

A PATHWAY TO CIRCULAR ECONOMY – TRANSFORMING OUR WATER INFRASTRUCTURE

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ABSTRACT

The New Zealand Water Reform announced in July 2020 has sparked a drastic shift for the three-waters sector. The Reform Programme intends to transition the management of these services to accelerate the improvement in infrastructure investment, environmental outcomes, and adaptation to climate change for the three waters: drinking-water, wastewater, and stormwater services. Circular economy (CE) is gaining momentum as a well-positioned framework that supports these concerns. CE takes a holistic perspective on minimising environmental burden through reducing resource reliance, restorative solutions, and cradle to cradle design.

This paper presents the research outcomes of incorporating CE principles for three-water services by New Zealand councils. The findings explore international examples of implementing CE into three-water infrastructure, providing insights into what transition could look like for New Zealand. Three-water service delivery for a sample of councils were assessed using the Asset Management Maturity framework used within the Treasury Investor Confidence Rating framework and publicly available documents, including strategic asset management plans and infrastructure strategies. Current Asset Management Maturity frameworks do not explicitly consider CE.

The research identified that strategic asset management plans or infrastructure strategies do typically integrate sustainability plans. While most councils acknowledge climate change and sustainability as issues to address, there is a gap in these sustainability strategies and the usage of CE that extend beyond just a focus on carbon.

The challenges that prevent the shift from linear water infrastructure thinking to circular are seldom technical – it is the pathway from status quo to something different that is the biggest unknown and risk. Drawing from case studies like Ireland’s Ringsend water treatment plant may hold some answers for overcoming current barriers. Insights include managing challenges such as coordinating stakeholders, ensuring a financially viable system, and accepting the risk of taking a novel approach.

The paper proposes suggestions that can make CE achievable for New Zealand. The current transition period in New Zealand’s water sector may provide the best opportunity for stakeholders to collaborate and embed circular practices as business-as-usual operations.

KEYWORDS

CIRCULAR ECONOMY, THREE WATERS REFORM, SUSTAINABILITY, INTEGRATED WATER MANAGEMENT

PRESENTER PROFILE

Emma Botha is a graduate water engineer at GHD. Her Background is in chemical and process engineering and has a master's in engineering management from the University of Canterbury. Throughout her career she aspires to contribute in meaningful ways and help make positive change for people and the environment.

1. INTRODUCTION

In July 2020, the New Zealand government announced the three waters reform programme, which will see the three waters (drinking water, wastewater, and stormwater) services transferred from councils to four new Water Service Entities (WSEs). These WSEs will be fully responsible for managing the three water assets from July 2024. The purpose of these entities is to provide safe, reliable, and efficient water services. Additional high-level objectives include protecting the environment and managing services in a sustainable manner.

Te Mana o te Wai – the vital importance of water, is the central element in transforming the way we not only look at water but also provides a strong influence on the future of three water services. Recognising that water is a crucial natural resource to the health and well-being of both people and the environment. It emphasises a need to protect water and show care and respect for its vitality. The water body's health is our first priority, the needs of the people coming second and commercial interests third. Within that is the idea of stewardship and governance through a multi-generational approach where all New Zealanders and those with authority to make decisions are responsible for maintaining and preserving future generations. This is a significant perspective shift from the historical prioritisation of business and people coming first.

Aotearoa New Zealand's First Emission Reduction Plan was published in May 2022 with the intention of providing a pathway to net zero carbon emissions by 2050. The plan expresses a desire to create a thriving CE and bioeconomy also by 2050 and that the public sector should lead by example. The water sector is not mentioned in discussion of CE, and the focus is more around municipal waste and recycling. The plan does allude to a future initiative that would support organisations in the pursuit of CE that could easily be extended to the water sector.

Water Reform is creating increased visibility towards asset management lifecycle practices and sustainability practices. Late 2021 saw the completion of a research project that aimed to better understand three water infrastructure asset management practice. A successful outcome of this research was identifying any opportunities to improve management of the three waters that aligns with the overarching goals of water reform.

When conducting the research, identifying anything that was both transformational and sustainability adjacent was of keen interest. How is sustainability defined? What are the outcomes trying to be achieved? In the context of asset management, these ideas are reflected in strategic asset management decision making and management of water assets throughout their lifecycle. Councils are considering sustainability and the impacts of climate change

within their region, however, there is a need to implement transformational delivery practise within the way we manage water assets.

To lead the CE transformation in shifting our thinking away from the linear mindset, we require a better understanding of these principles and a framework to progress the evolution. The interconnected nature of water and its socio-economic value is recognised through Integrated Water Management (IWM) – sometimes called One Water. IWM aims to take a coordinated approach to maximise environmental, social, and economic, outcomes for water resource management. Water – whether it be municipal drinking water, environmental flows, or industrial wastewater – is all interdependent. As such, water management should be something that puts the water system, its consumers, planners, policymakers, and engineers together with CE. However, our current water infrastructure approach handles potable water, wastewater, and stormwater as three separate components and lacks the interconnected considerations needed to fully realise CE potential.

The engineering and technical aspects of CE are well understood. There are full bodies of literature both academic and industry-based providing details on how materials can be recovered, and how waste streams can be recycled. The barriers preventing CE implementation are not necessarily technical, it is the uncertainty and more immediate demands on teams that is hindering stronger integration of CE. When faced with so much uncertainty and poor awareness of where to start coupled with poor guidance, ideas, ambitions are archived.

2. BACKGROUND ON MANAGING WATER

2.1. CIRCULAR ECONOMY

The three principles that drive CE are: eliminating waste, circulating products and materials at their highest value and regenerating nature to move away from linear processes where resources are taken from nature, used, then disposed of (Ellen MacArthur Foundation, 2019).

When used appropriately, CE is a tool that is part of a greater system of strategies that can assist in achieving sustainable outcomes both environmentally, socially, and financially. Water is circular in nature and our infrastructure stands to benefit from implementing circularity.

IWM is a key concept supporting NZ Water Reform and can be achieved with the help of CE strategies. Taking CE in the context of water, the world bank shows the juxtaposition between a linear system (Figure 1) and a simple representation of a circular design (Figure 2). Here it becomes easier to visualise where recovery and regeneration occur.

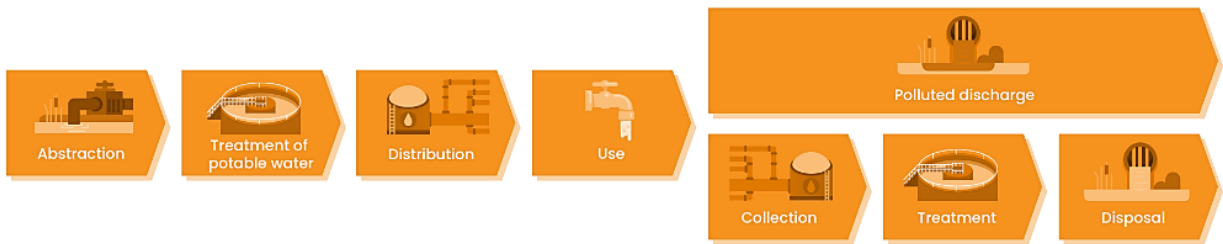


Figure 1: Linear model of water infrastructure (Delgado et al., 2021).

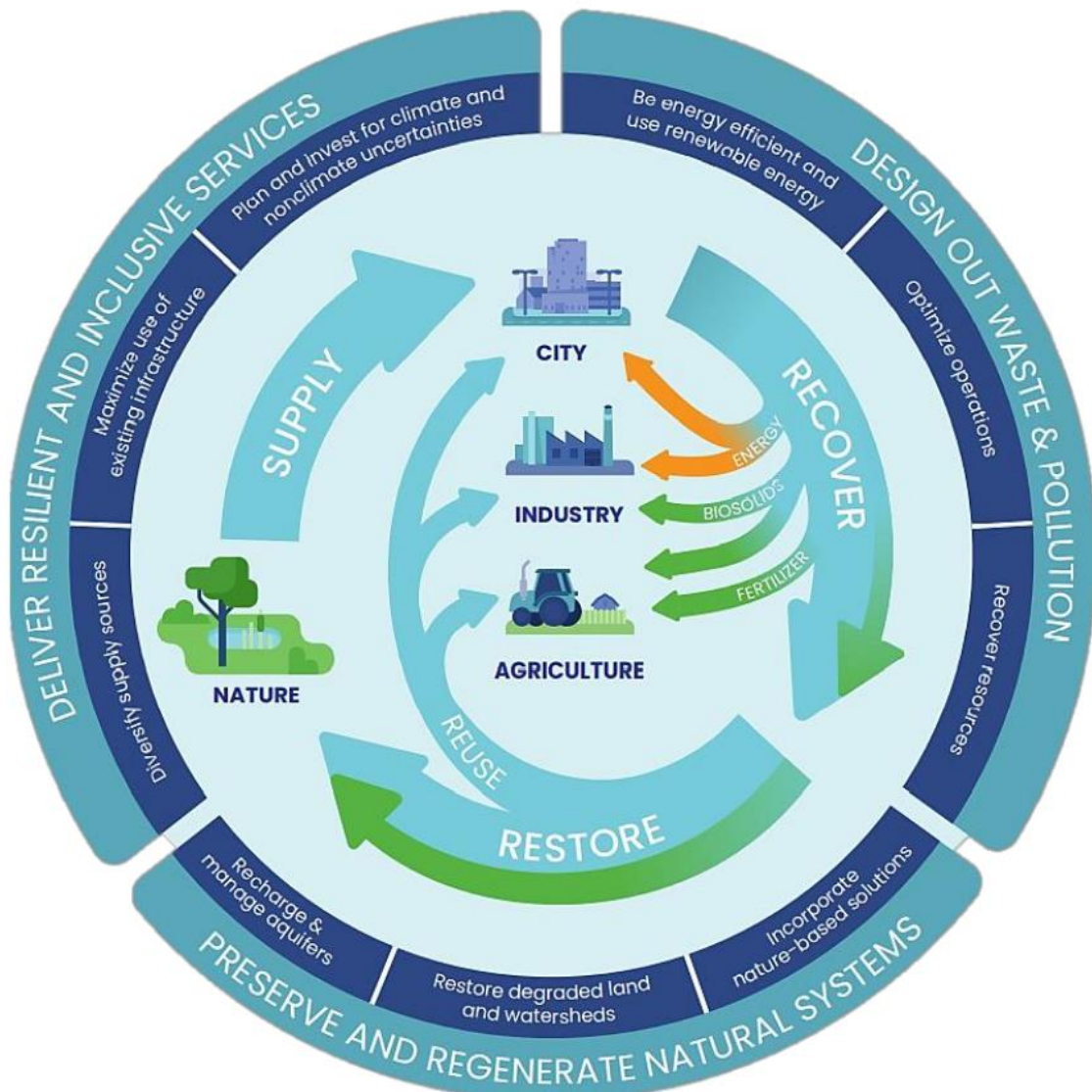


Figure 2: Circular model of water infrastructure (Delgado et al., 2021).

Multiple loops exist within three water infrastructure that interlink into other sectors. Figure 3 demonstrates the potential opportunities for circularity in the water sector and the intricate interrelationships that can exist.

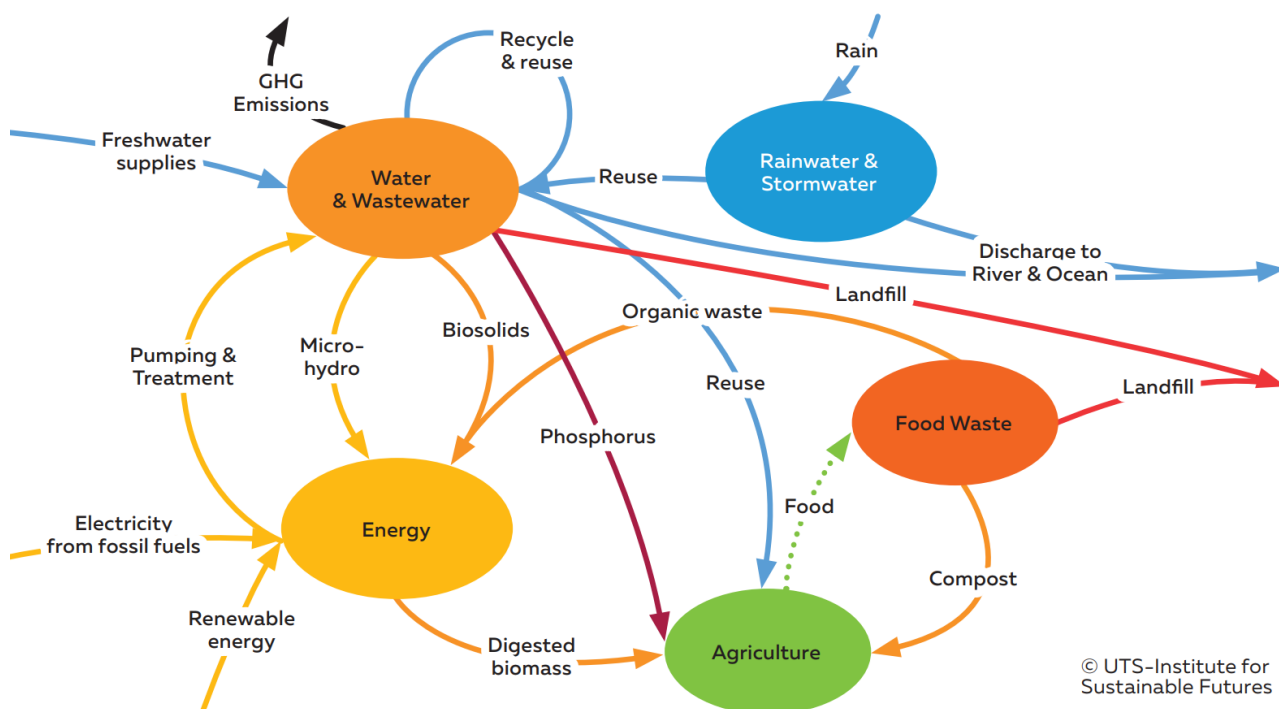


Figure 3: The different potential circular connections between water infrastructure and other sectors (Jazbec et al., 2020).

The Infrastructure Sustainability Rating Scheme is a tool used across Australia and New Zealand, developed by the Infrastructure Sustainability Council (ISC). The tool is used to evaluate sustainability initiatives and assess how it impacts the triple bottom line (social, environmental, and economic impacts). When used at the fullest of its capability, its use begins when considering design options and sustainability in design before consenting takes place. After consent, it plays a role in design iterations, and it remains in place with various calculations and the scoring of a range of sustainability attributes. The ISCA 'tool' moves into the construction phase where water usage and management, carbon, energy, fuels, and other materials are all monitored. Once complete, an as-built rating is achieved based on the outcomes (Infrastructure Sustainability Council, no date).

In New Zealand, Waka Kotahi has fully adopted this rating scheme. This use of scoring and metrics aligns well with achieving CE targets. It is yet to be widely implemented in the water sector, however some isolated examples do exist of early adoption practise (Christchurch City council (2019) have and MOU in place with ISCA).

Another framework becoming more common place is the use of life cycle assessments (LCAs) for the life cycle considerations of managing assets as a vector to sustainability. The decision to repair and maintain versus capital investment is not a new concept, but this was often considered through a financial lens. Now, it is starting to be used also with sustainability in mind. Repairing and maintaining can translate to a lesser reliance on virgin material input, avoiding the shipment of new materials and being more sustainable by needing less. There

is also greater awareness of how to manage materials when they reach their end of life with more people beginning to challenge landfill being an acceptable option. This type of thinking and considerations also would align with CE principles.

2.2. ASSET MANAGEMENT

Asset management, in essence, is one of several mechanisms through which assets in an organisation are managed add value to a business to help achieve its strategic objectives. The level of development of an asset management system is described in terms of maturity levels. It is not a measure of asset performance. Best practice is defined as achieving a maturity level appropriate to the size and complexity of the organisation. The assumption is that higher levels of Asset Management System (AMS) maturity, the better the performance of the system and the organisation overall.

The investor confidence rating (ICR) is an assessment framework created to evaluate the performance of agencies investment and AM capability to provide investors with a degree of confidence in their ability to fulfil and deliver on investment outcomes.

Within this assessment methodology exists an asset management maturity assessment 'pillar.' It draws upon a relevant understanding of AM from works such as the International Infrastructure Management Manual (IIMM) created by the Institute of Public Works Engineering Australasia (IPWEA). An Example of the parts contained within the 'AM pillar' is shown in Figure 4 below.

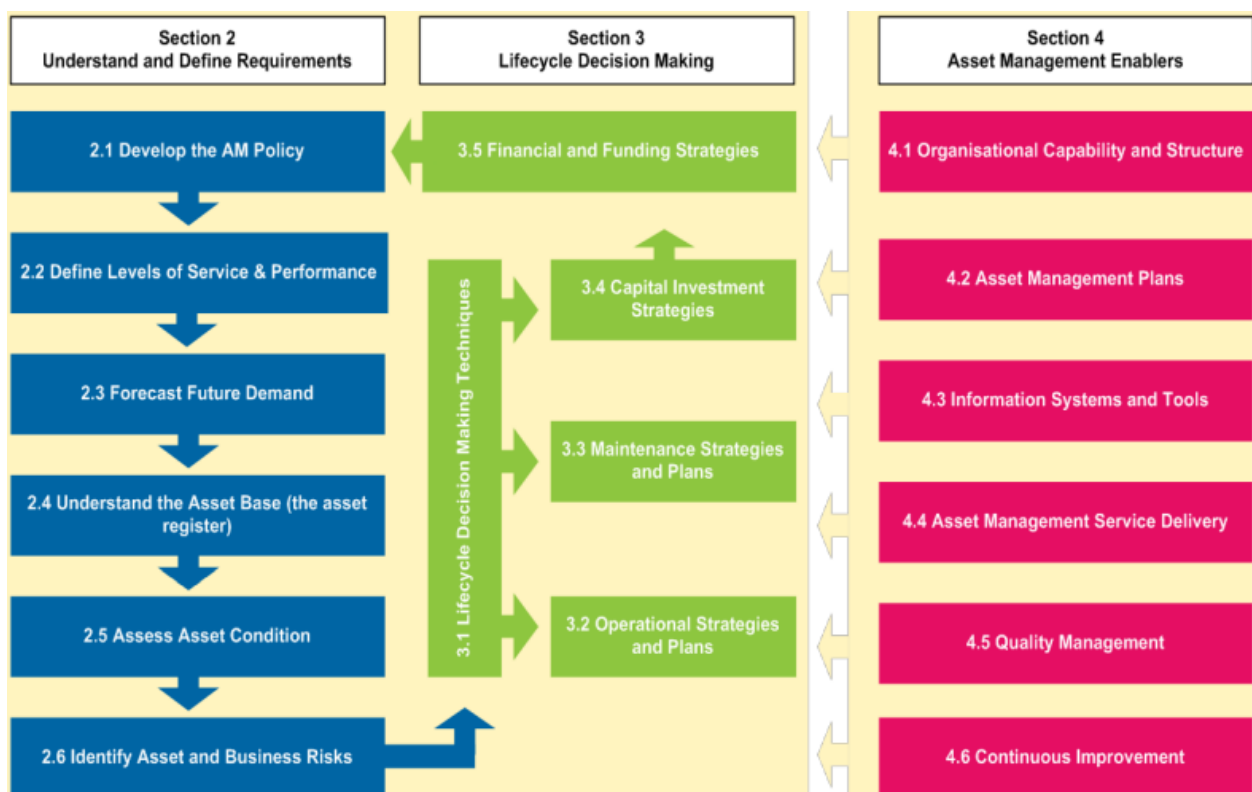


Figure 4: The different elements of AM and how they interconnect (The Treasury, 2017).

3. NEW ZEALAND'S CURRENT STATE OF CE IN AM

Nine councils/council-controlled organisations were analysed. The Scale is typically organised by one of three categories based on population: rural, provincial, and metro (Table 1).

Table 1: Criteria for assigning size categories to local authorities.

Size category	Rural	Provincial	Metro
Population range	<20,000	20,000-90,000	>90,000

A gap analysis was completed using the asset management maturity assessment framework used within the Treasury Investor Confidence for three of each of the three size categories. Using the AMM tool, individual maturity ratings were assigned to each of the 16 elements of AMS. These 16 elements are:

Understanding and Defining Requirements

- AM Policy and Strategy
- Forecasting demand
- Asset register data
- LoS and performance management

Lifecycle Decision Making

- Decision making
- Managing risk
- Operational planning
- Capital works planning
- Financial planning

Asset Management Enablers

- AM leadership and teams
- AM Plans
- Management systems
- AM information systems
- Audit and improvement
- Service delivery mechanism

Not all of these 16 elements are relevant to sustainability or would contain evidence of CE. Only AMP (Asset Management Plans) policy and strategy, decision making and managing risk is discussed.

3.1. RESULTS

The study found that when seeking deliberate consideration of CE principles, none was found. Councils do document that climate change is an issue and how that may impact their region, a few of them have implemented strategies to mitigate their environmental impact. The larger the council, the more developed the strategies as they have greater capability. These strategies do fall in within the realm of CE, but when used in isolation do not inherently provide circularity. Adoption of energy neutral treatment processes, resource recovery, carbon emission tracking and metering water usage are all aspects that can be a part of a broader circularity strategy. So, although circularity is not achieved in our water infrastructure management, we are not starting totally starting from nothing either.

3.1.1. AM POLICY AND STRATEGY

The research found that most councils acknowledge climate change as something to consider as part of their asset management system, but there was no unanimous approach. The most developed strategic initiative was the creation of Climate Resilience Strategy, Climate Change Strategy, Climate Change Policies or Climate Change Response documents. These belonged to a mixture of provincial to metro-sized councils. At the less developed end of the spectrum, was an expressed desire to want to do something. Many of these documents and policies

have been adopted over the last couple of years and are typically generalised for the entire council's operation. This means their specific area of focus water infrastructure gets in terms of sustainability. Whatever is achieved is limited by the resources available to councils.

Different councils are at various stages in developing sustainability objectives. However, in none of these documents reviewed are CE as related to water infrastructure explicitly mentioned.

3.1.2. RISK MANAGEMENT

The research showed that councils acknowledge climate change in varying capacities in their Long Term Plans and Infrastructure strategy. Some even articulate climate change's impacts on their region, e.g., increased drought, irregular rainfalls patterns, et cetera, and the need for assets to be climate change resilient. However, how the councils are changing project scopes or prioritising the most sustainable solutions was not clear due to limited discussion. Some councils have mentioned newer technologies such as bioreactors for generating electricity from biogas in treatment plants as a sustainability initiative.

3.1.3. DECISION MAKING

Research showed that most councils abide by some decision-making framework or business case template as part of the capital works planning process. Some councils include a section on how a project or option aligns with a council's values. If a value is sustainability related, that may result in more sustainable options being prioritised. However, affordability, especially for smaller councils is usually the biggest influential factor. No AM framework has a dedicated section for sustainability or means of favouring circular design. So, it is more likely that cheaper, less circular projects would be prioritised.

4. A CASE STUDY FROM IRELAND

4.1. IRELAND'S CE IMPLEMENTATION

CE has been a priority in Ireland's political agenda over the last several years. Motivated from European Union agreements such as the Paris Agreement and EU Circular Economy Package, Ireland has adopted different scales of circular strategies in various areas in infrastructure and develop their bioeconomy. Ireland has a focus called the 3 Ps: people, policy, places. Their intentions are to take a broad, holistic approach and create circular communities.

In July 2022, the Circular Economy and Miscellaneous Provisions Act 2022, was signed into Irish law. Within this bill, it provides a legal definition for CE, mandates a periodic review of their CE Strategy and various waste recovery and recycling schemes.

Ringsend water treatment plant (WWTP) is the first of its kind in Ireland that has a phosphorus recovery facility. It recovers the phosphorus from sewerage sludge to be used as more sustainably sourced fertilisers for farms to improve soil productivity. The construction of the phosphorus recovery facility is part of the large scope of works currently underway to upgrade the Ringsend WWTP. This upgrade project represents a €500 million dollar investment that intends to support future population growth of an extra >450,000 people in the greater Dublin area by 2040 while also protecting the environment (Irish Water, no date).

4.2. CHALLENGES TO IMPLEMENTING A CIRCULAR TRANSITION

An OCED Urban Study Report, The Circular Economy in Ireland, discusses further the challenges and retrospective lessons learnt for their broader CE strategy implementation including the Ringsend WWTP example (OECD, 2022). Some of the key challenges emphasised that are specific to Ireland are described in Table 2:

Table 2: Challenges in implementing CE in Ireland.

Challenge Area	Description
People and knowledge	Changing “business as usual” and contributing to a behavioural shift is not an easy task, especially when risks, costs and benefits are unclear.
	Holistic vision is lacking because of how traditionally siloed organisations are from one another.
	Awareness and education about CE can vary. Organisations with limited understanding may not fully appreciate the incentives to become circular in the water sector. Similarly, people responsible for writing policy are not typically a group with the greatest awareness or understanding of CE.
Regulation and Policy	Initially, policy and regulation did not incentivise circular practices. CE did not have as much visibility when policies and regulation were created and so circularity was not considered. This inadvertently prevented circular strategies from being implemented. Either the ability to implement a strategy was not allowed or there was a bureaucracy that was prohibitively difficult for private investment to occur.
	Policy related to CE was limited to recycling or solely focused on waste. There is a need to be a more integrated approach.
	Lack of data (inappropriate timeliness, insufficient granularity, or a total absence of any data) in particular for understanding material flows. Prior to Ireland’s new CE Bill, there was no legislative framework for CE and therefore organisations felt they lacked crucial foundation that would support a transition to CE.
Strategy	Public procurement favours proposals with lower prices and shortest construction period. Some CE implementations, such as the Ringsend phosphorus recovery unit, requires added costs and adds time to the construction period.
	Irish cities that lacked a CE strategy was also unlikely to have any action towards implementing circularity.
Financial	The smaller an organisation, the more unlikely they can get the financial and human resources necessary to shift into more circular processes.

Challenge Area	Description
	Absences of a clear funding framework or not understanding how to access grants.

4.3. RECOMMENDED ACTIONS TO OVERCOME CHALLENGES

The OCED Report, The Circular Economy in Ireland, also shares the lessons learnt of their previous and current CE strategy execution. It provides insights for what worked well in overcoming the challenges described in Table 2 as well as what they could have done better. These recommended actions are stated in Table 3.

Table 3: Recommended actions to overcoming CE implementation challenges based on a retrospective analysis from an OCED report (OECD 2022).

Action Area	Description	Who
People and knowledge	<p>A lesson learnt from the Ireland case study is that you need horizontal coordination across multiple departments. Water service providers should begin forming relationships with other organisations where synergies could exist. In the case of existing relationships, it was recommended to nurture these and identify where there are potential fragmentations in communication and understanding one another.</p> <p>What was said to work well in Ireland as an effective relationship builder was to collaborate on creating a common goal to work towards, together.</p> <p>Ireland, with the Ringsend WWTP, had collaboration with their agricultural sector to make the phosphorous recovery worthwhile.</p>	Water service provider, compatible industry organisations
	<p>Systematic data collection to improve knowledge. Especially anything related to material flows. Water usage and demand in the networks, energy usage to treat water, any water losses that occurs throughout a network or treatment facility, sludge production, emissions production.</p> <p>Ireland developed an information system that can help to check and adjust policy and have a shared sole source of truth between different organisations. A suggested metric to track is the number of jobs per an economic sector.</p>	Central government, water service provider
	<p>Foster innovation and set up "incubation hubs" that allows for entrepreneurship and experimentation of ideas.</p>	Central government, angel investors,

Action Area	Description	Who
	As well as using research and academic institutions to help pilot ideas. Similar to what bigger Australian water companies do.	capital investment firms
	Ireland Developed a national CE information system to monitor and adjust policy, by harmonising data collection among data providers, expanding data collection from waste-related data to environmental, economic, and social data, and collecting locally disaggregated and sectoral data, particularly in key sectors for the circular transition in Ireland (e.g., food and the built environment) to inform CE policy	Central government, Water service provider
Regulation and Policy	Have regulation that rewards circularity being appropriately implemented.	Central government
	Making funding schemes available that are specific to supporting circular projects or enabling circularity within a project.	Central government
	Strengthen policy relationships between climate change goals and initiative and CE.	Central government
	Ireland included CE into their national Enterprise strategy as a way of driving employment, sustainability, and resilience.	Central government
	Adapt the public procurement evaluation system, which emphasises valuing social and environmental ratings in association with price requirements.	Water service provider
	Adapting tender requirements to include circularity. Additions such as: <ul style="list-style-type: none"> • Favouring maintenance where possible, clever design and quality of products. Tools to help with this could be life cycle assessments. • Circularity in technical specifications, detailing performance requirements such as repairability, durability, reliance on virgin materials or being able to reuse items intended for disposal. 	Water service provider
Strategy	Central government helped to create a framework to implement CE. A first iteration strategy at a central government level should set out economy wide policy areas and should describe targets, incentives, and initiatives.	Central government

Action Area	Description	Who
	<p>Descriptions of timelines for the different targets should be clear.</p> <p>Water service providers should also have a strategy.</p>	
	<p>Find people, departments, or organisations responsible for:</p> <ul style="list-style-type: none"> • Ensuring progress towards transitioning to greater CE implementation • Tracking data and metrics • Fostering relationships between sectors • Assigning a "CE champion" – someone who can raise awareness and supply education on CE. 	Water service provider
	<p>A strategy should include how to track progress. What are the target metrics? Is there a way of choosing the proper metrics for a given? Investing to better develop methodologies for quantitative and qualitative assessment.</p>	Central government, Water service provider
	<p>Tracking progress on the achievement of the targets defined by their strategy (both government strategy and organisational).</p>	Central government, Water service provider

5. PROPOSED STRATEGIES

Broadly, there are four themes of recommended actions based on the Ireland Ringsend Case study that can inform how we apply CE to the New Zealand context:

1. Creating an explicit water infrastructure CE strategy, a high-level strategy from central government to act as guidance and a detailed one from water service providers that are specific to the region in which they reside.
2. Data collection to understand where the biggest impacts can be made.
3. Form partnerships and collaborate with different organisations.
4. Funding to ease the transition to circularity.

5.1. STRATEGY

First, we can start by broadening our strategic plans to explicitly include CE. In New Zealand's First Emissions Reduction Plan, there is a chapter dedicated to CE and bioeconomy. They say CE's importance to support economic and social wellbeing and help manage emissions. However, water infrastructure is still unmentioned as a specific sector where CE can be applied. Central government can help to form a narrative and an overall vision of where we should be heading. They can also supply guidance around a framework to track progress of water

service providers. Fully embracing CE is systemic challenge so systemic change is needed and this can come from top-down from a high-level framework.

We as an industry do not have to wait for this and can act immediately and create our own strategy. Water service providers can form more detailed strategic plans that can account for the local economic and social drivers. They also have greater ability to engage with local organisations and understand the different markets where circular products are appealing. This also related to the need to form partnerships as implementing CE strategies in isolation to other organisations would be near impossible.

5.1.1. CE STRATEGY EXAMPLES

5.1.1.1. SYDNEY WATER

Sydney Water has developed a strategy to incorporate what CE means to them to meet expectations of water service delivery. Especially with a need now more than ever for greater water resilience. The four strategic directions they abide by water planning framework are:

- Promoting an ambitious CE approach to water planning and operations
- Renew, refocus, and scale restoration
- Collaborate with industry to recover, use, and market materials
- Harness renewable energy within the system

The greater CE vision they developed has drawn upon the International Water Association’s Circular Economy Pathways (Figure 5).

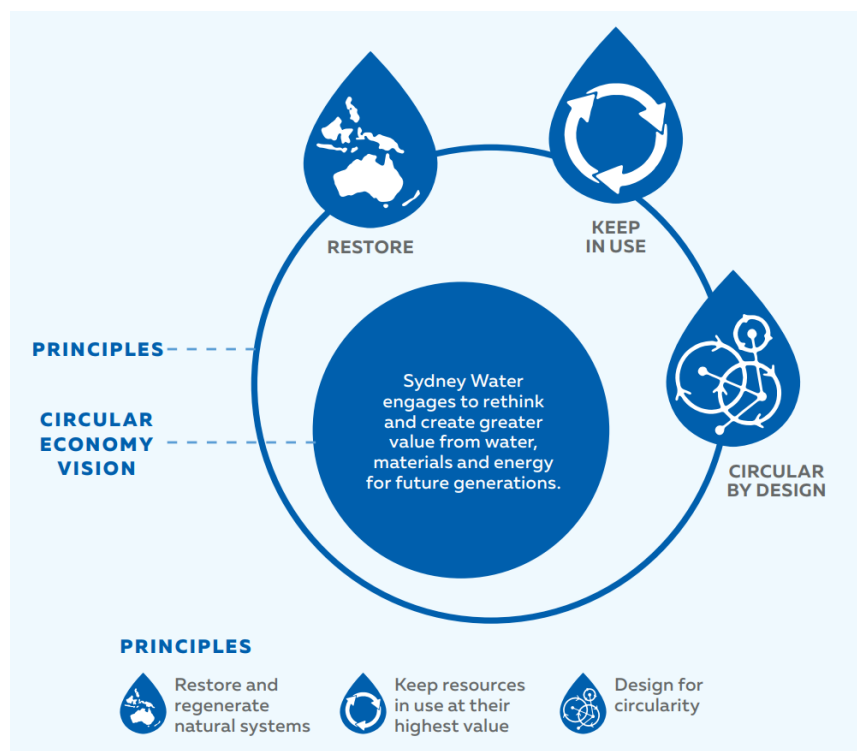


Figure 5: Sydney Water’s CE principles and vision (WB Solutions, 2019).

5.1.1.2. Watercare

Watercare is a water service provider who has taken their own initiative and internally has piloted a handful of projects that are in alignment with CE initiatives. Rob Tinholt, a Resource Recovery Manager at Watercare, is leading two biosolid resource recovery initiatives:

- Recovering struvite, a fertilizer from biosolids
- Pasteurised biosolids with bark as a potting mix at a nursery

During a discussion that occurred after the initial study, Mr Tinholt described how he and his team engages with organisations and communities to establish interest and buyers for both products. He has spent a vast amount of time reaching out to different stakeholders explaining the product, the benefits and – in the case of the potting mix – how it outperforms currently available alternatives on the retail market. Work has gone into identifying the market, setting a price point, and ensuring people are well informed about the benefits of the product, reassured about the safety of the product and are fully informed of its sustainable credentials.

Mt Tinholt and his team are in the process of establishing a niche in the market for the struvite product, being conscious of the degree to which it is possible to scale up production. He expressed how the struvite production cannot be scaled up such that all of Auckland's biosolids is dealt with, but a lot of work has gone into establishing a market who are willing to pay the premium at the current scale.

Overall, we should aim to increase understanding of the different options to implement circularity. This example shows how those that are in the water sector will need to reach out to other industries and organisations in their local marketplace and respond to the opportunities that present themselves. These do not necessarily have to be available now but may be feasible in future. In reaching out, we will need to influence behaviours and attitudes, like Mr Tinholt did, to create buy-in from the organisations and potential customers. To get community members or other stakeholders on board, you empower them with information. This allows for them to have a choice and make informed decisions about products they may choose to use.

There is no one silver bullet to achieving the benefits of CE. Traditionally water sector has sought solutions that make the biggest material difference at the lowest cost. We tend to put all eggs in one basket. Now, we should try to look more broadly at sustainable and circular solutions and see there are many options and opportunities available to us. While some may seem small and inconsequential, many of them can make a cumulative difference to the circular economy. The struvite example is not perceived to make a significant difference to the quantum of biosolids produced in the Auckland Region, but it is a small positive outlet with a ready niche market. A success factor so far is starting small to trial ideas and gradually gain traction and understanding. Then you can implement the initiative in a meaningful way.

5.2. INFORMATION AND DATA

Next area to improve upon is to collect information. What gets measured gets managed and before we can take appropriate action, we need to know what we are dealing with and how much there is of it. Understanding where our material flows are, not just in water but in other business/sectors where synergies could exist (e.g., agriculture, other industries). Being able to quantify performance around decarbonisation and resource efficiency is an important aspect within CE.

A useful example of data capture and use is through the Infrastructure Sustainability Rating Scheme tool, it lets you look at a range of environmental and sustainability metrics as part of the assessment and throughout the infrastructure project life cycle. A strength of the tool is that it is well established and recognised the New Zealand and Australian infrastructure sector. Its set structure for data collection and monitoring can make it easier to form KPIs. This provides an

opportunity to set clear and meaningful goals. Not only that but it allows benchmarking across different organisations and is not limited to the scope of what your organisation does. The tool also has a “Lessons Learnt” component to it after project completion. The foundation to be able to collate information that will help set targets for future projects and drawn upon a pool of existing knowledge and get better each time is already available to us. The next step is to make it or a similar approach more common practice in water infrastructure project to fully satisfy the need for useful information and data to enable CE.

5.3. POLICY, PROCUREMENT, AND REGULATION

Another action is changing procurement processes. Require proposal and tender submissions to show they have critically considered the various aspects that may have space for circularity. Make it so they must show the life cycles of different products. Is there a way to divert construction waste from disposal – has it been considered? Changing policies so that more sustainable initiatives have greater weighting. Such as the case with PUB, a water service provider in Singapore, where they have swapped the term “wastewater” to “spent water” to remove the negative association to help with public acceptance.

We as an industry can promote changes to central government. As seen in the Ireland example, if CE initiatives becomes a mandatory inclusion, financial support from central government is expected. Funding can prompt organisations to act where they would not have otherwise. Funding models could be like what Ireland has done, where organisations can access grants that are created specifically for CE related initiatives.

We can all benefit from funding initiatives that incentivise implementing circularity within a water infrastructure projects or a CE project that would not otherwise happen due to a lack of budget. While there are some examples of strategies that are considered circular that are by virtue the more economic decision (e.g., options that rely on less materials) that is not always true. It is common to see with resource recovery where there is a tension to produce a product that is at an acceptable price for buyers but also cover the costs of its production, as discussed in the Watercare struvite example.

However, there are changing attitudes from consumers. More people are demanding more eco-conscious products, wanting local and sustainably made. Until the proper market shift occurs (scale becomes viable thereby lowering price, or more people are willing to pay a premium), financial assistance can ease the shift towards circularity. Which is likely the case with the struvite Watercare project.

5.4. RISKS

Water service providers should consider the risks of not adopting circularity within (Table 4).

Table 4: The internal risks of not adopting CE initiatives to water service providers.

Internal Risk to Water Service Providers	
Compliance	It is likely that under the current water reforms, future water service entities will have to adhere to added mandated targets and increased responsibility to meet them.

Internal Risk to Water Service Providers	
	It could be for emission reductions or proving alignment towards Te Mana o Te Wai principles. CE can address both.
Resilience	<p>The impacts of climate change, increased urbanisation, and population growth leads to greater demand and lessening supply.</p> <p>CE strategies can be regenerative to our water supply and increase resilience. This will help water service providers meet their obligations.</p>
Social	<p>There is greater awareness and concern from communities that the infrastructure around them is provided in a safe, sustainable manner.</p> <p>Communities are wanting organisations to not only to consider climate change, but also do more than the bare minimum to be sustainable. Failure to do so leads to negative perception and reputational risk.</p>
Disengaged communities	There may be certain communities that are culturally less aware or do not value CE. These communities may be less willing to pay for changes in relation to CE. A growing awareness and recognition for the need of CE may change attitudes.
Iwi/Māori Expectations	An aspect of water reform is recognising and honouring Iwi/Māori interests. It is fair to say that there is aligning goals within CE and Māori values. Not applying CE initiatives where feasible could risk meeting our obligation to align with Māori values.
Loss of revenue or increased costs of business	<p>Changing markets from the emissions trade scheme (ETS) and desire from consumers to have sustainably made products and processes.</p> <p>Being late to adopt carbon absorbing processes may result in increased costs later or missed revenue streams that can help a water service provider financially. This also relates to avoiding the increasing cost of landfill tariffs through waste reduction.</p>

As said previously, CE is a tool that when implemented appropriately it can achieve sustainable outcomes. It is part of a wider toolbox rather than a standalone silver bullet. It makes sense that, if used inappropriately, not only will you not achieve the expected outcomes, but there may be also adverse impacts too. Inappropriately applied CE initiatives may result in monetary loss and wasted resources. However, this is preventable with having the proper data, market knowledge and trialling where appropriate.

5.5. OPPORTUNITIES

There are several opportunities from implementing CE initiatives (Table 5). Implementing CE opportunities should be integrated into existing structures within

an organisation. If it is separate consideration, you miss the opportunity to apply systems thinking, which is important to realising the benefits of CE.

Table 5: Opportunities of adopting CE across the water sector

Opportunity	
Increased Capability	<p>The formation of the new water service entities, the scale of operation has increased, and the organisation will likely have capability to have dedicated teams and resources to be able to explore and pilot CE initiatives.</p> <p>In the cases of Watercare and Sydney Water, it is likely that their capacity to pull together resources increases their ability to investigate CE initiate and pilot ideas. This is not something smaller water service providers can do easily.</p>
Increased Resilience	<p>CE can help lessen the negative impacts of climate change, growing population, and increased urbanisation.</p> <p>Dryer and longer drought periods coupled with growing population increasing demand for water necessitates CE strategies of regeneration and restoration of water sources.</p> <p>Coping with flood and droughts is a concern we face today and should be managed. We may be able to do this more effectively using concepts such as integrated water management.</p> <p>Planning for these types of changes and future uncertainties need strategies such as adaptive pathway planning to become more commonly used.</p>
Emissions Trade Scheme	<p>The ETS puts a price on greenhouse gas emissions (Ministry for Primary Industries, 2022). There is an opportunity for the water sector to earn credits for activities that absorb carbon. These credits can be traded and the ability to do so will make the economic incentive for some circular initiatives more appealing and can drive supply chain innovation. It can also be an additional revenue stream for water service providers.</p>
Supply Chain Resilience	<p>In situations of resource recovery creating new products, the ability to create products locally can reduce risk of supply chain issues. This issue has been of particular interest given recent history with the Covid-19 pandemic and increasing fuel costs making international shipment difficult.</p>
Cultural	<p>Many of the holistic and sustainable ways of thinking within CE tend to align well with kaitiakitanga Māori values.</p> <p>Embracing CE provides an opportunity for meaningful and authentic partnerships with iwi, which will be beneficial for ensuring an effective co-governance.</p>
Net Zero Targets	<p>Depending on the initiative, CE can help us achieve net zero carbon emissions by 2050.</p>

Opportunity	
CE in Construction Phase	This addressed the aspect of sustainability in design and construction. In the design phase, we can focus on sustainability in design. In the construction phase, there are opportunities to recycle materials or reuse materials from elsewhere. The ISC Rating tool can be used to look at the materials embedded carbon and can gain carbon credits. There are opportunities for CE thinking in the project lifestyle planning to infrastructure delivery and operations.
Water-Energy Nexus	Energy and water are interdependent – you can use water to generate energy and energy is needed to treat water. There are opportunities to generate electricity to power parts of the plant or neighbouring areas.
Cost saving	There may be opportunities, particularly in construction phase, where materials can be reused. For example, an initiative to use recycled plastic hoarding instead of plywood. Not only does plywood typically end up being sent to landfill after construction is complete, but the ability to reuse the plastic hoardings ends up being a cost saving initiative. There are also opportunities for operational cost saving. Such as biogas for electricity production minimising the cost of purchased power to run treatment plants

6. CONCLUSIONS

Right now, in New Zealand, we have this unique opportunity with water reform. A significant aspect will be to achieve the transformational outcomes being called out now as part of the water reform process. Our shift in thinking to align with principles in Te Mana o te Wai, putting water and its already natural circular system at the centre will be a key component for our stronger adoption of CE practise. One of these outcomes will be in providing a more sustainable and resilient water infrastructure. The principles of CE connects with the outcomes and for example and could help with the transformation we are seeking. If we were waiting for a sign for the right moment to change – now is the time. It would be the biggest waste of an opportunity to let this moment pass and not seriously form plans from the water reform 'transformation strategy' to pursue CE and implement it.

We *can* start today and by beginning to form plans at an organisational level and collecting information we can meaningfully effect changes. Transformation also needs to come from the top – demand the changes you want to see from government that would help enable you to implement CE initiatives. Empower yourselves with knowledge – learn who is in your backyard, form industry partnerships, engage with communities, collect, and collate data about material flows and energy usage. Plan for how to approach it, form an internal strategic framework and continue to iterate it. Do not let the idea of great, stop you from doing good.

Achieving total circularity is difficult, and there may not be a clear 'finish line,' but we as an industry do always seek continuous improvement and efficiency gains, but the imperative to implement CE into our business is now more urgent than ever. We should start small, pilot and test ideas from there iterate and develop momentum and draw from other areas to help accelerate. This allows us to mitigate risk and identify challenges. It gives us confidence to pursue different options and explore the benefits. If we start doing a little, a lot, over time the social, environmental, and economic benefits will add up. Because at the end of the day, it is doable and there is much to gain and a lot to lose.

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