Auckland Water Strategy Supplementary Document

Investigation of barriers and opportunities to further implement Water Sensitive Design in Auckland

FEBRUARY 2022

Sue Ira (Koru Environmental)

Koru Environmental Consultants Ltd

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Auckland Water Strategy Supplementary Document: Investigation of barriers and opportunities to further implement Water Sensitive Design in Auckland

February 2022

Report prepared by Sue Ira
Koru Environmental Consultants Ltd

Recommended Citation
Ira, S.J.T. 2022. Auckland Water Strategy Supplementary Document: Investigation of barriers and opportunities to further implement Water Sensitive Design in Auckland. Report prepared for Auckland Council.

ISBN 978-1-99-110151-8 (Pdf, Online)

EXECUTIVE SUMMARY

Auckland continues to face significant stormwater challenges related to historical development, as well as increased growth and redevelopment of its urban area. The Auckland Plan 2050 identifies that urban development and effects of climate change (including inundation and increased flooding) will have the biggest impact on the region's environment. The Plan also acknowledges that the state of Auckland's marine and freshwater environments are declining due to, amongst other things, poor water quality.

For a number of years now a water sensitive approach to stormwater management in Auckland has been required, to varying degrees, to address these effects. Most notably, it has been used in greenfield areas, areas with high contaminant loads (e.g. roading), areas upstream of sensitive urban stream environments, and for stormwater assets to be vested to council. Over the past two decades, and more recently through the Auckland Unitary Plan process, Auckland Council has made significant progress around the promotion of water sensitive design through the integration of land use and water planning, and the council group continue to develop and implement work programmes to further this progression. In relation to this, Auckland Council Group is developing the Auckland Water Strategy to provide clear strategic direction to the council group's activities for 2021-2050 to address the identified challenges. The vision for the Auckland Water Strategy is '*te mauri o te wai o Tāmaki Makaurau, the life supporting capacity of Auckland's water is protected and enhanced*'. The Auckland Water Strategy proposes that council adopt eight overarching strategic shifts. Improving the integration of land use and water planning has been identified as being essential to achieve Auckland's vision of protecting and enhancing the life supporting capacity of our waters - te mauri o te wai o Tāmaki Makaurau. This report provides information in support of strategic shift 6 '*Integrated land use and water planning*' via a water sensitive design (WSD) lens. It identifies gaps and barriers to, and opportunities for, the holistic and widespread implementation of WSD to support the delivery of te mauri o te wai o Tāmaki Makaurau.

Various terminology related to WSD has been defined and best practice WSD approaches are discussed in Table 1 of the main report. The discussion considers WSD implementation at the site, neighbourhood and catchment scale, and relevant WSD case studies are provided.

The report has also investigated barriers to the wide-spread implementation of WSD in Auckland, with specific reference to Auckland's current planning framework. Barriers to delivering WSD outcomes, as perceived by industry stakeholders in Auckland, are also presented. The review (Section 4) found that Auckland's plans and policies recognise and reference the value of integrated stormwater management (ISM), green infrastructure (GI) and WSD to varying degrees but they do not provide a clear mandated and incentivised framework for the wide-spread implementation of a holistic approach to WSD across Auckland. Many of the challenges and barriers to implementation which have been identified (Section 5) result from the multi-disciplinary nature of WSD. Clear direction is therefore needed at the Auckland Plan and AUP level to ensure that Auckland Council Group have a common understanding of WSD and a common purpose in facilitating wide-spread "on-the-ground" holistic WSD outcomes. The wide-ranging WSD nomenclature across the plans, technical guidelines and codes of practices potentially leads to confusion and could undermine consistency of outcomes. Developing an agreed, Auckland-specific definition of WSD which encapsulates the principles of Mātauranga Māori, underpinning the Auckland Water Strategy vision 'te mauri o te wai o Tāmaki Makaurau, will assist in addressing this challenge and providing strategic direction.

Section 6 of the report presents intervention opportunities which could assist council to overcome identified barriers. A summary of barriers, along with opportunities to overcome these barriers is presented in **Table E.1**. The opportunities are provided within the context of Auckland's water

sensitive journey, starting in the early 2000s with the implementation of various techniques and broad principles associated with ISM and GI, and further developed through the Auckland Unitary Plan processes in the 2010s. The paradigm shift to achieve holistic, wide-spread implementation of WSD will take many years, decades even, with many of the recommended opportunities being long term and/ or requiring on-going effort. Whilst potential timeframes for implementation have been suggested in **Table E.1**, implementation of opportunities are subject to resourcing and this report provides no indication of the ability of council to commit to or deliver the suggested opportunities.

If the challenge of meeting Auckland's growth targets whilst still maintaining or enhancing our unique receiving environment is to be met, then WSD needs to be strongly and consistently mandated and incentivised in the Auckland planning documents. WSD is greater than GI or ISM, and the Auckland Council Group and development community alike need to be incentivised to adopt a WSD lens. With respect to retrofitting WSD in developed/ brownfields areas, clear technical guidance and support tools are needed. Sustainable funding sources need to be investigated and workshopped across the region to support on-going operational costs of maintenance and monitoring. Importantly, these funding sources must be equitable and grounded by the "polluter pays" principle. Finally, on-going locally based training is needed to build capacity within council and the wider development industry.

Barriers are merely opportunities in disguise, with the intervention opportunities offered as potential routes to a supporting a sustainable, consistent and widespread implementation of WSD across Auckland.

Table E.1 High level barriers and intervention opportunities for the widespread implementation of WSD in Auckland

Theme	Barriers	Intervention Opportunities	Timeframe for Implementation
Strategic planning documents and regulatory capacity to influence development outcomes	1. Inherent uncertainty of the RMA plan change process limits council's ability to ensure intended outcomes are reflected in the operative planning documents. 2. Implementation of some rules in the AUP are spatially fragmented leading to inconsistent outcomes being achieved on the ground. 3. The planning framework limits council's ability to monitor the performance of on-site GI devices which form part of the private stormwater network and undertake compliance on poorly maintained private stormwater assets. 4. Lack of cohesion and consistency in the narrative and terminology used between council and	1. Development of a common, holistic definition of WSD for Auckland which incorporates water sensitive city and Mātauranga Māori[1] considerations and which can be incorporated more widely into council planning and technical documents and decision-making. 2. Investigate opportunities to undertake a plan change to further support WSD – Auckland Council is currently carrying out Section 35 monitoring of the Auckland Unitary Plan, which will review the effectiveness and efficiency of the AUP across a variety of topics, including water outcomes. Building on from this evidence base, an investigation needs to be carried out into the strengths and weaknesses (a 'SWOT' type analysis) of the current planning framework to support WSD. The SWOT analysis could include a stocktake of the AUP to assess how well it reflects the overall concepts of WSD. Based on the outcome of the monitoring and SWOT analysis, a Plan Change to strengthen WSD outcomes could be considered. Potential future plan change(s) could investigate and/ or incorporate[2]: a. Regulation of WSD, including mandating or requiring certain WSD principles or practices (such as green roofs, as has been done overseas) b. Incentives for WSD developments (incentives could include reduced consenting requirements)	Short term to medium term (< 5 years) and jointly with mana whenua Short to medium term (<5 years) (s.35 review underway by Plans and Places)

[1] Mātauranga Māori is a taonga held and protected by each respective mana whenua and tangata whenua. For true recognition – it cannot be an add-on to current guidance, rather council processes need to be adapted to bring in the Mātauranga Māori specialists into the assessment, guidance development and decision-making process.

[2] It is acknowledged that while the council may propose plan changes, it is the Independent Hearings Panel that makes the ultimate recommendations. During the AUP process, council made a concerted effort to bring WSD into the AUP, however some of these aspects were not progressed due to IHP recommendations.

	CCO outcomes, regulations and codes of practice. 5. No regulatory incentives. 6. Wider benefits of WSD not taken account of during consenting – not required by the policies. 7. Life cycle assessments not required through the consenting process. 8. The need for more WSD "Influencers". 9. Retrofitting WSD not well considered through the consenting process. 10. No mandate for three waters integration (although work on this issue is now occurring via the Three Waters Reform process).	c. Assessment criteria consideration to include benefits of WSD (both water and non-water benefits) d. Assessment criteria to include consideration of life cycle assessments e. Provision of technical documents to guide retrofitting opportunities using a WSD approach. 3. A review of CCO and council CoPs to ensure definition of WSD (as per intervention 1) is supported consistently across Auckland Council Group. 4. Investigation of opportunities for staging and in the engineering approval processes of vested GI assets to ensure assets are adequately maintained and protected during construction of adjacent 'small sites'. 5. Development of a cross-council and CCO strategic direction (SD) which, amongst other things, addresses three waters integration and the reuse of both stormwater and wastewater to reduce wastewater overflows and water supply demands. 6. Integration of WSD expertise across council is needed. Healthy Waters (HW) consistently advocates for WSD, but WSD expertise could also be included in other council and CCO departments (such as the Urban Design Unit, Watercare and Auckland Transport), to further integrate and influence ongoing WSD implementation.	Short term (1 – 2 years) Short term (1 – 2 years) Short to medium term (<5 years) (likely an interim SD in light of three waters reform process) Medium term (3 – 5 years)
Operational Considerations for council group owned water sensitive infrastructure	1. Differing standards relating to GI acceptance across council and its CCOs. 2. Inconsistent ICT platforms which do not accommodate GI needs.	1. A review of council group CoPs to ensure definition of WSD (as per intervention 1) is supported consistently across council and all its organisations. 2. Review of council group databases which support GI assets and a review of asset information which is required to be provided at the asset vesting stage. Asset database fields	Short term (1 – 2 years) Underway by HW. Short to Medium Term (<5 years)

	3. Lack of clarity regarding GI device ownership. 4. Lack of understanding around maintenance needs and costs of GI. 5. Inconsistent on-the-ground maintenance or lack of maintenance leads to poor public perceptions of WSD.	and requirements should be consistent (streamlined) across council and its CCOs. 3. Development of a GI asset database which tracks inspection and maintenance expenditure for all council group GI assets. This could also include monitoring of device performance thereby assisting in building an understanding of life cycle performance and cost. 4. Review of council maintenance procedures/ models for GI (e.g. 2 in a Ute programme effectiveness vs large scale maintenance providers) and development of maintenance guidelines for contractors maintaining <u>vegetated</u> council assets.	 Underway by HW. Short term (1 – 2 years) Underway by HW. Short term (1 – 2 years)
Funding and financing	1. Benefits of WSD and GI are wide-reaching but are not accounted for through business cases for funding. 2. Indirect costs to society and the environment (e.g. costs of carbon) are not considered during decision-making processes. 3. There is no sustainable funding source (other than rates) for operational maintenance and performance monitoring. 4. Regulatory and monetary incentives for WSD approaches are virtually non-existent.	1. Consistent, council group development of business case templates for funding based on water and non-water benefits of WSD and cultural benefits as integral to decision-making for all council group funded projects. Business cases to also take indirect costs (carbon costs, costs of environmental remediation) into account during option analysis and decision making. 2. Development of a benefit-based value engineering process for project design and delivery that realises benefits and does not 'value engineer' options solely on the basis of cost. 3. Investigate pathways for the implementation of sustainable funding systems and incentive mechanisms in Auckland, including assessing: a) Investigating the use of the existing road user tax and the targeted water quality rate for the provision of a sustainable funding source for ongoing maintenance and monitoring of GI; b) opportunities for co-benefit based funding; and	Underway by HW. Medium term (1 – 3 years) Underway by HW. Short term (1 – 2 years) Underway by HW. Short term (1 – 2 years)

		c) gaps in capacities to pursue the opportunities afforded by alternative potential funding regimes. 4. Investigation into providing financial incentives for WSD development (e.g. reduced consenting fees, WSD subsidies). 5. Development of a WSD rating scheme similar to the 'green star' process where developers can financially benefit from WSD approaches and create a market demand for environmentally sensitive approaches to urban development. 6. Recognising and rewarding WSD success stories.	 Medium term (3 – 5 years) Medium term (3 – 5 years) and ongoing Short term (1 – 2 years) and ongoing
Conflicting outcomes	1. Commercial (development yield) and public service (affordable housing, roading), often outweigh WSD considerations and benefits (since these are not valued through the decision-making process). 2. Retrofitting WSD not well supported (technically or legislatively).	1. Intervention opportunities previously recommended which would assist in overcoming conflicting outcomes include: a) Regulation of WSD, including mandating or requiring certain WSD principles or implementation tools. b) Integration of WSD expertise across council is needed. Healthy Waters consistently advocates for WSD, but WSD expertise could also be included in other council and CCO departments (such as the Urban Design Unit, Watercare and Auckland Transport), to further integrate and influence ongoing WSD implementation. c) Consistent cross-council development of business case templates for funding based on water and non-water benefits of WSD and cultural benefits as integral to decision-making for all council group funded projects. Business cases to also take indirect costs (carbon costs, costs of environmental remediation) into account during option analysis and decision making. d) Development of a benefit-based value engineering process for project design and delivery that realises	Previously provided.

		benefits and does not 'value engineer' options solely on the basis of cost. 2. Guidance on methods for retrofitting WSD in areas of existing development, for instance as part of brownfield redevelopment projects. This could also include design and decision-making support tools to support consent applications (e.g. a 'green scoring sheet' or 'WSD success matrix' for redevelopment projects). 3. Development of detailed design exemplars to support council and CCO staff in assessing acceptable long term infrastructure to be vested.	Short term (1 – 2 years) Short term (1 – 2 years)
Capability and capacity	1. Inexorable contesters of WSD base opinions on misinformation. 2. Lack of design, construction and maintenance training courses for industry practitioners. 3. Lack of budget and time for training needs of council and CCO staff.	1. Working jointly with industry, universities and professional institutions, to develop additional locally based training programmes to support design and implementation of WSD to complement the NGICP course (based on the WSD training framework developed by Feeney (2021). 2. Developing transitioning strategies, institutional and governance arrangements and methods for promoting behaviour change in the Auckland context. 3. The need to build capacity to better reflect Te Ao Māori values in WSD design and implementation and improved models for including Māori in decision-making and governance. 4. Evaluate a range of WSD case studies for the degree to which each project incorporates Te Ao Māori. These case studies can serve as reference projects illustrating good and bad practice, informing the design of future projects and the wider building of industry capacity.	Partially underway by HW. Short to medium term (1 – 5 years) and on-going Long term (>5 years) Short to medium term (1 – 5 years) and on-going Partly underway by APSR[3]. Short to medium term (1 – 2 years)

[3] Auckland Plan Strategy and Research Department, Auckland Council

Table of Contents

1. Introduction 1

2. Defining water sensitive design 3

3. Best practice water sensitive design 6

3.1 Defining best practice 6

3.2 Case studies demonstrating "best practice" WSD in Auckland 7

3.2.1 Site/ individual lot scale WSD approaches 7

3.2.2 Subdivision/ neighbourhood scale WSD approaches 8

3.2.3 Catchment WSD approaches 12

4. Auckland's WSD Planning Framework 17

4.1 Background 17

4.2 The Auckland Plan 2050 18

4.3 Auckland's Urban Ngahere (Forest) Strategy 19

4.4 Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan (2020) 19

4.5 Auckland Unitary Plan 19

4.5.1 Background to the Auckland Unitary Plan 19

4.5.2 Current AUP provisions 20

4.6 Stormwater-specific planning provisions 23

4.6.1 Stormwater Bylaw 2015 23

4.6.2 Stormwater Code of Practice 23

4.6.3 Stormwater Network Discharge Consent 23

4.7 Auckland Transport Design Manual (2021 - Road Drainage v.1.2) 23

4.8 Watercare's Statement of Intent (2018 – 2021) and Code of Practice (2015 - v.1.5) 24

4.9 Summary 24

5. Barriers to delivering best practice WSD 26

5.1 Barriers in the planning framework 26

5.2 Actual or perceived barriers from an industry perspective 27

6. High level intervention opportunities 36

6.1 Strategic planning and regulatory opportunities 36

6.2 Operational opportunities 39

6.3 Funding and financing opportunities 41

6.4 Opportunities to reduce conflicting outcomes 44

6.5 Opportunities to enhance capability and capacity to deliver WSD 45

7. Conclusion 48

8. References 50

Acknowledgements 53

List of Figures

Figure 1 Auckland Water Strategy overview, highlighting strategic shift 6 '*Integrated Land-Use and Water Planning*' 2
Figure 2 Change in stormwater management over time, with the advent of LID in the 1990s and integrated stormwater management and WSD in the 2000s. A full WSD approach would additionally consider wider non-water benefits to society to improve urban liveability and cultural benefits (adapted from Fletcher *et al.*, 2015). 4
Figure 3 A suggested classification of urban drainage terminology for the Auckland context (idea adapted from Fletcher *et al.,* 2015)....5
Figure 4 Examples of on-site GI practices....8
Figure 5 Talbot Park before redevelopment (left photo) and as redesigned and implemented (right photo). 9
Figure 6 Talbot Park roadside rain gardens....9
Figure 7 Roadside swales and narrow road widths, no footpaths (Goodland Estates) 10
Figure 8 Goodland Estates: Original subdivision layout (left) (TP124) and consented subdivision layout (right) (Sources: Woods and Earl Shaver)....10
Figure 9 Rain gardens and paving providing water quality....11
Figure 10 Kirimoko Park, Wanaka: WSD pipeless subdivision with narrow road widths, swales, rain gardens, rain tanks and infiltration basins....11
Figure 11 A green street in Long Bay....12
Figure 12 Long Bay Structure Plan showing Type A and Type B stream management areas. 13
Figure 13 A green streets approach to roading in Long Bay (source: Auckland Design Manual)....14
Figure 14 Auckland Council planning instruments influencing land use....17
Figure 15 Number of times each barrier theme was referred to in survey responses from respondents in Auckland (source: Moores *et al.*, 2018)....27
Figure 16 Number of times each barrier theme was referred to at the Auckland and Christchurch workshops in relation to their key "burning issues" (source: Moores *et al*., 2018)....28
Figure 17 Urban Water Transitions Framework (source: Brown *et al*., 2009). 29
Figure 18 Transition Dynamics Framework – advocating and contesting narratives (source: Brown *et al*., 2016)....29
Figure 19 The six phases of the transitions dynamics framework and the five domains of change (source: Brown *et al*., 2016) 30
Figure 20 Building a Strategic Transition Program: Where are we at in Auckland? (source: Moores *et al.*, 2018)....31
Figure 21 An example of the type of maintenance which is occurring on many rain gardens in Auckland....40
Figure 22 The water sensitive cycle as a stormwater sector development tool (Feeney, 2021) 46

List of Tables

Table 1 Summary of intervention options which can be used as part of a WSD toolbox approach to development 15
Table 2 Examples of various WSD implementation tools within the AUP 22
Table 3 Barriers to wide spread implementation to WSD in Auckland 33
Table 4 Strategic planning and regulatory opportunities 38
Table 5 Operational opportunities 41
Table 6 Funding and financing opportunities 43
Table 7 Opportunities to reduce conflicting outcomes 44
Table 8 Opportunities to build capacity and capability to implement WSD 47

1. Introduction

Auckland continues to face a number of significant challenges related to historic development as well as increased growth and redevelopment of its urban area. These include issues such as:

- increased flooding which stresses existing property owners as well as existing infrastructure
- increased volume and flow of stormwater which compromises existing levels of service as well as creating stressors on aquatic habitats through the process of accelerated stream channel erosion
- deterioration of the quality of receiving waters and sediments
- costs associated with long term maintenance of constructed stormwater practices built to mitigate the abovementioned effects.

The Auckland Plan 2050 acknowledges that the state of Auckland's marine and freshwater environments are declining due to, amongst other things, poor water quality. Additionally, it identifies that urban development and effects of climate change (including inundation and increased flooding) will have the biggest impact on the region's environment.

Auckland Council Group is developing the Auckland Water Strategy to provide clear strategic direction to the council group's activities for 2021-2050 to assist in addressing the identified challenges. The vision for the Auckland Water Strategy is *'te mauri o te wai o Tāmaki Makaurau, the life supporting capacity of Auckland's water is protected and enhanced*'. The Auckland Water Strategy proposes that council adopt eight overarching strategic shifts. A Strategy Framework has been developed to guide this process and has set a direction that is adaptive as conditions change (e.g. the recently released updates to the National Policy Statement for Freshwater Management which council needs to ensure consistency with).

Land use and development decisions are closely connected to the health and wellbeing of water, and the risks of water related natural hazards to communities. Improving the integration of land use and water planning is essential to achieve our vision of protecting and enhancing the life supporting capacity of Auckland's waters - te mauri o te wai o Tāmaki Makaurau. This report provides information in support of strategic shift 6 '*Integrated land use and water planning*' (Figure 1). This strategic shift has eight interrelated aims:

1. water is recognised as a major determinant in sense of place in Tāmaki Makaurau
2. spatial planning integrates land use, water and infrastructure decision-making
3. the cumulative effects of land use within catchments are understood and managed to protect and enhance mauri
4. avoiding pollutants entering Auckland's waterbodies as a result of land use activities
5. Aucklanders have safe, equitable access and feel connected to healthy, protected blue and green spaces
6. exposure to water-related natural hazard risk decreases over time; growth occurs outside of natural hazard areas and provides appropriate mitigation where this is not practicable and risks are low
7. Auckland's development framework delivers water sensitive outcomes
8. water-sensitive infrastructure is consistently maintained to a high standard by all asset owners.

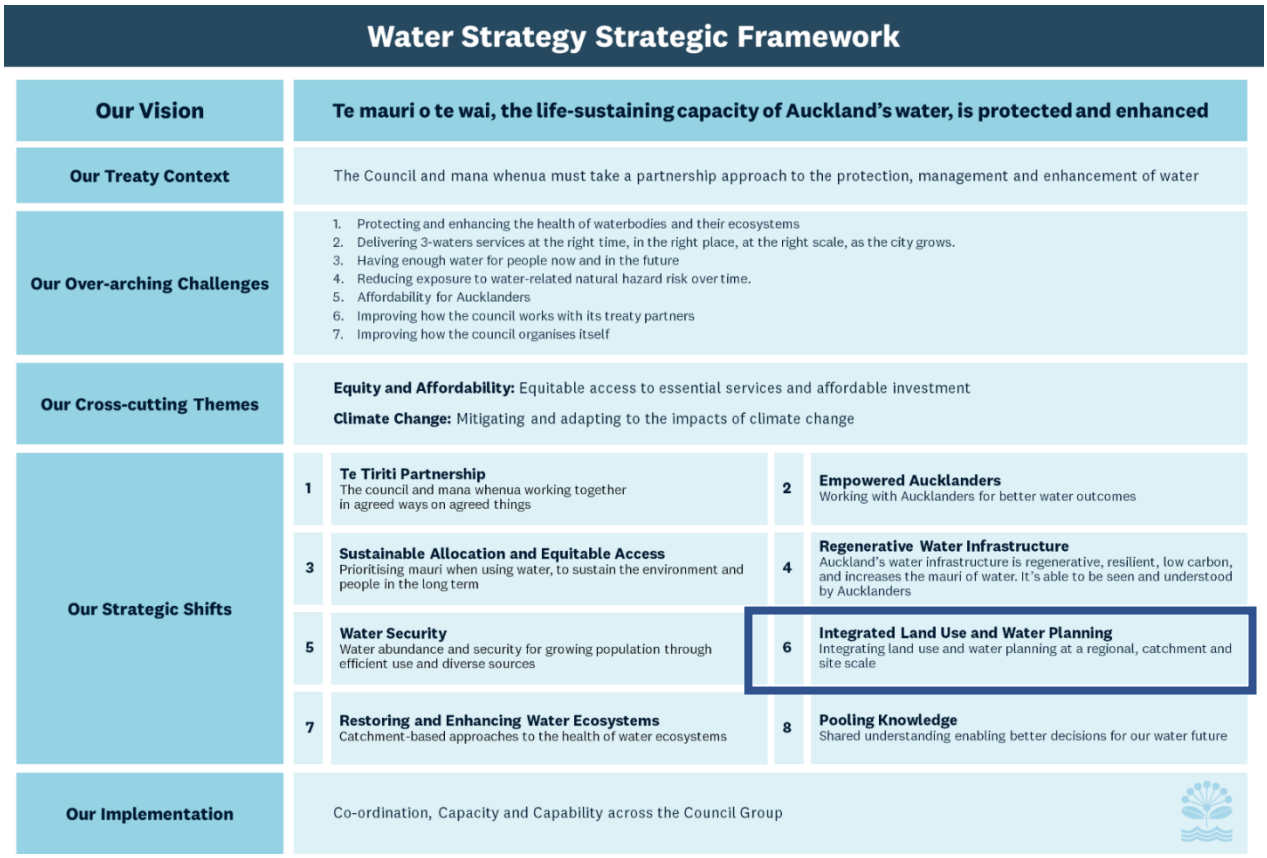


Figure 1 Auckland Water Strategy overview, highlighting strategic shift 6 '*Integrated Land-Use and Water Planning*'

Auckland Council has made significant progress towards integrating land use and water planning, and council departments and council-controlled organisations (CCOs) continue to develop and implement work programmes to further this progression. Despite this, improvement can still be made in some areas. This strategic shift directs where and how this improvement can be achieved to deliver te mauri o te wai o Tāmaki Makaurau.

Strategic shift 6 recognises that water sensitive design (WSD) has been offered up as a solution to address gaps or barriers to implementation. WSD has historically been applied to varying degrees across Auckland. Often at source controls are limited or utilised in an ad hoc manner, and land use interventions are not integrated throughout a catchment, particularly in brownfield areas or smaller developments which can result in cumulative adverse effects. Whilst this is partly due to limitations in the matters over which council has control, and partly a symptom of council needing to respond to reactive commercial development systems consented under an RMA effects-based approach; the question remains as to whether the current planning framework could be strengthened to be more directive and provide cohesive, holistic support for WSD.

In support of strategic shift 6 within the Auckland Water Strategy, this report investigates the level to which Auckland's strategies, policies, rules and non-statutory tools are clearly aligned. It documents previously identified barriers to the wide-spread implementation of WSD in

Auckland and investigates potential opportunities available to the Auckland Council Group to overcome these barriers.

2. Defining water sensitive design

WSD is an alternative approach to conventional forms of urban development. It aims to integrate urban planning and water management in order to better manage challenges such as flood risk, water supply security, water quality of our aquatic resources, and amenity values of waterbodies (Moores, *et al.*, 2018). WSD is not a new approach to managing stormwater discharges and has been called Low Impact Design (LID) in the United States (and previously as Low Impact Urban Design and Development (LIUDD) in New Zealand), Sustainable Urban Drainage Systems (SUDS) in the United Kingdom and Europe, and Water Sensitive Urban Design (WSUD)/ WSD in Australia and more recently in New Zealand. The term "LID" first emerged in Vermont in the USA in the late 1970s, but was more influentially used in the early 1990s by Prince George's County, Maryland, USA (Fletcher, *et al*., 2015). Fletcher *et al.* (pp. 527, 2015) stated that "*the original intent of LID was to achieve a 'natural' hydrology by use of site layout and integrated control measures*". Since this time the concept of LID, SUDS or WSD has been continually evolving. Figure 2 illustrates this progression and increasing complexity of stormwater management, integrated with three waters management, over time.

In the New Zealand context, WSD aims to limit stormwater runoff and contaminant generation via source control of contaminants (such as by using inert roofs) and at source by minimising the construction of impervious surfaces, such as roads and roofs. This can be achieved, for instance, by building clusters of multi-storey dwellings in order to retain larger areas of undeveloped green space. Secondly, it aims to maintain the functioning of natural drainage systems, rather than replacing stream networks with piped systems. In combination, these practices aim to maintain characteristics of catchment hydrology, including infiltration, groundwater recharge and stream flow characteristics, similar to those that existed pre-development. Thirdly, WSD uses green technologies (often referred to as 'green infrastructure') to better manage stormwater in a way that complements its approach to land use planning. The use of permeable paving, for instance, can help to promote infiltration and reduce stormwater runoff. Bioretention systems, or rain gardens, also provide for flow control while providing treatment to improve stormwater quality via the removal of contaminants as stormwater infiltrates through an engineered soil media. Wetlands also provide stormwater treatment and runoff control, as well as providing habitat and amenity services. Amongst other things, WSD can also feature riparian planting, or the revegetation of stream banks, to improve stream habitat quality and connectivity (Moores *et al*., 2018).

The Auckland Council's Guidance Document 04 on WSD (Lewis, *et al*., 2015 – herein after referred to as GD04) defines WSD as:

"An approach to freshwater management, it is applied to land use planning and development at complementary scales including region, catchment, development and site. Water sensitive design seeks to protect and enhance natural freshwater systems, sustainably manage water resources, and mimic natural processes to achieve enhanced outcomes for ecosystems and our communities."

GD04 lists four key principles that are incorporated within WSD, namely to:

- promote interdisciplinary planning and design
- protect and enhance the values and functions of natural ecosystems
- address stormwater effects as close to source as possible
- mimic natural systems and processes for stormwater management.

Currently, and as reflected in GD04, Auckland's approach to WSD has been through 'integrated stormwater management' (ISM), which represents a key component of WSD that focuses on managing stormwater discharges and protecting and enhancing receiving water bodies via practices that mimic the natural water cycle (see Figure 2). This approach relies on, amongst other things, source control and green infrastructure (GI) practices to mitigate stormwater discharges. In the Auckland context, GI also refers to natural assets such as streams. The Auckland region has more than 16,000km of permanent natural freshwater streams, much of which form an integral part of Auckland's stormwater network (AC Healthy Waters Asset Management Plan, 2018). Since the drought of 2020 wider consideration has been given to integrating stormwater management with water supply via rain tanks. Within the wastewater sector, detention tanks have historically been used in combined sewer catchments to reduce overflows. However, WSD as a design philosophy and it's wider use within the wastewater sector (e.g. using wastewater as a resource for non-potable supply) and in relation to wider (non-water) contributions to urban liveability (i.e. the social and cultural benefits of WSD) have received limited attention in Auckland. A holistic WSD approach (Figure 2) is wider than integrated stormwater management and would ideally include some or all of these wider potential roles.

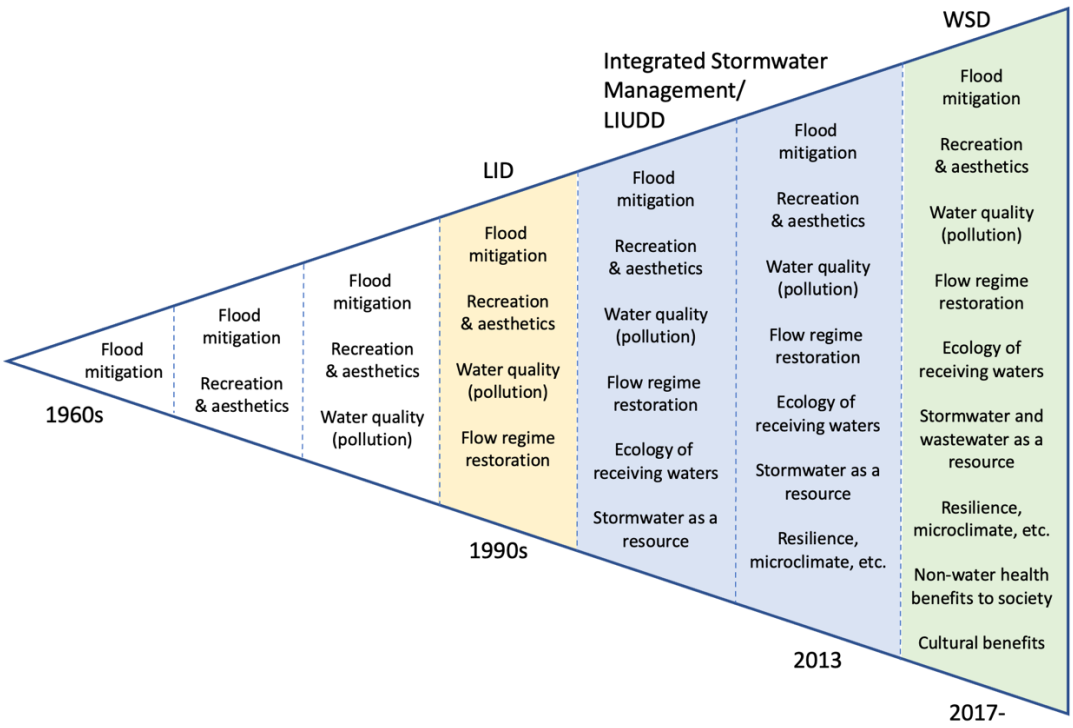


Figure 2 Change in stormwater management over time, with the advent of LID in the 1990s and integrated stormwater management and WSD in the 2000s. A full WSD approach would additionally consider wider non-water benefits to society to improve urban liveability and cultural benefits (adapted from Fletcher *et al.*, 2015).

The wide-ranging terminology which is generally applied to a 'WSD-type' approach to water management can lead to confusion amongst practitioners and decision-makers alike. Interestingly, Fletcher *et al*., (2015) discusses the idea that these many different terms can be classified based on the primary focus of the term and the specificity of the technique. Whilst these classifications are arbitrary in nature, they assist in providing the reader with an understanding of the different terms used within this report (Figure 3) and highlight that GI and ISM are important tools for implementing components of WSD. In the context of this report, WSD refers to the full, holistic definition of WSD as described in the literature (e.g. Moores *et al.*, 2018) and highlighted in green in Figure 2 and illustrated in Figure 3.

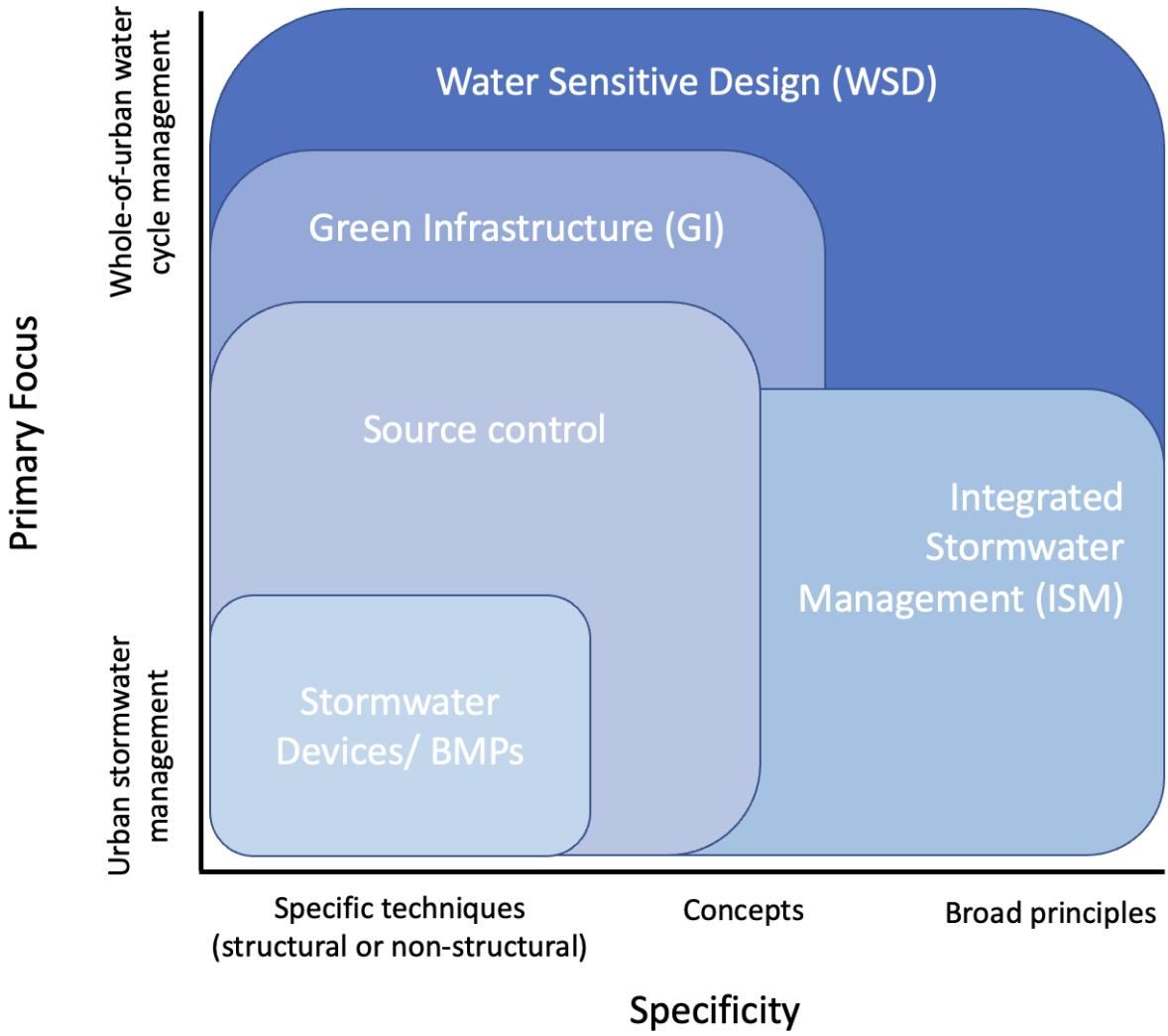


Figure 3 A suggested classification of urban drainage terminology for the Auckland context (idea adapted from Fletcher *et al.,* 2015)

3. Best practice water sensitive design

3.1 Defining best practice

As discussed in Section 2, WSD is a design approach based on a set of guiding principles. WSD can therefore be thought of as a toolbox of structural and non-structural methods which need to be applied on a case by case basis (or 'best fit' approach) within a planning or design context to minimise effects and maximise benefits.

As discussed previously, GD04 is Auckland Council's guideline document on WSD for stormwater. GD04 provides a comprehensive summary of the site design process, along with concept designs for source control and GI structural and natural solutions. It summarises all information needed during the site assessment phase and demonstrates how this can be used during the site analysis and concept design phase of a land development project. GD04 does not cover wider benefits of a holistic WSD approach on liveability (i.e. non-water benefits) nor integration with water supply and wastewater outcomes, and is more focussed on an ISM approach as described in Figure 3.

In general WSD approaches vary not only according to the scale of their implementation (i.e. site/neighbourhood scale vs catchment scale) but also according to the current level of development within an area. For example, in a greenfield situation where there is a mix of valuable native areas, sensitive receiving environments and degraded rural streams, the WSD approach should focus on protection of the natural resources where they are significant and the enhancement of degraded urban streams. In a brownfield, redevelopment or retrofit situation, the approach would be more focussed around reducing existing impervious areas. This can be done through, for example, the use of green roofs, integrating/retrofitting GI into the roading corridor to allow for greening of ultra-urban areas, and retrofitting water re-use rain tanks to reduce loading on combined stormwater/wastewater systems or under-capacity stormwater systems.

Given that WSD is a philosophy towards site and catchment land-use planning and design, 'best practice' implementation of WSD solutions is generally determined by the outcomes sought via planning or consenting provisions as well as:

- existing catchment and site constraints (e.g. rainfall, flood risk, geology and soils, slope, groundwater levels, existing services, etc.)
- existing site resources (natural resources such as streams, wetlands, estuaries, terrestrial significant natural areas, and built resources)
- the sensitivity of the receiving environment to the increase in flow rate and volume of stormwater discharges (e.g. Auckland's small headwater streams are very vulnerable to increases in the volume of water discharged into them – limiting impervious surfaces in these areas would be a priority)
- the sensitivity of the receiving environment to effects from water quality
- the contaminant generation potential of the land use (e.g. high contaminant land use such as high use roads, industrial and commercial areas).

The most effective WSD solution is one that begins at the land use planning stage (e.g. via a structure plan or catchment plan) and is able to integrate non-structural planning rules (e.g. limits on impervious surface areas, road layout, subdivision yields, requirements for re-use)

with mitigating GI solutions and three waters integration. This approach assists with accounting for cumulative effects of developments within a catchment, sets the planning framework for mitigating effects from historic development as areas are redeveloped, and assists with ensuring that future 'infill' development effects are considered and managed holistically.

3.2 Case studies demonstrating "best practice" WSD in Auckland

3.2.1 Site/ individual lot scale WSD approaches

Depending on available space within individual lots, there are many different ISM, GI and WSD practices which can be applied. Permeable paving can be used for parking and driveway areas, rain tanks can capture water from inert roofs for water reuse (and powered by solar panels), living roofs can be placed on roof areas which are not being used for water reuse and infiltration/rain garden areas can be used to capture overflow from rain tanks (Figure 4).

A dual strip driveway (reduced impervious area) in Pakuranga

Green roof, rain tank and solar panels at Wiles Ave, Remuera (photo courtesy of Robyn Simcock)

Rain tanks in Rising Way, North Shore

Permeable paved driveway on Waiheke Island (Photo courtesy of Wynand du Toit, Stormwater360)

House rain garden in Rising Way, North Shore

Permeable paving for off-road parking areas, Omaha

Figure 4 Examples of on-site GI practices

3.2.2 Subdivision/ neighbourhood scale WSD approaches

Talbot Park[4] (brownfields redevelopment)

The Talbot Park Community Renewal project in Glen Innes was completed in 2007 and used WSD and CPTED[5] principles to deliver a sustainably designed urban design for 219 homes. Key aims of the redevelopment were to improve living conditions for Housing New Zealand residents by providing medium-density housing via quality urban design that addressed key community concerns: personal and community safety, lack of local employment and poor community health (Figure 5).

[4] Information taken from the Activating WSUD in NZ case study on Talbot Park: https://www.landcareresearch.co.nz/uploads/public/Discover-Our-Research/Environment/Sustainable-society-policy/WSUD/Case_study_Talbot-Park-Final-July19.pdf

[5] Crime Prevention Through Environmental Design

Figure 5 Talbot Park before redevelopment (left photo) and as redesigned and implemented (right photo).

The development incorporated the following WSD practices:

- rain tanks for water reuse
- narrow road widths to reduce impervious surfaces
- high quality natural soils were retained in park and garden areas (the Tamaki area has deep, free-draining soils)
- rain gardens within the roadway which acted as "bump-outs" to slow traffic speeds
- trees within the rain gardens (and complementary landscaping) provide shade and shelter
- retention of existing large trees on site where possible
- use of native vegetation in landscaping and rain gardens provide a range of ecological and cultural values including providing resources for insects and birds
- edible plants have been added in some areas by local residents within the community garden and park areas.

Figure 6 Talbot Park roadside rain gardens (photo courtesy of Robyn Simcock)

The success of the project can be attributed to strong community support for sustainable design and WSD features by iwi, conservation and recreational groups.

Goodland Country Estate (greenfields development)

Goodland Country Estate is a country-side living subdivision north of Albany. It provides an excellent example of how clustering of lots can reduce impervious surfaces and protect significant natural areas. Based on the traditional subdivision design, the developer was able to obtain 46 lots. Using a WSD approach, the developer increased their yield to 63 house lots. The subdivision was essentially pipeless, with all roads being treated via swales and filter strips. Road widths were kept to a minimum. All streams were planted with native vegetation and fenced off so that the remaining open space could be used as a farm area for the community. All houses make use of rain water tanks. Properties are covenanted to prevent further subdivision of lots and to protect the GI and riparian buffers. A residents association (or similar) was set up to take ownership of and maintain the GI.

Figure 7 Roadside swales and narrow road widths, no footpaths (Goodland Estates)

The success of the project can be attributed to the willingness of the developer to take an innovative approach to land development and to WSD champions within the former Auckland Regional and Rodney District Councils (RDC) who drove the process. It is noted that the road widths and subdivision layouts did not meet their RDCs codes of practice and planning rules, and non-complying consents were needed for the subdivision to proceed.

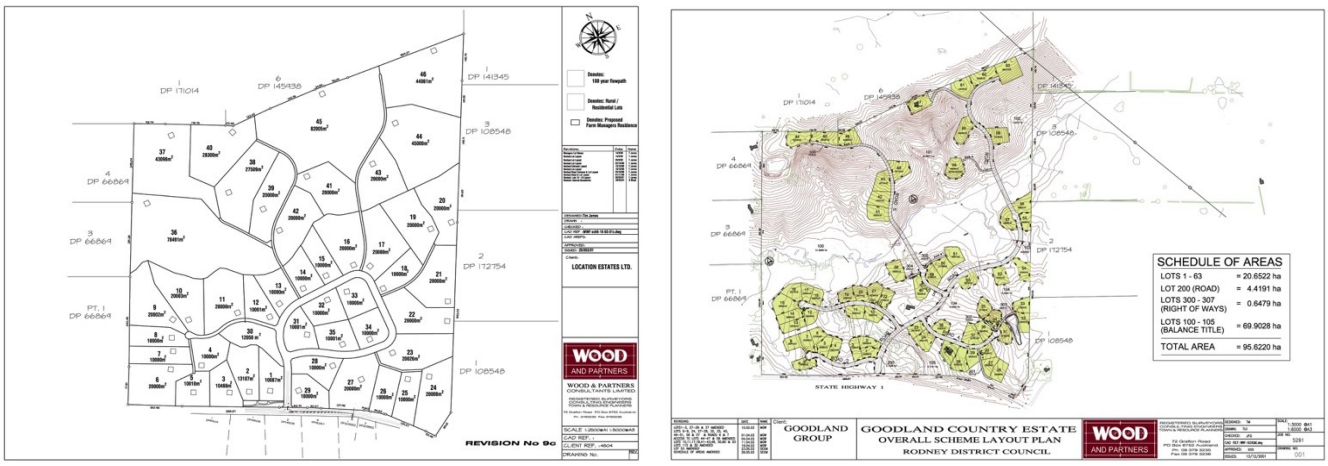


Figure 8 Goodland Estates: Original subdivision layout (left) (TP124) and consented subdivision layout (right) (Sources: Woods and Earl Shaver)

Other case studies

The development at Omaha Beach also incorporates several GI practices, including:

- protection of natural areas;
- infiltration via rain gardens;
- reduced impervious areas through narrower road widths and permeable paving for parking areas;
- infiltration basins which are dual use as they provide amenity areas for local residents.

Figure 9 Rain gardens and paving providing water quality treatment and infiltration in Omaha

Unfortunately many of the rain gardens have subsequently been grassed over and further investigation is needed to determine why this occurred.

An excellent example of best practice WSD is the Kirimoko Park subdivision in Wanaka. It is a medium density, pipeless subdivision that reduces impervious areas via narrow road widths, has protected remnant stands of kanuka, source control of building materials, and uses a treatment train approach by GI at source (swales and rain gardens for infiltration and treatment) and at a neighbourhood scale (community areas also serving as infiltration basins) to achieve the developer's sustainability outcomes. Fords have been used for overland flow paths to reduce the need for expensive pipes and to assist with traffic calming. Lots are covenanted to protect natural features and GI, and the residents had to sign-up to the '*Kirimoko Code'* on purchase. As part of this code individuals choose from list of sustainable and ecological features for building and landscapes. More information about Kirimoko Park can be found at:

Figure 10 Kirimoko Park, Wanaka: WSD pipeless subdivision with narrow road widths, swales, rain gardens, rain tanks and infiltration basins

https://www.landcareresearch.co.nz/uploads/public/Discover-Our-Research/Environment/Sustainable-society-policy/WSUD/Case_study_Kirimoko-Park-FINAL-06-19.pdf

The "*Activating Water Sensitive Urban Design in New Zealand*" research project (funded by the National Science Challenge for Building Better Homes Towns and Cities) also wrote up a case study on a WSD approach to redevelopment of a road transport corridor (Panmure) and using green roofs. Links to these case studies are as follows:

https://www.landcareresearch.co.nz/uploads/public/Discover-Our-Research/Environment/Sustainable-society-policy/WSUD/Case_study_AMETI-FINAL_July2019.pdf

https://www.landcareresearch.co.nz/uploads/public/Discover-Our-Research/Environment/Sustainable-society-policy/WSUD/Case_study_Green-Roofs-FINAL.pdf

3.2.3 Catchment WSD approaches

WSD can be achieved to its full extent when it is applied at the catchment scale, as the full principles of WSD including reducing impervious areas, protecting natural areas and avoiding stormwater effects can be realised. It also allows for WSD to be fully integrated with land use planning and zoning during the structure planning stage (including the incorporation of rules into relevant planning documents) and the systematic implementation of source control and GI via a treatment train approach.

Long Bay is New Zealand's quintessential case study of WSD being applied at the catchment scale. Planning to allow for redevelopment of the area was the subject of several court decisions in the 1990s and in the 2000s, a structure plan and catchment plan were developed simultaneously by the former North Shore City Council to rezone land in Long Bay for urban development. The Structure Plan was the first of its kind as the development footprint was driven by a WSD approach, with stormwater requirements being hard-wired into the Structure Plan maps and rules (Heijs, 2008). The plan change process was an arduous one, being heavily debated throughout, but the Environment Court did eventually uphold the majority of the zoning recommendations and WSD features within the Structure Plan.

Figure 11 A green street in Long Bay

WSD was applied in the structure plan via a combination of (Heijs, 2008):

- "*avoiding or minimising land modification and urbanisation of those parts of the catchment that have sensitive receiving environments*
- *concentrating urbanisation in areas where the effects are minimal or can better be managed*
- *as a result of the above two requirements, the urbanisation has concentrated towards the lower part of the catchment to avoid deletion or unwanted deterioration of the headwaters and upper part of the stream system*
- *'fit-for-purpose' stormwater management requirements relative to receiving water environment and landuse. Stormwater management zones A and B were introduced to ensure that stormwater requirement are appropriate and justified*
- *the use of on-site stormwater management practices such as rain tanks and bio-retention, to minimise changes to stormwater runoff from the site, including roads.*"

The land zoning/layout was driven by ecological requirements, ensuring that directly connected impervious areas within the sensitive "Type A" stream areas (Figure 12) was kept to less than or equal to 15% of the total catchment area. This zoned (or stream classification) approach to stormwater management was based on international research on the effect of imperviousness on freshwater streams. A WSD approach to development in Long Bay was able to facilitate protection of the sensitive freshwater streams and marine reserve, as well as allow the council to meet growth targets.

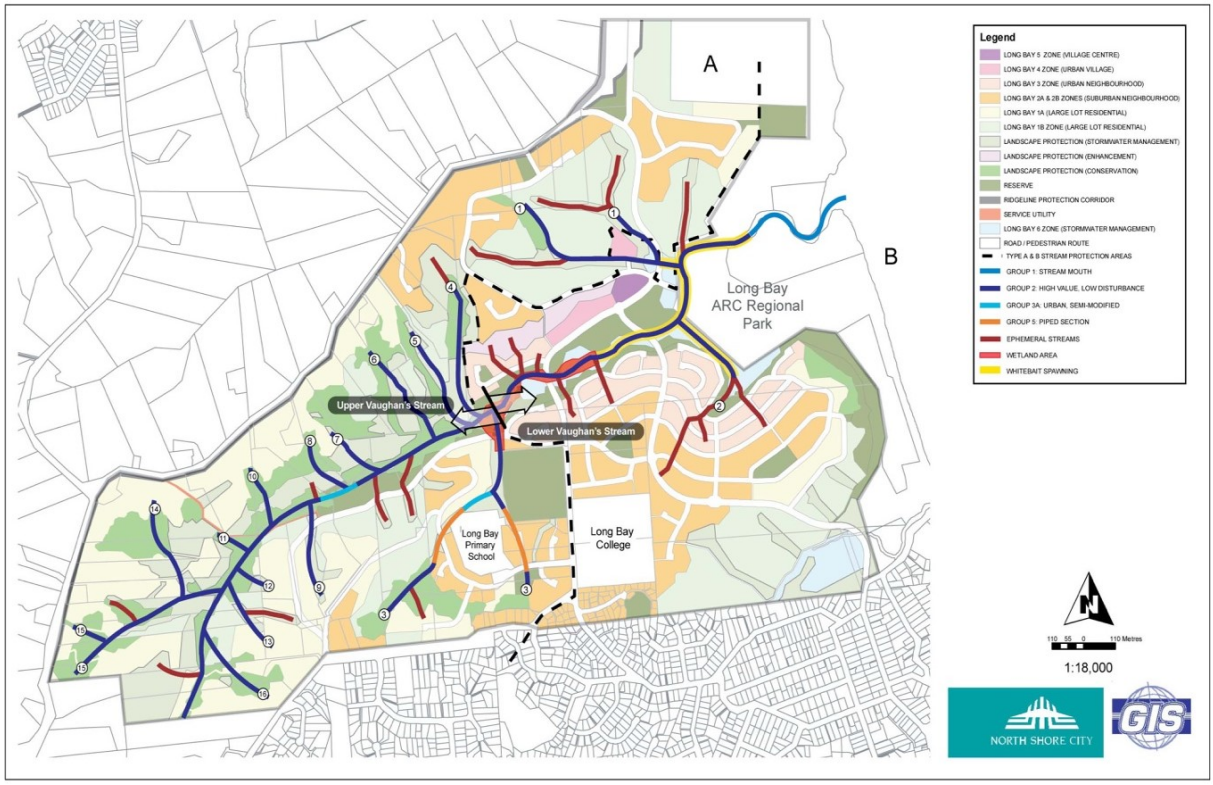


Figure 12 Long Bay Structure Plan showing Type A and Type B stream management areas.

Additionally, this application of WSD allowed for earthworks (and disturbance) to be kept for a minimum, thereby reducing sediment discharges to the marine reserve. It promoted a treatment train approach for stormwater management, and reduced impervious areas via narrow road widths where practical (Figure 13). The treatment train approach included the use of source control via inert roofs and various at source stormwater management devices (rain tanks, permeable paving, rain gardens, swales) at the lot scale, which then discharge to neighbourhood level rain gardens and sub-catchment wetlands. To assist with implementation of the Structure Plan, the former NSCC developed their 'Long Bay Practice Notes' which clearly outlined and illustrated the WSD requirements for various development zones in Long Bay. The notes assisted in ensuring that the Structure Plan rules could be clearly and consistently implemented.

Long Bay is provided as an exemplar case study of integrated urban development and WSD in the Auckland Design Manual.

Figure 13 A green streets approach to roading in Long Bay (source: Auckland Design Manual)

In summary, WSD is a design approach to water and land management which is based on a set of guiding principles. In essence, it can be thought of as toolbox of structural and non-structural methods which need to be applied on a case by case basis (or 'best fit' approach) within a planning or design context to minimise effects and maximise three waters integration as well as other water and non-water benefits. WSD is most effective when it can be applied at the land use planning stage (e.g. via a structure plan or catchment plan) and is able to integrate non-structural planning rules (e.g. limits on impervious surface areas, road layout, subdivision yields, water reuse) with ISM and GI solutions across the three waters.

Table 1 provides a summary of the different tools which can be used as part of a WSD toolbox approach to urban development. It is noted that GD04 also provides a comprehensive description of various ISM solutions which can be used at the site and catchment scale.

Table 1 Summary of intervention options which can be used as part of a WSD toolbox approach to development

SCALE	CATCHMENT TYPE	STRUCTURAL SOLUTIONS	NON-STRUCTURAL SOLUTIONS
Site and neighbourhood scale	Greenfield catchments	• water reuse rain tanks • living roofs and walls • swales (for conveyance and treatment – swales can be used instead of piped systems where soils allow for infiltration and where space and slope constraints allow) • filter strips (mainly used in countryside living areas for treatment of road run-off) • rain gardens: these can be used at the site scale as well as at the road sub-catchment scale. • permeable paving (in areas of low contaminant generation, e.g. driveway and parking areas) • wetlands (at the neighbourhood scale)	Policy provisions for: • impervious surface limits • clustering • inert roofs • minimising site disturbance/ earthworks • soil rehabilitation • protection of natural areas • requirements for water re-use • covenants/ consent notices • planning for and protection of overland flow paths
	Brownfield catchments	• water reuse rain tanks • living roofs and walls • swales (but note that space could be an issue) • rain gardens: these can be used at the site scale as well as at the road sub-catchment scale. • tree pits • permeable paving (in areas of low contaminant generation, e.g. driveway and parking areas) • underground filter systems • gross pollutant traps	Policy provisions for: • impervious surface limits • clustering • inert roofs • requirements for green roofs • requirements for stormwater and wastewater water re-use (especially in combined sewer areas where, for example, roof water could be disconnected from the combined system via rain tanks, or wastewater or stormwater used for irrigation of parks and fields) • covenants/ consent notices • planning for and protection of overland flow paths
Sub-catchment and catchment scale	Greenfield catchments	• sub-catchment rain gardens • wetlands • riparian buffers	Policy provisions for: • as above for site scale provisions. • catchment management plans

		• stream enhancement • wastewater re-use	• focussed development areas – "no go" zones for development (e.g. no development in floodplains or significant natural areas) • focussed development areas – Aiming to meet 15% effective imperviousness in areas which discharge to sensitive freshwater streams and 30% effective imperviousness to tidally influenced streams. • requirements for 1x to 1.5x mitigation
	Brownfield catchments	• retrofit existing ponds with floating wetlands • wetlands • riparian buffers • stream daylighting and enhancement • wastewater re-use	Policy provisions for: • as above for site scale provisions • catchment management plans • requirements rehabilitation of stream corridors

4. Auckland's WSD Planning Framework

4.1 Background

Auckland's current planning framework related to water outcomes is illustrated in Figure 14.

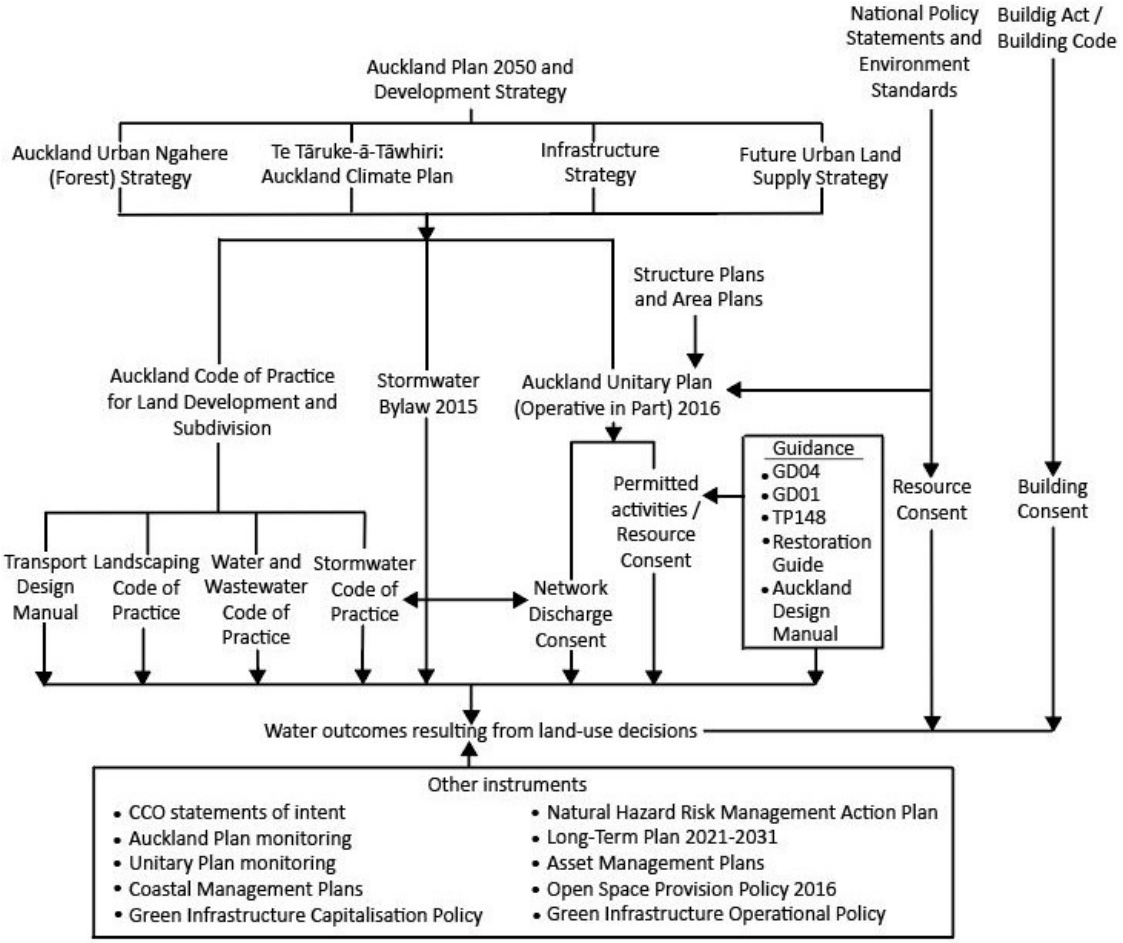


Figure 14 Auckland Council planning instruments influencing land use

A review of the Auckland planning documents has been undertaken in order to ascertain whether the planning framework supports a holistic implementation of WSD. Figure 14 highlights that this planning framework is influenced by, and needs to be consistent with, national legislation, policy statements and environmental standards. Most notably is the updated National Policy Statement for Freshwater Management 2020 (NPS-FM) which came into effect on 3 September 2020[6]. Auckland Council is currently developing a plan change to implement the NPS-FM, which is to be notified by late 2024. Auckland Council is also currently carrying out s.35 monitoring of the Auckland Unitary Plan (AUP), which will review the effectiveness and efficiency of the AUP across a variety of topics (including water outcomes). Recommendations from this review related to water may form part of a plan change to the

[6] https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/

AUP. It is recommended that the information provided in this study assists in supporting the s.35 review and could form the basis and scope for further analysis.

An additional consideration which will impact the way in which stormwater, wastewater and water supply is managed in Auckland is the current central government proposal to change to the way these 'three waters' are managed across New Zealand (i.e. NZ's Three Waters Reform process). Central government is proposing to create four new, large-scale water service delivery entities to manage all of New Zealand's stormwater, wastewater and water supply networks. Under the proposal, Auckland's three water services would form part of a new entity also responsible for delivering these services to Kaipara, Whangārei and the Far North[7]. Technical working groups are currently working to refine the details of this reform, with the aim of all water service entities being in place by July 2024. Given that the relationship between council and any newly proposed Three Waters entity could be more distant than it currently is with Watercare, council's ability to influence the holistic implementation of WSD could be reduced. Conversely, the aim of the Three Waters Reform is to increase regulation, accountability and resources for water services, so the reform could also increase holistic implementation of WSD through consent requirements. Given the uncertainty in this space, reviews of and proposed changes to Auckland's planning framework in relation to water will need to be cognisant of this process.

4.2 The Auckland Plan 2050

The Auckland Plan 2050 sets the strategic direction for Auckland's future by outlining major challenges faced by the region and setting direction for tackling these challenges. Six outcome areas are identified. Focus area 3 of the environment and cultural heritage outcome relates to fully accounting for past and future impacts of growth. GI is offered up as an option for accounting for these impacts, and is cross referenced as being able to address threats from climate change (Auckland Climate Plan) and contribute to the Auckland Urban Ngahere Strategy. GI is also offered up as a solution to deliver resilient, long term cost saving and quality environmental outcomes (focus area 6). Interestingly, GI is mentioned around 20 times in the Auckland Plan as assisting in embedding sustainable outcomes in building practices or meeting focus areas within outcomes. The Plan also advocates for the use of environmentally sustainable practices and green building principles, seeks opportunities for enhancement (e.g. stream daylighting), and specifically mentions that new ways of delivering old services, such as recycling wastewater, need to be sought. The application of GI is supported in Auckland Council's Stormwater Asset Management Plan (p. 159) and recommended as an approach for managing effects of transport systems on the environment (p. 158). Interestingly, on page 158 the Plan states "*Environmentally sensitive approaches such as water sensitive design, quality urban design and future-proofed infrastructure can be embedded in developments from the start, rather than retrofitting later or doing expensive restoration projects*".

Other than the mention on page 158, WSD is only discussed as a concept in the supporting documentation for the Auckland Plan. These mentions occur on page 171 where it states:

[7] https://akhaveyoursay.aucklandcouncil.govt.nz/3waters

"*Water sensitive design: This design places water quality and water conservation at the heart of urban design and development. The goal is to protect and enhance natural freshwater systems, sustainably managing freshwater resources and mimicking natural processes. Implementing water sensitive design has benefits for freshwater and marine receiving environments. Water Sensitive Design is supported in the Auckland Design Manual.*"

A definition of GI, along with supporting case studies, is also provided within the supporting documentation.

Based on this review, the Auckland Plan 2050 has a greater focus on the use of GI rather than WSD to meet its strategic directions. WSD philosophies and practices (such as stream daylighting, wastewater reuse and green building principles) are mentioned, but there is no cohesive or wide-spread advocation of WSD as an overarching strategic direction, focus or outcome.

4.3 Auckland's Urban Ngahere (Forest) Strategy

Auckland's Ngahere Strategy is fully consistent with the principles of WSD, and references GI such as green roofs and natural stormwater assets (streams) as providing a positive contribution to Auckland's urban ngahere. Importantly, the Urban Ngahere Strategy details a range of social, environmental, economic and cultural benefits that urban trees deliver. These benefits are consistent with the water and non-water benefits delivered by WSD (Moores and Batstone, 2019; Moores *et al.*, 2019). Section 3.3 of the Strategy acknowledges that GI provides an opportunity to grow Auckland's ngahere, but WSD as a concept is not discussed.

4.4 Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan (2020)

One of Auckland's core goals under the Climate Plan is to reduce greenhouse gas emissions by 50% by 2030 and achieve net zero emissions by 2050. The plan acknowledges that Auckland needs to support and increase resilience in the water cycle, and offers that individual responses to this could include enabling the capture and reuse of water at a household scale, as well as shifting to "circular" water systems that restore and build resilience within the natural environments, habitats and ecosystems. Whilst climate-related benefits of WSD are well documented internationally (Moores., et al. 2019), the Plan includes no discussion on the benefits of WSD for reducing the urban heat island effects or for carbon sequestration. Rather, the document states that a priority area is to "*implement nature-based solutions in planning*", thus further increasing the layers of nomenclature surrounding WSD.

4.5 Auckland Unitary Plan

4.5.1 Background to the Auckland Unitary Plan

The proposed Auckland Unitary Plan (AUP) was first notified in September 2013 and went through a thorough submissions process until the hearings were held between 2014 and 2016. Decisions made by the Independent Hearings Panel (IHP) related to stormwater are documented in the IHP Report to Auckland Council Topic 046, 047, 048, 049 Water (2016-07-

22)[8]. During this AUP process, council made a concerted effort to bring WSD into the AUP; however some of these aspects were not progressed due to IHP recommendations[8]. Most notably, the IHP replaced the term WSD with ISM. The IHP report[8] (pp. 6, 2016) stated that:

"*The term 'water sensitive design' has been changed to 'integrated stormwater management approach'. This better reflects what it actually is. Notwithstanding the name change, the policy approach is similar to that in the notified Plan.*".

This comment by the IHP[8] likely reflects past stormwater implementation practices in Auckland (see Figure 2) rather than a forward-looking vision for integrated water management and land use planning through WSD.

Additionally, the IHP[8] amended a number of provisions for stormwater discharges in order to provide for greater flexibility in permitted activities and standards, especially relating to the SMAF[9] provisions. As an example, impervious area thresholds were increased; infiltration requirements in relation to SMAF areas amended; the provisions relating to high contaminant yielding building materials were deleted (due to noted conflicts with the Building Act); and changes made to the definition of and provisions relating to high contaminant car parks and roads. Each of the provisions amended or deleted relate to WSD principles of reducing effects of discharges at source and through source control.

The AUP hearing process clearly demonstrates the uncertainty of the RMA plan change process, therefore limiting council's ability to ensure that intended outcomes, backed by scientific research and advice, are reflected within the operative planning documents.

4.5.2 Current AUP provisions

The Regional Policy Statement within the AUP makes no reference of WSD or GI in the policies, nor as a method to reduce environmental risk (Sections B1, B2, B3, B7, B8, B9 and B10). Whilst it does highlight the use of the Auckland Design Manual as a method in Section B1.6, there is no specific mention of WSD. Policies under B7.4.2, which detail policies for integrated management, water quality, sediment runoff, stormwater and wastewater, are silent on WSD as an overriding concept or policy direction.

ISM as well as other WSD tools (see Figure 3) are referenced and supported across a number of AUP sections. This includes B7 (natural resources and development), Appendix 1 (urban development), E1 (water quality), E3 (protection of streams), E8 (treatment of stormwater discharges), E9 (land use controls for high contaminant generating areas), E10 (land use controls for SMAF areas) and E38 (subdivision controls - urban). Concepts such as protection and enhancement of streams, 'treatment at source', impervious surface limits for certain zones and maintaining natural areas are promoted, but there is no requirement for consent applicants to use or apply WSD as a whole, nor reference to the council's Water Sensitive Design Manual, GD04. Section E1, Policy E1.3(10), talks about taking an ISM approach and has regard to "*the use and enhancement of natural hydrological features and green*

[8] Auckland Unitary Plan Independent Hearings Panel Report to Auckland Council Topic 046, 047, 048, 049 Water (2016-07-22)

[9] Stormwater Management Area – Flow 1 and 2 (SMAF). This is a geographical layer and control within the AUP which is applicable to catchments discharging into sensitive and/or moderate/high value watercourses.

infrastructure for stormwater management". WSD, ISM and GI are not included as Definitions in the AUP, nor is GD04 included in *Chapter M Appendix 17 – Documents Incorporated by Reference*. As discussed in Section 4.1, WSD was removed from the draft AUP by the IHP as they felt it was encompassed by the policies on integrated stormwater management (AUP IHP recommendations report on topic 065 Definitions, 2016[8]).

Whilst the AUP does include a number of WSD implementation tools, they represent fragments of holistic WSD processes and are not clearly articulated as being linked to WSD (Table 2). The examples provided highlight that only certain aspects of WSD tools, mainly in relation to ISM, are being advocated for through the AUP. Despite this, WSD is being advocated for, on an ad-hoc basis, through precinct plans. For example:

- I412 Flat Bush Precinct: an assessment criterion relating to the roading network refers to 'an acceptable low impact stormwater management solution'
- I519 Long Bay Precinct refers to low impact design and has all the measures noted earlier in the report
- I547 Wēiti Precinct is based on clustered housing with provisions designed to protect the marine reserve
- I603 Hobsonville Corridor Precinct refers to water sensitive design features;
- I610 Redhills Precinct refers to water sensitive design
- SHA Drury 1 Precinct stormwater management provisions require treatment of runoff of impervious surfaces.

Whilst some of the above precincts have required a treatment train approach and refer to WSD implementation tools, the differing terminology adds a layer of confusion and differing standards will likely lead to inconsistent outcomes.

Additionally, the review of the AUP has highlighted that implementation of some rules are spatially fragmented. For example, SMAF includes some WSD concepts, but is limited to specific catchments. Likewise, water quality controls are largely limited to high contaminant generating carparks, high use roads or spatially scattered precincts.

WSD, by definition, is diverse and includes a wide-ranging set of implementation tools which occur at varying geographical scales. Given the emphasis of WSD on managing water at the source, many of the resulting GI assets end up being located on private land. Additionally, in Auckland, much of the urban stream network which is an integral part of the stormwater system, is also located on private land. The existing legislative framework does not support the long term, sustainable and reliable use of private infrastructure performing a public good function. As an example, all on-site wastewater disposal systems which are permitted under Section E5.6.1 of the AUP are required to be serviced on a regular basis by a suitably qualified service provider. Records of services need to be retained and made available to council if requested. No such provision exists for GI on private land, severely limiting council's ability to monitor the performance of the private stormwater network and undertake compliance on poorly maintained private stormwater assets.

Finally, while the regional policy statement and regional provisions in the AUP include strong objectives and policies on some aspects of WSD, these are not always successfully translated into strong or prescriptive rules. This can make it challenging for council to require WSD

outcomes in developments and gives developers room to negotiate around WSD or ISM outcomes through the adoption of a "*best practicable option*" approach (B7.4.2(9)(b)) for stormwater discharges. A key issue for council going forward is how well the differing AUP standards and associated supporting documents will work together to lead to wide-spread 'on-the-ground' WSD outcomes.

Table 2 Examples of various WSD implementation tools within the AUP

Outcome	AUP Section
Reduce stormwater runoff, including moderating peak flow rates of stormwater runoff, reducing total volume of stormwater runoff, and reducing surface flooding	E1 – Water quality and integrated management E8 – Stormwater – discharge and diversion E10 – Stormwater management area – flow 1 and flow 2 E36 – Natural hazards and flooding E38 – Subdivision - urban Appendix 1 – Structure Planning
Manage stormwater quality	E1 – Water quality and integrated management E3 – Lakes, rivers, streams and wetlands (i.e., prohibits littering and dumping) E4 – Other discharges of contaminants E5 – On-site and small-scale wastewater treatment and disposal E6 – Wastewater network management E8 – Stormwater – discharge and diversion E9 – Stormwater quality – high contaminant generating car parks and high use roads
Minimise soil disturbance	E1 – Water quality and integrated management E11 – Land disturbance – regional E12 – Land disturbance – district
Promote ecosystem health, including promotion of continuous stream corridors, headwater streams, wetland environments, coastal environments and biodiversity	E1 – Water quality and integrated management E2 – Water quantity, allocation and use E3 – Lakes, rivers, streams and wetlands E7 – Taking, using, damming and diversion of water and drilling E10 – Stormwater management area – flow 1 and flow 2 E15 – Vegetation management and biodiversity E38 – Subdivision – Urban H zones – Riparian yard provisions in each zone D overlays – such as Natural Stream Management Areas, Natural Lake Management Areas, Urban Lake Management Areas, Wetland Management Areas, and Significant Ecological Areas Appendix 1 – Structure Planning

4.6 Stormwater-specific planning provisions

4.6.1 Stormwater Bylaw 2015

The Stormwater Bylaw 2015 references that any asset vested with council must comply with the Code of Practice. The focus of the Bylaw is on ensuring constructed assets are built and maintained according to best practice and in accordance with relevant consent conditions (i.e. it is a means of enforcing the Code of Practice and network discharge consent). Given this focus within the Bylaw, it is unlikely that it would prevent a WSD approach being taken during the design phase.

4.6.2 Stormwater Code of Practice

The design of a stormwater system needs to be in accordance with the Stormwater Code of Practice (CoP), Auckland standards (as set out in the AUP) and the Auckland stormwater network discharge consent (NDC). The Stormwater CoP is incorporated into the Auckland Design Manual (ADM) in Chapter 4. As discussed previously, the ADM encompasses and encourages WSD as a design approach to urban development, and the stormwater provisions in Chapter 4 state that the CoP should be used in conjunction with (amongst other documents) GD04 – Auckland's WSD guideline. The 2021 Stormwater CoP explains the concepts and principles of ISM (Section 4.3.3 of the CoP) for managing stormwater discharges and references SNZ HB44: Subdivision for People and the Environment as providing guidance on ISM. The CoP recommends that all future development should use an ISM approach and be in accordance with GD04. Whilst the CoP states that the requirements of the CoP take precedence over any guidance provided in GD04, the recommendations generally align with each other, with WSD principles such as watercourse rehabilitation and daylighting being promoted.

4.6.3 Stormwater Network Discharge Consent

The NDC is a single, region-wide consent to divert and discharge stormwater from the public stormwater network held by Auckland Council and it came into effect on 29 October 2019 (3 years after the AUP became operative). The requirements of the NDC and the AUP are not consistently integrated and despite the need to comply with the NDC, links to the NDC on the AC website are hard to find. In most instances, when the NDC is referenced, the reader is told to contact Healthy Waters. After extensive searching, a description of the NDC was found in the ADM under the "regulations" section. In general, if developments wish to be considered under the NDC, a stormwater management plan (SMP) is required (Figure 14 shows the relationship between the AUP and the NDC). Importantly, the guidance information states that the SMP must consider the Stormwater CoP and WSD principles. Additionally, many of the items which the SMP must address includes WSD elements such as restoring natural hydrology as far as practicable, identifying significant site features and hydrology, and minimising stormwater related effects from developments (as outlined in Schedule 4 of the NDC). SMPs also need to be consistent with Schedule 2, the NDC Strategic Objectives and Outcomes, and 6 yearly targets. Use or uptake of WSD is not listed as a performance target, but is mentioned in Schedule 2 in relation to growth and stakeholder collaboration.

4.7 Auckland Transport Design Manual (2021 - Road Drainage v.1.2)

Cumulatively, roads contribute to the most significant areas of impervious surfaces within our region. Auckland Transport (AT) has recently released its Transport Design Manual (TDM),

"Road Drainage" (Version 1.2, accessed in September 2021). Section 2.1 of the Road Drainage TDM uses the following wording to describe it's approach to WSD:

"AT *strongly supports the use of WSD (or Integrated Stormwater Management) principles and requires road drainage designs to demonstrate an inter-disciplinary approach to stormwater management. This approach is clearly defined and explained in detail in Guidance for Water Sensitive Design, GD04.*

AT recognises the value of the street tree canopy to attenuate the effects of rainfall events and reduce peak flows. Planting street trees is encouraged at the time of development and the use of shrubs and amenity plantings to contribute to the management of stormwater."

The TDM also helpfully provides information on implications for WSD in the road reserve, including items such as road layout designs to retain existing landforms and drainage patterns, keeping impervious surface ratios low, using stormwater management systems and treatment suites that reflect natural water management systems and trees, and that earthworks should be minimised. Whilst the AT drainage TDM sends a strong message that a WSD solution to road design should be considered, it is noted that parts of Section 4 (Stormwater management devices) are slightly contradictory with the AC stormwater CoP. For example, proprietary rain gardens and devices which have been accepted for use by AC, do not apply to their use in the road corridor.

4.8 Watercare's Statement of Intent (2018 – 2021) and Code of Practice (2015 - v.1.5)

As discussed in Section 2, historically the application of WSD in Auckland has focussed primarily on stormwater management. Although some recent consideration has been given to the use of rain tanks as an alternative water supply source, it's use within the wastewater and water supply sectors has generally received little attention. Watercare's Statement of Intent (SOI) (2018 – 2021) makes no mention of integrating WSD into their planning, operations or as a tool to mitigate effects of growth on the wastewater or water supply network. Considering that Watercare's SOI does need to be consistent with the Auckland Plan and AUP, stronger advocation or mandating of WSD in those plans would help to promote greater integration of three waters planning.

Whilst not specifically mentioning WSD, it is noteworthy that Section 5.3.10 of the Water and Wastewater Code of Practice for Land Development and Subdivision requires the installation of detention tanks in combined sewer areas.

4.9 Summary

Section 4 provides a desk-top analysis of Auckland's planning documents in relation to WSD.

Overall, whilst Auckland's planning framework doesn't preclude WSD, it more strongly supports a narrower focus on WSD implementation tools such as ISM and GI. Whilst the proposed AUP included WSD, the IHP[8] replaced the term with ISM. Unfortunately this decision is more reflective of historic stormwater management in Auckland rather than underpinning a forward-thinking approach to integrated water management through WSD. Resultantly, whilst ISM and other WSD tools (see Figure 3) are referenced and supported

across a number of AUP sections, there is no requirement for consent applicants to use or apply WSD as a whole, nor is there any reference to the council's Water Sensitive Design Manual, GD04. Additionally, the review of the AUP has highlighted that implementation of some rules are spatially fragmented and that strong objectives and policies on some aspects of WSD are not always successfully translated into strong or prescriptive rules. The stormwater specific planning provisions are generally aligned with the promotion of ISM and GI to manage stormwater discharges.

A clearer direction and stronger advocation for a holistic WSD approach in both the Auckland Plan and AUP would help to promote greater integration of three waters planning across council and the CCOs.

5. Barriers to delivering best practice WSD

Despite Auckland's strategic direction favouring many WSD implementation tools, holistic implementation of WSD in Auckland is still relatively sporadic. Given that the Auckland Plan references WSD as having benefits for freshwater and marine receiving environments (pp. 171), there is a need to understand why implementation is not wide-spread and considered "business as usual".

5.1 Barriers in the planning framework

A brief review of the Auckland planning framework has highlighted that whilst Auckland's planning framework doesn't preclude WSD, it places more value on individual WSD implementation tools rather than holistic implementation. In general, planning documents are consistent with each other and advocate a development approach which uses GI or encompasses integrated stormwater planning. The myriad of differing terminology around WSD and WSD implementation tools can be confusing to stakeholders and potentially undermine holistic implementation. It is unfortunate that the IHP[8] looked to historic implementation practices when setting stormwater objectives and policies, rather than enabling the AUP to underpin a vision for holistic WSD being consistently implemented across the region. Overall consideration of a holistic WSD approach for land development and integration of three waters (Figure 3) is not provided for consistently within the plans.

Meeting the challenges outlined in the Auckland Plan (i.e. managing population growth and reducing environmental degradation) is inherently underpinned by a water sensitive approach, integrated with te mauri o te wai and incorporating Mātauranga Māori, the narrower application of GI and ISM is therefore considered to be a barrier. Other barriers identified in Section 4 include:

- The uncertainty of the RMA plan change process which limits council's ability to ensure that intended outcomes, backed by scientific research and advice, are reflected within the operative planning documents.
- Whilst the AUP does include a number of WSD implementation tools, they represent fragments of holistic WSD processes and are not clearly articulated as being linked to WSD.
- Implementation of some rules in the AUP are spatially fragmented.
- The planning framework limits council's ability to monitor the performance of on-site GI devices which form part of the private stormwater network and undertake compliance on poorly maintained private stormwater assets.
- Whilst the regional policy statement and regional provisions in the AUP include objectives and policies on some aspects of WSD, these are not always successfully translated into strong or prescriptive rules.
- There is a lack of consistency in the narrative and terminology relating to stormwater management, ISM, GI and WSD across Auckland Council Group standards, the NDC and CoPs.

5.2 Actual or perceived barriers from an industry perspective

In the latter half of 2017, shortly after the AUP became operative, the National Science Challenge for Building Better Homes, Towns and Cities funded a research programme to investigate ways to enhance New Zealand's WSD capability via engaged, active, community of practice networks based on research, workshops and field trips[10]. Phase 1 of the research programme consisted of a survey and workshops to better understand barriers to implementing WSD in New Zealand (Moores *et al.*, 2018).

The on-line survey was conducted over the period 20 November to 21 December 2017[11] using the SurveyMonkey® platform, and was sent out to WaterNZ members via their newsletter as well as directly emailed to identified stormwater stakeholders (including researchers, iwi, consultants, developers, council and network operators, and national government representatives across New Zealand) (see Moores *et al.*, 2018 for a full description of the survey questions and outputs). The survey asked the following five questions:

1. What barriers to WSUD do you find in your work?
2. What barriers (listed above) have you most recently experienced in a WSUD project?
3. What would support you to more fully implement WSUD in your job?
4. What 'activating factors' were effective in your most recent experience or project?
5. We are running workshops around New Zealand. How do we make these of most value to you?

Figure 15 highlights that regulation, design and construction, maintenance and economic issues are key barriers, both perceived and as experienced by the Auckland stormwater community.

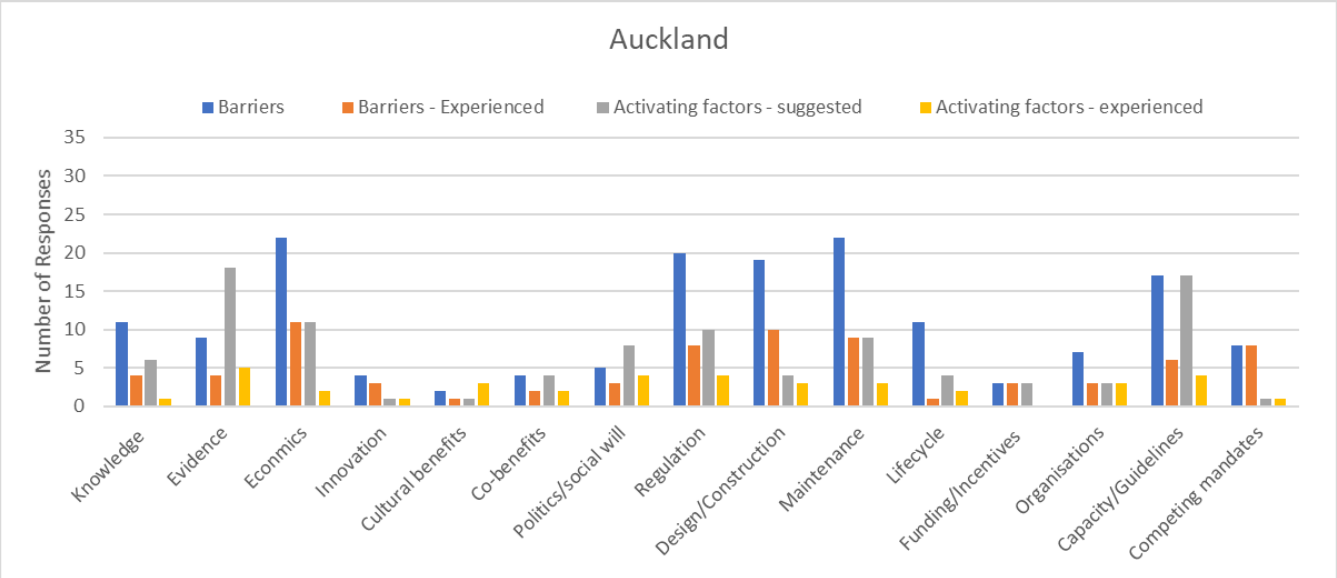


Figure 15 Number of times each barrier theme was referred to in survey responses from respondents in Auckland (source: Moores *et al.*, 2018)

[10] https://www.landcareresearch.co.nz/discover-our-research/environment/sustainable-society-and-policy/activating-water-sensitive-urban-design-for-healthy-resilient-communities/

[11] The survey was re-opened in January 2018, allowing the ongoing collection of views on barriers to WSUD in parallel with research activities conducted during Phase 2 of the project.

In addition to the survey, an Auckland-based workshop was held in November 2017 to investigate key barriers to implementation of WSD. A mixture of iwi groups, council officers, consultants, researchers and developers attended the workshop. Figure 16 illustrates key burning issues as barriers to the implementation of WSD in Auckland, in contrast to those identified in at a similar workshop in Christchurch. The theme "regulation" was the most frequently nominated burning issue or barrier at the Auckland workshop (Moores *et al.*, 2018).

Figure 16 Number of times each barrier theme was referred to at the Auckland and Christchurch workshops in relation to their key "burning issues" (source: Moores *et al*., 2018)

The workshop also included a benchmarking exercise adapted from methods developed by Australia's Cooperative Research Centre (CRC) for Water Sensitive Cities (Brown et al, 2016). The purpose of the session was to assist participants in thinking about where Auckland may fit within the "urban water transitions framework continuum" (Figure 17). Participants used the "advocating and contesting narratives" in the transitions dynamics framework supplied by the CRC for Water Sensitive Cities (pers comm. Briony Rogers, November 2017) to identify which phase of change Auckland could be in (Figure 18). They also identified barriers to WSD using the CRC's matrix (Figure 19). These group exercises assisted in generating discussion amongst the participants to further identify strategic and institutional barriers to the implementation of WSD, and provided the research team with a "practitioner view" of those areas of further work that would be required to build a Strategic Transition Programme for Auckland and for New Zealand (Moores *et al.,* 2018).

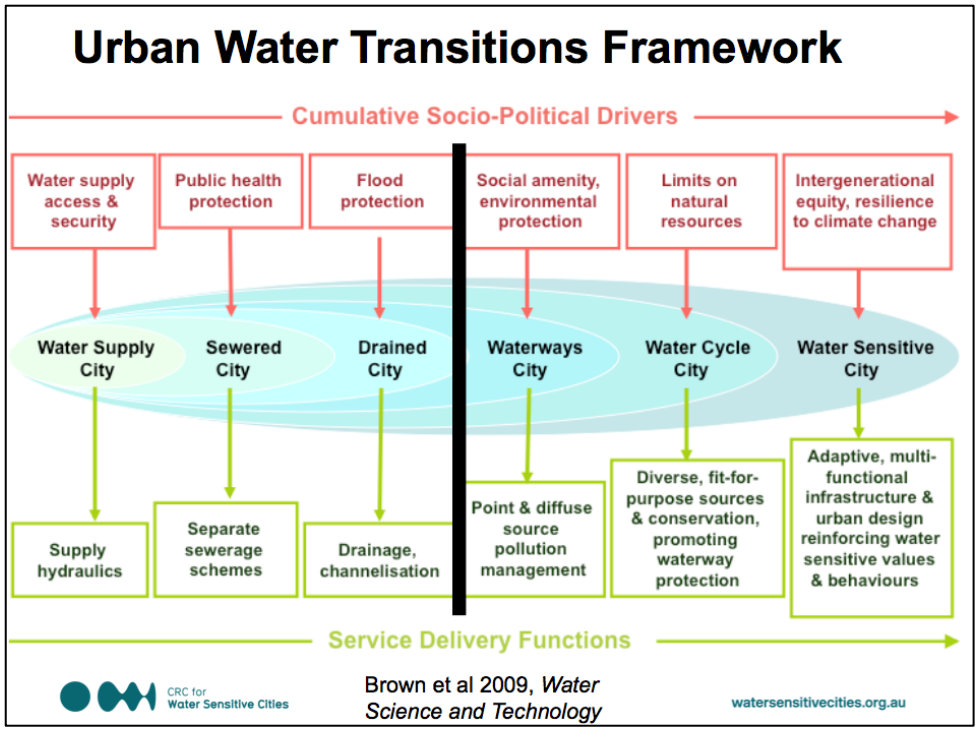


Figure 17 Urban Water Transitions Framework (source: Brown *et al*., 2009).

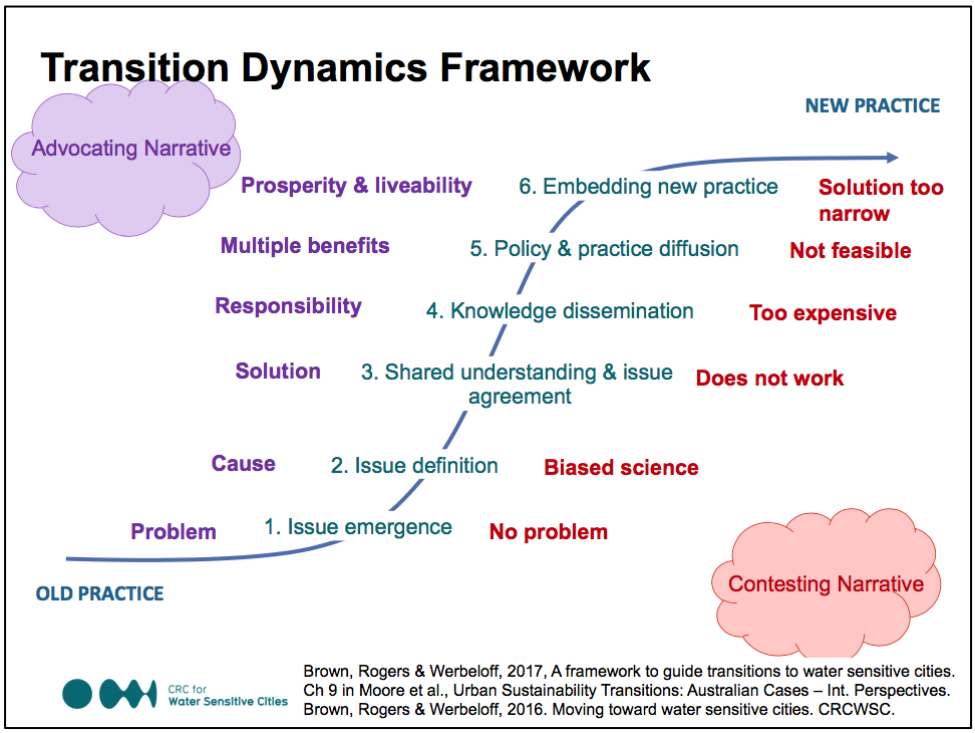


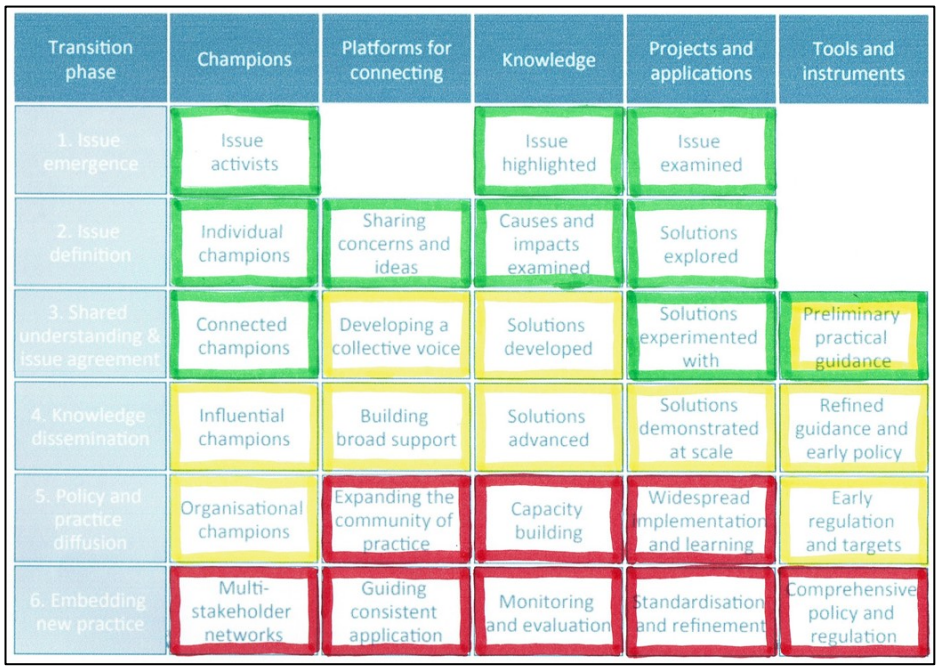
Figure 18 Transition Dynamics Framework – advocating and contesting narratives (source: Brown *et al*., 2016)

Transition phase	Domains of change				
	Actors Key networks of individuals	**Bridges** (Semi) Formalised organisations, structures, & processes for coordination & alignment	**Knowledge** Research, science, & contextualised knowledge	**Projects** Experiments, demonstrations, & focus projects	**Tools** Legislative, policy, regulative, & practice tools
1. Issue Emergence	Issue activists	N/A	Issue discovery	High profile scientific studies	N/A
2. Issue Definition	Science leaders	Science-industry	Cause–effect	Laboratory-based & scientific solution prototypes	N/A
3. Shared Understanding & Issue Agreement	Technical solution coalition	Science-industry-policy	Basic technological solutions	Minor scientific field demonstrations	Draft best-practice guidelines
4. Knowledge Dissemination	Informal policy coalition	Science-industry-policy-capacity building	Advanced technological solutions	Major scientific field demonstrations	Best-practice guidelines, targets
5. Policy & Practice Diffusion	Policy & decision coalition	Science-industry-policy-capacity building	Modelling solutions, capacity building	Numerous industry-led field experiments	Legislative amendments, market offsets, national best-practice guidelines, regulatory models
6. Embedding New Practice	Multi-agency coalition	Formalised institution	Next research agenda	Standard practice	Political mandate, coordinating authority, comprehensive regulatory models & tools

Figure 19 The six phases of the transitions dynamics framework and the five domains of change (source: Brown *et al*., 2016)

The outcome of this benchmarking exercise is represented in Figure 20, with future work in Auckland needed to support the wide-spread implementation of WSD being focused on those areas/ boxes highlighted in yellow ("we are partly doing this – some presence") and red ("we are not doing this – gap in current transition phase").

Broadly, the exercise highlighted the need to improve knowledge dissemination in Auckland via influential and organisational champions, create multi-stakeholder networks to generate a unified voice and understanding of WSD, share knowledge, and apply policy and practice in a consistent way such that WSD practice becomes embedded within comprehensive policies and plans for the region.



Key

we are doing this (complete presence)

we are partly doing this (some presence)

we are not doing this (gap in current transition phase)

Figure 20 Building a Strategic Transition Program: Where are we at in Auckland? (source: Moores *et al.*, 2018)

Two particularly important barriers identified both through the workshops and in overseas literature include:

- the lack of awareness of the problem of existing 'Business as Usual' stormwater management – across the general public and among planners, landscape architects/architects and engineers; and
- the lack of coordination across departments in cities. This leads, among other things, to a failure to realise potential co-benefits of non-stormwater-focused projects, e.g. urban forestry programmes, park and other green-space upgrades.

Whilst the research undertaken by Moores *et al.* (2019) provides a unique summary of barriers to implementing WSD in Auckland (and in New Zealand), it was undertaken only a year after the AUP had been made operative. The barriers identified and views expressed of participants therefore provide a 'snap-shot in time' and should be read within that context. However, it is interesting to note that many of the barriers identified are consistent with those identified by *Ferguson et al.* (2014). To supplement these studies, and in support of the Water Strategy reform process, Auckland Council Group is currently undergoing a new dual benchmarking exercise. This approach applies two benchmarking frameworks, including Australia's CRC for Water Sensitive Cities Index (western lens) and a Mātauranga Māori Benchmarking Framework (Te Ao Māori lens). Results from the CRC's benchmarking study are reported in Clarke *et al.* (2021). The Mātauranga Māori Benchmarking Framework is still being developed. Clarke *et al.* (2021) documents Auckland's progress to a waterways city

(see Figure 17), which is reflective of the progress made in ISM and GI since the AUP became operative. Discussions documented in Clarke *et al.* (2021) are also generally consistent with previous research, demonstrating that whilst all areas of the council group are implementing some form of WSD in their projects, some challenges do remain. Some of the challenges highlighted include that planning documents tended to encourage rather than require a water sensitive approach and that there was a general lack of integration of GI within the existing built form. Despite some great examples, a 'multi-functional' view of water infrastructure was not deemed to be commonplace, and issues around maintenance and the need for training and capacity building were discussed.

In summary, key barriers to delivering best practice wide-spread WSD outcomes in Auckland have been collated in Table 3. Barriers have been divided into 5 "themes", namely:

a) strategic planning documents and regulatory capacity to influence development outcomes,
b) operational considerations for council-owned water sensitive infrastructure,
c) funding and financing,
d) conflicting outcomes, and
e) capability and capacity.

Table 3 Barriers to wide spread implementation to WSD in Auckland

Theme	Barrier(s)	Key Messages
Strategic planning documents and regulatory capacity to influence development outcomes	1. Narrow focus on GI and lack of advocacy of WSD through the Auckland Plan 2050 and Unitary Plan. 2. Inherent uncertainty of the RMA plan change process limits council's ability to ensure intended outcomes are reflected in the operative planning documents. 3. Implementation of some rules in the AUP are spatially fragmented leading to inconsistent outcomes being achieved on the ground. 4. The planning framework limits council's ability to monitor the performance of on-site GI devices which form part of the private stormwater network and undertake compliance on poorly maintained private stormwater assets. 5. Lack of cohesion and consistency in the narrative and terminology used between council and CCO regulations and codes of practice. 6. No regulatory incentives. 7. Wider benefits of WSD not taken account of during consenting – not required by the policies. 8. Life cycle assessments not required through the consenting process. 9. The need for more WSD "Influencers". 10. Retrofitting WSD not well considered through the consenting process. 11. No mandate for three waters integration (although work on this issue is now occurring via the Three Waters Reform process).	• There is a need for a strong strategic direction which advocates for and regulates a holistic and consistent approach to implementing WSD in Auckland. • The RMA plan change process can limit council's ability to set outcomes. • There is a need for the planning documents to facilitate compliance of both private and public GI practices in order to ensure the long term sustainability and performance of the stormwater system. • Council and it's CCOs do not always take an integrated, multi-disciplinary approach to WSD. Projects are often influenced by departments or individuals with entrenched (WSD or anti-WSD) perspectives on urban development and stormwater management. "Flagship" projects highlighted in strategic documents as examples of WSD or GI are often expensive and unrealistic to implement on a wide-spread scale. Additionally, WSD as an approach to integrating three waters management is ad-hoc. • There is a need for greater emphasis and transparency on WSD in council plans and consenting processes. • There is a need for WSD champions or influencers. • Consideration of WSD's wider social, health and environmental benefits and the opportunity costs of failure to implement WSD is an important omission from the consenting process. • The regulatory process does not regulate WSD approaches, nor does it incentivise WSD. • Decision-making needs to take account of the full life cycle; from planning, design, construction, handover, maintenance and operations, through to asset disposal/renewal. • The consenting process can be restrictive and doesn't necessarily provide the flexibility needed to implement WSD in a retrofit scenario.

Operational considerations for council group owned water sensitive infrastructure	1. Differing standards relating to GI acceptance across council and its CCOs. 2. Inconsistent ICT platforms which do not accommodate GI needs. 3. Lack of clarity regarding GI device ownership. 4. Lack of understanding around maintenance needs and costs of GI. 5. Inconsistent on-the-ground maintenance or lack of maintenance leads to poor public perceptions of WSD.	• Lack of will by CCO's and council to accept certain GI devices. • Challenges during the asset hand-over stage to accurately record devices and include on asset registers. • Existing and historic databases still in use do not include data fields for GI practices and databases do not always align. Whilst work is underway to better align AT and council databases differing ICT platforms and other ICT barriers are a big issue. Leveraging funding to upgrade and align ICT platforms is going to be an important aspect to tackle this moving forward. • GI ownership can lie with Community Facilities, Healthy Waters or Auckland Transport – multiple ownership leads to confusion and duplication of consenting approvals through to asset vesting and maintenance. • Lack of asset ownership and poor maintenance results in device failure and a bad look for WSD. Council needs to change the perception that maintenance is a burden by making it accounted for at the start of the design process (i.e. "*designing for maintenance*"). • There is a paucity of reliable data on maintenance costs. • Large-scale maintenance contracts tend to be inefficient in maintaining distributed networks. • Maintenance requirements are often poorly specified and hence appear as a burden, as a result of lack of a full life cycle plan for WSD installations. • Consenting does not require a full life cycle approach to understanding effects of a project resulting from various GI vs traditional assets.
Funding and financing	1. Benefits of WSD and GI are wide-reaching but are not accounted for through business cases for funding. 2. Indirect costs to society and the environment (e.g. costs of carbon) are not considered during decision-making processes. 3. There is no sustainable funding source (other than rates) for operational maintenance and performance monitoring. 4. Regulatory and monetary incentives for WSD approaches are virtually non-existent.	• Maintenance costs are a specific knowledge gap. • Reliable methods and information is required for assessing the full range of direct and indirect benefits. • Indirect costs to society and the environment are not taken account of during funding applications. • Business cases for funding council group projects does not consistently incorporate non-stormwater benefits which arise from WSD approaches. • Costs and benefits should be assessed relative to those associated with conventional approaches. • There is a lack of regulatory or economic incentives promoting the uptake of WSD in NZ. • The implementation of WSD is held back by funding constraints, for instance for monitoring to enable WSD as unanticipated opportunities arise.

Conflicting outcomes	1. Commercial (development yield) and public service (affordable housing, roading), often outweigh WSD considerations and benefits (since these are not valued through the decision-making process). 2. Retrofitting WSD approaches are not well supported (technically or legislatively).	• Environmental, social and cultural benefits are not consistently valued through the land development and engineering design processes, with decision-making generally based on lowest cost options and highest profit options. • Retrofitting of WSD approaches is not well supported in the ultra-urban environment and it not mandated through the regulatory process, nor incentivised. • Lack of guidance relating to implementation of retrofit WSD developments.
Capability and capacity	1. Inexorable contesters of WSD base opinions on misinformation. 2. Lack of design, construction and maintenance training courses for industry practitioners. 3. Lack of budget and time for training needs of council and CCO staff (especially regulatory services staff).	• Key sectors in the WSD value chain, for instance construction and maintenance contractors, lack the basic knowledge for successful implementation of WSD – industry capacity building and training in this space is limited and there is no requirement for professionals to undergo training in this field. • No currently prepared or run Auckland training courses on WSD for designers. • Related to the above, badly designed/constructed/maintained WSD examples tend to be held up by inexorable contesters of WSD as to the reasons why it doesn't work. • Lack of budgets and time set aside for regulatory services staff to be trained in WSD. • Lack of budgets and time set aside for CCO staff to be trained in WSD.

6. High level intervention opportunities

This section sets out recommended high level intervention opportunities which reflect the results of this review and the previously identified barriers to widespread implementation of WSD in Auckland. The opportunities presented are by no means exhaustive, but they provide a summary of key actions which could assist council in improving holistic implementation of WSD. It is further noted that these opportunities would need to be workshopped and ground-truthed with the relevant council departments. No particular priority is assigned to any of the opportunities. Whilst potential timeframes for implementation have been suggested, implementation of opportunities are subject to resourcing and this report provides no indication of the ability of council to commit or deliver each of the opportunities in the short to medium term. The opportunities are provided within the context of Auckland's water sensitive journey, starting in the early 2000s with the implementation of various techniques and broad principles associated with ISM and GI (Figure 3), and further developed through the Auckland Unitary Plan processes in the 2010s. The paradigm shift to achieve holistic, wide-spread implementation of WSD will take many years, decades even, with many of the recommended opportunities being long term and/ or requiring on-going effort.

With the aim of better recognising and providing for the wide-spread delivery of WSD projects, the opportunities summarised in Sections 6.1 – 6.5 and Tables 4 – 8 are recommended.

6.1 Strategic planning and regulatory opportunities

Section 5 identified that, amongst other things, Auckland's planning documents do not fully support a consistent and holistic approach to the wide-spread implementation of WSD across the region. Five opportunities (Table 4) have been identified to assist with overcoming planning barriers. The first opportunity relates to developing a common, "Aucklandized" definition of WSD which is used consistently across the range of planning documents and codes of practices/ technical guidelines. This will assist in building a common understanding of WSD goals and practices for Auckland.

The second intervention opportunity recommends the need to investigate undertaking a plan change to the AUP to incorporate WSD as a concept and outcome in the AUP. The AUP could also more strongly mandate desired WSD implementation tools via regulation. As an example, London (United Kingdom), Basel (Switzerland), Copenhagen (Denmark), France, Germany and the Netherlands all regulate the requirement for green roofs within city boundaries (Grant and Gedge, 2019; The Nature Conservancy, 2019[12]). Currently a s.35 monitoring study is being undertaken to assess the effectiveness of the AUP with respect to water outcomes. Aligned with and building on this evidence base, a detailed SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of the current planning framework to understand how the various tools function together and where existing strengths and weaknesses lie should be undertaken. The SWOT type analysis could additionally identify key players, and their roles and tools at each of the development phases, i.e. strategic direction in the Auckland Plan, regulatory provisions under the AUP, design,

[12] https://www.nature.org/en-us/about-us/where-we-work/united-states/new-york/stories-in-new-york/nyc-laws-green-roofs-solar-panels/

construction, ongoing maintenance and operation. In this regard, the analysis could use case studies to identify why initially successful WSD approaches failed to deliver 'on-the-ground' outcomes.

To support this review, there is also an opportunity to investigate the use of incentives to promote implementation of WSD. For example, the Philadelphia Water Department provides zoning incentives for green roofs and green roof tax credits to businesses. They also have a retrofit programme whereby grants or rebates are provided to large scale construction retrofit projects across the city (Ira and Batstone, 2019). Whilst the AUP cannot provide tax credits, it can provide consenting incentives for various WSD approaches (e.g. reduced consenting pathways for particular WSD implementation tools such as rain tanks, green roofs, reduced impervious areas, stream restoration and daylighting, and so on). This approach is also consistent with preliminary advice provided to Auckland's Water Strategy by the Mana Whenua Kaitiaki Forum (2018)[13] who stated that:

> "*We will know we are on the right track when……*
> *….5. Regulatory and financial incentives are designed to encourage and facilitate actions and activities that protect and sustain te mauri o te wai (it should be easier and faster to gain regulatory approvals, use public infrastructure and secure access to public funds if a proposal promotes te mauri o te wai) …*".

Additional opportunities recommended include the provision of assessment criteria within planning documents to encourage or regulate decision making based on non-water benefits of WSD and life cycle considerations, a review of council and CCO CoPs to ensure consistency of terminology across organisations, and the inclusion of staff within council group units responsible for the implementation of WSD in Auckland. Ongoing engagement between Healthy Waters (HW), Watercare, Auckland Transport, Community Facilities and Eke Panuku is also recommended to further explore how they can continue to work together to consistently roll-out WSD implementation tools to reduce wastewater overflows in existing urban areas and supplement existing water supply sources. This is already occurring in some instances, with HW and Community Facilities exploring initiatives to use stormwater ponds and detention devices for sport field irrigation (pers comm Janet Kidd 15-10-21). These informal discussions could be strengthened by creating a council and CCO wide WSD strategic direction focussing on three waters integration and the reuse of both stormwater and wastewater to reduce wastewater overflows and water supply demands.

[13] Memo to Auckland Counci from Mana Whenua Kaitiaki Forum, October 2018

Table 4 Strategic planning and regulatory opportunities

Theme	Barriers	Intervention Opportunities	Timeframe for Implementation
Strategic planning documents and regulatory capacity to influence development outcomes	1. Narrow focus on GI and lack of advocacy of WSD through the Auckland Plan 2050 and Unitary Plan. 2. Inherent uncertainty of the RMA plan change process limits council's ability to ensure intended outcomes are reflected in the operative planning documents. 3. Implementation of some rules in the AUP are spatially fragmented leading to inconsistent outcomes being achieved on the ground. 4. The planning framework limits council's ability to monitor the performance of on-site GI devices which form part of the private stormwater network and undertake compliance on poorly maintained private stormwater assets. 5. Lack of cohesion and consistency in the narrative and terminology used between council and CCO regulations and codes of practice. 6. No regulatory incentives. 7. Wider benefits of WSD not taken account of during consenting – not required by the policies. 8. Life cycle assessments not required through the consenting process. 9. The need for more WSD "Influencers".	1. Development of a common definition of WSD for Auckland which incorporates water sensitive city and Mātauranga Māori considerations, and which can be incorporated more widely into council planning and technical documents and decision-making[14]. 2. Investigate opportunities to undertake a plan change to further support WSD. Auckland Council is currently carrying out Section 35 monitoring of the Auckland Unitary Plan, which will review the effectiveness and efficiency of the AUP across a variety of topics, including water outcomes. Building on from this evidence base, an investigation needs to be carried out into the strengths and weaknesses (a 'SWOT' type analysis) of the current planning framework to support WSD. The SWOT analysis could include a stocktake of the AUP to assess how well it reflects the overall concepts of WSD. Based on the outcome of the monitoring and SWOT analysis, a Plan Change to strengthen WSD outcomes could be considered. Potential future plan change(s) could investigate and/ or incorporate: a. Regulation of WSD, including mandating or requiring certain WSD principles or practices b. Incentives for WSD developments (incentives could include reduced consenting requirements) c. Assessment criteria consideration to include benefits of WSD (both water and non-water benefits) d. Assessment criteria to include consideration of life cycle assessments	Short to medium term (<5 years) and jointly with mana whenua Short to medium term (<5 years) (s.35 review underway by Plans and Places)

[14] Mātauranga Māori is a taonga held and protected by each respective mana whenua and tangata whenua. For true recognition – it cannot be an add-on to current guidance, rather council processes need to be adapted to bring in the Mātauranga Māori specialists into the assessment, guidance development and decision making.

	10. Retrofitting WSD not well considered through the consenting process. 11. No mandate for three waters integration (although work on this issue is now occurring via the Three Waters Reform process).	e. Provision of technical documents which to guide retrofitting opportunities using a WSD approach. 3. A review of CCO and council CoPs to ensure definition of WSD (as per intervention 1) is supported consistently across Auckland Council Group. 4. Investigation of opportunities for staging and in the engineering approval processes of vested GI assets to ensure assets are adequately maintained and protected during construction of adjacent 'small sites'. 5. Development of a cross-council and CCO strategic direction (SD) which, amongst other things, addresses three waters integration and the reuse of both stormwater and wastewater to reduce wastewater overflows and water supply demands. 6. Integration of WSD expertise across council is needed. Healthy Waters consistently advocates for WSD, but WSD expertise could also be included in other council departments (such as the Urban Design Unit, Watercare and Auckland Transport), to further integrate and influence ongoing WSD implementation.	Short term (1 – 2 years) Short term (1 – 2 years) Short to medium term (>5 years) (likely an interim SD in light of three waters reform process) Medium term (3 – 5 years)

6.2 Operational opportunities

Many of the barriers relating to implementation of WSD occur at the operational level, when GI practices supporting WSD (see Figure 3) are designed, constructed and maintained. There is often a lack of clarity regarding ownership of GI practices, along with different standards relating to the acceptance of GI assets. The Auckland Council Group additionally use different databases to collect and hold asset data, and some databases may not be appropriate for storing GI asset data or do not align with each other. Whilst work is underway to better align AT and council databases, differing ICT platforms and other ICT barriers are a big issue. There is generally a poor understanding of costs and maintenance obligations around GI practices, and inconsistent maintenance standards between different council group departments. Council also has very limited abilities to ensure that maintenance is undertaken on private

stormwater assets. Poor on-the-ground maintenance has the potential to lead to poor public perceptions of WSD (see Figure 21). Research undertaken by Ira and Simcock (2019) has contributed to our understanding on long term costs of WSD and best practice maintenance, but further work is needed. As WSD implementation becomes more widespread (as would happen if mandated via the AUP), and potentially more GI practices fall under private ownership, these challenges will continue to build and opportunities to overcome them must be sought.

Four intervention opportunities have been recommended (Table 5), including reviewing code of practice documents to ensure alignment across the Auckland Council Group, undertaking a review of council group asset databases to ensure consistency across the databases and streamlining of data information, development of a maintenance cost database to track maintenance activities and cost information, and a review of council maintenance procedures to improve future maintenance activities and support the perception that WSD positively contributes to amenity areas for communities.

A rain garden at the Panmure Train Station before maintenance (left) and after maintenance (right)

Figure 21 An example of the type of maintenance which is occurring on many rain gardens in Auckland

Discussions with Healthy Waters (HW) have highlighted that Operational Recommendations 2, 3 and 4 are all underway to some degree for HW owned assets, and they have set up Service Level Agreements to assist CCOs with these aspects. As with all operations and maintenance programmes, these measures will need to be reviewed and improved on an ongoing basis. Work has also been actively underway for some time now to better align AT and council databases, but differing ICT platforms are a barrier.

Table 5 Operational opportunities

Theme	Barriers	Intervention Opportunities	Timeframe for Implementation
Operational considerations for council group owned water sensitive infrastructure	1. Differing standards relating to GI acceptance across council and its CCOs. 2. Inconsistent databases and ICT platforms which do not accommodate GI needs. 3. Lack of clarity regarding GI device ownership. 4. Lack of understanding around maintenance needs and costs of GI. 5. Inconsistent on-the-ground maintenance or lack of maintenance leads to poor public perceptions of WSD.	1. A review of council group CoPs to ensure definition of WSD (as per intervention 1) is supported consistently across council and all its organisations. 2. Review of council group databases which support GI assets and a review of asset information which is required to be provided at the asset vesting stage. Asset database fields and requirements should be consistent (streamlined) across council and its CCOs. 3. Development of a GI asset database which tracks inspection and maintenance expenditure for all council group GI assets. This could also include monitoring of device performance thereby assisting in building an understanding of life cycle performance and cost. 4. Review of council maintenance procedures/ models for GI (e.g. 2 in a Ute programme effectiveness vs large scale maintenance providers) and development of maintenance guidelines for contractors maintaining vegetated council assets.	Short term (1 – 2 years) Underway by HW. Short to medium term (<5 years) Underway by HW. Short term (1 – 2 years) Underway by HW. Short term (1 – 2 years)

6.3 Funding and financing opportunities

In a recent review of three waters infrastructure provision and delivery (Minister of Local Government and Minister of Health, 2018[15]) the New Zealand Cabinet 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. PwC (2004) determined that if water quality outcomes were identified to be important (as they have now through the NPS-FM), then the cost to council for managing stormwater infrastructure could rise to as high as $11.2 billion over a 20 year planning horizon. More recently, the Auckland Plan has identified a funding shortfall of between $10 - $15 billion to meet infrastructure

[15] Minister of Local Government and Minister of Health. 2018. Future state of the three waters system: regulation and service delivery. Paper prepared for the Cabinet Economic Development Committee of New Zealand.

costs. Sustainable and equitable funding sources therefore need to be investigated for Auckland. Auckland Council has instituted a "water quality targeted rate" which allows for total investment of $856 million over ten years to deliver cleaner harbours, beaches and streams ($452 million collected via an additional council water quality targeted rate and $404 million funded via water charges from Watercare)[16]. The rate is based on property capital value, with 25.8% of the revenue requirement being raised from business. This equates to around $78 per property per annum. In general, the rate was reasonably well supported by the Auckland Community (60% of respondents supported the targeted rate and approximately 30% opposed it)[16]. Unfortunately the rate generally does not cover ongoing OPEX (operational) costs associated with asset maintenance and monitoring. Additionally, it is not linked to the level of imperviousness on each property, nor the pollutant generation potential of different property types. This approach is contrary to the application of stormwater fees internationally (Ira and Batstone, 2019) as it perpetuates the notion that non-polluters are subsidising the polluters, effectively giving them social license to continue polluting, and creating no incentives for on-going behavioural change.

In order to overcome this 'funding gap' barrier, it is recommended that council investigate various pathways for the implementation of sustainable funding systems and incentive mechanisms in Auckland (Table 6). Previous research (Ira and Batstone, 2019) has shown 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; grounded within the "polluter-pays" principle, i.e. while the whole community may benefit from stormwater infrastructure, the people who generate the effect should be required to pay to mitigate it. Furthermore, international experience clearly demonstrates that effective implementation of WSD requires that the funding strategy encompass fee credits and/or programme incentives to assist in creating behavioural change within the community and increase awareness of stormwater effects (Ira and Batstone, 2019).

Opportunities to improve council decision-making via the development of business case templates for funding applications, based on water and non-water benefits of WSD and cultural benefits rather than just direct costs of a project, are integral to supporting implementation of WSD (Table 6). Indirect costs (such as the cost of carbon) should also be considered and the "value engineering" approach reviewed such that projects are valued based on the wider benefits they provide to communities rather than only on the costs that are incurred by network operators.

In addition to sustainable funding sources and a review of decision-making procedures, non-regulatory opportunities around celebrating success and creating a 'green star' rating system (or similar) for WSD will help to publicise WSD and create a market demand for environmentally sensitive approaches to urban development (Table 6).

[16] Auckland Council. Undated. AC WQ Targeted Rate: https://ourauckland.aucklandcouncil.govt.nz/media/19292/attachment-b-water-quality-targeted-rate.pdf . Accessed on 1 February 2019.

Table 6 Funding and financing opportunities

Theme	Barriers	Intervention Opportunities	Timeframe for Implementation
Funding and financing	1. Benefits of WSD and GI are wide-reaching but are not accounted for through business cases for funding. 2. Indirect costs to society and the environment (e.g. costs of carbon) are not considered during decision-making processes. 3. There is no sustainable funding source (other than rates) for operational maintenance and performance monitoring. 4. Regulatory and monetary incentives for WSD approaches are virtually non-existent.	1. Consistent council group development of business case templates for funding based on water and non-water benefits of WSD and cultural benefits as integral to decision-making for all council group funded projects. Business cases to also take indirect costs (carbon costs, costs of environmental remediation) into account during option analysis and decision making. 2. Development of a benefit-based value engineering process for project design and delivery that realises benefits and does not 'value engineer' options solely on the basis of cost. 3. Investigate pathways for the implementation of sustainable funding systems and incentive mechanisms in Auckland, including assessing: a) Investigating the use of the existing road user tax and the targeted water quality rate for the provision of a sustainable funding source for ongoing maintenance and monitoring of GI b) opportunities for co-benefit based funding c) gaps in capacities to pursue the opportunities afforded by alternative potential funding regimes. 4. Investigation into providing financial incentives for WSD development (e.g. reduced consenting fees, WSD subsidies). 5. Development of a WSD rating scheme similar to the 'green star' process where developers can financially benefit from WSD approaches and create a market demand for environmentally sensitive approaches to urban development.	Underway by HW. Medium term (1 – 3 years) Underway by HW. Short term (1 – 2 years) Underway by HW. Short term (1 – 2 years) Medium term (3 – 5 years) Medium term (3 – 5 years) and ongoing

		6. Recognising and rewarding WSD success stories.	Short term (1 – 2 years) and ongoing

6.4 Opportunities to reduce conflicting outcomes

Due to the lack of weight given to WSD in the planning documents as well as environmental, social and cultural benefits not being valued through the land development and engineering design processes, outcomes which have greater statutory weight or have lower costs generally out-compete WSD approaches. Additionally, retrofitting of WSD approaches is not well supported (or understood) in the ultra-urban environment and is not mandated through the regulatory process, nor incentivised.

Many of the opportunities already recommended will assist in reducing the conflict between a WSD outcome and outcomes such as development yield or affordable housing. In many cases, it is a lack of understanding of how WSD can be applied in urban areas that leads to these conflicts. The case study provided in Section 3.2.2 (Goodland Estates), although not in an ultra-urban area, demonstrated that a WSD approach achieved a higher property yield for the developer than a traditional approach. Guidance on methods for retrofitting WSD in existing urban areas, for instance as part of brownfield redevelopment projects, is an opportunity which should be explored to overcome this barrier (Table 7).

Table 7 Opportunities to reduce conflicting outcomes

Theme	Barriers	Intervention Opportunities	Timeframe for Implementation
Conflicting outcomes	1. Commercial (development yield) and public service (affordable housing, roading), often outweigh WSD considerations and benefits (since these are not valued through the decision-making process). 2. Retrofitting WSD not well supported (technically or legislatively).	1. Intervention opportunities previously recommended which would assist in overcoming conflicting outcomes include: a) Regulation of WSD, including mandating or requiring certain WSD principles or practices. b) Integration of WSD expertise across council is needed. Healthy Waters consistently advocates for WSD, but WSD expertise could also be included in other council and CCO departments (such as the Urban Design Unit, Watercare, Auckland Transport) to further integrate and influence ongoing WSD implementation. c) Consistent cross-council and CCO development of business case templates for funding based on water and non-water benefits of WSD and cultural benefits as integral to decision-	Previously provided.

		making for all council group funded projects. Business cases to also take indirect costs (carbon costs, costs of environmental remediation) into account during option analysis and decision making. d) Development of a benefit-based value engineering process for project design and delivery that realises benefits and does not 'value engineer' options solely on the basis of cost.	
		2. Guidance on methods for retrofitting WSD in areas of existing development, for instance as part of brownfield redevelopment projects. This could also include design and decision-making support tools to support consent applications (e.g. a 'green scoring sheet' or 'WSD success matrix' for redevelopment projects).	Short term (1 – 2 years)
		3. Development of detailed design exemplars to support council and CCO staff in assessing acceptable long term infrastructure to be vested.	Short term (1 – 2 years)

6.5 Opportunities to enhance capability and capacity to deliver WSD

As shown in Table 3, there are currently limited opportunities for stormwater or WSD training courses or education programmes for designers and construction and maintenance operators in Auckland. It is noted that the United States National Green Infrastructure Programme (NGICP) was amended for use in New Zealand by Auckland Council and trialled here. The course has now been converted to an on-line course with time allocated for practical learning in the field. The course will soon be re-launched by Healthy Waters. A key part of any transition strategy to wide-spread WSD implementation is capacity building and training (Briony et al., 2016). This is an opportunity area for Healthy Waters, who could develop focussed, locally based training programmes for the design and implementation of WSD. Feeney (2021)[17] has developed a training framework to aid implementation of WSD on behalf of Water New Zealand. The framework (Feeney, 2021) (Figure 22) and training strategy assesses the availability of stormwater education or training, urgency of the training need and priority of training for New Zealand. Surveys undertaken by Water New Zealand to support this work identified that WSD training needs were ranked highest out of a potential 16 different stormwater related topics. Feeney (2021) concluded that many of the urgent

[17] Please note that the report referenced is a Confidential pre-release draft.

training needs identified by industry can be met through continuing professional development (CPD) training. The strategy focusses on unmet WSD training needs, with training defined as:

"*Training is the acquisition of work-related knowledge, skills and practices that will improve a specified aspect of on-the-job performance in objectively observable ways.*"

Building capacity and skills within council and the wider Auckland stormwater industry (Table 8) will assist in overcoming inexorable or inflexible contesters of WSD who base their concerns on misinformation.

Securing a sustainable funding source for WSD implementation (see Table 6) also assists in overcoming budgetary issues which prevent council officers (especially within Regulatory Services) from attending training. AC also have a unique opportunity to build industry capacity to better reflect Te Ao Māori values in WSD planning and implementation, and improved models for including Māori in decision-making and governance (Brockbank and Afoa, 2019). Part of this capacity building could incorporate opportunities around evaluating a range of WSD case studies for the degree to which each project incorporates Te Ao Māori. These case studies can serve as reference projects illustrating good and bad practice, informing the design of future projects and the wider building of industry capacity (Brockbank and Afoa, 2019). This could build on the work undertaken for the Water Strategy Shift 5: Regenerative Infrastructure process (Tektus Consultants, 2021).

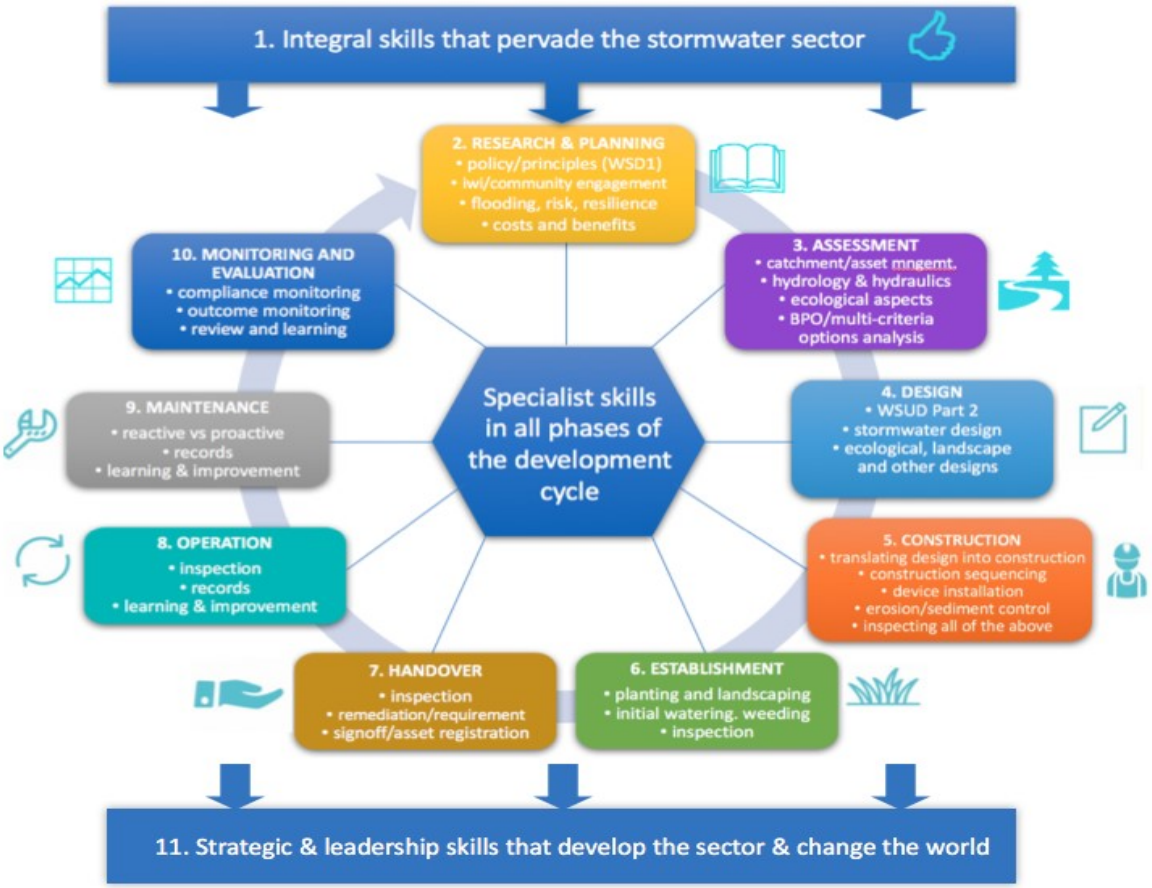


Figure 22 The water sensitive cycle as a stormwater sector development tool (Feeney, 2021)

Table 8 Opportunities to build capacity and capability to implement WSD

Theme	Barriers	Intervention Opportunities	Timeframe for Implementation
Capability and capacity	1. Inexorable contesters of WSD base opinions on misinformation. 2. Lack of design, construction and maintenance training courses for industry practitioners. 3. Lack of budget and time for training needs of council and CCO staff.	1. Working jointly with industry, universities and professional institutions, to develop additional locally based training programmes to support design and implementation of WSD to complement the NGICP course (based on the WSD training framework developed by Feeney (2021).	Short to medium term (1 – 5 years) and on-going
		2. Developing transitioning strategies, institutional and governance arrangements and methods for promoting behaviour change in the Auckland context.	Long term (>5 years)
		3. The need to build industry capacity to better reflect Te Ao Māori values in WSD design and implementation and improved models for including Māori in decision-making and governance.	Short to medium term (1 – 5 years) and on-going
		4. Evaluate a range of WSD case studies for the degree to which each project incorporates Te Ao Māori. These case studies can serve as reference projects illustrating good and bad practice, informing the design of future projects and the wider building of industry capacity.	Partly underway by APSR[18]. Short to medium term (1 – 2 years)

[18] Auckland Plan Strategy and Research Department, Auckland Council

7. Conclusion

Auckland's plans and polices recognise and reference the value of WSD, ISM and GI to varying degrees but they do not provide a clear mandated framework for the wide-spread implementation of a holistic approach to WSD across Auckland. A brief review of these documents has been undertaken and whilst no major inconsistencies were found, the wide-ranging WSD nomenclature across the planning documents, technical guidelines, CoPs and NDC could lead to confusion amongst stakeholders and undermine consistency of outcomes.

Challenges and barriers to the wide-spread implementation of WSD in Auckland have been discussed in Section 5, many of which result from the multi-disciplinary nature of WSD. Clear direction is needed at the Auckland Plan and AUP level to ensure that Auckland Council Group, as a whole, have a common understanding of WSD, have a common purpose in facilitating wide-spread WSD outcomes and allow for implementation of WSD to be considered 'business as usual'.

Section 6 has recommended a series of high-level intervention opportunities which reflect the results of this review. The opportunities presented are by no means exhaustive, but they provide a summary of key actions which could assist council in improving holistic implementation of WSD. No particular priority is assigned to any of the opportunities and they need to be workshopped and ground-truthed with the relevant council/CCO departments. Whilst potential timeframes for implementation have been suggested, implementation of opportunities are subject to resourcing and this report provides no indication of the ability of council to commit or deliver each of the opportunities in the short to medium term. The opportunities are provided within the context of Auckland's water sensitive journey, starting in the early 2000s with the implementation of various techniques and broad principles associated with ISM and GI. The paradigm shift to achieve holistic, wide-spread implementation of WSD will take many years, decades even, with many of the recommended opportunities being long term and/or requiring on-going effort.

Developing an agreed, Auckland-specific definition of WSD which encapsulates the principles of Mātauranga Māori and underpins the Auckland Water Strategy vision 'te mauri o te wai Tāmaki Makaurau, will assist in providing strategic direction. Additionally, recommendations in this report, along with a recommended SWOT-type analysis could supplement the current s.35 monitoring review of the AUP and inform future plan changes.

If the challenge of meeting Auckland's growth targets whilst still maintaining or enhancing our unique receiving environment is to be met, then WSD needs to be strongly mandated and consistently regulated and incentivised in the Auckland planning documents. WSD is broader than GI or ISM, and decision-makers and the development community alike need to be incentivised to adopt a WSD lens. Clear technical guidance and decision support tools are needed to assist with this process, particularly with respect to providing guidance on retrofitting WSD in developed/brownfield areas. Sustainable funding sources need to be investigated and workshopped across the region to support on-going operational costs of maintenance and monitoring. Importantly, these funding sources must be equitable and grounded by the "polluter pays" principle. Finally, on-going locally based training is needed to build capacity within council and the wider development industry.

Barriers are merely opportunities in disguise, with the intervention opportunities offered as potential routes to a supporting a sustainable, consistent and widespread implementation of WSD across Auckland.

8. References

Afoa, E. and Brockbank, T. 2019. Te Ao Māori & Water Sensitive Urban Design. Report prepared as part of the Activating WSUD for Healthy Resilient Communities research programme funded by the National Science Challenge for Building Better Homes, Towns and Cities.

Auckland Unitary Plan Independent Hearings Panel. 2016. Report to Auckland Council on Hearing topics 046, 047, 048 and 049. Water quality and quantity; lakes, rivers and streams; aquifers and groundwater; and discharges of stormwater and wastewater

Brown, R.R., Keath, N., & Wong, T.H.F. 2009. Urban water management in cities: Historical, current and future regimes. Water, Science and Technology: A Journal of the International Association on Water Pollution Research, 59(5), 847–55.

Brown, R., Rogers, B. and Werbeloff, L. 2016. Moving toward Water Sensitive Cities: A guidance manual for strategists and policy makers. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

Citation for the Water Sensitive Cities Benchmarking report - Clarke, Farrant, & Toulmin 2021. Water Sensitive Cities Benchmarking and Assessment: Tāmaki Makaurau – Auckland. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

Feeney, C. 2021. Stormwater Education, Training and Sector Development Strategy: Summary. Report prepared for Water New Zealand (confidential pre-release draft)

Fletcher, T.D., Shuster, W., Hunt, W.F., Ashley, R., Butler, D., Arthur, S., Trowsdale, S., Barraud, S., Semadeni-Davies, A., Bertrand-Krajewski, J., Steen Mikkelsen, P., Rivard, G., Uhl, M., Dagenais, D. and Viklander, M. 2015. SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage, Urban Water Journal, 12:7, 525-542, DOI: 10.1080/1573062X.2014.916314

Ferguson, B.C., Brown, R.R. and Werbeloff, L., 2014. Benchmarking Auckland's stormwater management practice against the Water Sensitive Cities framework. Prepared by the Cooperative Research Centre for Water Sensitive Cities for Auckland Council. Auckland Council technical report, TR2014/007

Grant, G. and Gedge, D. 2019. Living roofs and walls: from policy to practice: 10 years of urban greening in London and beyond. www.livingroofs.org

Heijs, J and Kettle, D. 2008. Low Impact Design in the Long Bay Structure Plan; What Happened?. 2008 Water New Zealand Stormwater Conference.

Hoyer, J., W. Dickhaut, L. Kronawitter, and B. Weber. 2011 Water Sensitive Urban Design: Principles and Inspiration for Sustainable Stormwater Management in the City of the Future. Jovis, Berlin, Germany, p. 144

Ira, S. and Batstone, C. 2019. An Investigation of Alternative Funding and Incentive Mechanisms to Support Implementation of WSUD in New Zealand. Report prepared as part of the Activating WSUD for Healthy Resilient Communities research programme funded by the National Science Challenge for Building Better Homes, Towns and Cities.

Ira, S. and Simcock, R. 2019. Understanding the Costs and Maintenance of WSUD in New Zealand. Report prepared as part of the Activating WSUD for Healthy Resilient Communities research programme funded by the National Science Challenge for Building Better Homes, Towns and Cities.

Lewis, M., J. James, E. Shaver, S. Blackbourn, A. Leahy, R. Seyb, R. Simcock, P. Wihongi, E. Sides, and C. Coste. 2015. Water Sensitive Design for Stormwater, Auckland Council Guideline Document GD2015/004. Auckland Council, Auckland, New Zealand, p.193

Mainstream Economics and Policy. 2012. Measuring the regulatory burden of Water Sensitive Urban Design in South East Queensland. A report for the Queensland Competition Authority.

Moores, J., Batstone, C., Simcock, R. and Ira, S. 2018. Activating WSUD for Healthy Resilient Communities – Discovery Phase: Results and Recommendations. Report prepared as part of the Activating WSUD for Healthy Resilient Communities research programme funded by the National Science Challenge for Building Better Homes, Towns and Cities.

Moores, J. and Batstone, C. 2019. Assessment the Full Benefits of WSUD. Report prepared as part of the Activating WSUD for Healthy Resilient Communities research programme funded by the National Science Challenge for Building Better Homes, Towns and Cities.

Moores, J., Ira, S., Batstone, C. and Simcock, R. 2019. The 'More Than Water' WSUD Assessment Tool. Report prepared as part of the Activating WSUD for Healthy Resilient Communities research programme funded by the National Science Challenge for Building Better Homes, Towns and Cities.

PriceWaterhouseCoopers. 2004. Funding Auckland Regional Stormwater: An Options Analysis. Prepared for Infrastructure Auckland.

Tektus Consultants Ltd. 2021. Auckland Council Water Strategy Shift 5: Regenerative Water Infrastructure – Draft report.

List of referenced planning documents:

- National Policy Statement for Freshwater Management (September 2020)
- Auckland Plan 2050 (2018 version)
- Auckland's Urban Ngahere (Forest) Strategy
- Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan (2020)
- Operative Auckland Unitary Plan
- Stormwater Bylaw – 2015
- Stormwater Code of Practice (v. 2 - 2015 and v.3 - 2021)
- Stormwater Network Discharge Consent
- Auckland Transport Design Manual (Road Drainage v.1.2)
- Watercare's Statement of Intent (2018 – 2021)
- Watercare's Code of Practice (v.1.5, 2015)

Acknowledgements

I would like to thank the staff of Auckland Council's Healthy Waters, Natural Environment Strategy, and Plans and Places teams for their knowledge, guidance and assistance in compiling this report.