water supports the use of WSD and GI but has identified that high life cycle costs are a significant risk if GI is not deployed judiciously and with the right supporting systems in place. Wellington Water and its client councils need to prepare for future development and environmental regulation, to minimise future costs and maximise benefits when GI is required.

To this end, Wellington Water has a goal to establish a regional GI management regime to support the successful and sustainable long-term implementation of WSD. Wellington Water's initial position on key areas is discussed based on learnings from around New Zealand. The key areas discussed are:

- Public and private ownerships criteria,
- Asset management responsibility,
- Operations and maintenance responsibility, and
- Funding strategy.

With water reform now confirmed to include stormwater management, this work takes on more importance as there is an opportunity to address long standing challenges in our current operating environment. It is possible that the new water service entities may have similar relationships to council teams as Wellington Water currently holds. It follows that these same areas for agreement on GI will be relevant to new water service entities. Notably, the scale and regulatory design will have a bearing on the optimal configuration for GI management and the interfaces with Transport and Parks, Sports & Recreation teams.

KEYWORDS

Water Reform, Green Infrastructure, Water Sensitive Design, Wellington Region, Stormwater Management.

PRESENTER PROFILE

Francis Leniston is a Senior Design Engineer at Wellington Water. He has led the development of a new technical design guideline for green infrastructure in collaboration with technical experts and key stakeholders. This paper is based on work that he led following the release of the guideline.

1 INTRODUCTION

Water sensitive design (WSD) is a holistic approach to freshwater management that involves applying land-use controls, engaging with communities, and operating built infrastructure. WSD is Wellington Water's preferred approach to stormwater management because of its prominence as best practice and the multiple benefits that it achieves.

The built infrastructure component to WSD includes a sub-set of stormwater management devices referred to as green infrastructure (GI). GI can be used for managing stormwater at different scales, ranging from individual properties (eg green roofs, pervious paving) to entire catchments (bioretention, wetlands). In contrast to 'grey' or 'hard' stormwater infrastructure, GI devices generally require a surface area at ground level and employ a combination of hydrological and physico-chemical treatment processes. The term 'green' relates to the use of living vegetative systems that are integral to devices' treatment functions.

GI has specific management requirements over its asset life cycle. In short, GI involves living vegetative systems that are often sited in locations accessible to the public and as such are subject to die off and ongoing attrition. Moreover, many GI devices include filter systems that require media replacement when the filter reaches its capacity to trap contaminants. Achieving both primary and secondary benefits of GI is heavily dependent on the knowledge and capability of the operator and maintainer, but also depends on an asset manager and integrated vesting and approvals process.

GI is set to become a much greater part of the Wellington region's built environment both in private and public spaces. This paper outlines Wellington Water's recommendations for the ownership, management, and funding of green infrastructure devices, and then explores how these discussions may evolve with Water Reform, particularly in regards to the relationships to other council departments, namely Transport and Parks, Sports & Recreation teams.

2 BACKGROUND

The management of GI has proved challenging for many urban authorities across New Zealand. These challenges can be attributed to:

- the wide range of professional expertise needed to design, construct, and maintain GI (engineers, ecologists, scientists, planners, landscape architects), along with the multiple overlapping benefits that GI achieves;
- its integration with and relationships to traditional city infrastructure functions, e.g. roading contractors having to maintain vegetated practices, or the location of GI in parks and public spaces.

GI practices may therefore fall between council and network operator departments, leading to a lack of specific maintenance of the engineered components and/or inadequate tending and maintenance of the vegetative features. Overlap between multiple departments can also mean that maintenance costs are inflated as one department checks an inlet or outlet,

whilst another department sends a contractor out to inspect the health of the vegetation. In some cases it is not clear where the responsibility falls.

There is already an existing asset base of publicly owned GI in the Wellington region that needs better maintenance and management if the benefits are to be enjoyed, and this is set to increase in scale with the high level of regional growth predicted. The following paragraphs outline the specific challenges that are being faced in our existing situation.

2.1.1 UNCLEAR EXPECTATIONS FOR DEVELOPERS

Private developers are faced with conflicting messages and unclear expectations over GI. Environmental regulation is pushing GI devices into developments, but without guidance as to what types of devices may be vested to council and how these are best deployed.

The future ownership of GI is often unclear in the development process. This results in assets being included to satisfy regional consent conditions without buy-in from key local body council teams and, in some cases, any formal hand-over. In time, the GI assets can become a significant liability and unsightly to residents. Client councils may eventually request Wellington Water or other council departments to maintain the devices, however the outcomes are often poor because the designated owner/operator did not have input into the design, may lack the appropriate skills and capability to undertake maintenance, and most importantly, isn't allocated any additional funding to manage the devices proactively.

2.1.2 INEFFICIENCIES IN REACTIVE MANAGEMENT

In this fashion, land development growth has created an existing asset base of GI across Wellington Water's client councils that is being poorly funded and inadequately maintained. The lack of a dedicated GI operator and maintainer presents a significant risk to client councils and the wider community because unmaintained GI devices have higher life-cycle costs, do not perform to their intended design, and are more likely to fail; leading to impacts on the community and the environment. They may also fail to achieve optimal amenity and recreational benefits.

A recent national research project on the implementation of WSD concluded that the life cycle costs of GI are minimised under a proactive maintenance schedule. This is achieved through the creation of dedicated ownership responsibilities, executing planned maintenance schedules, and by taking a life cycle asset management approach (Ira & Simcock 2019).

2.1.3 OPERATION AND MAINTENANCE PERSPECTIVE IN DESIGN

Clearly designating ownership responsibilities, and having a dedicated GI operator and maintainer, would enable advocacy for the operational phase of the asset at design and approval stages. Conversely, without a dedicated owner and operator, the insights gained during operation are not easily embedded into best practice or communicated back to designers and planners. Photograph 1 and 2 demonstrates examples of the type of insights gained during operation. In this case, raingarden placement and design have been found to have significant impact on the cost of

operations and maintenance. On the left in Photograph 1 the raingarden is sited in the median strip to utilise the space for water quality purposes, however in practice the operation of this device involves expensive traffic management control to safely maintain the device. An operational perspective in design will help avoid high ongoing costs from poor design decisions.

Photographs 1 and 2: Left: Bioretention in central median strip in Albany, Auckland; Right: Bioretention placed between kerb and footpath in Long Bay, Auckland.



2.1.4 CHANGING REGULATORY ENVIRONMENT

Implementation of the National Policy Statement for Freshwater (NPS-FM), and its imperative to achieve Te Mana o Te Wai, is changing the local regulatory environment for stormwater network managers. For the Wellington region, this means a step change in stormwater quality targets which will lead to significant retrofitting programmes to address existing water quality issues on top of new assets for growth. New GI will be constructed to manage run-off from existing impervious surfaces, e.g. urban spaces, local roads and carparks, and this will expand the existing GI asset base significantly.

In summary, we expect a surge in the number of GI devices based on future growth projections and regulatory changes. This means it is critically important to ensure that the legacy of GI assets constructed in coming years are optimised for maintenance and operation to ensure their long-term effectiveness and efficiency.

3 DISCUSSION

Wellington Water's first initiative to address these GI management issues was to improve the design quality of land development-led GI. Wellington Water released a technical design guideline focussed on the detailed design of four device types (Farrant et al 2019). The development of the guideline provided a useful forum for consultation on the wider issues around WSD and GI. The primary stakeholders to the guideline included client council representatives from transport, PSR, urban design, consents, planning, and asset management teams. In the process of identifying the barriers to implementation of the guideline, the primary

stakeholder group identified three parallel work streams that were essential to enabling WSD in the Wellington region:

- Policy and planning – setting up the right regulatory environment
- Asset management – putting the supporting management systems in place
- People and capability – supporting our people to meet the new challenge

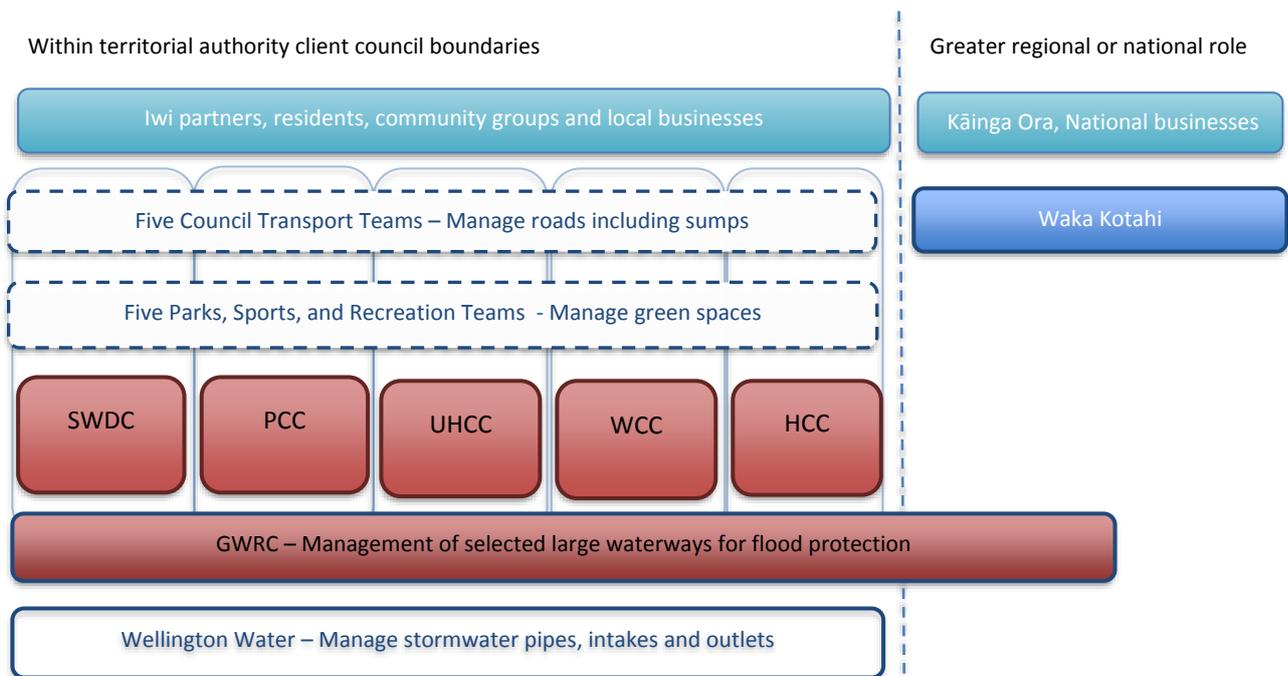
Our implementation strategy was formed around these workstreams with the vision that the combined outputs of these work streams will work to incorporate WSD into existing service delivery systems and ultimately support successful and sustainable implementation of WSD in the Wellington region.

The first step under the Asset Management workstream was to establish a regional management approach for GI.

3.1 ESTABLISHING A REGIONAL MANAGEMENT APPROACH

Stormwater management in the Wellington region is complex. The responsibility for stormwater management is split between multiple organisations whose responsibilities and roles include the management of resources, land-use, and stormwater-related infrastructure. The first step towards establishing a new management regime was to understand the existing roles and responsibilities of stormwater infrastructure providers in the Wellington Region. Figure 2 shows Wellington Water in relation to its five District and Regional Council owners, Private Infrastructure Providers, and Waka Kotahi.

Figure 1: Stormwater infrastructure providers in Wellington Region schematic



Through thorough exploration of the existing challenges in context of the roles and relationships to stormwater management, an initial position on how a regional GI management approach may work was defined as a first step towards achieving agreement between Wellington Water and its client councils. The position is articulated in four key areas in the following sections:

- Public and private ownerships criteria,
- Asset management responsibility,
- Operations and maintenance responsibility, and
- Funding strategy

3.1.1 ASSET MANAGEMENT RESPONSIBILITY

Wellington Water recommends that Green infrastructure is added to the existing stormwater asset classes under Wellington Water's management on behalf of Hutt City Council (HCC), Upper Hut City Council (UHCC), South Wairarapa District Council (SWDC), Greater Wellington Regional Council (GWRC) and Porirua City Council (PCC).

Assigning clear responsibilities for GI has the potential to yield many benefits, including:

- the ability to advocate for, explain, and defend budgets;
- reduced risk of asset failure and oversight of critical infrastructure;
- appropriate investment, funding, and decision-making around GI assets;
- development of robust business cases;
- the ability to improve maintenance efficiency over time as data is collected on GI asset maintenance and included via feedback loops into asset management software.

The basis for our recommendation is that the primary benefit and purpose of GI is stormwater management. Although GI can achieve multiple benefits for urban design, ecology, and landscape amenity, it is primarily a form of stormwater management. Therefore GI asset management must sit within the overarching stormwater asset management strategy and stormwater catchment plans. Wellington Water currently holds the responsibility for stormwater asset management and catchment planning on behalf of HCC, UHCC, WCC, SWDC, and PCC. It is appropriate that the asset management of GI falls within Wellington Water's responsibilities to enable the entire network to be managed in a holistic and cohesive manner.

Accountability for the stormwater management outcomes must be linked to the ability to manage and upgrade networks for stormwater quality. Wellington Water currently holds the regional discharge consent for discharges from the stormwater network to the environment. The current interim consent to discharge will expire in 2023 at which time Wellington Water will be required to re-consent its network operations. Greater Wellington Regional Council's environmental regulation team have signalled that there will be significantly higher expectations for stormwater quality under the new consent.

GI is a key tool for delivering improved stormwater quality. Wellington Water will need to be able to plan for growth and upgrade the stormwater networks to meet the new environmental expectations. This means implementing WSD for land development and retro-fitting the existing networks over time.

GI aligns with international best practice for stormwater management and will become the new "business as usual" in the Wellington region. The NPS-FM requires water quality targets to be set by regional and local councils to reduce contamination of New Zealand's freshwater, groundwater and marine receiving environments. The requirements of the NPS-FM mean that a traditional piped "business as usual" (BAU) approach is no longer acceptable in New Zealand cities. Internationally and nationally, WSD and GI have been shown to provide alternative ways of managing stormwater to meet water quality targets.

3.1.2 PUBLIC AND PRIVATE OWNERSHIP CRITERIA

Wellington Water recommends that:

- the ownership status of land, i.e. public or private, in which a GI device is sited is the guiding determiner of whether a GI device is to be vested to Wellington Water's client councils or to remain in private ownership. This is consistent with other infrastructure, such as roads and water pipes (except where easements are used) and provides an easily understandable basis for ongoing responsibility.
- Public GI assets are to be owned by Wellington Water's client councils in line with other three waters infrastructure under Wellington Water's management and if a new GI asset is to be included in a road reserve or a recreational area as part of a new development, the land within which the device is to be sited shall be vested to council as drainage reserve.
- A compliance regime is to be established for management of private GI assets in private property where their role is integral to meeting water quality objectives. The regime should be designed to ensure that devices continue to provide water quality benefits over their intended operational life.

The basis for these recommendations are that spatially distributed 'at source' infrastructure in private property presents significant challenges for a public infrastructure provider.

A key concept of WSD is to manage stormwater onsite where ever possible. This introduces a tension for public infrastructure providers between advantages of managing stormwater on site and the consolidation of flows to achieve efficient centralised treatment. Although treatment at lot level is a principle of WSD, it is significantly more expensive for a public infrastructure to deliver because it requires managing multiple sites, obtaining access approvals and following-up to reinstate in private property.

Photograph 3: Privately owned raingarden in Rotokauri subdivision development, Hamilton



Photograph 3 above shows a privately owned raingarden in Rotokauri, Hamilton. This type of device can provide good stormwater management benefits if implemented across urban catchments, however if vested into public ownership, would create huge liability and access challenges for the infrastructure operator and maintainer.

Moreover, private property landowners are not incentivised to provide a public good and do not have capability to efficiently operate and manage larger green infrastructure. The management of infrastructure that serves entire communities requires long-term planning, risk assessment, and ongoing compliance with environmental and H&S legislation that body corporates or residents' groups do not have capability to self-perform efficiently and effectively.

Further complexity is added by the fact that the benefits of GI are often for public good and/or the environment and are only evident at a distance from the infrastructure site. This means that a private resident group may not have a clear understanding of whether a device is functioning or be incentivised to maintain the benefit to others. In such a scenario, an external monitoring and compliance regime will be required to hold the resident group and maintainer to account, which significantly decreases efficiency of the system as a whole.

A recent paper on the success of WSD related assets in the Auckland region) identified that WSD devices in private management were not maintained due to a lack of understanding and the regulatory body did not enforce the conditions of consent when the device fell into a poor state due to the lack of an effective compliance regime to enforce consent requirements once built and operational (Norman & Chouremootoo 2019). This highlights the need for an external compliance regime.

Land management and access permissions can also be a significant obstruction to maintenance activities. This inefficiency is avoided by ensuring that the landowner is also responsible for maintenance and operation. Aligning land ownership to device ownership and maintenance ensures that both landowners and public service providers are not required to obtain access approval to carry out maintenance on GI, and that landowners are incentivised to manage their land in such a way that future maintenance / access costs are minimised.

3.1.3 OPERATOR AND MAINTAINER RESPONSIBILITY

Wellington Water's recommends that its Customer and Operations Group (CoG) in collaboration with the five Parks, Sports, and Recreation (PSR) teams of Wellington Water's client councils are given the responsibility for operation and maintenance of GI. The division of tasks and responsibilities are to be set out in binding memorandums of understanding between Wellington Water's CoG and each council PSR department.

The basis for the recommendation is that the operator and maintainer must have the right skillset and be organisationally aligned to the benefits of GI. GI has specific operation and maintenance requirements that include landscape amenity, ecology, and stormwater management. Furthermore, because GI is located across urban environments, an operator and maintainer must be able to work in busy transport corridors, parks and reserves, and in sensitive natural watercourse environments.

Alignment between the benefits of GI and the organisational drivers of the operator and maintainer will ensure the management agreement is sustainable over time. This is particularly important for GI because the benefits are often for public good and/or the environment, and only apparent at a distance from the infrastructure site. This means that an operator may not have a clear understanding of whether a device is functioning or be incentivised to maintain the benefit to others if they are not aligned with the overall goal to provide the public good. In such a scenario, an additional external monitoring and compliance regime will likely be required to hold the operator and maintainer to account.

In addition, the operator and maintainer must have strong links with the asset life cycle, including the vesting and approvals process, catchment planning, and strategic asset management direction. The success of GI and WSD as a whole depends heavily on good management over the entire asset life cycle. Good asset management procedures and software also assist with the collection of maintenance data which can then be analysed to refine the operational programme over time (allowing for more efficient, pro-active maintenance).

Taking a regional approach to GI management will enable the development of specialist skills and O&M practice knowledge. There is relatively smaller asset base of GI and therefore only a limited number of staff with experience in GI across the region compared to other NZ urban centres. Assigning the maintenance and operation responsibility to a regional entity such as Wellington Water's CoG Alliance in conjunction with PSR departments will allow a critical mass to form around GI management that will encourage specialist knowledge to be developed, instead of the responsibility being split between a larger number of operators and essentially undertaken only as part of a groups wider functions.

3.1.4 FUNDING STRATEGY

Wellington Water recommends that our client councils to investigate a cohesive, Wellington-wide funding strategy for stormwater management in light of the significant challenges ahead.

In a review of three waters infrastructure provision and delivery (Minister of Local Government and Minister of Health 2018) the New Zealand Cabinet acknowledged that there are challenges facing council stormwater services, however that it is difficult to quantify these challenges due to a lack of good quality information about the condition of stormwater infrastructure, along with its susceptibility to climate change. In addition, it was acknowledged that along with the governance framework, funding and financing to upgrade infrastructure is one of the key problems facing three waters provision, with a resultant recommendation being that the NZ Government embark on a process of three waters reform over the next few years.

In a local government review of funding, Local Government New Zealand (LGNZ) identified that property rates (the primary funding mechanism for stormwater infrastructure across New Zealand, and that used in the Wellington region) are the cornerstone of funding for local government, however, they are not the best and only tool to address the funding challenges which are facing local authorities (National Council of Local Government NZ 2015). Borrowing, and to a much lesser extent, developer contributions are also used as funding sources.

The current funding regime is not fit for purpose for the current or future set of challenges that Wellington Water and its client councils face for stormwater management. It is clear that alternative mechanisms for funding stormwater must be considered. A recent study (Ira & Batestone 2019) on the alternative funding mechanisms available to stormwater managers identified the following key principles as a sound basis for a future funding model:

- **Sufficiency:** The need to secure adequate funds to renew existing infrastructure, improve service levels consistent with public priorities, and provide for growth.
- **Certainty:** The need to ensure that sufficient funds will be available when required.
- **Equity:** The principle of exacerbator (polluter) pays, i.e. those that generate additional demand for stormwater services should significantly contribute

to its provision. This includes homeowners, commercial properties, road users and developers.

- Efficiency: The principle that a funding mechanism should provide incentives for behaviour consistent with the goal of reducing stormwater volumes and contaminant to levels that achieve the desired environmental and social outcomes.
- Acceptability: The likelihood that the recommended strategy would be politically acceptable.

The study also identifies a number of potential alternative mechanisms to general rates collection that are used in NZ and overseas, including:

- Targeted rates
- Road user charges
- Voluntary offset credit and incentive systems
- Negotiated agreements
- Cap and trade schemes

The study explains that there is no silver bullet which can solve the funding gap facing councils and network operators in New Zealand. Rather, a toolbox approach to funding is needed. The exact make-up of this funding approach for Wellington would need further investigation, but it could include the following elements:

- New development (greenfield and large scale brownfield) CAPEX costs to be funded through development and financial contributions and implemented in a way which provides greater flexibility for councils/ utilities to have more say in what types of assets are delivered;
- Targeted rates for stormwater OPEX funding of existing stormwater infrastructure and to cope with maintenance costs of new infrastructure;
- Incentives and reduced fees for properties incorporating green infrastructure;
- Road user charges to account for contamination from roads (up to 35% of impervious surfaces are located on non-rateable land, and 60% of expenditure associated with pollution control is required because of pollution caused by motor vehicles);
- Cap and trade schemes for urban catchments which incorporate large rural areas;
- Third party operators and/or public private operators to deliver and manage standalone integrated water schemes.
- A national government incentives programme (similar to the Melbourne Water "Living Rivers" programme) which allows regions to sustainably implement the NPS-FM and provides support to WSD projects in local councils, financing activities and employees to build capacity and facilitate projects which councils would not otherwise take on.

3.2 WATER REFORM

With confirmation that water reform will also include stormwater assets and functions, the recommendations take on new significance and the following sections consider this important opportunity to establish a better GI management approach.

3.2.1 TRANSPORT

In the Wellington Region, stormwater road sumps and their lead up until its connection with a manhole or stormwater main are owned and managed by the respective council transport teams. This arrangement is generally well understood and although it requires close coordination on sump maintenance, flooding response, and secondary flow path management, it is a functioning arrangement.

This interface is set to get more complex with the introduction of Wellington Water's first network stormwater discharge consent under the NPS-FM. The network consent will introduce stormwater water quality limits on network discharges and the council transport teams will in effect be bundled into the consent. In theory, Wellington Water will at this point be responsible for holding the council transport teams to account on their discharges into the public stormwater network.

If the new Water Service Entities are assigned the responsibility for stormwater quality network outcomes, it would be appropriate and in line with our recommendations on GI management that the management of green infrastructure in road corridors is also assigned to the entity to ensure that the GI is managed holistically across the catchment. Notwithstanding this, the discussion on alternative funding mechanisms is particularly relevant, as it would be paramount that any funding pathway from Waka Kotahi for the management of GI in local roads was maintained or adequately replaced.

3.2.2 PARKS, SPORTS, AND RECREATION

In our recommendation on operations and maintenance responsibility in section 3.1.3, the Parks, Sports, and Recreation teams were to share the operations and maintenance duties for GI with Wellington Water's Customer and Operations Group. This recommendation was made with the knowledge that there is currently a small number of GI assets in the Wellington Region and it was therefore considered most efficient to utilise the existing skill sets across different organisations.

In light of the scale of water reform, it is conceivable that there would be sufficient workload to justify the new water service entities to establish a dedicated GI management operations group, rather than rely on a combination of skill sets that exists within the current configuration.

Establishing a dedicated group for GI management would be preferable if scale allows because it minimises the number staff involved with a particular asset and

reduces the need to closely coordinate with PSR teams on the ongoing management of GI, whilst enabling a centre of specialisation and excellence in GI management.

4 CONCLUSION

WSD is Wellington Water's preferred approach to stormwater management and we have a goal to bring our region into line with current international best practice in stormwater management. Additionally, the requirements of the NPS-FM means that a traditional piped "business as usual" (BAU) approach is no longer acceptable in New Zealand cities, and WSD/ GI can assist the Wellington region in meeting new water quality requirements. The Wellington region is one of the last urban areas in NZ to start implementing WSD and this provides an opportunity to learn from failures and successes in other regions.

We are aware that there are significant challenges and pitfalls with taking a water sensitive approach, particularly the ongoing costs of GI devices that are either poorly designed for their application and / or inadequately maintained over their operational life. This is evidenced by the existing asset base of GI in the Wellington region that is currently not well managed and the experiences of early adopting councils like Auckland and Hamilton City.

The existing challenges created by GI are set to expand significantly with the implementation of the NPS-FM and the high level of regional growth predicted. This is strong motivation to address the existing management challenges to ensure that GI associated with future growth and network retrofitting is optimised, functional, and fit for purpose.

In response to these challenges, Wellington Water has identified multiple workstreams that together seek to establish the necessary supporting systems to successfully and sustainably implement a water sensitive design approach. The first workstream is underway is to establish ownership and management agreement for GI.

Through exploration of the problem and context, it has been concluded that Wellington Water and its client councils should agree positions on the following:

- Asset management responsibility,
- Public and private ownerships criteria,
- Operations and maintenance responsibility, and
- Funding strategy.

These recommendations take on new significance with the inclusion of stormwater in the Three Waters Reform programme. Given Wellington Water's existing model, it is possible that these recommendations may also be relevant to the design of the new water service entities. In addition, there are potential improvements on these recommendations that scale may offer, particularly in

regards to the opportunity to form a dedicated GI operation and maintenance function in the new water service entities that simplifies the interrelationships between the new water service entities and existing functions in councils.

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