Hawke's Bay Regional Water Assessment

2023

Kānoa
Regional Economic Development
& Investment Unit

HAWKES BAY
REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Contents

Purpose of report

The Regional Water Assessment is a project jointly funded by Hawke's Bay Regional Council and Kānoa – Regional Economic Development and Investment Unit.

The purpose of this report is to:

- Provide an account of the volumes of water supply and water use in Hawke's Bay and, using the 2019/20 year as a base, assess the likely additional pressures on demand in the future;
- Assist Councillors, the Māori Committee and Regional Planning Committee to incorporate regional freshwater security into regional plans and strategies;
- Help us understand freshwater from a regional, as well as district, perspective;
- Identify gaps in knowledge that we need to more fully understand;
- Provide a platform for discussions on how best to manage the region's demand for water through water use efficiency and conservation measures, and guide decision-making on this issue; and
- Discuss the role of above and below ground water storage as a climate change adaptation tool that promotes resilience for the environment and communities.

This report does *not*:

- Set freshwater allocations, targets, or limits. This will be done via Regional Council's freshwater plan engagement programme (see page 15 for more).
- Provide an account for, discuss the implications of, or analyse ways of managing water volumes following extreme rainfall events, such as Cyclone Gabrielle.

Contributors

A number of groups, consultants, territorial authority and regional council staff have contributed to this report.

Acknowledgements include:

- Regional Water Security Programme team
- Project Steering Group, including representatives of all Hawke's Bay councils' 3 Waters managers
- EnviroStrat
- M.E Research
- HB Future Farming Trust, Dr Phillip Schofield
- Matana director, Reece Martin
- Frank Engagement director, Erin Harford-Wright

Report structure

This report is made up of the following chapters:

Section 1: Regional Water Assessment background and context

Section 2: Regional Water Assets Accounts

Section 3: Regional water supply, use and analysis, including projected climate change impacts on water balance, and key options for managing freshwater in the future

Section 4: Future Demand Scenarios, providing three scenarios based on efficiency technology levels, with constrained and unconstrained demand.

Section 5: Recommendations for regional water security interventions, including findings on what the future might hold, and recommendations for what we should do to prepare for the region's freshwater future.

Introduction from the Chair

Our region has challenging times ahead, as climate change puts pressure on our environment, our communities, and our economy.

We've seen first-hand how the two extremes of climate change impact on water in Hawke's Bay in the last five years, facing two years of severe drought and a devastating cyclone during our wettest year on record.

We also see the impacts of decades of a first-in-first-served regime for allocating natural resources, including water.

We need to change the way we value this precious taonga, how we use it and how we ensure there's enough to go around. And we need to do it soon.

It will take courage to make decisions that help our community navigate that difficult transition.

We are guided by Central Government's Te Mana o te Wai, a framework that sets a clear hierarchy for how we manage freshwater to ensure Hawke's Bay has long-term, climate-resilient, and secure supplies of freshwater, *for all*.

It puts the health of the wai/water first, then the hauora/health of our community – and only after those needs are meet, can other uses be considered. Te Mana o te Wai also puts the community and iwi, hapū and whanau at the forefront of the korero.

We are at a pivotal point in our history, where we need to think carefully about how we protect our environment for future generations.

Cyclone Gabrielle has only increased the urgency for our region to make good decisions about ensuring our environment, our communities and our economy are resilient to the impacts of climate change on water – whether that's too much or not enough.

This report focuses on water use now and into the future, the impact of climate change on water supply, and options for reducing demand and increasing supply.

How we manage the supply, demand and accessibility of water has the potential to divide us.

We need unity to build a future for our mokopuna who will judge our success on how we worked together as a community to solve these complex issues - for the greater good, not the individual.

Despite the challenges, there are opportunities for all interests – our communities, Māori and industry - to get what they need to thrive.

Hawke's Bay Regional Council's freshwater plan will be the mechanism for us *all* to work through how we want to manage freshwater.

I am pleased to share this report, the Hawke's Bay Regional Water Assessment, which provides robust analysis and practical options for how we can all play a role in securing a sustainable and prosperous freshwater future for our region.

Hinewai Ormsby

Chair, Hawke's Bay Regional Council

H Ormsby

Ko te wai te ora ngā mea katoa

Water is the life giver of all things

Executive Summary

How we use water needs to change. The Regional Water Assessment (RWA) aims to set the foundations for the new direction we choose to take for water security.

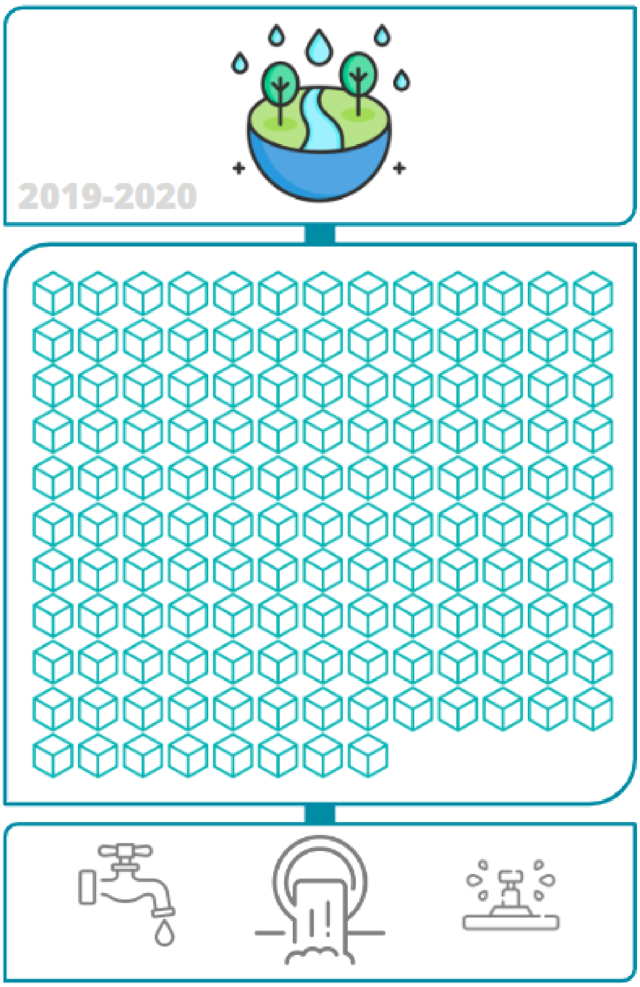
Having experienced two years of severe droughts, in the summer and autumns of 2019/20 and 2020/21, the Napier floods in November 2021, and the devastating Cyclone Gabrielle during our wettest year on record, the need to take action to build a region resilient to climate change has never been more front of mind.

We already know that Hawke's Bay community demands on freshwater will continue to grow, the environment has no more water in summer to give, and we need to retain more water in the environment to safeguard aquatic ecosystems as the impacts of climate change intensify.

The report provides robust data and analysis on water use now and into the future, the impact of climate change on water supply, and ways for managing the gap between supply and demand.

This report explores the growing gap between the demand for freshwater in Hawke's Bay and supply during drier years, which are set to increase – both now and into the future.

In the 2019/20 year, used as a case study, a total of 138 million cubic metres of freshwater was taken from our rivers, streams, and aquifers for domestic, industrial and irrigation needs.



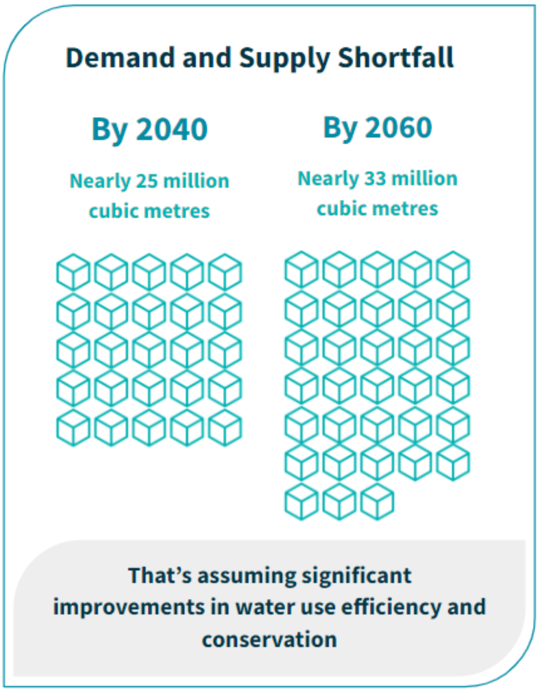
By 2040, the region could experience a shortfall between demand and supply of freshwater of nearly 25 million cubic metres, increasing to 33 million cubic metres by 2060. These estimates are under medium scenario projections that assume significant improvements in water use efficiency and conservation.

The RWA focuses on the dynamics of the supply and demand for freshwater in our region, the major drivers of those dynamics and what that might mean for the direction we take with freshwater management in the future.

The RWA identifies how and where we use freshwater, and what demand could look like in future. It also identifies the key issues that will impact Hawke's Bay's freshwater future, including Central Government's direction on freshwater management, including Te Mana o te Wai, the competing demands and pressures on the freshwater system and the growing impacts of climate change.

The RWA outlines some of the potential options available for managing sustainable freshwater supplies for Hawke's Bay. However, there is no quick fix, no silver bullet, and no clear point in the future when our freshwater challenges will be solved. Instead, we must embrace a system-wide approach to managing our freshwater use, adopting multiple tools and methods to resolve current and future freshwater issues. We'll need to increase water use efficiency and conservation, utilise more efficient horticulture and farming practices/systems, and explore freshwater storage options, to the extent they are available.

The task is not choosing one option over another but finding a new direction altogether for how we manage freshwater in Hawke's Bay.



This community discussion will occur through Regional Council's freshwater planning, wider recovery and other planning processes .

Freshwater planning is one element of the Kotahi Plan, a previously proposed process to develop a combined plan and update the Regional Policy Statement, Resource Management Plan, and Coastal Environment Plan, setting a blueprint for how we care for our environment – including freshwater.

This community discussion on freshwater management is now intended to occur as part of the Regional Council's wider recovery planning processes.

We have an opportunity to look to the horizon, and to plan and prepare so that Hawke's Bay has long-term, climate-resilient, and secure supplies of freshwater, *for all*.

Regional Water Security:

Demand at a glance

Reduce demand

We need to **pull every lever** we have to radically reduce our demand for freshwater – through technology, behaviour, and allocation.

Te Mana O Te Wai puts the environment first

Central Government's freshwater framework Te Mana o Te Wai prioritises freshwater for the environment, then human health, then other water uses.

25 million

cubic meters (Mm^3) of additional water will need to be found in the system by 2040, even if we implement water savings and efficiencies. That's projected to increase to 33Mm^3 by 2060.

64%

of all water use in Hawke's Bay is for agriculture and horticulture.

Agriculture (incl. irrigation)	**64%**
Municipal Water Collection and Supply	**19%**
Manufacturing and Processing	**13%**
Non-reticulated Households	**2%**
Service Industries*	**2%**
TOTAL	**100%**

*Table from EnviroStrat report pg. 32

138 million

cubic meters (Mm^3) of water was used in economic activities and households in the Hawke's Bay region in the 2019/20 year.

Regional Water Security:

Supply at a glance

Increase Supply

We need to **investigate all practical options** available for increasing freshwater supplies in Hawke's Bay to protect the environment, human health, and our community.

64%

of all water abstaction is from aquifer systems.

Source	m³	%
Ground Water	88,681,000	64%
Surface Water	48,908,000	35.3%
Collected rainwater	1,058,000	0.07%
TOTAL	138,647,000	100.0%

35.3%

of water we used was taken directly from rivers and streams.

13 billion cubic meters (Mm³)

of water was carried by our rivers

79%

of average annual rainfall in the 2019-20 year. This July-June period was worse than the 12/13 year, providing a useful reference point for us to use as a proxy for high demand use in a fully-allocated system.

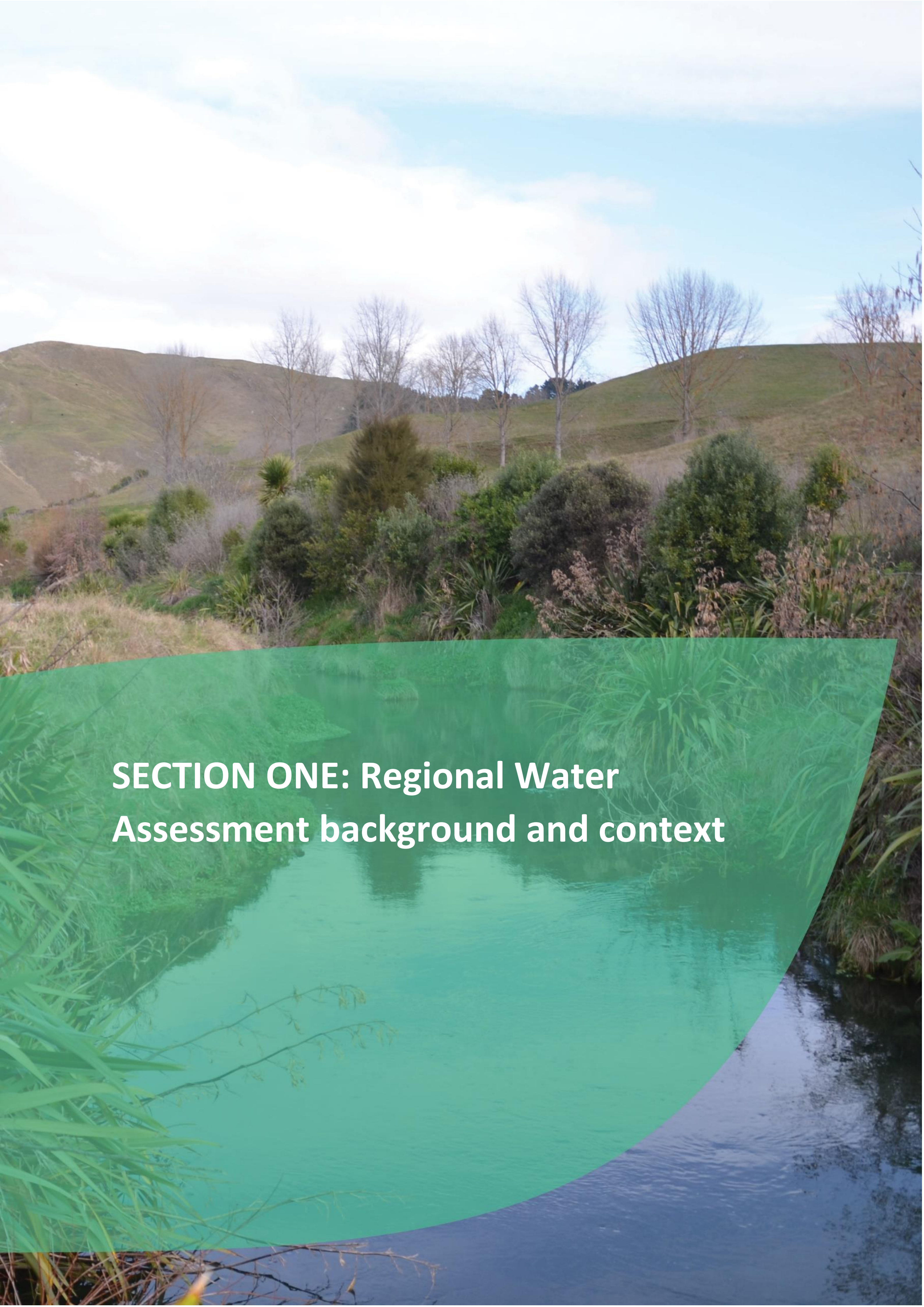
Slowing water down...

is key to holding more water in the environment and supplementing supply during dry summers, including restoring and improving wetlands, farming system changes, encouraging natural aquifer recharge, water reuse technologies or building community-scale water storage, such as dams or Managed Aquifer Recharge.

Freshwater demand

is projected to outstrip seasonal supply. Climate change will reduce what's available. The Regional Water Assessment aims to inform strategic water security decisions at a regional scale.

**All figures related to the 2019/2020 year*



SECTION ONE: Regional Water Assessment background and context

Why Regional Council is carrying out a Regional Water Assessment

Hawke's Bay Regional Council (Regional Council) plays a key role in promoting sustainable, long-term freshwater management in Hawke's Bay. Regional Council's freshwater management work is principally guided by the Resource Management Act (RMA), and RMA tools, such as National Policy Statements and National Environmental Standards.

Regional Council is required under the RMA to have a Regional Resource Management Plan (RRMP), which sets out the minimum flows and allocation limits for the region's waterbodies, and standards and limits for water quality.[1] The RRMP sets out the rules around the take and use of freshwater.

Regional Council also carries out scientific monitoring and investigations to understand the nature of the resources and the systems that they support. In addition, Regional Council regulates the water limits and levels and monitors these across the region's interconnected surface and groundwater resources.

Regional Council is also required to give effect to the National Policy Statement for Freshwater Management 2020 (NPSFM). The NPSFM provides national direction on how to manage freshwater under the RMA.[2] The NPSFM requires Regional Council to account for freshwater takes and contaminants, set freshwater objectives, and provides for greater involvement of Hawke's Bay iwi/Māori in our freshwater management system.[3]

Hawke's Bay iwi/Māori have a central role to play in helping Regional Council incorporate iwi/Māori values and perspectives into our water security programme, and the wider work to implement the NPSFM. Iwi/Māori also have a role in partnering with Regional Council to help govern our freshwater projects and work programme.

Iwi/Māori partnerships are crucial to implementing Regional Council's RMA responsibilities and are going to become even more fundamental under the resource management reforms proposed by Government. These reforms propose to give stronger recognition to the principles of Te Tiriti of Waitangi and provide greater recognition of Te Aō Māori - including mātauranga Māori – in the proposed resource management system.[4]

The NPSFM includes principles and a framework encapsulated in Government's national freshwater framework, *Te Mana o te Wai* (TMOTW).

TMOTW acknowledges the fundamental importance of water and recognises that protecting the health of freshwater protects the health and well-being of the wider environment.

Figure 1: Regional Council staff member monitoring water quality

The NPSFM directs Regional Council to establish objectives describing how the management of freshwater in the region will give effect to TMOTW through tools such as our Regional Policy Statement and Regional Resource Management Plan.

Te Mana o te Wai (TMOTW) sets out a hierarchy of obligations for how councils manage freshwater.

The NPSFM, and TMOTW, are likely to create major changes to how water and land is managed and used in the future.

This hierarchy of obligations is:

1. First, the health and well-being of water bodies and freshwater ecosystems;
2. Second, the health needs of people (such as drinking water); and
3. Third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.[5]

TMOTW encompasses six principles relating to the roles of tangata whenua and other New Zealanders in the management of freshwater, and these principles inform the NPSFM and its implementation.

The six principles are:

1. **Mana whakahaere:** the power, authority, and obligations of tangata whenua to make decisions that maintain, protect, and sustain the health and well-being of, and their relationship with, freshwater;
2. **Kaitiakitanga:** the obligation of tangata whenua to preserve, restore, enhance, and sustainably use freshwater for the benefit of present and future generations;
3. **Manaakitanga:** the process by which tangata whenua show respect, generosity, and care for freshwater and for others;
4. **Governance:** the responsibility of those with authority for making decisions about freshwater to do so in a way that prioritises the health and well-being of freshwater now and into the future;
5. **Stewardship:** the obligation of all New Zealanders to manage freshwater in a way that ensures it sustains present and future generations; and
6. **Care and respect:** the responsibility of all New Zealanders to care for freshwater in providing for the health of the nation. [6]

Freshwater Planning

The National Policy Statement for Freshwater Management 2020 (NPSFM) requires all regional councils to have notified freshwater catchment plans by 31 December 2024.

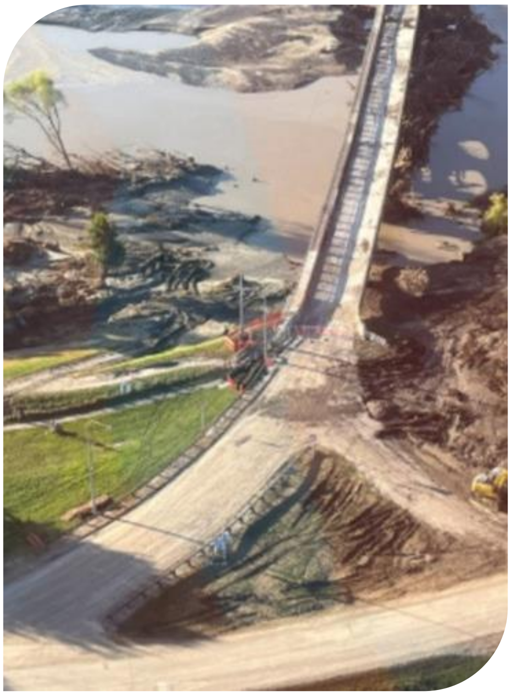
Regional Council intended to meet this obligation through the development of the Kotahi Plan, a new plan to care for the environment that replaced the Regional Policy Statement, Resource Management Plan and Coastal Environment Plan.

In 2022, Regional Council began a programme to engage iwi, hapū and whanau and the community in the development of the new Kotahi Plan.

Due to the impact of Cyclone Gabrielle, at the time of writing, Regional Council was focussed on the recovery of Hawke's Bay, including reinstatement of regional flood protection and drainage schemes, and working with rural communities to restore impacted catchments.

Resourcing for this critical work has affected the timing of a range of Regional Council's programmes, including development of the Kotahi Plan.

At the time of writing, Regional Council was working with Central Government on the timeline for meeting its obligations to give effect to the NPSFM.



Considerations for partnering with iwi, hapū and whanau on water security solutions

Introduction

Ensuring Hawke's Bay has long-term, climate-resilient, and secure supplies of freshwater, *for all* is a key concern for iwi, hapū and whanau, at both a regional and local level.

The Regional Water Assessment (RWA) informs the wider discussion Hawke's Bay Regional Council is having with iwi, hapū and whanau about the future of freshwater management in our region, through the freshwater plan process.

As Treaty Partners and kaitiaki of our waterways, iwi and hapū have a significant voice in the direction we take in freshwater management within the freshwater plan, through giving effect to Te Tiriti o Waitangi and Central Government's framework for freshwater management, Te Mana o te Wai (TmotW).

Giving effect to Te Mana o te Wai requires Regional Council to work with mana whenua and communities to determine their values, interests, and priorities for each waterway and, involve mana whenua in the decision making of how that vision is implemented.

This approach is supported by recent announcements on the proposed form of the Natural and Built Environments Bill (NBE) and Spatial Planning Bill (SPA), which seek to further strengthen the role of Māori in resource management decision-making and delivery.

The NBE would require all persons exercising powers and performing functions and duties under the Act to *give effect* to the principles of Te Tiriti o Waitangi. In addition, persons exercising functions under the NBE, must recognise and provide for the responsibility and mana of each iwi and hapū to protect and sustain the health and well-being of te taiao in accordance with kawa, tikanga and mātauranga in their rohe. The Bill also establishes a National Māori Entity to provide independent monitoring of decisions under the NBE or the SPA.[7]

RWSP iwi, hapū and whanau engagement

While the RWA supports the future decision-making process for freshwater management through the freshwater plan, the principles of Te Mana o te Wai are also core to the objectives of the RWSP itself – with the belief that if we ensure the long-term sustainability of our rivers, streams and aquifers, then our communities will have what they need too.

Accordingly, the RWSP team has taken a multi-tiered approach to informing, engaging and partnering with iwi, hapū and whanau throughout the programme and its option investigations. Integrating Māori values and perspectives into each element of the programme is critical.

Over the course of the programme, the RWSP team has regularly updated Regional Council's Māori Committee, which represents the region's four Taiwhenua organisations, and the Regional Planning Committee, which represents the region's nine Post Settlement Governance Entities (PSGEs). Updates have included progress on the Regional Water Assessment, and investigations into options for increasing supply and reducing demand options.

Prior to Cyclone Gabrielle, both committees, through the All-Governors committee (which bought those committees and Regional councillors together) were integral to the development of the freshwater plan through the Kotahi Plan engagement process, within which were discussions on how Māori were to be engaged on water security.

In 2020, Regional Council also engaged a group of organisations representing Treaty Partners and Iwi Authorities connected to the Heretaunga catchment specifically. Those were Ngāti Kahungunu Iwi Incorporated, Heretaunga

Tamatea Settlement Trust, Mana Ahuriri Trust, Te Taiwhenua o Tamatea.

This guided a set of fundamental principles for working with Heretaunga iwi, hapū and whanau on water security investigations. Central to those principles was that any resulting water security projects be co-designed and community-owned, and Te Ao Māori world view be incorporated into how freshwater was managed.

The RWSP team has also worked closely with Tamatea hapū on how water security can be supported in Central Hawke's Bay, including the proposed Managed Aquifer Recharge trial.

Consideration of Māori values

Now the water supply and use accounts for the region have been collected into the RWA, the hard analytical work to transition from data to wisdom begins.

Regional Council continues to be committed to working alongside iwi and hapū to integrate their values and perspectives into freshwater planning, and other regional planning processes. Through those processes, it will be important to consider how those values and perspectives apply to:

- Freshwater demand and supply at the regional and local level for Māori: What are the specific issues at both a region and local level? Are they the same or different? What are the known and emerging issues for Māori?
- How freshwater is managed: What do Māori think of how water use/allocation is currently managed?
- Future demand, competing demands and pressures on the freshwater system and the growing impacts of climate change: What does water use in the future look like from a Māori perspective? What are the key issues we need to address to ensure we can sustain future Māori wellbeing? What are the solutions to resolving these issues?
- Opportunities for freshwater management: What are the opportunities for Māori, Regional Council, and the wider community in effectively considering and addressing freshwater supply, demand and allocation issues? What do we gain from tackling this issue effectively?

Iwi and hapū expectations

Rights and interests regarding water allocation is a key unresolved issue for Māori and the RWSP cannot avoid intersecting with this issue as the freshwater plan develops.

Although the RWSP is not specifically focussed on addressing these rights and interests, there is an expectation that the programme acknowledges this issue.

The RWSP team is also committed to ensuring its work does not detrimentally inhibit or impede any of these rights and interests.

Māori expect to see broader thinking around how the RWSP links and integrates with the broader freshwater work that Regional Council is doing, as well as the broader work that Central Government is doing around freshwater and climate change, the 3 Waters reforms, and resource management reforms.

Looking forward

The methodology for ensuring Māori values, interests, and issues are considered at a broader strategic level within freshwater planning, and within water security solutions could include:

- Clearly identifying with Māori how water security fits with Regional Council's broader freshwater work programme, i.e. What the RWSP and RWA does and does not cover?
- Identifying the key interests and parties to this kaupapa to ensure that key iwi/Māori interests and representatives are engaged in the freshwater plan and future strategic processes i.e. What does future freshwater demand and supply/allocation look like through the lens of Te Mana o te Wai, the NPSFM, Te Tiriti o Waitangi, and iwi/Māori development and wellbeing?
- Evaluating and analysing the values, interests and issues for iwi/Māori i.e., what are the impacts on Māori households, iwi, hapū, marae, and Māori businesses/economy? What are the impacts on Māori land and development? What are the most significant impacts? What are the most important issues?
- Scoping of some of the potential options/solutions to these issues and their impacts on Māori; and
- Identifying the key conclusions/ recommendations for advancing the consideration of Māori values and perspectives within the freshwater plan.

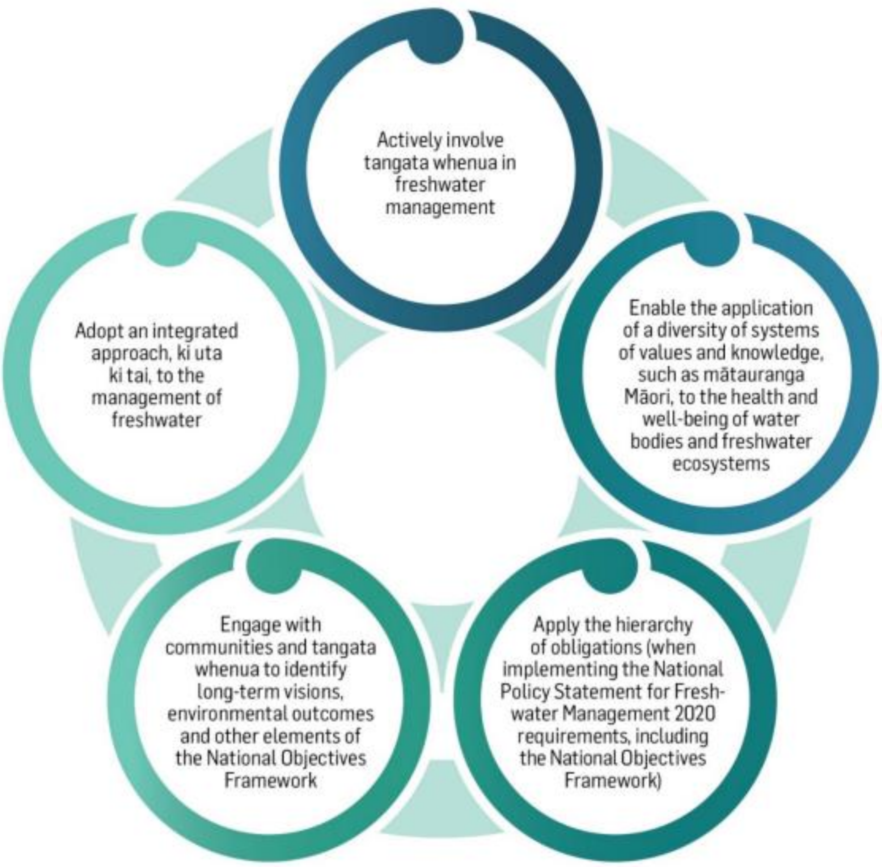


Figure 2: Source: Ministry for the Environment - Te Mana o te Wai Fact Sheet sheet - [Essential Freshwater: Te Mana o te Wai factsheet | Ministry for the Environment]

Climate change and future freshwater supply

Climate change is already impacting New Zealand – temperatures are rising, weather is more unpredictable across the seasons and on the East Coast there will be less water overall. See Figure 4 (page 19) for a demonstration of how New Zealand temperatures have increased over the last 110 years.

How we respond to climate change is a key focus area for this report. Hawke's Bay Regional Council is leading Hawke's Bay's response to climate change and climate change is central to everything the organisation does.

In June 2019, Regional Council declared a climate change emergency and acknowledged that Hawke's Bay has a small window for action to avoid the most damaging effects of climate change.

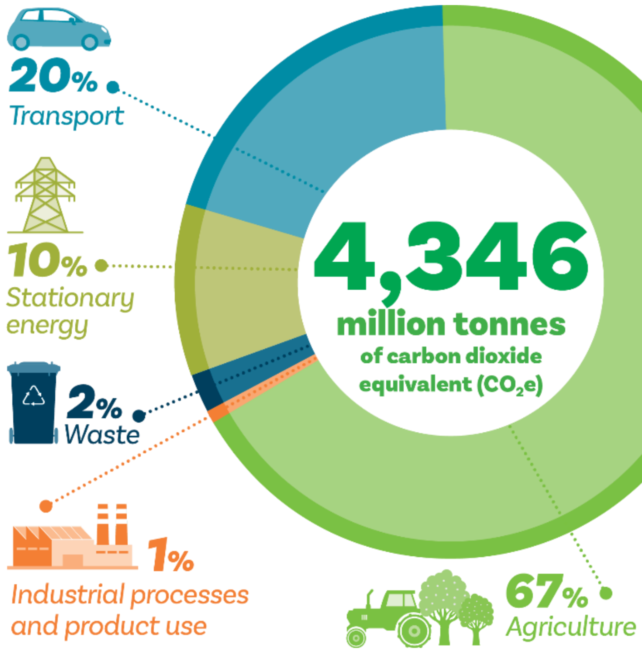


Figure 3: Prepared for HBRC by AECOM

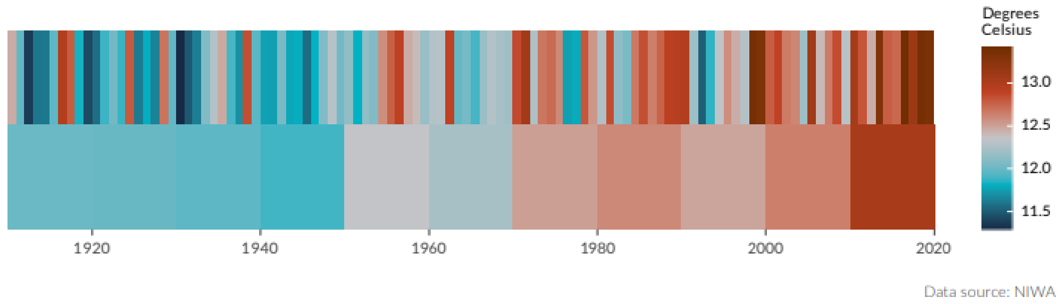
The United Nations body assessing the impacts of climate change, the International Panel for Climate Change (IPCC) has emphasised that we have limited time to act to keep global warming to under 1.5/2 degrees Celsius to 'secure a liveable future'.

The impacts of climate change will have a significant bearing on future freshwater supply and security issues in Hawke's Bay and is a key driver behind Regional Council's freshwater security work.

This section outlines the global impacts of climate change, how climate change is likely to impact the Australasian region, how that will look on the East Coast of New Zealand specifically, and what Regional Council is doing to ensure we are prepared.

Our response to climate change will require Hawke's Bay to both:

- Limit our contribution to activities that cause global warming through reducing our Greenhouse Gas (GHG) emissions, such as carbon and methane (see the HB GHG emissions figure by Stats NZ on this page), and reducing pressure on our environment, such as reducing our demand for water, and in the short term, increase activities that sequester or draw down carbon from our atmosphere, such as tree planting – this is known as **Climate Change Mitigation**;
- Prepare for the impacts of climate change such as heat waves, drought, forest fires, flooding, and groundwater contamination from sea-level rise, such as protecting coastal communities, reinforcing stop banks and keeping more winter water in the landscape through improved farming practices and storing high-flow water for when we need it in summer – this is known as **Climate Change Adaption**.



Note: Stripes on the top row show the annual average temperature for a year. Stripes on the bottom row show the average temperature by decade.

- 2010–19 was New Zealand's warmest decade on record.

Figure 4: Annual and decadal average temperature between 1910 and 2019 credit: MfE

Global climate change impacts on water scarcity

The IPCC recently released the *Climate Change 2022: Impacts, Adaptation and Vulnerability* report.

It projects that water demand is likely to increase due to climate change, with demand for domestic, industrial and agricultural uses "projected to increase by 20% to 30% by 2050...depending on the socio-economic scenario." [8]

At a regional level, the impacts of climate change reduce water availability, with projected water scarcity *"causing water management policies and planning challenges in future."*

How we respond to the impacts of climate change on water security are described in the report as 'water-related adaptation responses'.

Globally, it is thought 60%-70% of total water withdrawals are for agriculture, but there is high confidence that a significant share of water-related adaptations are already occurring in the agriculture sector, *"such as improved cultivars and agronomic practices, on-farm irrigation and water management and water and soil moisture conservation."*

The report states that *"Adaptive water management measures were critical in addressing climate-related uncertainty."*

The report also stressed "*the importance of transformational adaptation instead of incremental adaptation".*[9]

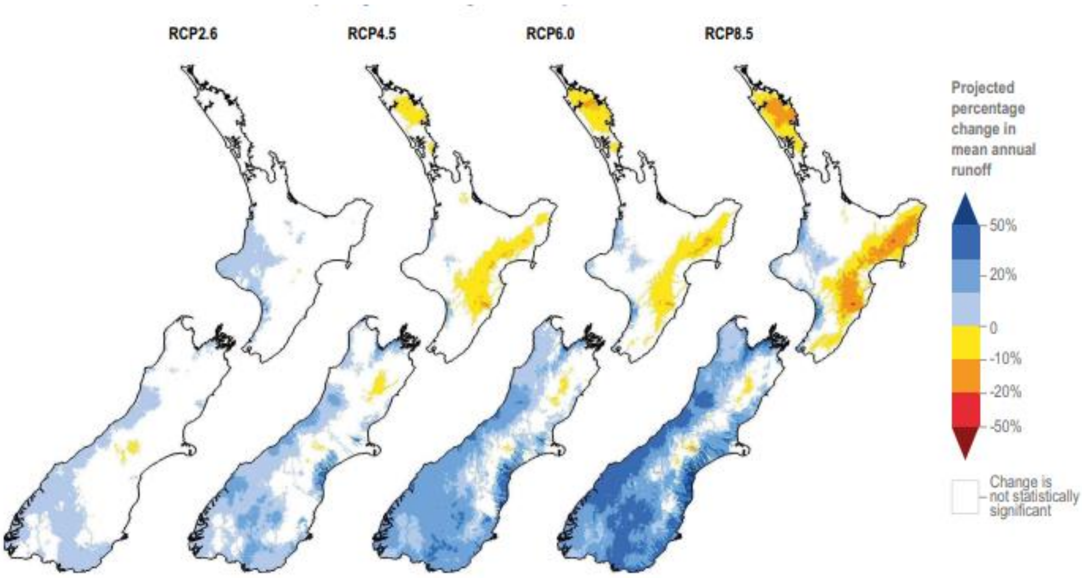


Figure 5 Projected percentage change in mean annual runoff for 2086–2099 relative to 1986–2005 from hydrological modelling informed by six CMIP5 – source: Climate Change 2022: Impacts, Adaptation and Vulnerability – chapter 11: Australasia.

Local Climate Change impacts

The IPCC report outlines global impacts, but also includes impacts specific to Australasia. New Zealand is experiencing *"further warming and sea-level rise, more hot days and heatwaves, and less snow.*

"…most of the south has become wetter while most of the north has become drier."

"The frequency, severity and duration of extreme fire weather conditions have increased in southern and eastern Australia and eastern New Zealand."

In recent years, New Zealand has seen:

- Its hottest year in 2016;
- Three widespread marine heatwaves during 2016-2020;
- Category 4 cyclone Debbie in 2017 (and now Cyclone Gabrielle);
- Two major hailstorms over New Zealand from 2014-2020; and
- Four major floods in New Zealand during 2019-2023.

Looking forward, the IPCC is projecting, with "very high confidence", that New Zealand will get more hot days, fewer cold days, less snow and glacial ice, ongoing sea-level rise and ocean acidification.

The East Coast of the North Island is projected to see drier conditions, caused by stronger westerly winds, in winter and spring. There could be more rainfall in increasingly less predictable summers, less in autumn and spring and there will be less rainfall over the year, and droughts more likely.

River flows are projected to decrease on the East Coast of the North Island and runoff will decrease across the North Island in spring and summer.

"In New Zealand, many water supplies are at risk from drought, extreme rainfall events and sea-level rise, exacerbated by underinvestment in existing water infrastructure (in part due to funding constraints), and urban densification.[10] Lessons can be learned from global experience (e.g., Cape Town, South Africa). Some towns are only partially metered or not metered at all, which exacerbates the adaptation challenge."[11]

The report notes that climate change adaption has been largely incremental and reactive.

"A step change in adaptation is needed to match the rising risks and to support climate resilient development… A shift to transformative and proactive adaptation can contribute to climate resilient development.

The scale and scope of cascading, compounding and aggregate impacts require new, larger-scale and timely adaptation."

"The (Australasian) region faces an extremely challenging future. Reducing the risks would require significant and rapid emission reductions to keep global warming to 1.5-2.0^{o} C, as well as robust and timely adaptation. The projected warming under current global emissions reduction policies would leave many of the region's human and natural systems at very high risk and beyond adaptation limits."

"Delay in implementing adaptation and emission reductions will impede climate resilient development, resulting in more costly climate impacts and greater scale of adjustments."

"Climate change impacts on freshwater resources cascade across people, agriculture, industries, and ecosystems. The challenge of satisfying multiple demands with a finite resource is exacerbated by high inter-annual and inter-decadal variability of river flows."

"Unregulated or absent water supplies accentuate risks to vulnerable groups of people.[12] Māori view water as the essence of all life, which makes any impacts on water, of governance and stewardship concern, and increasingly, the subject of legal claims.[13] Māori understanding of time can also open up new spaces for rethinking freshwater management in a climate change context that does not reinforce or rearticulate multiple environmental injustices."[14]

"Water resource adaptation in New Zealand is variable across local government and water authorities but they all actively monitor water availability, demand and quality, and most have drought management plans."

"[T]here remain tensions between land, water and people which are exacerbated by climate changes and yet to be addressed."

Hawke's Bay's Climate Change Response

As outlined previously, Hawke's Bay Regional Council declared a climate change emergency in 2019 and set a goal for the region to be carbon neutral by 2050. The declaration recognised the climate crisis as an urgent and pervasive threat to human and ecological wellbeing.

In 2020, Regional Council, alongside Gisborne District Council, commissioned NIWA to complete the "Climate change projections and impacts for Tairāwhiti and Hawke's Bay" report.[16] It showed that the range of likely climate change impacts for Hawke's Bay includes:

- Increased storm intensity, which may mean more slips, floods, and erosion, and damage to infrastructure (e.g., roads, water supply), the forestry sector, and agricultural land productivity (Cyclone Gabrielle being the most recent example of this);
- Reductions in overall rainfall levels, with annual rainfall forecast to drop up to 5% by 2040, and up to 15% in parts of Hawke's Bay by 2090, and increases in drought severity;
- Reduced water availability from lower river flows, and the potential impacts on freshwater ecosystems, and availability for irrigation and urban supply; [17]
- Annual average temperatures projected to rise between 0.5°C and 1°C by 2040, and between 1.5°C and 3°C by 2090, on top of the 1°C increase over the last century;
- Coastal areas may have five fewer frosty days by 2040 – This could increase to 50 fewer frosty days for inland areas by 2090;
- Heat waves, defined as three or more days above 25°C, will become increasingly common, increasing to 10-20 days by 2040, and 20-60 days by 2090;
- Expected sea level rise of up to 40 centimetres in 40 years, worsening coastal erosion and inundation (under the extreme worst-case scenario).[15]

Actions Regional Council is taking to mitigate climate change and adapt to its impacts include:

- Creating a **Climate Action Ambassador** role to coordinate Regional Council work and create collective momentum for regional carbon neutrality by 2050;
- Commissioning a **Climate Risk Report**, which identifies street by street, how Hawke's Bay will be impacted by the range of climate change impacts;
- Leading an **Emissions Reduction Plan**, with local practitioners focussed on systematic changes (rather than community or individual actions);
- Establishing a **Joint Climate Action Committee**, which will ensure all five Hawke's Bay councils work toward being carbon neutral by 2050;
- Establishing **the Regional Water Security Programme**, of which this Regional Water Assessment is a key workstream.
- Reviewing the **freshwater plan**, as part of the broader Kotahi Plan engagement process.

Cyclone Gabrielle – the reality of climate change hits

The Regional Water Assessment is focused on how water scarcity – not enough water - is likely to impact our region's environment and what we can do to secure our freshwater future.

Through the M.E Research economic assessment (See Appendix B), commissioned by Regional Council in 2020, we understand the costs of not building our environment's resilience to water scarcity are significant (see more on page 31).

Under mid-range climate change scenarios, Hawke's Bay could see a reduction in the regional Gross Domestic Product (GDP) of $30-$40 million by 2030, escalating to annual losses of $500 million by 2060.

Hawke's Bay's pipfruit industry alone could see annual loss in revenues of $60 million under the most extreme climate change scenarios late this century, with obvious knock-on impacts to the wider economy.

However, water scarcity, at worst severe, multi-year drought, is just one side of the climate change coin. Flooding – too much water – is the other side of the coin. Heads we lose, tails we lose - the odds are not in our favour. Not only are the weather events more severe but the volatility of lurching between these extremes will also increase.

The summer of 2022/23 was already the wettest on record, bought on by the global phenomenon of Lā Ninā which brings warm, wet weather systems to New Zealand, when Hawke's Bay was hit by Cyclone Gabrielle.

At the time of writing, the El Niño-Southern Oscillation was moving from La Niña to neutral, but it was predicted that El Niño conditions would develop during winter 2023, potentially bringing dry weather and possibly drought.

While our region's focus in the short term will naturally be on recovering from the event and enhancing the region's environmental resilience to future rain events, we are obliged to ask ourselves, "If this is the destruction a significant flood event can cause, what will be the impact of a significant multi-year drought event?" Both floods and drought are likely to be more frequent in coming decades due to climate change.

As Hawke's Bay mobilises to "build back better, safer and smarter", it would be a mistake to focus on only one-half of the problem bearing down on our region.

If the next disaster we face is not enough water, we must consider how we build resilience to this as we look to invest in re-establishing primary production on the Heretaunga Plains.

The costs of both not enough and too much water *are* the cost of climate change. This is an issue the whole nation faces, with a recent Deloitte report stating that inadequate climate action could take -$4.4billion off New Zealand's GDP by 2050 if warming reaches 3°C.[18]

On the flip side it states that $64 billion could be added to GDP by 2050, if decisive climate action is taken. In Hawke's Bay, understanding the costs of not responding at all, adequately or fast enough, both financially and in lost opportunity, will help us sensibly weigh up the costs of building our climate change resilience to ensure our freshwater future.

The following section is an outline of the impacts of Cyclone Gabrielle on our region and the costs publicly understood at the time of writing. Due to the scale of the impact and the speed of the response, the figures outlined are not totalled, as there is likely to be cross over and change as the impacts are better understood. Estimates are presented to demonstrate the sheer magnitude of the financial challenge ahead due to the cyclone – a weather event that is likely to be repeated more frequently in the coming century due to climate change.

Cyclone Gabrielle

On February 13 and 14 2023, Cyclone Gabrielle lashed Hawke's Bay with gale-force winds, a large easterly swell and record rainfall, causing rivers to over top and burst stopbanks, having a devastating impact on the region. A National State of Emergency was declared on Tuesday, 14 February and was lifted on Tuesday, 14 March.

While the cyclone impacted the wider North Island, Hawke’s Bay was hit hardest.

Eight people died in Hawke’s Bay, 87 buildings were red-stickered, 1034 yellow-stickered and 379 white-stickered across the region.

Thousands of people experienced lengthy power outages (many without power for weeks) and there was severe damage to key roads connecting the region to the rest of New Zealand. Several rural communities were still isolated six weeks after the event due to road damage and destruction of bridges.

Many areas across the region were devastated by raging flood waters, silt and mud - damaging homes, marae, lifestyle blocks, prime agricultural, horticultural and viticultural land. Estimates are that 40% of the kiwifruit crop, 33% of the pipfruit crop and 25% of the grape crop have been affected.

Major employers in the region, such as Pan Pac Forest Products and Ravensdown, had flood waters through their entire plants and will take many months to recover and get back to their pre-cyclone levels of production.

A desktop scan of reports and articles released since the cyclone shows that much of the cost of the cyclone damage is still being understood by the industries involved. While it is relatively easy to assess the cost of physical damage, loss of income, numbers of unemployed, and the amount of insurance claimed as a result of cyclone damage and its upfront economic effects, it is harder to quantify the flow-on economic costs and the social cost in terms of mental and physical stress to health, the grief and loss of people and places, and the displacement from home and whanau.

In the week following the cyclone, Finance and Cyclone Recovery Minister, Grant Robertson, was quoted as estimating the cost of the cyclone to New Zealand as $13.5 billion. He expected the total cost to be similar to the Canterbury earthquakes.

The following table attempts to record the known or estimated costs (as at the time of writing in May 2023) of the cyclone to Hawke’s Bay. Sources for this information are fully outlined in Appendix F.

At the time of writing, the Hawke’s Bay Regional Recovery Agency (HBRRA) had been established to coordinate the funding needs of the region and develop a regional recovery plan. The costs of recovery from Cyclone Gabrielle will be more fully understood as that process advances.

Industry/Area	Estimated Cost
Primary sector - Agriculture/farming, horticulture, viticulture	$1,712,500,000
Local Government infrastructure costs – Hastings District, Napier City, Central Hawke’s Bay District, Wairoa District and Hawke’s Bay Regional Council	$1,485,160,000
Central Government costs and funding packages – Civil Defence costs, Mayoral relief funds, community support, primary sector support, business support, Māori communities support (via Te Puni Kokiri), silt and solid waste management support, transport (via Waka Kotahi)	$827,948,986
Insurance claims (to 23 March)	$481,227,673
Cancelled Events	$30,000,000
Disaster Relief Payments made (Mayoral relief, HB Disaster Relief, HB Foundation, Red Cross)	$4,650,846

Table 1: Costs of Cyclone Gabrielle to Hawke's Bay (as at May 2023)

See Appendix F for sources and more information.

Regional Water Security Programme

To respond to the increasing threats of climate change on water security, Regional Council established a Regional Water Security Programme (RWSP)[19], which has the objective of “ensuring Hawke’s Bay has long-term, climate-resilient, and secure supplies of freshwater, *for all*”.

The focus of this work lies in protecting our natural environment and ensuring secure, sustainable freshwater supplies to protect and support our communities for future generations.

In its totality, managing freshwater is an incredibly complex undertaking, guided and informed by legislation, regulation, science, culture and values, and a range of communities of interest often seeking competing social and economic outcomes.

This complexity overlays the physical nature of freshwater itself. As a resource, water is both a stock - measured at one specific time - and a flow - subject to seasonal fluctuations and long-term trends, measured over an interval of time.

Water also physically occupies a ‘receiving environment’ that is impacted by activities in surrounding and heavily modified urban and rural environments.

To map and consider these complexities, and to guide decision-making to ensure water security in future, the RWA sets an information baseline for the RWSP.

Sitting under this overarching work, are the investigations into potential options for reducing demand and increasing supply, including the Freshwater Demand Reduction Investigations, Heretaunga Water Storage feasibility study and the Central Hawke’s Bay Managed Aquifer Recharge trial.

These investigations are to help Regional Council and the community to understand what options are available in future (and which are not viable), so decisions can be based on the best possible information.

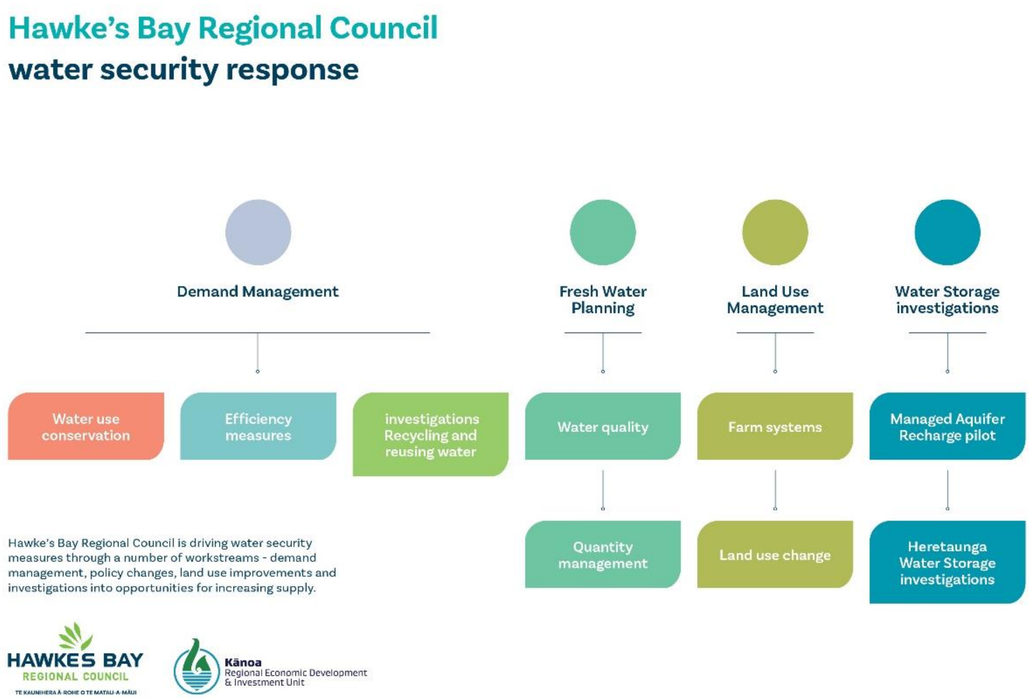


Figure 6 Hawke’s Bay Regional Council’s water security work programme

Policy Context

It is almost universally acknowledged that, without meaningful change, our recurring patterns of behaviour of freshwater use and management threaten the sustainability of both the quality and quantity of our freshwater.

It is therefore no surprise that this report is written against a backdrop of far-reaching and fast-moving reform that will impact the management of New Zealand's freshwater. [20]

In addition to the new NPSFM, the entire Resource Management framework is undergoing complete reform[21], as is the management of Three Waters Reform Programme[22]. Central Government recently announced its plans to enact the Natural and Built Environments Bill (NBE) and Spatial Planning Bill (SPA) and outlined the process for the development of the Climate Adaptation Act (CAA) to follow in 2023.

In May 2022, the Government set out its Emissions Reduction Plan (ERP)[23], including the strategies, policies, and actions for achieving New Zealand's first emissions budget to contribute to global efforts to limit temperature rise to 1.5C above pre-industrial levels.

Sitting alongside the ERP, Central Government released its National Adaptation Plan[24] in August 2022, which sets out how New Zealand could transition to a low-emissions, climate-resilient future.

Project funding

The RWSP started in 2020 with support from the Government's Provincial Growth Fund, facilitated by Kānoa – Regional Economic Development and Investment Unit (formerly Provincial Development Unit).

PGF funding was allocated to RWSP projects, with both $2.6 million in grant funding and $5.5 million in suspensory loans for option investigations, which would need to be repaid if investigations move to a project phase.

Those funds were to support four projects:

- This report, the Hawke's Bay Regional Water Assessment;
- Central Hawke's Bay Managed Aquifer Recharge pilot;
- Heretaunga Water Storage feasibility study; and
- 3D Aquifer Mapping

Regional Council contributed co-funding of $6.7 million from the 2018-2028 Long Term Plan.

If option investigations do move to the project phase, Kānoa has indicated further support through the availability of loan funding, based on certain criteria, to approximately $27.1 million.

Funding of $1 million was also allocated by Regional Council for the Freshwater Demand Reduction Investigations from the 2021-2031 Long Term Plan.

Regional Water Assessment process

To manage freshwater security at a regional scale, Regional Council needs to understand the volume of water available now and projections for the future. This is the first time Regional Council has undertaken work on freshwater volumes within a natural capital accounting framework, with a view to supporting policy decisions on securing freshwater – now and in the future. To complete this assessment, three phases of work have been carried out:

Phase One: Current Water Supply and Demand Accounts

Carried out by consultancy, EnviroStrat, this phase saw the development of physical water supply and use accounts (flow accounts), covering the amount of water abstracted from the environment by agriculture, industry, and households (domestic). It also determined how it flows through the economy, and the volumes that are returned to the environment e.g., the discharges of treated sewerage water.

For the first time in Hawke's Bay, Regional Council is using the UN System of Environmental-Economic Accounting (SEEA) - Water (also referred to as SEEA-Water) as a core reference methodology.[25] The period covered in the supply and use tables is July 2019 - June 2020.

Phase Two A: Water Asset Accounts

Carried out by Envirostrat in conjunction with NIWA, this phase details information on water resources (physical stocks of water) available in surface water (artificial reservoirs, lakes, rivers, snow/ice) groundwater and soil water. This is a challenging exercise that involves hydrological considerations regarding stocks, including spatial distribution and changes in time for different water assets, while still considering and recognising their interconnectedness across the entire water system.

Phase Three: Future Water Demand Projections

Carried out by M.E Research, this phase identified estimates of the future demand for freshwater, under constrained and unconstrained supply assumptions. This analysis also takes into account the impact of the success or failure of water conservation and efficiency interventions over time.

Phase Four: Interventions and Action Plan

This includes an analysis and discussion of the priority, scale and sequence of demand and supply interventions necessary to achieving the region's water security objective of "ensuring Hawke's Bay has long-term, climate-resilient, and secure supplies of freshwater, *for all*". This will occur through future processes, such as the freshwater plan and the proposed Regional Spatial Plan.

Demand Interventions verses Supply Interventions – roles of mitigation and adaptation

In Hawke's Bay, the most significant demand on our freshwater resource is found in our two major aquifer and supporting river systems on the Heretaunga and Ruataniwha Plains. These areas have always been home to a significant proportion of the region's population and economic activity – in no small part due to the opportunity provided by a combination of sunshine, high-quality soils and seemingly abundant freshwater.

However, through the implementation of National Policy Statement for Freshwater Management (NPSFM) plan changes, in recent years the surface and groundwater resource in both catchments has been determined, for the most part, to be fully allocated.

Catchment demands

Increasingly, those looking to access either more water or increase the reliability of their existing water takes have looked to water storage – storing available surplus (high flow) winter water for use in the summer – to meet this demand.

Outside of an existing consented community water storage scheme, only very limited high-flow water is still available in the Tukituki Catchment.

In the Ngaruroro catchment, the proposed TANK Plan Change increases and regulates both the amount of high-flow water that can be taken for water storage and how that water can be used, without compromising environmental outcomes.

> **"...in recent years, the surface and groundwater resource in both catchments has been determined, for the most part, to be fully allocated."**

The TANK Plan Change also introduces a requirement to investigate streamflow maintenance schemes, sourced from above ground water storage, as a means of mitigating the collective impacts of groundwater abstraction from the Heretaunga Aquifer system on surrounding waterbodies, by supplementing flows to support aquatic ecosystems in the drier summer months.

This approach seeks to mitigate the impacts of abstraction on one hand, while on the other, continuing to provide water users with sufficient certainty and reliability for their intended use of water.

Water Security Economic Impacts

In July 2020, Regional Council commissioned an analysis of the economic impacts of diminishing water security in the region, with a particular focus on agricultural systems.[26] This M.E Research economic assessment (Appendix B) was deliberately framed in this manner because, (a) agriculture and horticulture is collectively the largest category of regional water use,[27] and, (b) alongside other extractive uses, is in the lowest priority category within the Te Mana o Te Wai framework.

In a climate change-impacted future, it is likely more water will need to be retained in the environment for the health of water bodies and human health. Therefore, in the absence of additional water storage, the 'source' of any additional water will need to come from reductions in allocations to extractive users, of which the primary sector is the largest.

The 2020 report quantified the wider economic impacts on Hawke's Bay and the rest of New Zealand, sectoral-level impacts of climate change and changes in water supply projecting an annual reduction in GDP of up to $110m by 2060 under the RCP4.5 scenario (see below).

As a matter of broader context, the report's authors provided the following observation:

	2030	2045	2060
RCP4.5			
Hawke's Bay	-30	-70	-110
Rest of NZ	-10	-90	-400
Total NZ	**-40**	**-180**	**-500**
RCP8.5			
Hawke's Bay	-20	-60	-120
Rest of NZ	-10	-80	-370
Total NZ	**-30**	**-160**	**-470**

Figure 7 Net Change in Annual Gross Domestic Product under Alternative Climate Scenarios ($2019m) as at 2030, 2045 and 2060

"Interestingly, many of the largest impacts are associated with construction and service industries, particularly in the rest of New Zealand. This underscores the complex nature of economic systems, especially when considering relationships and feedbacks that build over a period of 30-40 years. Although losses in income may initially be generated in agriculture and closely aligned activities such as food processing, they ultimately flow through the economy causing less funds available for new construction and capital investment – impacting not only on construction activities but ultimately the growth of all economic industries."

Finally, noting that the study had only focused on the water security impacts associated with climate change, and that many other impacts e.g., sea-level rise, coastal inundation, wildfires, etc, are likely to significantly impact the Hawke's Bay region, the authors concluded:

"Now that the magnitude and extent of the 'do nothing' scenario on water security under climate change are, to some degree, understood it is recommended that HBRC consider the value of possible resilience building initiatives. The wellbeing of many smaller communities on the TANK and Tukituki catchments are interconnected with the fortunes of the primary sector.

Our analysis shows that under climate change, with reduced water security (particularly post-2050), there is likely to be significant impacts not only on the environment and natural habitat that underpins the region's wealth, but also on the socio-economic wellbeing of the region's people. Our assessment indicates that the socio-economic implications of climate change on water security is not just a localised issue for the Hawke's Bay region but is an issue that has impacts for all of New Zealand."

This analysis reflects an important aspect of the Water Security Programme: that the motivation and incentives for acting now are primarily focussed on ensuring that the community avoids 'shrinking'[28] through a failure to address long-term regional water security, as opposed to being focussed exclusively on growth.

Any long-term strategy and action plan to secure freshwater is likely to require far-reaching behaviour change and frameworks to mitigate the demands we make on our freshwater resources.

Figure 8: Pivot irrigator: Credit: David Brooks/ Forest & Bird

Two-pronged approach – Supply and Demand

The RWA also shows that if long-term water security can only be achieved through demand management, the demands placed on existing water users are likely to be far reaching, challenging and disruptive.

But managing demand, is potentially only one side of the equation. This report demonstrates that the other side of the solution is slowing water down or retaining more winter water in the landscape so there is more water available in the drier summer months. The adaptation toolbox could include regenerative farming practices, supporting wetlands and increase riparian planting, improved erosion control as well as, should circumstances allow, community-scale water storage, either above or below ground.

At this point, it is critical to note that references to water storage in this report refer to infrastructure established at scale, for and on behalf of the wider community, sufficient to meet the long-term requirements of the entire community.

Water storage in this report does not refer to small or private water storage facilities that operate for the principal benefit of private individuals or entities.

Water storage can support many objectives, but it cannot be a substitute for improving the way we use water. Instead, water storage can offset the extent and urgency with which changes must be made to our water demands.

Crucially, for the future we face, water storage can also support aquatic ecosystems by providing more reliable flows during periods when even the most ambitious demand reductions are still not sufficient. Releasing stored water into rivers in summer can also support natural river recharge into the aquifer. Sitting alongside RWA investigations, Regional Council is working with Lincoln Agritech on a Ministry of Business, Innovation and Employment (MBIE) funded research programme to investigate the impacts of dry summers on aquifer recharge from rivers – specifically the Ngaruroro in Heretaunga.[29]

Water storage can of course support the future regional growth of the community and the economy, particularly in line with our internationally recognised ability to produce, process and ship high-value and high-quality produce.

Finally, while yet to come into effect, the proposed portfolio of resource management reforms necessary to give effect to New Zealand's response to the impacts of climate change is increasingly pointing to the role of water storage as an enabler of the transition to a lower emissions economy. In its June 2020 report,[30] the Centre for Informed Futures – Koi Tū noted:

"For the land-based primary sectors more specifically, there is a big opportunity for more beneficial and effective land and water use. Water harvesting needs to be optimised based on sound science and local knowledge, and its use in irrigation carefully targeted for environmentally sympathetic production intensity and increased product value. A lot of flat land with suitable access to water is amenable to arable cultivation and the development of high-value horticultural crops. Such a move, combined with suitable precision, will create a mosaic of land uses, increased employment, ecosystem stability and a hedge against some of the effects of climate change."

In its recently released report,[31] "Water Availability and Security in Aotearoa New Zealand", the Ministry for Primary Industry concludes that:

"[a] transition towards land uses that have a higher economic and lower environmental footprint, and improved community resilience, will require increased water security. This will require a strategic response that addresses and integrates approaches that consider the current and future supply, demand, and priorities for the use and protection of freshwater and the resources dependent on it."

For its part, He Pou a Rangi - The Climate Change Commission's May 2021 advice[32] to the New Zealand Government, makes numerous recommendations that will need to be enabled

Figure 9 Hawke's Bay River Network

by water storage. The Commission cautions on the need to be careful not to constrain the ability of an economy to support deeper reductions later and to reflect the time it will take to fundamentally change the way things need to be done.

The same reasoning can be applied to ensuring long-term water security that includes both demand and supply solutions. To support reductions in biogenic methane, the Commission's demonstration pathway assumes 2,000ha of land is converted to horticulture per annum between 2025 and 2050 – and that this target could be increased if certain barriers, including water availability and supply, are addressed. Hawke's Bay is noted as already being a national leader in horticultural supply chain infrastructure and expertise.

A successful example of this type of conversion from sheep and beef to horticulture is Craigmore Sustainables NZ Limited's Springhill Orchard in Central Hawke's Bay. The development is the largest fully-netted pipfruit orchard in New Zealand and has a network of data sensors monitoring soil moisture so the fully-automated drip irrigation can be as efficient as possible. Not only is the environmental footprint smaller and the productivity higher, but, when at full production, it is expected there will be 73 full time equivalent roles with a majority of those being locals.[33]

While this report investigates above ground and below ground water storage, the ability to rely on the use of above ground water storage as a 'tool in the water security toolbox' cannot and should not be taken for granted in New Zealand.[34] The reality is that this country does not have a strong track record for establishing community-scale water storage for broader community and environmental benefit.

This reflects a number of challenges these projects face, which are not limited to the significant technical challenges arising in relation to site-specific geotechnical, seismic, and hydrological factors. The larger scale of community schemes increases the environmental impacts that must be avoided, remedied or mitigated to meet legislative regulatory or local planning frameworks, or rule a site out altogether.[35,36] Under the current first-come-first-served approach of the RMA, this can result in a perverse outcome, making it more likely that multiple, smaller private water storage projects can collectively access a high-flow allocation that could otherwise be reserved for the benefit of the wider community, including long-term water security for urban communities.

Furthermore, some in the community insist that community-scale water storage should be rejected in favour of solutions that do not modify the environment.

Accordingly, before we can know if supply solutions (in the form of community-scale above or below-ground water storage) can be included in future plans, a significant level of effort, investigation and engagement is required.

Kānoa – Regional Development Unit funding has provided Regional Council with an opportunity to proactively investigate water storage solutions, so it can validate or discount the potential options for addressing future freshwater supply. This work includes the investigation of small-to-medium-sized water storage options in the Heretaunga catchment to supplement flows, support aquatic ecosystems in the Ngaruroro River and lowland streams, and build greater reliability and resilience in the system in anticipation of climate change impacts.

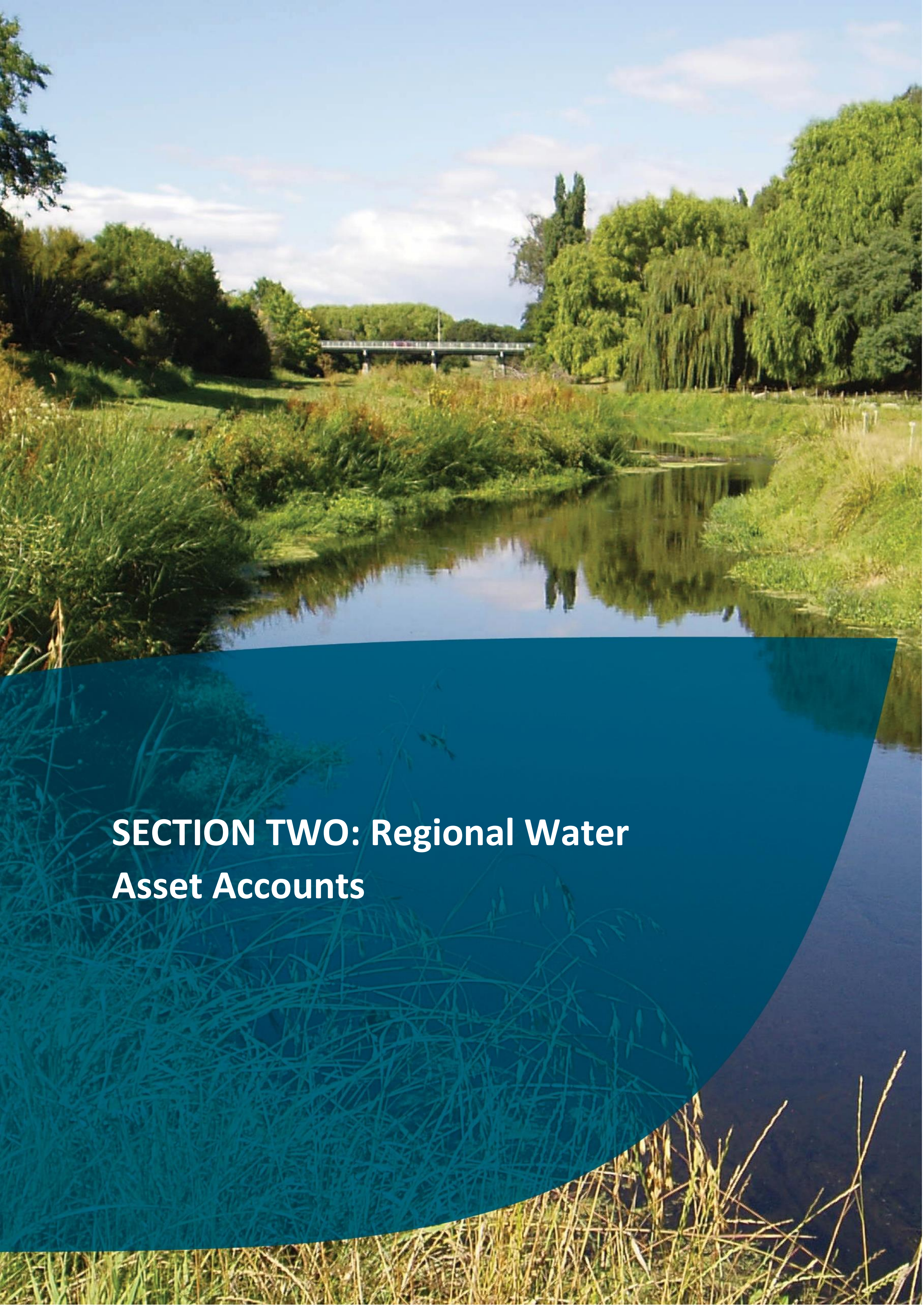
This funding has also allowed Regional Council to commence a Managed Aquifer Recharge pilot [37] using peak river flows to supplement groundwater in Central Hawke's Bay.

Our ability to strike a sensible balance between reducing demand and increasing supply will determine the future freshwater management direction we take.

Should these investigations rule community-scale water storage out, then the community will be in an informed position to understand what is collectively required to significantly reduce our demand - to ensure there is fair and equitable access to freshwater for the long-term.

If, on the other hand, these investigations identify viable water storage options, the community will need to decide how those will form part of a portfolio of demand and supply solutions.

Even then, just because water storage may be technically feasible, affordable and able to be consented, no assumption should be made that it will eventuate in the absence of widespread community support.[38]



SECTION TWO: Regional Water Asset Accounts

Regional Water Asset Accounts

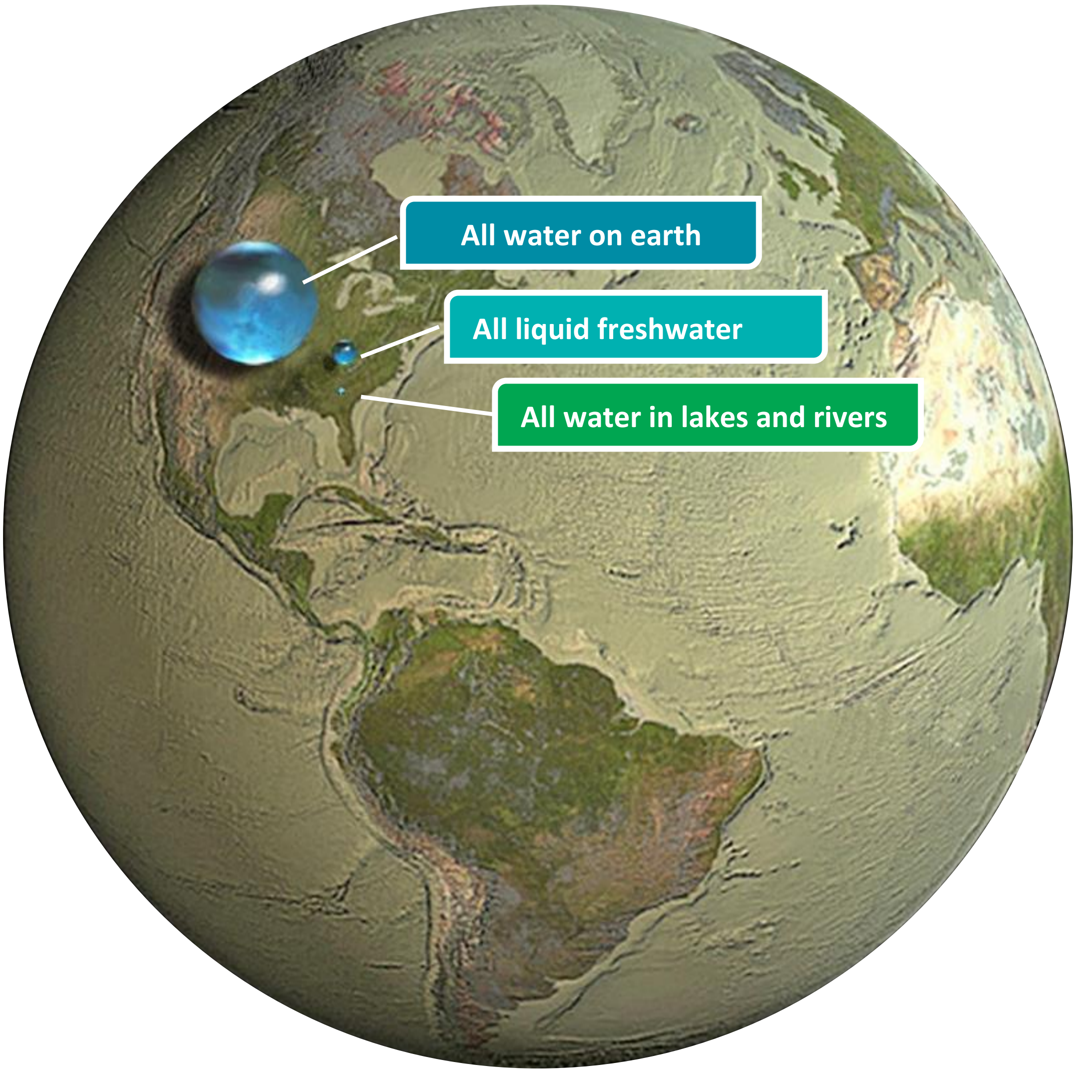


Figure 10: Attribute: Howard Perlman

World of water

Freshwater, or H_2O, has been described as the precarious molecular edge in which we survive.

Figure 12 shows[39] that 97.5% of Earth's water is saline, in our oceans and seas and some groundwater and lake systems, and only 2.5% is freshwater.

Of global freshwater, 68.7% is in our glaciers and ice caps and 30.1% comprises our groundwater systems, leaving a mere 1.2% of the 2.5% that constitutes the world's total freshwater resource to make up the water in our lakes, soil, wetlands, rivers, atmosphere, and all living things. Incredibly, nearly 70% of this fraction of a fraction forms the earth's ground ice and permafrost. And a full 83% of the 20% of surface freshwater that forms the worlds' lakes can be found in three lake systems in Africa, North America and Russia.

Although the atmosphere may not be a great storehouse of water, it is the superhighway used to move water around the globe. About 90 percent of water in the atmosphere is produced by evaporation from water bodies, while the other 10 percent comes from transpiration from plants. If all the water in the atmosphere rained down at once, it would only cover the globe to a depth of 2.5 centimetres.

It is said that if climate change was a shark, water is its teeth. Water is the visible face of climate, and therefore climate change. So, we will experience climate change through the medium of water: floods, drought, cyclones, sea level rise from melting ice and snow.

For a visualisation of the distribution (by volume) of water on Earth[40], see Figure 11. Each tiny cube (such as the one representing biological water) corresponds to approximately 1400 cubic km of water, with a mass of approximately 1.4 trillion tonnes.

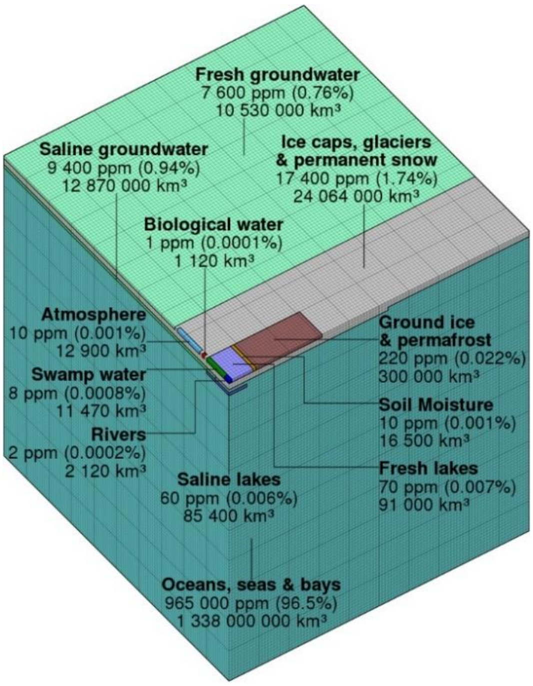


Figure 11 Visualisation of the distribution (by volume) of water on Earth. Each tiny cube (such as the one representing biological water) corresponds to approximately 1400 cubic km of water, with a mass of approximately 1.4 trillion tonnes

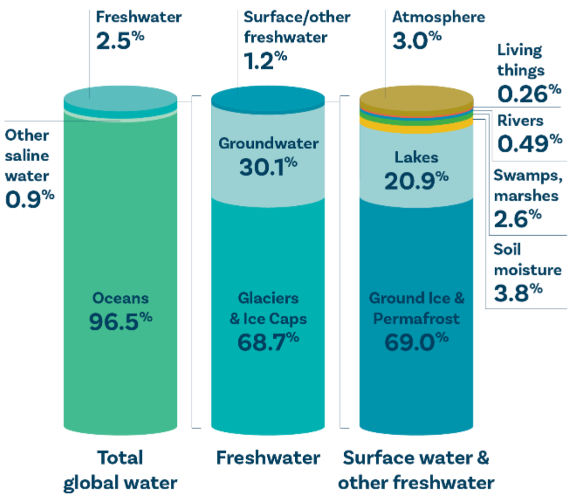


Figure 12 Where is the World's Water

In summary, the freshwater water we are most familiar with, the water we see in our rivers and lakes, the rain we experience and the precious water that sustains us, that feeds us and cleans us, represents only the tiniest fraction of our region's freshwater.

Water Assets Accounts Highlights and Results

Below are the highlights from the Water Assets Accounts for the 2019/2020 year.

The highlights show how much water is held or moves through the different water sources.

10.2b m^3

(Approximately) Of water held across all sources in Hawke's Bay as at 1 July 2019.

23.3b m^3

Transferred between various surface, ground and soil water systems within Hawke's Bay.

17.9b m^3

Left the region via evapotranspiration, discharges to the ocean or other regions.

16.3b m^3

Of rain fell in Hawke's Bay.

5.4b m^3

Returned to the atmostphere via evaporation.

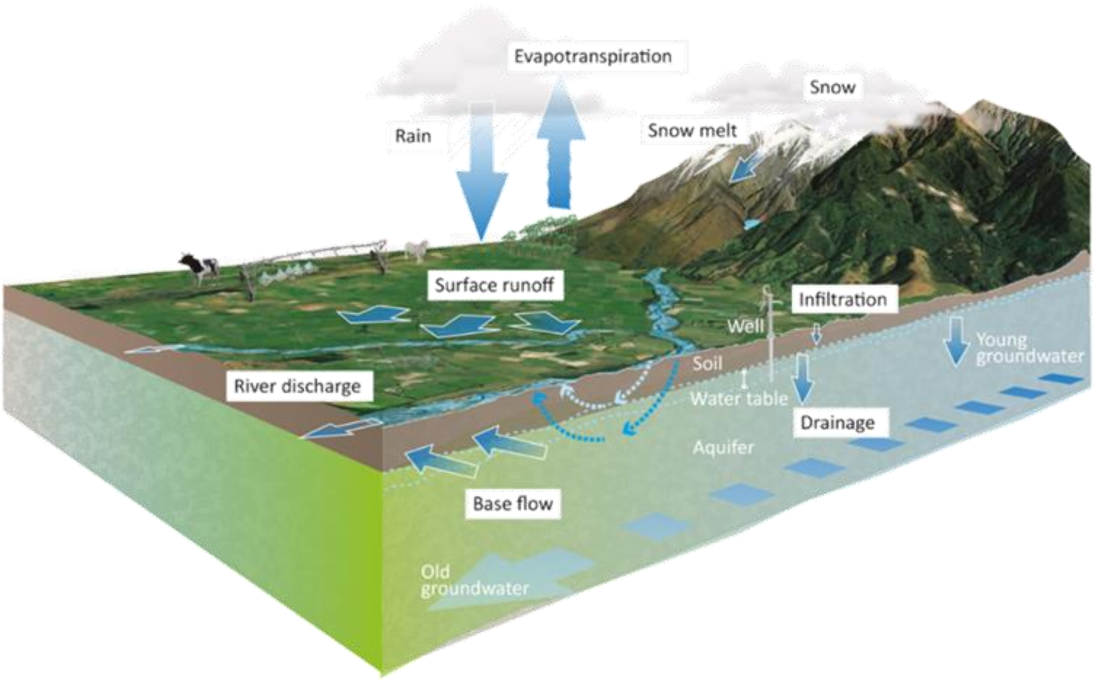
13.9b m^3

Of water carried by our rivers. Of that 2.4b m^3 was from other regions and 11.4b m^3 internal flows (predominantly run-off.

1.2b m^3

Water flowed to other regions and 7.2 b m^3 flowed to sea

It is estimated that the region's groundwater systems were recharged by 10.3 billion cubic meters of water, but overall ended this very dry period with 677 million cubic meters less water than the start of the year. In what is a good example of the connected and temporal nature of the water system, by the end of June 2020 soil water had increased 241 million cubic meters, reflecting recovering soil moisture.



What are Water Asset Accounts?

Water assets accounts can help describe flows between water assets – or what form water takes at that time.

Hawke's Bay is the first region in New Zealand to look at its freshwater demand and supply through Water Accounts.

Notwithstanding the data limitations associated with a first-generation report, we know the exchanges between assets to be significant in some cases.

The graphic above provides a visual description of the New Zealand water model. Starting in the mountains, snow melts and moves into river systems, surface precipitation runs off into rivers and soil water drains into groundwater assets.

Water asset accounts not only highlight the scale and complexity of the water cycle, but help inform the challenge of freshwater management and policy by placing the amount of water we extract, use and return to the environment in the context of the overall quantity of water that passes through the environment every year.

It is against this backdrop that this assessment has made a first attempt to take an inventory of the region's water assets.

Water assets tables were produced in line with the SEAA-Water methodology for water assets accounting and divide water assets into:

- Surface waters: Artificial reservoirs or storage; lakes; rivers and streams, and glaciers, snow and ice;
- Groundwater; and
- Soil water.

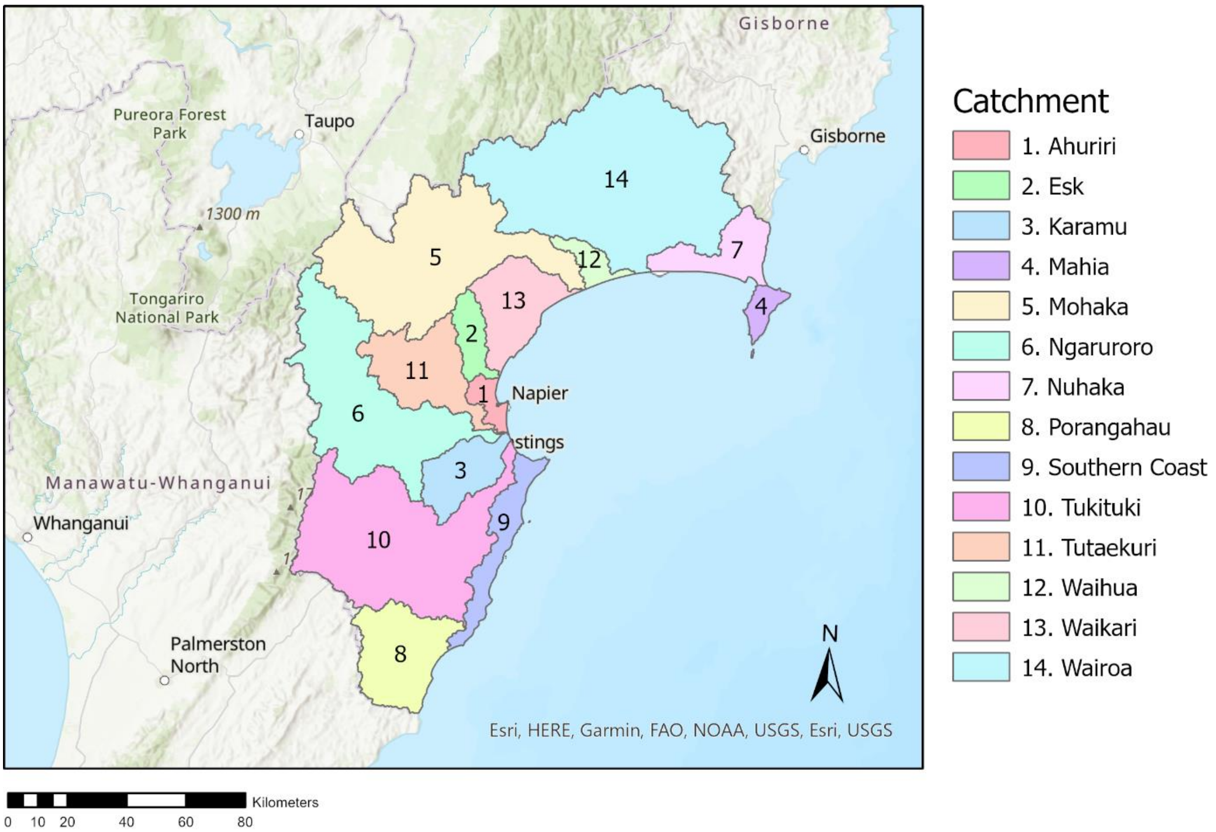


Figure 13: Catchment zones in Hawke's Bay Region

Again, it is not the purpose or intent of this report to be a guide to policy setting around allocation decisions for specific catchments, but instead to provide Regional Council and the community a baseline for decision-making through future planning instruments, such as the freshwater plan,

The report's authors make the following comment:

> *"A critical distinction needs to be made between water stocks and water accessibility. Just because there are large stocks of water assets (relative to abstraction and use) doesn't mean these are accessible for the region's and districts' needs. As described by Dinka in the 2018 book Water Challenges of an Urbanizing World, physical and economic scarcity are not the same thing. This is a familiar concept in economics – abundant freshwater may be contained within water assets, but it may be too expensive to extract and use. Therefore, care must be taken when interpreting the values for asset stocks in the water assets tables.*
>
> *Also, taking more water from an asset than is supplied to it (through hydrological cycles and economic discharges) can have adverse impacts on the ecosystems that rely on these assets. Ecosystems and biodiversity provide a range of ecosystem services that improve water quality and availability (through filtration, flood protection, water storage and several other services).*
>
> *The capability of ecosystems to provide these services diminishes with poor water management decisions. Therefore, water management decisions should consider the implications for local biodiversity, as any harmful effects will likely flow on to water assets within the region. Water accounts could be combined with biodiversity and ecosystem health indicators to track how different volumes and types of water use and discharge impact biodiversity values. The water accounts should also serve as a guide*

for producing further natural capital accounts (for biodiversity, water quality, marine ecosystems, etc.). If ANZSIC codes are used throughout these accounts, it becomes much easier to connect natural capital accounts with traditional financial accounts.

Moreover, the water accounts, do not differentiate between individual assets within a class. In many instances, water will be extracted from one lake (for example) and discharged into another. This process could deplete the first lake while maintaining "overall lake stocks". Clearly, this stresses the importance of effective, transparent and efficient water management decisions. As Rogers et al. (2005) asserts, water scarcity is a "governance crisis, not a [water] resource crisis".

Insights and analysis

In the following section we will see that the supply and use accounts estimate that approximately 138M m³ of water was abstracted from the environment across the region in the 19/20 year. Of that, it is estimated that approximately 66M m³ was returned to the surface land and soil water in the form of irrigation water return flows, direct discharges, treated wastewater, and distribution losses. This suggests that losses to the environment through actual water consumption only represents 52% of total water extracted.

Agriculture returns the lowest amount, and it is estimated that 92% of its abstraction goes into plant and/or product, or alternatively evapotranspiration and irrigation returns. These figures pale in comparison to the billions of cubic meters of water that flowed through the region's landscape, even in this relatively dry year. For example, it is estimated that approximately 66M m³ was taken from surface water sources.

This represents less than 1% of the 7.2b m³ of water that was estimated to have flowed to the sea that year.

At the macro scale, the 138M m³ of total water abstracted from the environment represents just 0.76% of the approximate 18b m³ of water that came and left the region, or 0.6% of the water that transferred between sources (or accounts) through the year.

To suggest that long term water security can be achieved simply by further harnessing this apparent abundance would be to miss the complexity of the natural environment upon which we rely so much. These numbers represent annual flows, the bulk of which will be heavily skewed to the wetter months. The stresses on our surface waterbodies because of our collective demand for water through the summer, particularly from agriculture, should not be underestimated.

This report identifies multiple opportunities to develop new approaches to freshwater management in Hawke's Bay. The analysis suggests that a focus by our largest water user groups on finding consistently incremental pathways to reducing demand, either by improving practices, eliminating leakage and waste, and investing in data and new technology could have the most transformative impact on long term water security.

Hand in hand with that work, we can continue to investigate ways and means to hold more water in the landscape, either in our soils through newly adopted farm management practices, or in our aquifers either through in-river or ex-river recharge, or through community-owned above-ground storage that operates in a way that does not exacerbate water security problems but resolves them.

Lakes, rivers and soil water

NIWA's TopNet rainfall-runoff model (a semi-distributed hydrological model) is used to calculate the opening stocks (or volume at the start of the monitored period) of lakes, rivers and soil water assets. TopNet also estimates the distribution of precipitation (based upon asset land coverage), evapotranspiration and river flows. Below are basic descriptions of the methods used:

- Soil water content is the volume of water stored in the soil rooting zone (usually the top one metre of soil). Soil water is simulated by TopNet and depends on soil type, land use, rainfall and evapotranspiration (which also depends on soil water – this is one interdependency within the model).
- River stocks are taken as the volume of water in the active riverbed (in line with SEAA-Water methodology) at the start and end of the reporting period. Flows are simulated by TopNet.
- River flows to other regions, i.e. leaving Hawke's Bay, are estimated using TopNet under the assumption that no abstraction occurs. This is corrected using supply and use data when the water assets accounts are compiled.
- Lake stocks are taken as the measured volumes of lakes at the start and end of the recording period; Lake volume is calculated for 35 natural lakes linked to the river network.
- Overall precipitation is based on actual measurements and precipitation is then distributed between assets based on relative area coverage.
- Evapotranspiration is simulated by TopNet as actual evapotranspiration based on measurements of wind speed, temperature, solar radiation, data on vegetation and estimates of soil water content.

Groundwater and artificial reservoirs

These assets were calculated based on an extensive review of relevant information to develop an estimate of groundwater and water storage for the Hawke's Bay Region.

To develop scientifically credible estimates for Hawke's Bay, a combination of data outputs from the TopNet Model, GIS Spatial Analysis and expert judgements of storage estimates for the eight aquifer types across the region was applied.

Groundwater

The following items were calculated for each of the modelled sub-catchment areas (262 sub-catchments) through TopNet model run, at a minimum we would require:

- Total Groundwater Recharge – TopNet reports as cumulative infiltration from the root zone to the saturated zone (d).
- Total Groundwater Discharge – TopNet reports as cumulative baseflow discharge (qb).
- Total Groundwater Storage – TopNet reports as total storage in the aquifer at the start and end of the year (Sa).
- Basic water budget parameters by 15 Catchments Zones.

The outputs from TopNet were augmented with the GNS hydrogeological map and the Regional Council wells GIS shapefile database to generate estimates of groundwater storage and usage across all of Hawke's Bay. Validation of the results is still ongoing.

Artificial reservoirs / storage ponds

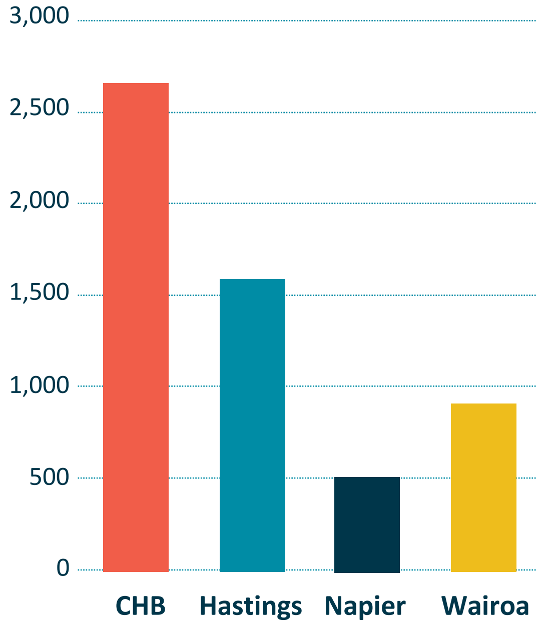
There are several thousand ponds across the region, of different sizes. Several sources of data are used to determine volume, including a 2014 master thesis on water storage on farms in Hawke's Bay. Methods used included:

- Allocation of precipitation to reservoirs is based on the area covered by reservoirs (run off is not included at this point).
- Total cumulative precipitation (P) and total cumulative evaporative losses (er + ec) for the region are generated by the TopNet model.

District Breakdowns

The water asset accounts show regional and district volumes for Wairoa, Napier, Hastings, and Central Hawke's Bay. Further detail is available by each region in Appendix A. Here are a few highlights.

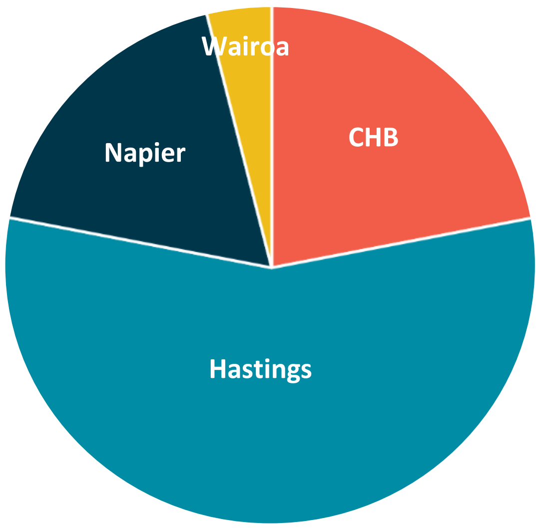
Average Water Use Per Capita



Overall Water Use by District

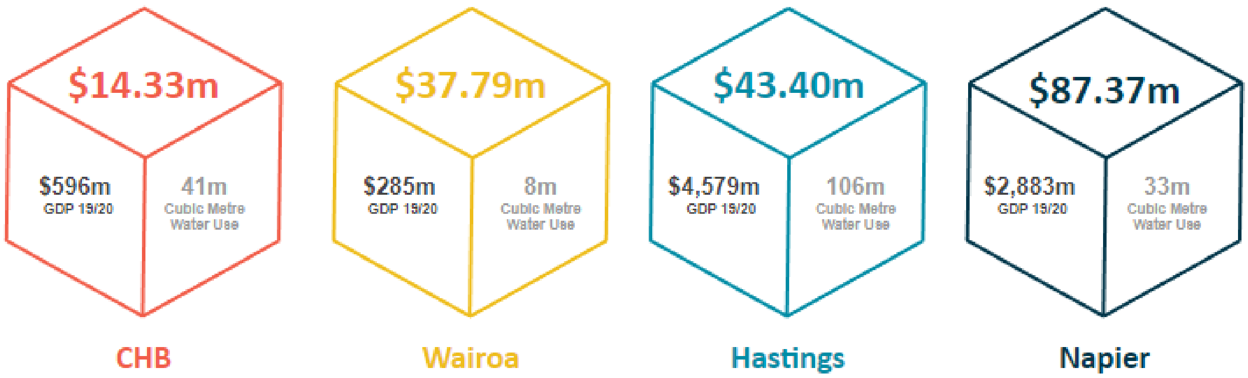
This shows a breakdown by the million cubic metre, and the percentage by each district.

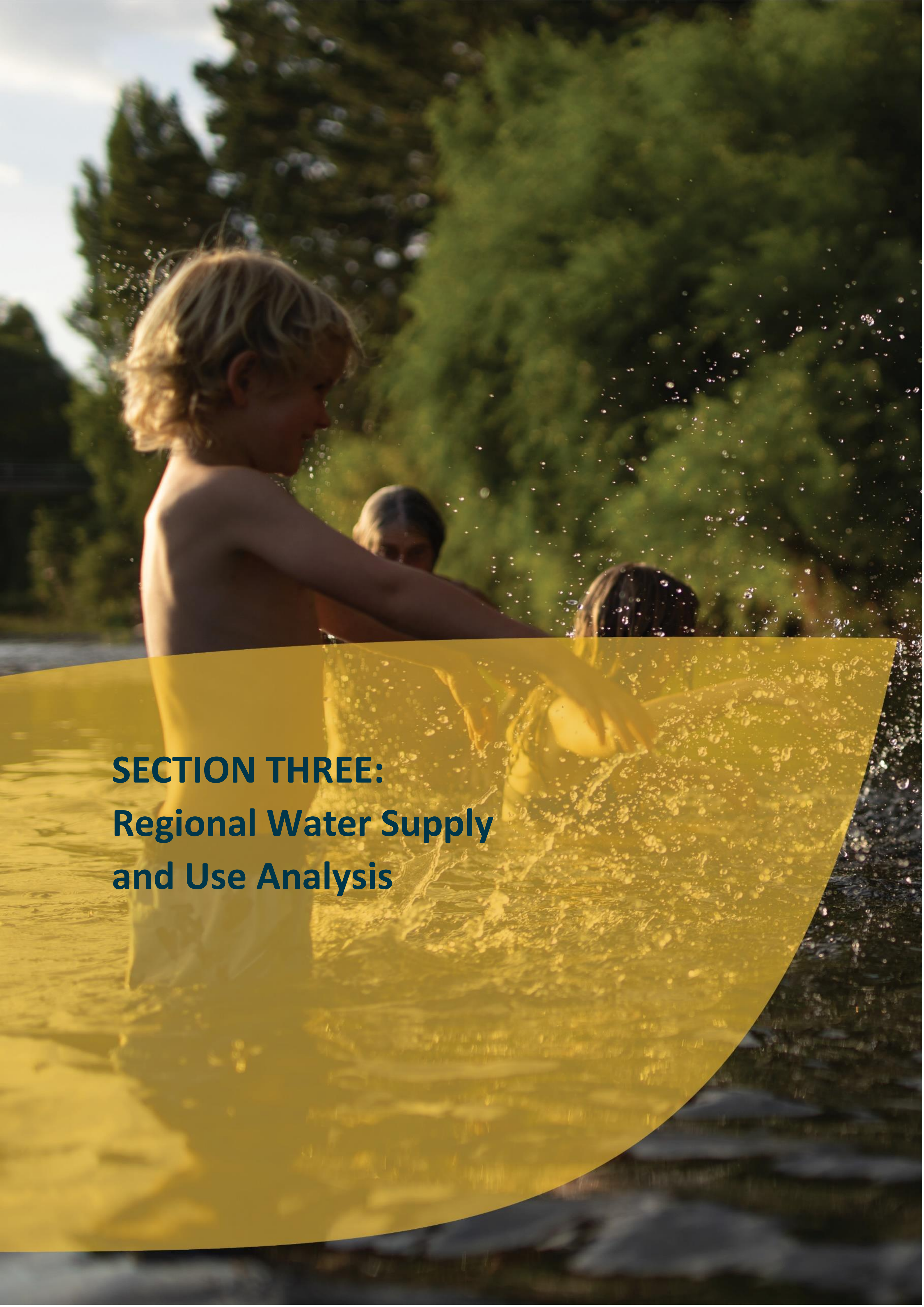
	(000s m^3)	% of total
CHB	41,262	22%
Hastings	105,506	56%
Napier	32,997	18%
Wairoa	7,541	4%



Water Use and GDP

This shows how much is earned in GDP for every 1 million cubic metres of water used.





SECTION THREE: Regional Water Supply and Use Analysis

What we know about freshwater in Hawke's Bay today

To complete Phase One of the Regional Water Assessment, the Current Water Supply and Use Accounts (S&U Accounts), Hawke's Bay Regional Council commissioned analysis on the annual water supply and use for the region. Put simply, it quantified the amount of water abstracted, or taken, from the environment by various sectors of the economy/community.[41]

The S&U Accounts research, using data for the July 2019 to June 2020 period, represents the first systematic effort to produce a water account at a regional and district council level in New Zealand.

In doing so, the project team had to navigate known data issues and information gaps, and the fact that accounting for region-wide water supply and use had not been undertaken before. This is acknowledged as a national issue.

In the Ministry for the Environment's 2019 state of the environment report – Environment Aotearoa 2019,[42] it was noted that the quality and completeness of data on actual water use (as opposed to consented volumes) is inconsistent across regions. A 2019 Parliamentary Commissioner for the Environment report[43] also acknowledged this issue and recommended that a comprehensive, nationally coordinated environmental monitoring system be established for freshwater.

As a key action in its 2011 Hawke's Bay Land and Water Management Strategy[44], Regional Council mandated the installation of water metering on all irrigation takes above five litres per second between 2012 and 2016. This has provided greater confidence in the data relating to irrigation, the largest extractive use category.

This section summarises the methodology, results, and key insights. The analysis focuses on the development of the supply and use water accounts (tables) – a complex process of data collection, review and validation that involved input and support from Regional Council staff, as well as Territorial Authorities' staff.

The supply and use tables focus on water flow i.e., the amount of water abstracted from the environment by agriculture, industry, services, municipalities, and households, how it flows through the economy, and the volumes that are returned to the environment.

The supply and use accounts represent 'first generation' water accounts for Hawke's Bay. The current tables rely significantly on the resource consent data available from Regional Council, which was not designed for the purpose of statistically valid water accounting.

The S&U Accounts provided significant insights and learnings in terms of data availability and quality for water statistics purposes, including the asymmetric nature of water data, namely:

- More information on: Abstraction of water i.e., take from the environment, focused on volume as it is linked to availability and allocation limits;
- Less information on: Discharge of water i.e., return to the environment, focused on quality as it is linked to impact on human health and ecosystems.

An important consideration of approaching the analysis using the SEAA methodology is the opportunity to combine the water accounts with socio-economic data and growth models in future, including in relation to assessing value add and high-value water use and efficiency. This would require a statistical underpinning of the data through alignment to the Australia New Zealand Standard Industrial Classification of All Economic Activities (ANZSIC).

To date, the process of water allocation and consenting under the RMA has required a consideration and analysis of the effects of the water take and, increasingly, the use of water.[45] Consent decision makers are not empowered to consider the merits of the activity or prioritise between uses of water.

While water has been readily available for abstraction and use, this has not presented a problem, however as we combine an increasingly water-scarce future with the Te Mana o te Wai framework, it is likely that policy makers will need to consider the introduction of methods to prioritise access to water.

While not yet law, the recently announced Natural and Built Environments Bill (NBE), proposes an end to the 'first-come-first-served' approach of the RMA, and replacing it with new principles for allocating scarce resources, such as freshwater, through a sustainability, efficiency, and equity lens.

The SEAA framework represents a step in that direction by enabling analysis of the impacts of prioritising both within and between categories of use, or if the use of economic instruments is introduced to freshwater management.

SEEA-Water provides a specific organising template table for water supply and use informed by the concept of flows and interactions between the environment and the economy, namely flows:

- From the environment to the economy;
- Within the economy; and
- From the economy back to the environment.[46]

The standard economic activities included in the physical supply and use table include:

- Agriculture, forestry and fishing;
- Mining and quarrying, manufacturing, and construction;
- Water collection, treatment and supply;
- Sewerage; and
- Service industries.

Normally the accounts would include the activity designated as electricity, gas, steam and air-conditioning supply. However, for Hawke's Bay this represents the water takes and discharges associated with hydro-electric schemes in Esk Valley and Waikaremoana. It is the nature of these takes that the water is almost simultaneously taken, used and discharged in a manner that is entirely non-consumptive. These massive volumes also skew and conceal the true picture for the region. For the purposes of this report, we have excluded this use category from the analysis.

Description of 2019/20 Year

The 2019/20 year provided another example of a particularly dry year in Hawke's Bay. With only 79% of average rainfall, above average rainfall in October and June masked the impact of successively dry months from November through May. Through this period, the Waipawa River was on ban for a total of 118 days.

Below is a historic graph of total rainfalls for Napier for the full hydrological year, which is July to June demonstrating that the 2019/20 year was a record dry year.

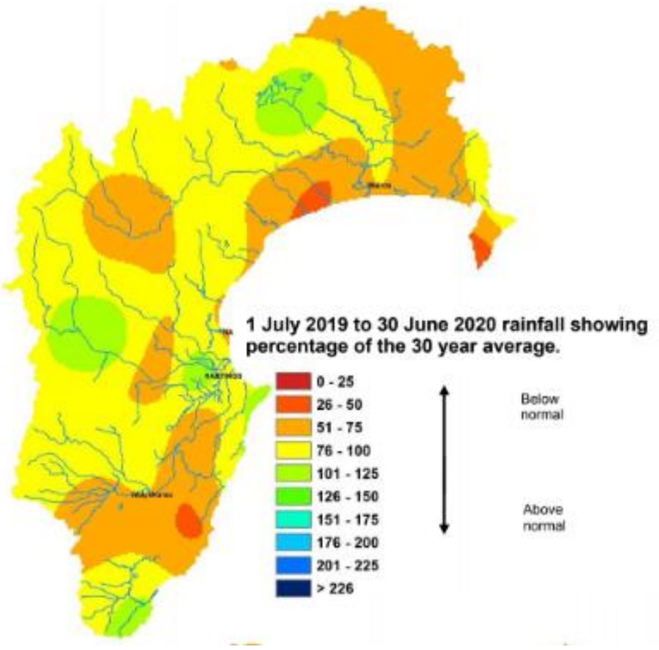


Figure 14 Rainfall Report 1 July 2019 - 30 June 2020 HBRC

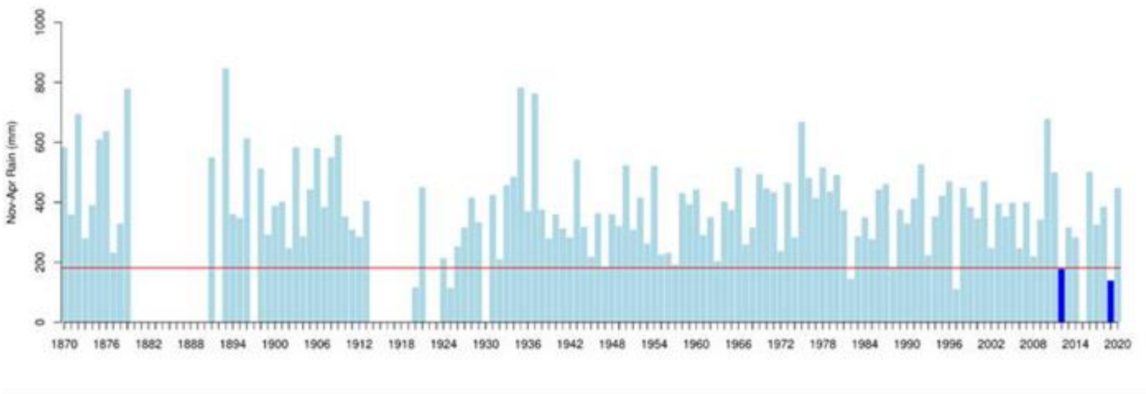


Figure 15 Historic rainfall for Napier with the 2012/13 and 2019/20 years highlighted.

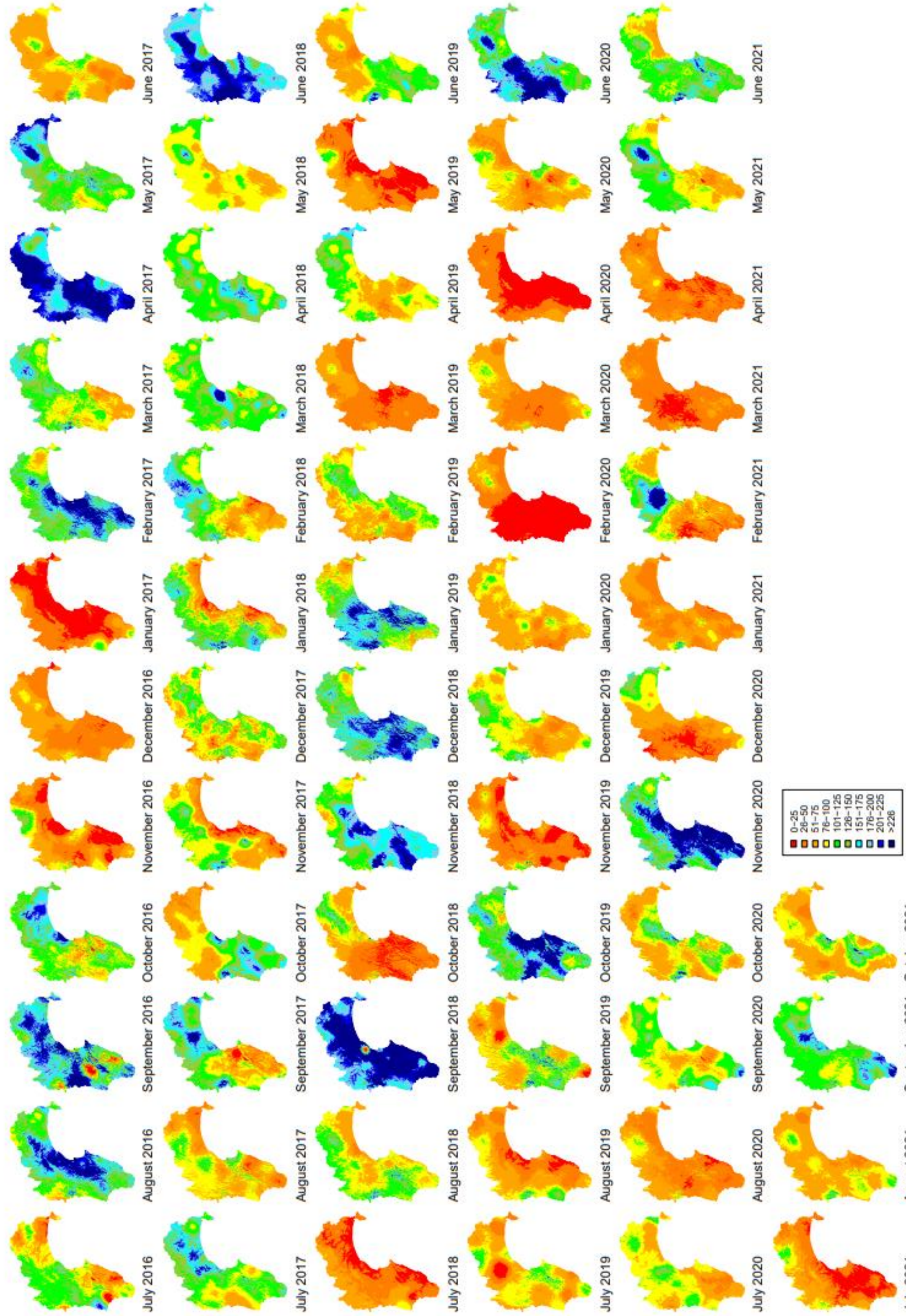


Figure 16 Rainfall summary 2016-2021

Approximately 138 million cubic meters (Mm³) of water was used in economic activities and households in Hawke's Bay in the 2019/20 year.[47] A summary of water abstraction by the key sectors/activities is shown below:

	m³	%
Agriculture (including irrigation)	88,487,000	63.8%
Water Collection and Supply	26,952,000	19.5%
Manufacturing and Processing	18,689,000	13.5%
Non-reticulated Households	2,490,000	1.8%
Service Industries	1,951,000	1.4%
TOTAL	**138,647,000**	**100.0%**

Figure 17 Uses of freshwater in 2019/20 hydrological year in Hawke's Bay

Water supply was predominantly sourced from groundwater supplies, as shown below:

Source	m³	%
Ground Water	88,681,000	59.42%
Surface Water	48,909,000	39.80%
Collected rainwater	1,058,000	0.08%
TOTAL	**138,647,000**	**100.0%**

Figure 18 Sources of freshwater demand in 2019/20 hydrological year in Hawke's Bay

These abstraction volumes mark the beginning of a complex flow of water through physical, human/biological and economic systems before returning to the natural freshwater and marine environments.

Agriculture was the highest use sector and accounted for over half of all water use in the 19/20 year.[48] Irrigation accounts for 81% of agricultural water use, with the remaining 19% estimated to represent permitted takes for livestock. This category also represents the highest consumptive use of water i.e., water that is taken but not returned to the system.

Based on estimates of the amount of irrigation water that was not taken up by plants but returned to groundwater, of the 78 Mm³ total regional water abstracted but not returned to the freshwater or marine environment, agriculture made up 71 Mm³ or 91% of the consumptive take.

The second highest use category is "water collection and supply" which used 26.9 Mm³ of water i.e., 19.5% of overall water takes. These takes represent some of the most complex flows in the system and, combined with stormwater systems, form a part of the three waters network managed by the Territorial Authorities This water is conveyed to households, sportsgrounds and parks, and industry where it is used and, net of system losses, it is predominantly returned via wastewater infrastructure for treatment and return to the environment.

The next highest use is manufacturing and processing (industry) at 18.6 Mm^3 or 13.5% of total abstraction. Of this, 81% is sourced from groundwater. Of the total amount taken, approximately 7.4 Mm^3 (39%) does not return to the environment, with the balance coming back via municipal wastewater systems (50%) and the balance being discharged to land, freshwater and the sea.

For completeness, not included in this analysis of total abstraction is the estimated water use for hydroelectricity generation at the Waikaremoana Power Scheme operated by Genesis Energy[49] and Trust Power's Esk Valley Scheme.

In addition to the detail provided in the EnviroStrat Report, we have provided brief summaries by District in Appendix D.

SECTION FOUR: Future Demand Scenarios

What freshwater demand looks like in the future?

To help understand Hawke's Bay's potential future freshwater use/demand, ME Research was commissioned to develop projections of future water demands for the region, based on forecasts of future population growth and economic growth.[50] The Water Accounts in the previous section have been cross-referenced as the base year for these projections out to the year 2060.

Because the 2019/20 account figures represent what is essentially a randomly selected year, the primary value of the analysis is to identify future trends for water use based on a range of demand and supply scenarios. The 2019/20 year represented a very dry year in Hawke's Bay and the analysis helpfully uses a year of high-water use.

Developing these projections involved significant assumption and uncertainty e.g., predicting future population and economic growth, speed of technology change, future water use efficiency, climate change impacts etc. A range of different projections and scenarios have been developed to help us consider and prepare for the likely challenges ahead, so that we can address these issues and changes strategically and purposefully.

The projections and scenarios developed are intended to help with:

- Understanding the immediate and known issues;
- Discussing and debating emerging issues; and
- Developing regional and collective responses to these key issues.

How the projections were developed

Two sets of projections were developed for future water demand:

- **Unconstrained:** Where the primary question was "how can we expect the demand for water to change over time, assuming that there are no restraints on the ability to meet those demands, and hence no decisions need to be made about allocating water to only some uses?". The water demand projections generated are referred to as 'unconstrained' projections in the sense that no constraints are placed on industry growth through water supply limitations. By comparing the unconstrained demand projections, with knowledge of water supply availability, we can appreciate the size of the 'water availability gap' or the potential opportunity cost of competing policy preferences.
- **Constrained:** Where the primary question is "how can we expect the future demands for water to change over time, should agriculture be constrained to current water use"? Increasingly, water constraints are evident within the region and policies to maintain river flows and prioritise human health and needs have significant implications, particularly for the extractive agriculture and industry sectors. It is possible that constraints placed on agriculture water use in particular will have flow on effects to the water demanded by other sectors, given that agriculture is highly connected within the regional economy.

Projections notes:

The IPCC defines a Representative Concentration Pathway (RCP) as a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC. Four pathways were used for climate modelling and research for the IPCC fifth Assessment Report (AR5) in 2014.

The M.E Research, which investigated the climate change scenarios for the RWA, says "In this study, given the need to keep the number of combined scenarios tractable, only two of the four RCP scenarios are considered – the moderate-low emission pathway given by RCP4.5, and the high emission scenario of RCP8.5."

Whichever pathway we are on, M.E Research notes "all four scenarios do not track too differently during the first half of this century and that the forecasts developed in this study do not extend past 2060."

The projections utilised three principal domains of uncertainty:

- Global/national economic futures: Five alternative 'Reference Economic Futures' were considered.
- Water intensity: A key question to address in developing the water use projections is to determine how water intensity may change over time. Three scenarios of changes in water-use intensity were considered. The lowest rate of change scenario (Technology Scenario 1) assumes there is zero improvement in water use intensity for industries and households over the next 40-years in terms of the quantity of water required per $ of economic goods produced (or per person in the case of households). The middle scenario (Technology Scenario 2) assumes rates of improvement in water use intensity of between 0.6 and 1.0% per annum, and the high scenario (Technology Scenario 3) assumes rates of 1.2 and 2.1% per annum. The selection of these scenarios to test within the modelling has been guided by a review of national and international literature (see Figure 22).
- Climate Change: Two alternative Representative Concentration Pathways (RCPs) developed by the International Panel on Climate Change (IPCC) were considered: RCP4.5 (a reduction scenario in which a significant GHG mitigation) and RCP8.5 (very high GHG emissions without additional efforts to constrain emissions).

	Annual Decrease in Water Use, Assuming Constant Production (industries)/ Consumption {households}		
Industry	**Technology Scenario 1**	**Technology Scenario 2**	**Technology Scenario 3**
Horticulture and fruit growing	0.0%	1.0%	1.9%
Sheep, beef cattle and grain farming	0.0%	0.8%	1.7%
Dairy cattle farming	0.0%	1.0%	2.1%
Poultry, deer and other livestock farming	0.0%	0.8%	1.7%
Other industries	0.0%	0.6%	1.2%
Households	0.0%	0.6%	1.2%

Figure 19 Assumed Changes in Water Use Intensity

Unconstrained projections for agricultural use did not directly involve assumptions about an increase in the area under irrigation. As a first estimate, the quantity of future water demanded by agriculture, whether for irrigation or other purposes, was simply assumed to scale in proportion to the change in agricultural output. However, any improvements in water use intensity were then used to adjust this estimate. In addition to the effect of increasing agricultural production, additional water necessary to maintain production under climate change was added to the demand estimates. The researchers employed a calculation that factored changes in plant requirements and then estimated corresponding increase in irrigation requirements to maintain production.

Exploring Scenarios

Drawing from the report, we focus on a set of scenarios to illustrate what future water use might look like and, most importantly, what early indications of a gap between supply and demand might be. In this section, we explore three similar scenario sets.

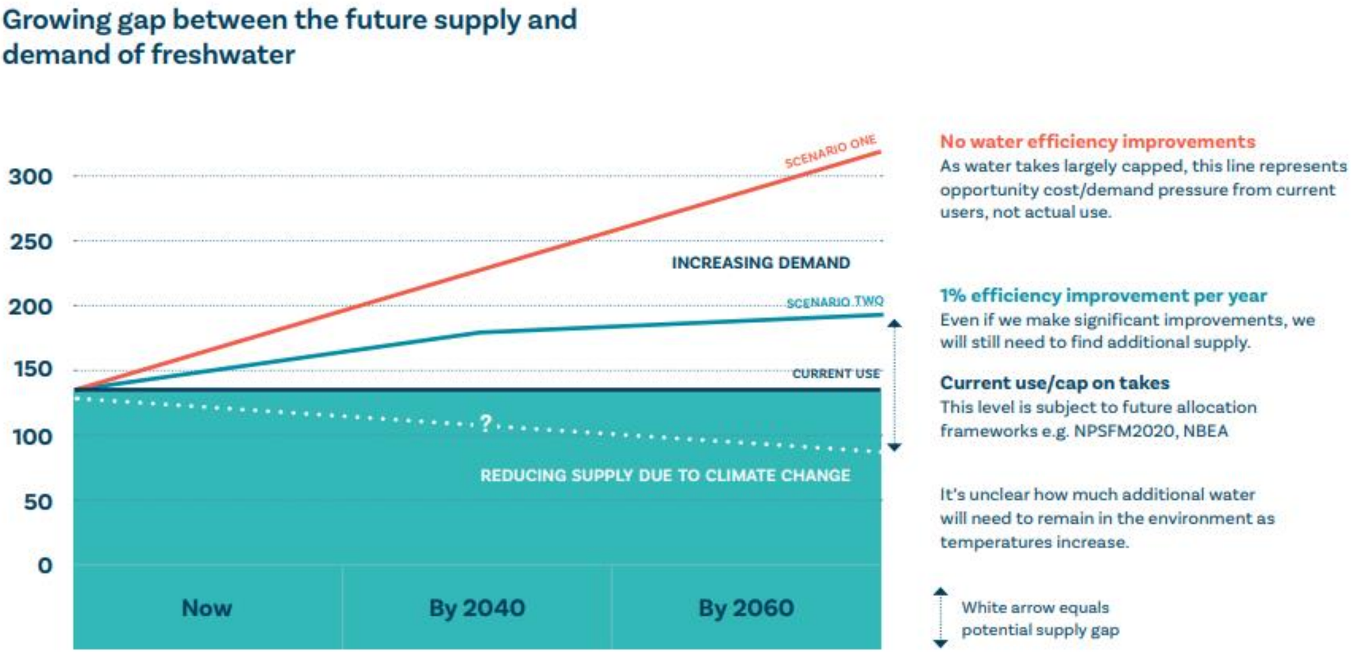


Figure 20 Growing gap between supply and demand

Scenario One

In this example we have selected the following scenario:

- Climate Change Future RCP 4.5 [51]
- Technology Scenario 1
- Baseline Economic Reference Future (with low/high ranges of other futures in the Unconstrained Scenario)

By selecting Technology Scenario 1, (see table below) excludes any annual assumed improvements in water use by all water user groups that offsets the absolute growth in demand.

Unconstrained results

Under this scenario, by 2040 the region could need to require between 42.84 Mm³ and 83.52 Mm³ more water than the 2019/20 year.

By 2060, the requirements could be between 60.42 Mm³ and 207.85 Mm³.

Constrained Results

The Authors note that although we might intuitively expect constraints on growth in the agriculture sector, caused by limited water supply, to lead to losses in water demand elsewhere in the economy due to the strong connection between agriculture and the rest of the economy, this does not appear to be a strong outcome of the modelling. While the constrained specification will have lower economic activity and economic growth overall compared to the unconstrained specification, there are still resources available within the economy to allocate towards economic production, i.e. labour, existing capital, and funds for investment in new capital.

Given the constraints placed on agriculture, it becomes a much less desirable sector for allocation of these resources under the constrained specification compared to the unconstrained specification, and so more of these resources end up allocated to other economic activities. This causes slight increases in production and hence water demands for some industries. Thus, it is prudent to presume that any limitations placed on the agriculture sector will not alone be sufficient to curb water demands in non-agriculture industries (in the absence of strong improvements in water use intensity). Under mid-range outcomes this is reflected in a 16.98 Mm³ and 32.76 Mm³ greater demand, across the whole economy, by 2040 and 2060 respectively.

Using Baseline Reference Future, RCP 4.5 and Technology Scenario 1. (Mm³)

	Mid-Point Reference				Range		Totals		
	Agriculture	*Municipal*	*Other*	**Total**	*Low*	*High*	*Low*	*Med*	*High*
2019-20 Base	88.47	26.95	23.03	**138.45**				**138.45**	
2039-40									
Unconstrained	132.43	34.26	33.23	**199.92**	-18.63	22.05	181.29	**199.92**	221.97
Constrained	88.47	33.91	33.05	**155.43**				**155.43**	
2059-60									
Unconstrained	170.14	40.00	43.47	**253.61**	-54.74	92.69	198.87	**253.61**	346.30
Constrained	88.58	39.40	43.23	**171.21**				**171.21**	

Indicative Additional Regional Water Demand in RCP 4.5 and Technology Scenario 1 with upper/lower range for Reference Economic Futures (Unconstrained Scenario only)

	Low		Mid		High	
2039-40	*Mm³*	*%*	*Mm³*	*%*	*Mm³*	*%*
Unconstrained	42.84	31%	**61.47**	44%	83.52	60%
Constrained			**16.98**			
2059-60						
Unconstrained	60.42	44%	**115.16**	83%	207.85	150%
Constrained			**32.76**			

Scenario Two

In this example we have selected the following scenario:

- Climate Change Future RCP 4.5
- Technology Scenario 2
- Baseline Economic Reference Future (with low/high ranges of other futures in the Unconstrained Scenario)

By selecting Technology Scenario 2, (see table below), includes annual assumed improvements in water use by all water user groups that offsets the absolute growth in demand. For example, horticulture and fruit growing is assumed to have a 1% annual decrease in water use, assuming constant production, or a 32% reduction in water use through technology and innovation by 2060. Industry and households are assumed to each achieve a 21% reduction in the intensity of water use.

Unconstrained results

These figures indicate that by 2040, the region could require between 10 Mm³ and 43.7 Mm³ more water than the 19/20 year with a mid-point of 25.9 Mm³. By 2060, the requirements could be between -3 Mm³ and 95.8 Mm³ with a mid-point of 45.7 Mm³. The contrast with Scenario 1 outcomes highlighting the impact of the higher annual improvements in water intensity on the absolute growth in demand.

Constrained Results

We see similar results to Scenario One, but with the benefit of improved water use intensity the projections are for lower upward pressure in demand of 9.6 Mm³ and 15.3 Mm³ by 2040 and 2060 respectively.

Water Demand Projections Scenario 2

Using Baseline Reference Future, RCP 4.5 and Technology Scenario 2. (Mm³)

	Mid-Point Reference				Range		Totals		
	Agriculture	*Municipal*	*Other*	**Total**	*Low*	*High*	*Low*	*Med*	*High*
2019-20 Base	88.47	26.95	23.03	**138.45**				**138.45**	
2039-40									
Unconstrained	104.52	30.37	29.46	**164.35**	-15.89	17.85	148.46	**164.35**	182.20
Constrained	88.47	30.19	29.40	**148.06**				**148.06**	
2059-60									
Unconstrained	106.09	31.44	34.17	**171.70**	-36.88	62.64	134.82	**171.70**	234.34
Constrained	88.47	31.18	34.11	**153.76**				**153.76**	

Indicative Additional Regional Water Demand in RCP 4.5 and Technology Scenario 2 with upper/lower range for Reference Economic Futures (Unconstrained Scenario only)

	Low		Mid		High	
2039-40	*Mm³*	*%*	*Mm³*	*%*	*Mm³*	*%*
Unconstrained	10.01	7%	$\boxed{25.9}$	19%	43.75	32%
Constrained			9.61			
2059-60						
Unconstrained	-3.63	-3%	$\boxed{33.25}$	24%	95.89	69%
Constrained			15.31			

These are the figures used in the Demand Projections on p.10

Scenario Three

In this example we have selected the following scenario:

- Climate Change Future RCP 4.5
- Technology Scenario 3
- Baseline Economic Reference Future (with low/high ranges of other futures in the Unconstrained Scenario)

By selecting Technology Scenario 3 (see table below), includes annual assumed improvements in water use by all water user groups that offsets the absolute growth in demand. For example, horticulture and fruit growing is assumed to have a 1.9% annual decrease in water use, assuming constant production, or a 54% reduction in water use through technology and innovation by 2060. Industry and households are assumed to each achieve a 38% reduction in the intensity of water use.

Unconstrained results

Given the very high rates of improvement in the intensity of water use, under this scenario by the 2040 year the region could need to require between 16.2 Mm³ ***less*** water and 11.4 Mm³ *more* water than the 2019/20 year. By 2060, the requirements could be between negative 47.7 Mm³ and 21.86 Mm³ *more* water.

Constrained Results

We see similar results to Scenario One and Two but based on the assumptions for improved water use intensity, the projections under this scenario are for a reduction in demand of 3.1 Mm³ by 2040 and a 20.9 Mm³ reduction in overall demand by 2060.

Water Demand Projections Scenario 3

Using Baseline Reference Future, RCP 4.5 and Technology Scenario 3. (Mm³)

	Mid-Point Reference				Range		Totals		
	Agriculture	*Municipal*	*Other*	**Total**	*Low*	*High*	*Low*	*Med*	*High*
2019-20 Base	88.47	26.95	23.03	**138.45**				**138.45**	
2039-40									
Unconstrained	82.33	26.91	26.10	**135.34**	-13.09	14.56	122.25	**135.34**	149.90
Constrained	82.33	26.91	26.10	**135.34**				**135.34**	
2059-60									
Unconstrained	65.97	24.68	26.82	**117.47**	-26.81	42.84	91	**117.47**	160.31
Constrained	65.97	24.68	26.82	**117.47**				**117.47**	

Indicative Additional Regional Water Demand in RCP 4.5 and Technology Scenario 3 with upper/lower range for Reference Economic Futures (Unconstrained Scenario only)

	Low		Mid		High	
2039-40	*Mm³*	*%*	*Mm³*	*%*	*Mm³*	*%*
Unconstrained	-16.2	-12%	**-3.11**	-2%	11.45	8%
Constrained			**-3.11**			
2059-60						
Unconstrained	-47.79	-35%	**-20.98**	-15%	21.86	16%
Constrained			**-20.98**			

Rate of improvements in water use intensity are critical to outcomes

This analysis shows the significant impact that the adoption of measures that drive water use conservation measures and more efficient use of water through improved practices and technology can have. However, the authors of this analysis provide a note of caution in relation to the model outputs. They acknowledge that the key assumptions are sourced from international literature and the applicability to the Hawke's Bay environment is not certain. They observe that:

"This study has also applied constant annual rates of change in water use intensity when projecting forward future water demands. Although this is a reasonably typical approach to the inclusion of technological change within future forecasts, one should note that when the timeframe is reasonably long, such as the 40 years of this study, small differences in the annual rate chosen will accumulate to very large changes in water use overall. As there are likely to be diminishing returns to actions that reduce water use intensity, it may not be realistic to assume that the same rate of decline can be achieved over the longer timeframes i.e., a diminishing rate of change may be more appropriate."

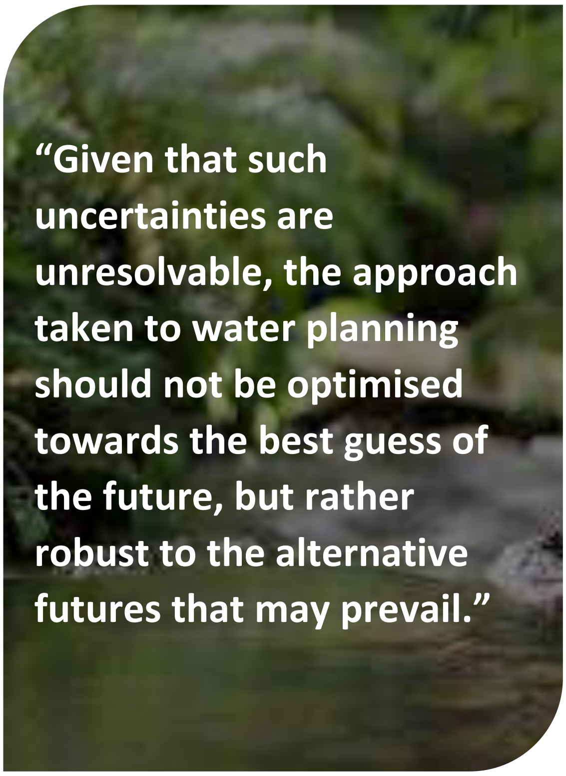
Summary of demand projections

The following concluding comments are made:

"Planning and managing the region's water uses is clearly an example of decision making under significant and unresolvable uncertainty. The range of scenarios considered in this application illustrate that future water demands will vary significantly depending on the economic context and economic growth pathway followed by the regional/national/international economic system, the ability to implement improvements in water use technologies, and the way water is allocated among uses.

Generally, the level of uncertainty also grows the further out in time we attempt to look. Given that such uncertainties are unresolvable, the approach taken to water planning should not be optimised towards the best guess of the future, but rather robust to the alternative futures that may prevail.

There is also a need to constantly monitor, reflect and re-evaluate as more information becomes available. For these reasons water use accounts and projections should be produced regularly as part of the ongoing process of resource management within the region."



Irrigation potential in Hawke's Bay

The RWA has not been commissioned to specifically investigate or assess the potential for water storage to bring new areas of land under irrigation. Rather, the focus has been to consider what the future water supply and demand balance is projected to be, using the 19/20 year as a reference point, without introducing new industry.

Furthermore, this report potentially highlights the need to prioritise any additional water secured via water storage towards increasing the resilience of the region's freshwater resource ahead of increasing the region's reliance on that same resource.

However, for completeness we include references to past investigations on this matter.

In 2009 and 2011, Regional Council commissioned two separate feasibility studies to be undertaken on irrigation potential in the Ruataniwha Plains/Central Hawke's Bay area, and the Heretaunga Plains area.[52] The land included in the calculations is the most suitable areas of land for irrigation i.e., relatively flat rolling land, and other more rolling country was discounted.

The potential area of irrigable land, and the total water requirements for the two areas are shown in the table below:

Area	Potential new irrigable land (ha)	Average irrigation demand (m^3/ha/pa.)	Total water required (Mm^3)
Ruataniwha Plains	22,500	3.5	80
Heretaunga Plains	3,500	3.5	12
TOTAL	**25,500**	-	**92**

Figure 21 Estimated additional irrigation land and water requirement

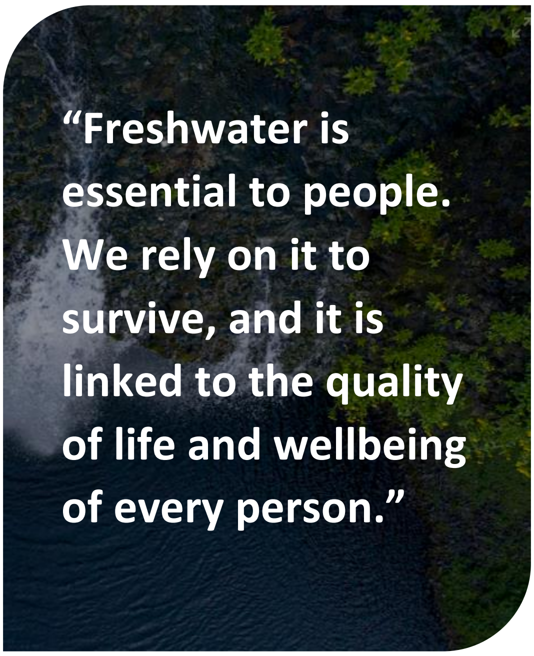
SECTION FIVE: Recommendations for Freshwater Security Interventions

Freshwater security intervention introduction

Long-term regional water security will require changes to the way our water is managed. This section briefly outlines and discusses the regulatory framework for managing freshwater under the Resource Management Act 1991, specifically in respect of water quantity, the complexity associated with water allocation, the current policy approaches that are used to manage water allocation and use and the challenge over-use provides water managers and the community. It is too early to speculate how the proposed RMA reform will impact these issues.

These measures, actions, processes, and programmes are collectively termed policy interventions. The report will provide:

- A description of the intervention;
- High-level summary of benefits and costs;
- Brief case studies (where available) and estimated water savings (where available).



Freshwater Management – Water Quantity

The region’s natural freshwater resources include rivers, streams, springs, lakes and wetlands and groundwater. There is usually a high degree of hydraulic connection between surface water resources and groundwater systems, and in turn with lakes and wetlands. They are part of the hydrologic cycle, dependent on rainfall and drainage through the land and affected by evaporation and transpiration from vegetation. Changes to rainfall patterns due to climate change may change the characteristics of the winter and summer river flows and the volume of recharge of groundwater systems.

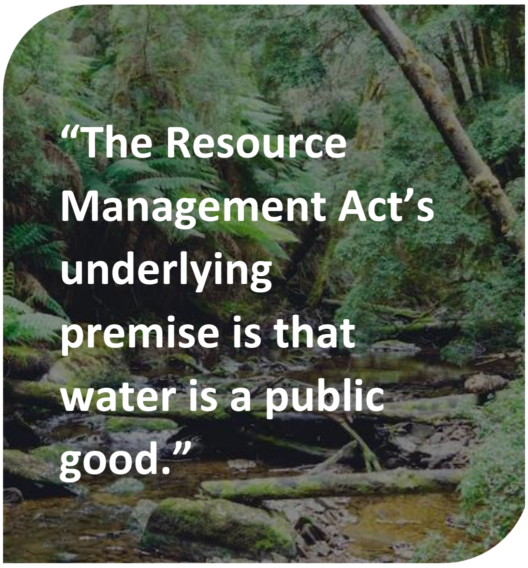
Freshwater is essential to people. We rely on it to survive, and it is linked to the quality of life and wellbeing of every person. It supports social, cultural, ecological, and recreational values and we rely on it for the region’s prosperity. Taking water out of the rivers and groundwater cannot be avoided. These factors make freshwater a dynamic and complex resource to manage from a water quantity perspective.

Planning Framework

The Resource Management Act is the primary legislation for managing freshwater in New Zealand. The RMA’s underlying premise is that water is a public good, in that the law says that a person cannot take water unless it is allowed under s14 of the Act (individual drinking water needs, stock drinking needs, firefighting purposes), is a permitted activity, or is authorised by a resource consent. Land however is considered a private good, in that the law says you can do anything on your land, unless a rule in a plan says you can’t, or can with conditions.

Regional Councils have the primary responsibility for managing freshwater. In addition to the preparation of Regional Policy Statements and Regional Plans for the purpose of managing freshwater, there are several planning instruments that can be prepared within the RMA to guide, assist and direct regional councils in performing this function including National Policy Statements and National Environmental Standards.

The regional water assessment background and context section provided a summary of the National Policy Statement for Freshwater Management 2020 and the potential consequences of the Te Mana o Te Wai framework.



This hierarchy of obligation or priority comes from the principles of Te Mana o Te Wai. In terms of the water quantity aspect of freshwater management, the setting of environmental flows and allocation limits in a regional plan would be intended to meet or contribute to the first priority.

Of the water determined to be available for allocation to consumptive uses, the second priority would indicate that a quantity/rate should be allocated for the health needs of the community, such as drinking water needs of people and stock.

It follows that a quantitative assessment of water for existing and future health needs would be required for this purpose. This is not necessarily a 'free for all' block of water.

The future demand for water for health needs can be managed/controlled by growth strategies and land use controls. This can both limit growth to ensure the future water demand of any proposed growth area can be met or allow growth where a future allocation for health needs has been provided for through planning processes.

This is more easily controlled where growth areas are to be serviced by local authorities. Other areas such as rural zoned land where zoning typically allows 1 or 2 households, the total 'water' health need and source is less easily determined but it would be possible.

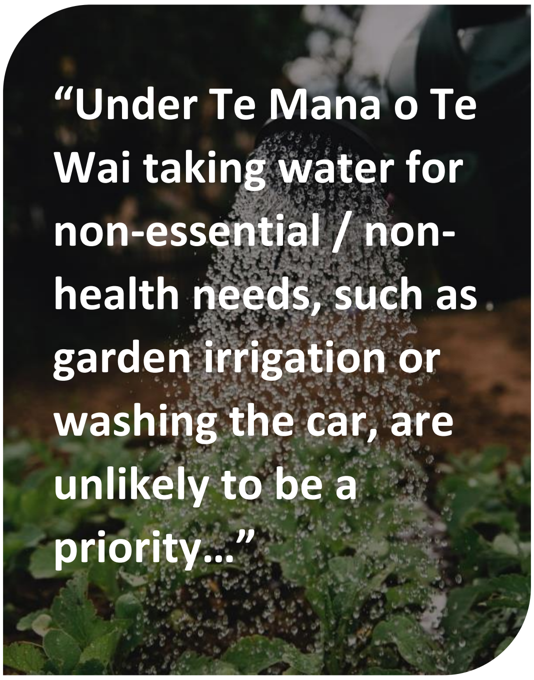
This "health needs' water would be limited to drinking water and providing sanitary services so the amount needed per person per day could be quite low and the cumulative amount in a sub-catchment, catchment, or region small relative to the total consumptive use which includes commercial, industrial and irrigation.

Under Te Mana o Te Wai, taking water for non-essential / non-health needs, such as garden irrigation or washing the car are unlikely to be a priority under this objective.

The third priority for the water remaining to be allocated is water that enables people and communities to provide for their social, economic, or cultural wellbeing, now and in the future. For the first time, Regional Council has set an allocation for cultural purposes in the TANK Proposed Plan Change. Otherwise, regional plans have not generally set aside specific allocation for other purposes.

Small water takes are often a permitted activity and councils do not necessarily know how many takes are active under the permitted activity rules. This makes quantifying the volume of take and the source of water difficult. In some catchments where water is scarce or water is fully or overallocated, there are no permitted activity rules for small takes; all takes require a resource consent. Despite the difficulty in quantifying permitted activity takes, and notwithstanding the cumulative volume is likely to be small relative to the total abstractive takes, some form of quantification is required so they can be accounted for in the remaining allocation block.

Other than permitted activities, all remaining water is generally allocated via the resource consent process, and it is generally water used for economic purposes. Where there is available water, both in terms of physical availability and any limits that apply at that site, consents will generally be granted provided that the applicant has demonstrated reasonable need and efficient use.



Managing allocation where interests compete

The RMA does not provide any guidance on allocating the resource among competing users, other than:

- stating that taking an individual's reasonable drinking water, stock drinking water, and water used for firefighting purposes is allowed without needing a consent, and
- giving some priority to existing consent holders over new applications.

Regional Councils are limited to considering the effects on the environment and the efficient use of water for the proposed end-use; they cannot consider whether the proposed end-use itself is of greater or lesser value or worth than another end-use.[53] Provided it was a reasonable need and the water was available, there would be little reason to decline the application.

In terms of giving priority to existing consent holders, councils must have regard to the consent holder's efficient use of the resource, adherence to industry good practice, the value of the investment and any enforcement issues when determining the application.

The principle of 'first in first served' arose when there was competing demand for a scarce resource and case law found that applications for resource consents should be determined in the order that the (complete) application was received. The application could only be assessed on its own merits and in isolation of other applications, with the RMA providing no further guidance on how to deal with competing users. That said, some councils had, for a long time, already set common expiry dates on a catchment basis so that all existing takes could be considered at the same time upon renewal, and to determine whether there was any water left over to allocate. This is now considered best practice.

Where a water resource becomes fully allocated due to decisions on consent applications, then based on the first-in-first-served principle, subsequent applications that fall outside the allocation limit are declined.

There are tools within the RMA, such as transfer mechanisms that were intended to drive efficient water use. A transfer of a water permit may allow the water to be used for highest value uses. The entity with the highest value use may be willing to pay the most and can compensate current users for the consumption that they are giving up. However, transfer/trading is limited to within the same catchment and aquifer and needs Council approval, with associated costs. And while water permits are not a property right, a water permit is associated with a particular parcel of land and can increase the value of that land, accordingly, thus selling the land with water is probably a better financial proposition than transferring the water and being left with land without water.

Where there is over-allocation

How does a freshwater resource find itself in a state of over-allocation?

The freshwater resources of New Zealand have been managed since 1967 with the Water and Soil Conservation Act 1967 and then the effects-based Resource Management Act 1991. Extensive water resource investigations have been undertaken over the last 50 years and catchment management plans prepared based on the level of science known at the time and the requirements of the legislation. Scientific knowledge is always increasing, and management plans were adapted to take into account new information.

The setting of minimum flows, or low flow limits or environmental flows has evolved over the years in various planning documents. Limits on the total amount of abstraction came later, but not all plans included allocation limits in every catchment. The use of minimum flows without any cap on abstraction effectively flat lined the river at a low flow for a long period of time. This would have been detrimental to the eco-system of the river.

The imposition of allocation limits seeks to restore the river or groundwater to a river flow/groundwater level regime that is more sustainable, supporting the eco-systems of the freshwater resources while allowing people and communities to live and prosper.

It is probably fair to say that freshwater allocation limits have never been imposed on a resource that had no or very few takes from it. Water managers have always had to deal with existing users when bringing in new management structures, such as allocation limits around freshwater management.

Initially, the allocation limit might have been set based on the amount the existing users were taking, and then adding a bit more for future takes. There might not have been the scientific knowledge at the time to indicate that this might not be sustainable in the long term, or to support a restriction on existing users.

As scientific understanding of the freshwater ecosystems and flow patterns increased, models were established to assist in setting scientific based methodologies for determining the acceptable minimum flow and allocation limit.

This might have resulted in some catchments where the existing takes exceeded the scientifically based allocation limit. Even in some of these situations, the allocation limit might be adjusted to reflect current takes to avoid the negative impacts on existing users.

At the same time, demand for water increased dramatically, particularly for irrigation with the growth of dairying and horticulture. Elected Council representatives had to make the decisions based on the social, economic, and political situation of the day.

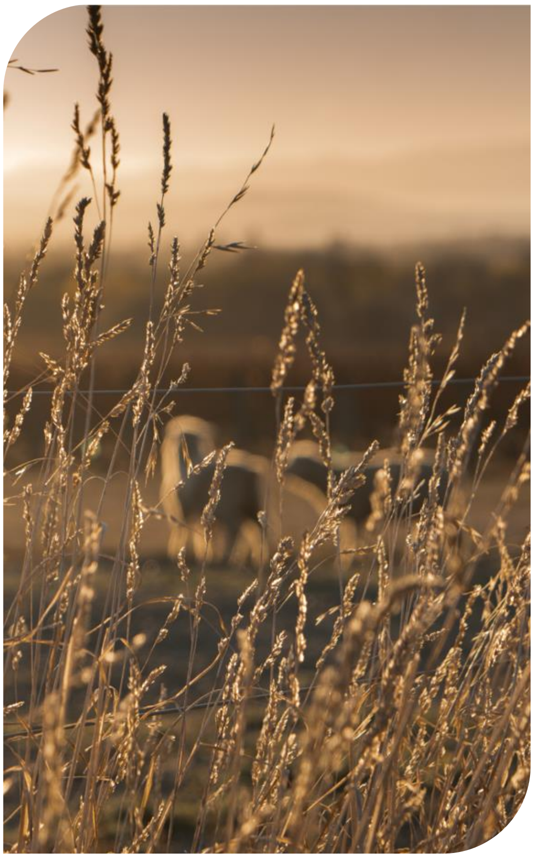


Figure 22 Tukituki River in mid-summer

It is noted that the reportedly poor state of many of New Zealand's freshwater resources are not solely a result of decisions on water quantity management.

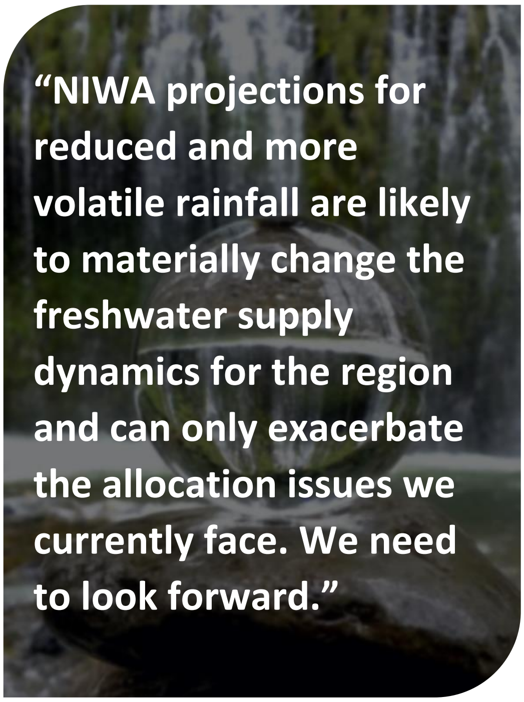
Land use intensification and diffuse discharges has contributed to degradation in water quality.

The NPS-FM2020 requires that overallocation is avoided and steps are taken to clawback allocation where it is over-allocated. This means that allocations to existing consent-holders may need to be reduced to fit within the allocation limits.

Sometimes the state of over-allocation is only 'on paper', that is while the amount or rate of water authorised to be taken by the resource consents might add up to exceeding the allocation limit, the actual amount /rate of water taken may well be within the allocation. This means that the status of 'overallocated resource' and any perceived adverse environmental effects on the freshwater body from the state of 'over-allocation' are not actually real.

This may occur where the amount allocated reflected a peak demand for a proposed development and that development has not yet been completed. For irrigation takes, the amount allocated reflects the crop water requirement in a particular return period drought and for a maximum area of crop development. Where climate conditions do not result in a drought of that return period, less water would be needed and taken. The amount authorised does however provide a reliability and security of supply for the grower which is important for the business operation.

Without detracting from the concerns of many in the community about the shortcomings of the historical processes of water allocation, the rapidly accelerating impacts of a changing climate on freshwater supply are guaranteed to impact the way water is managed in the future. Quite simply, NIWA projections for reduced and more volatile rainfall are likely to materially change the freshwater supply dynamics for the region and can only exacerbate the allocation issues we currently face. We need to look forward.



Managing over-allocation

Many regional councils have grappled with this situation, as has Regional Council with the TANK Plan Change 9 (PC9). In PC9, a range of policy approaches have been proposed to move the existing allocation back within limits. The new policies include:

- No further water can be allocated from most of the water bodies in these catchments;
- In some catchments, including the Heretaunga Plains groundwater and surface takes from the Ngaruroro River, water allocation is to be reduced based on actual and reasonable need (based on a specified 10-year period);
- New applications for water in many areas will be prohibited;
- To ensure efficient use of allocated water, a 95% reliability standard will be applied to irrigation takes;
- Enabling and supporting permit holders to develop flexible approaches to management and use of allocatable water within a management zone, including through catchment collectives, water user groups, consent or well sharing, or global water permits;
- Ensuring that transfers do not result in increased water use and to prevent the transfer of allocated but unused water; and
- Requiring extractive water users to contribute to the maintenance of flow in nearby waterways in proportion to the modelled impact of their abstraction on that waterbody.

Other Tools in Freshwater Management

Many existing consent holders have made significant investments in infrastructure and their businesses, and are important contributors to Hawke's Bay's economic wellbeing. With that in mind, if water conservation, efficient water use, and restricting individual allocations to

actual and reasonable needs is not sufficient to bring the overall allocation to within the allocation limit, what should the next steps be?

Should consented volumes be reduced on a pro-rata basis across all consents, should priority be given to certain uses and if so on what basis - a value per unit of water? Would a charging regime result in the businesses getting the most value from the water used surviving while others do not?

There has been much commentary on the use of market tools to drive allocation efficiency. The following tools are not currently provided for in the RMA or LGA:

- Tradeable permits (an improved mechanism than provided by s136);
- Collection of royalties (as provided for minerals);
- Recoveries of money (as provided for with geothermal resources);
- Tendering mechanisms to allot water; and
- Charging for water taken (beyond current s36 provisions).

Chapter 11 of the report of the Resource Management Review Panel (June 2020), titled New Directions for Resource Management in New Zealand[54] (The Randerson Report), considers water allocation and economic instruments. It comprehensively describes the issues and challenges associated with the current allocation systems and looks at a range of options.

There is an acceptance that greater national direction is required, along with better economic instruments. This report and its recommendations now sit at the centre of the most significant resource management reform proposed since the RMA came into force thirty years ago.

These issues have also been usefully summarised in a 2019 Otago Law dissertation.[55] Here the researcher concluded that, provided essential water (environmental and health needs) are adequately provided for, private property-based mechanisms could work for the remaining extractive uses. The use of economic instruments is unlikely to be progressed in any meaningful way until such time as iwi/Māori rights and interests around freshwater are considered and resolved at a national level.

Water Allocation and Iwi/Māori Rights and Interests[56]

The Randerson Report considered the impact of the Resource Management Act as a whole and the water allocation framework on iwi/Māori rights and interests. In terms of water allocation, it states:

"The first-in-first-served approach has particularly disadvantaged Māori in cases where they own under-developed land and cannot access water to improve production capacity, for example, when land is returned through Tiriti settlements. Māori see water as whakapapa with access confirmed by Te Tiriti.''

"Factors that have made better allocation of water resources difficult include little strategic planning to set limits, uncertainty in process and science, high transaction costs of permit trading due to the need for councils to compare environmental effects, tensions between certainty and flexibility in length of consent terms, and stalled discussions between the Crown and Māori with regard to rights and interests in freshwater"'.

"The government is yet to resolve Māori rights and interests in freshwater, although this is considered to be an important element in reform."

"…a more responsive system is now needed to address cumulative environmental effects and pressures arising as a result of climate change. It is also needed to provide access to resources for new users and Māori."

These concerns are reflected in the submissions received from various iwi/Māori groups to Council. Submissions on TANK Plan Change 9 is one example where these groups felt that the plan change should:

- Recognise and provide for their ancestral connections to their waters, wāhi tapu and taonga;
- Address their Treaty rights and propriety interests; and
- Address the cultural wellbeing of iwi/Māori.

Submissions suggested that allocative models may also include tikanga, whakapapa, recognition of rangatiratanga and Ngāti Kahungunu's native title and proprietary interests; and a mixed model that applies elements of these. Submitters sought a rethinking of the allocation principles/policies, to one that doesn't rely exclusively on first-in-first-served and 'grandparenting' and that enables allocation of water in a way that provides for tikanga and other iwi/Māori principles associated with freshwater management, including:

- Priority to specific limits that provide for mauri and environmental protections; and
- A cultural share for Ngāti Kahungunu; and
- Allocation for essential community wellbeing and use (such as drinking water for communities); and
- Allocation for commercial users on a competitive (willing lessee) on a discretionary basis, via a mixed-market model, incorporating a tender or bidding system, while also taking existing users into account.

As noted above, the impacts of resource management reform, a commitment by Government to tackle the rights and interests of iwi/Māori in freshwater (and allocation generally), and the stark realities of a more volatile climate, all combine to suggest that new tools and frameworks for freshwater management are required.

Supply and Demand

A more strategic approach is required to ensure that Hawke's Bay has long term, climate resilient and secure supplies for freshwater, *for all*, while at the same time giving priority to the essential uses as required by the RMA. This requires consideration of the factors that will affect supply and demand.

This section outlines the tools, such as policies, physical interventions, and behaviour change, that could potentially increase supply or reduce demand. Regional Council's Regional Water Security Programme is investigating these interventions to determine if they are options for a long-term strategy.

Factors which may affect demand, both positively and negatively, include:

- Population growth;
- People's behaviour around water conservation and efficiency;
- Changing land use and land-use practices to more or less water intensive systems;
- Use of innovation and technology to reduce industrial water use and wastewater discharges;
- How people and communities value the end-use of the water; and
- Water pressure in reticulated supplies.

Factors which may affect supply both positively and negatively include:

- Climate change – unpredictable rainfall, changing rainfall patterns, changing flow dynamics on which environmental flows and allocation limits are based, changing land use;
- Allocation limits;
- Reliability/design and maintenance of reticulated infrastructure – pipework, reservoirs, pressure;
- Creating new reservoirs to store high-flow winter water for use in the drier summer months, including aquifer recharge schemes; and
- Recycling water and wastewater.

Currently, there are areas in Hawke's Bay where demand exceeds supply. This could be addressed by reductions in volumes authorised by resource consents, but it would not be without economic impacts to individual businesses and the community. It could also be addressed through finding new water, with its own economic costs and environmental considerations. Other measures could also be taken to reduce water use in other areas and ensuring efficient water use.

Conversely, there are some areas in the region where supply exceeds demand, such as the Wairoa and Mohaka Districts. Perhaps policies that promote and support taking industry to water instead of moving water to industry can be an important component of achieving a more enduring regional water balance.

In the long term, well-being and prosperity of the region relies on local government (regional, district and city councils) having a sound understanding of supply and possible future supplies to align growth and future water demand – enabling communities to take steps to ensure supply and demand align.

The range of different interventions that could be imposed by local government and central government to address current and future supply/demand issues are addressed in the next section.

Intervention descriptions

The report describes a range of courses of actions and interventions that could be implemented to reduce consumer demand, reduce losses in reticulated systems and create 'new water' to meet current and future needs. A mixture on regulatory and non-regulatory interventions is recommended by practitioners in this area.

Water metering and volumetric charging are emerging as key drivers for reduction in water use with the range of conservation measures and efficient water fixtures being used to achieve the reductions. Such reductions may in some cases offset the need for new water supply sources/infrastructure.

With irrigation being the largest user, efficient use of that water is essential. Farming practices which improve/optimise the water holding capacity of the land and the soil profile will add resilience to the farming business, particularly the dryland farm.

Unconstrained projections for agricultural use did not directly involve assumptions about an increase in the area under irrigation. As a first estimate, the quantity of future water demanded by agriculture, whether for irrigation or other purposes, was simply assumed to scale in proportion to the change in agricultural output.

However, any improvements in water use intensity were then used to adjust this estimate. In addition to the effect of increasing agricultural production, additional water necessary to maintain production under climate change was added to the demand estimates. The researchers employed a calculation that factored changes in plant requirements and then estimated a corresponding increase in irrigation requirements to maintain production.

Figure 23 Artist's impression of Central Hawke's Bay's Managed Aquifer Recharge trial

Demand Interventions

Irrigation

Irrigation of agricultural crops is the largest water user in Hawke's Bay, accounting for some 80% of the total volume of water consented (but in 19/20 year 54% of total volume used). Irrigation systems range from drip irrigation of grapes, apples and summer fruits to big gun and centre pivot irrigators for arable crops and pasture.

Design standards and industry codes of practice have been developed to ensure irrigation systems deliver the water efficiency where it is needed. These have been incorporated into recent policies in the TANK plan change 9.

While still only proposed, it states:

When considering applications for resource consent, the Council will ensure water is allocated and used efficiently by:

a) ensuring that the technical means of using water are physically efficient through;

> *(i) allocation of water for irrigation end-uses based on soil, climate and crop needs;*
>
> *(ii) requiring the adoption of good practice water use technology and processes that minimise the amount of water wasted; and*
>
> *(iii) the use of water meters;*

b) using the IRRICALC water demand model if available for the land use being applied for (or otherwise by a suitable equivalent approved by Council) to determine efficient water allocations for irrigation uses;

c) allocating water for irrigation on the basis of a minimum water application efficiency standard of 80% and on a reliability standard that meets demand 95% of the time;

Figure 24 Pod irrigator credit: WaterForce

d) requiring all non-irrigation water takes (except as provided by Policy 50 for municipal and papakāinga supplies) to show how water use efficiency of at least 80% is being met and is consistent with any applicable industry good practice;

e) requiring new water takes and irrigation systems to be designed and installed in accordance with industry codes of practice and standards;

f) requiring irrigation and other water use systems to be maintained and operated to ensure on-going efficient water use in accordance with any applicable industry codes of practice.

Developing irrigation systems to meet the design standards and allocating water on the basis of soil, climate and crop needs provides a consistency for all irrigators and sets an acceptable standard for efficiency.

Benefits of irrigation standards include:

- Industry driven standards
- Efficiency driven means energy savings

Costs:

- Industry accepted costs

Agriculture conservation

There are a range of farming practices that can reduce water use, reduce water waste or hold the water on the land or soil longer. These include:

- Low or nil tillage
- Use of cover crop and planting inter-rows
- Selecting perennial crops over annual crops
- Selecting deep rooting crops
- Co-ordinating crop/animal rotations for improved mulching/ organic inputs
- Increasing the organic content of the soil
- Changing to subsurface irrigation if appropriate
- Improving rainwater harvesting – such as through restoring wetland areas
- Contour cultivation
- Fixing leaks in farm reticulation systems

For a dryland farm relying on rain, all these aspects are important but should also be important for irrigated farmland as a means of reducing irrigation demand.

There is a growing interest in 'regenerative farming' as a means of changing to a more sustainable agricultural system and to adapt to climate change. Regenerative agriculture has a broader scope than just water conservation. While regenerative agriculture has a broader scope than just water conservation, it does increase the amount of organic matter, which in turn increases the soil's ability to hold water and make the most of rainfall or irrigation.

Figure 25: Mulching crops

Figure 26 Farm wetlands – Credit Christel Yardley/Fairfax

Benefits of regenerative farming include:

- Increased organic matter in topsoil increases water holding capacity
- Ponds and wetlands help maintain water tables
- Water runoff is minimised or captured
- Exposure of bare soil/cultivated soil is minimised, reducing loss of nutrients and runoff

Costs:

- Education programmes, new technology and land use change

Demand management for reticulated public supply

There are a number of demand management actions that a local authority could implement and some of these are addressed in more detail in other sections of this report. The range of actions include:

- Infrastructure maintenance – fixing system leaks, programme of fixing household leaks;
- Water pressure reduction to reduce leakages in the system, and also reduce end-user use;
- Encourage end-user water conservation and efficiency measures and choice of water saving fixtures through education and social media programmes;
- Encouraging xeriscaping, which means matching the garden to the climate and landscape conditions, with councils providing an example of best practice;
- Encouraging the installation of onsite rainwater tanks, collection of greywater for garden irrigation through incentives and rebates or requiring such installation in new building through District Plan provisions;
- Water metering and volumetric charging;
- Other economic tools such as tariffs, water and wastewater charging, incentives and rebates to encourage innovative water systems in new builds using smart technologies.

Managing the demand on reticulated public water supplies has a number of benefits in addition to the obvious reduced demand of the water resource. The benefits are set out in the document Slowing the Flow (Aug 2008, page 5).

Figure 27: Hastings District Council small community water supply upgrades

Benefits of managing demand for reticulated public supply include:

- Cost savings through delaying or eliminating new capital infrastructure
- Reduced waste management costs, and reduced energy costs in households and in water and wastewater treatment
- Reducing demand, particularly competing demands, also builds resilience in the reticulation systems

Costs:

- Operational and maintenance costs
- Social marketing costs

Urban conservation and efficiency measures

It is helpful to start with a definition of water conservation and water efficiency:

Water conservation

as *'a beneficial reduction in water loss, waste or use. Water conservation includes all policies, programmes and practices designed to help people change their behaviours and use less water. The goal is to use only the water needed e.g., turning off the tap while brushing your teeth, or only running the dishwasher when full.'*

Water efficiency

as *'Minimisation of the amount of water used to accomplish a function, task or result. Water efficiency means doing more with less water e.g., washing dishes or flushing the toilet with the least amount of water necessary to get the job done. Water efficiency normally relies on well-engineered products or fixtures like reduced water use dishwashers or low flow toilets and shower heads'*

Water conservation measures are often the first phase of any community awareness programme where the council is asking the community to start reducing its water use to get through a peak summer water use period. It is usually voluntary and conveyed through various social marketing and educational channels.

It is usually targeted at domestic use within the household and the garden, asking residents to reduce loss, waste or use by fixing leaks and leaky taps, minimising car washes or washing cars on permeable surface, only flushing when 'brown', shortening shower times, only watering the garden with handheld hoses etc. In a reduced water supply/drought situation, water restrictions are generally put in place, often restricting garden watering and car washing. Auckland Council has also restricted commercial users in the 2020 drought situation. They have developed a separate website called WaterforLife to hold all information relating to the restrictions and conservation measures that can be undertaken.

Increasing water efficiency is generally achieved by purchasing water efficient products. These come with a WELS star rating. WELS, short for Water Efficiency Labelling Scheme, provides a national standardised star-rating system, with the more stars a product has, the more water efficient it is. It allows consumers to compare the water efficiency across different brands.

Products include dual flush toilets, low flow shower heads, tap aerators, 4-star rated washing machines.

Councils can encourage consumer choice through rebate schemes or promotions, or engineering standards for new builds to meet sustainable housing outcomes.

Water conservation and water efficiency is important in the urban/ community water supply context to get through a summer peak demand, or when supported by water metering and volumetric pricing, can provide significant reductions to hold off the need for additional water sources.

For rural households with their own water supplies, whether from rainwater collection, groundwater or springs, water conservation awareness is likely to be higher, but the education and knowledge about what further steps could be taken to conserve water would be equally valuable.

Industry can also make water savings in their processes from simply measures such as fixing leaks or preventing free running hoses to changes to process design and use of innovative technology. Often measures taken to save water use is driven by the desire to reduce trade waste discharges and associated costs and to reduce wastewater discharges into the environment.

Benefits of urban conservation and efficiency measures include:

- sufficient reductions to get through short periods of peak summer demand, particularly if there are mandatory restrictions;
- Water conservation habits continuing to be normal practice; and
- For industry - reduced wastewater discharges and associated costs.

Costs:

- Significant social marketing and communication strategy required to effect change in people’s behaviours.

Figure 29 Hawke's Bay councils already run summer water conservation campaigns, including encouraging people to wash their cars on the lawn

Urban water meters

Urban water supply networks provide water to properties within the distribution area including residential, commercial, and industrial properties. Having a water meter on each of these connections is recognised as an important tool in domestic water supply demand management, enabling unaccounted for water (losses in the network) to be identified, increased user awareness of their water use and enabling volumetric charging as an additional intervention to reduce demand.

A water meter is the most common form of a water measuring device for piped water supplies. Accuracy and reliability of meters varies but the technology appears to be becoming increasingly 'smart'.

Many towns and cities in New Zealand already have universal water metering on their urban water supplies but many do not, including Hawke's Bay urban water supplies.

In 2017, Water NZ undertook a survey and prepared a report titled New Zealand Water Consumer Survey 2017[57].

It looked at consumers response to questions on water efficiency, pricing, consumer experience, future of water and healthy waterways. The following is an extract relating to pricing.

Consumer perceptions appear to be aligning with a desire for transparent pricing. More than three in five respondents (63%) agree that they would prefer to pay for how much water they use rather than a fixed charge. One in four respondents (25%) neither agree or disagree or are unsure and 12% of respondents disagree and would prefer to pay a fixed charge. Pay-for-use pricing could support demand management and water resource allocations. In cities where there are large infrastructure upgrades it would also help in terms of pricing models that would drive behaviour. For example, smart water meters with peak and off-peak pricing models would help incentivise customers to use water in low demand periods, thereby delaying or reducing needs for costly infrastructure upgrades.

Figure 30: Checking a water meter. Credit: Watercare

Water New Zealand has updated its Good Practice Guide for Metering of Customers on Reticulated Supplies (May 2017)[58].

For other consented takes, water measuring devices are required to be installed on all surface and groundwater takes taking at a rate of over 5 l/sec under Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 and recently amended in 2020.[59]

The driver for the regulation was to improve New Zealand's ability to quantify how much water is being used in New Zealand to enable better management of the freshwater resources. This requirement applies to all new takes with existing takes being phased in from 2022 to 2026.

This will mean that nearly all irrigation takes, industrial and commercial takes, urban water supply takes will be metered in some form and the quantities of water taken reported.

Benefits for urban water meters include:

- Identifies leaks;
- Increased awareness of actual water use;
- Enables volumetric charging;
- Reduces water use; and
- Avoids / defers capital expenditure of additional supply infrastructure, e.g., storage.

Costs:

- Significant capital expenditure
- Equipment faults and maintenance
- Administration costs of charging regime

Water pricing

The Resource Management Act allows district councils to charge fees to recover the operational costs of supplying water, and the repairs and maintenance associated with the water supply network.

Councils without water meters do this via a general, differential, or targeted rate. Councils which have required water meters can use a volumetric charge as a basis for recovering the costs of supply. Often there is a fixed charge for a set volume of water, with a rate per volume charge for any water taken over and above that set volume.

As provided in the previous section, the use of water meters enables volumetric charging and has been shown to result in a reduction in water demand. A study of water pricing in Europe found that:

- *Water pricing policies implemented in combination with other non-pricing measures prove to be most effective in reducing household water consumption. Water demand management strategies need to find the right mix of pricing and non-pricing instruments.*
- *In some of the case studies, price does not appear to be a significant determinant of water demand. However, the overall results indicate that EU households facing a water price increase will react by reducing water consumption. Independently from water consumption targets - water pricing still remains a key instrument in achieving cost recovery for water services to ensure the maintenance and financing of existing and future water infrastructure.*

The RMA allows Regional Councils to charge fees to recover the costs of environmental management and resource consent monitoring, among other matters. It cannot charge for the water it allocates via a resource consent as if it were selling it.

But just as water meters and volumetric charging on individual connections on a public

Figure 31 Charging by volume has been found to reduce demand

water supply can reduce water demand, it is also likely that should a charging regime be applied to water users (and for that matter dischargers), there would be a reduction in water use and could therefore, be a tool for managing over-allocation. This was considered in a 2019 Otago Law dissertation *Freshwater Scarcity and the RMA: Developing Legal Tools to Achieve Efficient Outcomes (Ben Methven)*. The monies collected from such a charge *could serve several purposes beyond efficiency, such as providing a community return, and remedying adverse environmental effects. By in large, these purposes align with environmental, social and cultural values.*

The main reason why legislation has not provided that option is the question of "who owns the water". The position of the current Government is that no one owns the water. Water rights and interests is still a significant outstanding issue for iwi/Māori and in the context of water scarcity and security, and the benefits that charging may bring to water use efficiency, it is a conversation that any water security options recommended would need to consider.

Benefits of water pricing include:

- Reduced demand
- Cost recovery

Costs:

- Reduced demand will mean reduced revenue

Other economic instruments

Economic instruments can include financial incentives such as rebates. For example, to encourage water efficiency, a council may provide a rate rebate if the ratepayer installs a particular water efficient device such as a front loader washing machine.

Benefits of other economic instruments include:

- Reduced demand

Costs:

- Costs of rebates

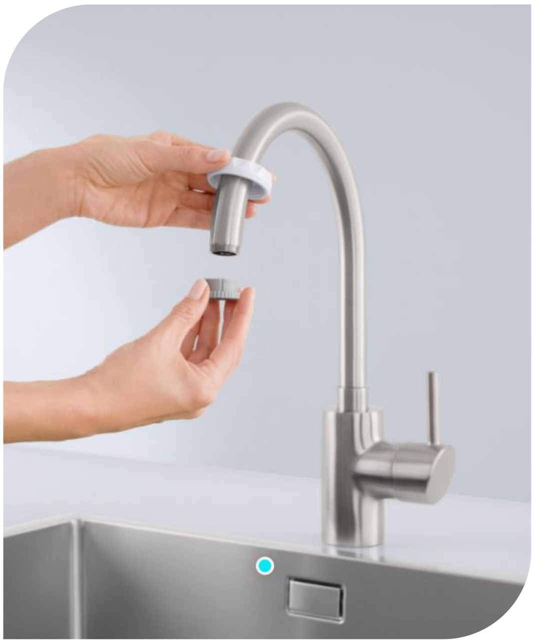


Figure 32 Councils can provide rebates for water efficiencies devices

Supply Interventions

Community Storage Infrastructure

Building reservoirs to collect water for future use is a traditional method of creating more water supply to meet demand. Water storage infrastructure can range from large scale dam structures on main river stems capturing all flow with varying flow release regimes, harvesting high flows only and pumping into off-river reservoirs, to small-scale, community storage reservoirs.

Large scale storage proposals can face stiff opposition from various sectors of the community. For the Ruataniwha Water Storage Scheme (RWSS), a primary concern was that the provision of water would enable land-use change, including dairying, in the area, leading to environmental degradation. There are also community tensions about the investment required, who pays and who benefits.

On farm storage reservoirs are often located on small springs and in small valleys collecting the runoff during rain events, with little or no flow during summer months.

Some storage reservoirs are by necessity created on flat land with the reservoir dug into the ground and walls built around the impoundment. Water is then pumped from a nearby river to fill it. Such impoundments have often been created for frost protection or for irrigation when the take from the river has been banned due to low flow restrictions.

Whether it is small-scale or large-scale storage, it captures the high flows of winter and storm events. Allocation limits are also proposed to manage the extent of that water capture. Large-scale water storage would require access to all that water to be efficient. Should the same rules of first-in-first-served apply or should consideration be given to priority of use?

Economies of scale point to a single, large scale or multiple smaller community storage schemes to support a change to a higher value horticultural land use. The Te Taitokerau Water Trust project is an example of such a scheme, as

Figure 33 Waimea Community Dam currently being constructed

was the Wakamoeka Community Water Storage Scheme in the Wairarapa.

The RWSS was a much larger project than options being investigated for the Heretaunga Plains, however it is an example of the commitment of time and investment required to undertake a community-scale project from pre-feasibility to feasibility and consenting. Such structures and associated takes are regulated through the Resource Management Act and the Building Act.

Innovative funding models are likely to be required to ensure the costs are equitably shared over the beneficiaries – direct and indirect and over time.

The RWSP is investigating options for small-to-medium scale, community storage on tributaries of the Ngaruroro as one option for supporting water security on the Heretaunga Plains. This investigation is proceeding on the expectation that the primary focus of any viable and community-supported project would be to supplement environmental flows through the dry periods as a partial offset for cumulative impacts of irrigation.

Benefits of community storage infrastructure include:

- Able to store large volumes of water
- Able to be multi-purpose – urban supply, irrigation, recreation
- Able to meet future demand
- Increased reliability of supply

Costs:

- Significant investment costs – prefeasibility, feasibility, regulatory costs;

- Effects on the environments – changes to river flow regimes, water quality, ecosystems; and
- Cultural impacts.

Managed Aquifer Recharge

Regional Council is currently undertaking its own investigations into Managed Aquifer Recharge (MAR).

MAR is a term that covers artificial recharge, aquifer storage and recovery, riverbank and riverbed filtration, groundwater banking, and other mechanisms of purposeful water recharge to aquifers for later recovery. MAR use has grown rapidly over the last two decades, progressing from an often-experimental concept to a management tool used in over 1000 sites around the world.

MAR can be used for a variety of purposes, including increasing water supply security:

- Flood risk management - recharge of floodwaters, in combination with surface storage, can dampen the flood peak
- Aquatic ecosystem restoration – discharging stored groundwater may help maintain timely environmental flows
- Drought resilience – MAR can provide back-up storage for multi-year droughts without losses due to evaporation
- Salt-water intrusion prevention – replenishing coastal aquifers can provide additional agricultural and potable water supply while keeping salt water at a safe distance
- Multi-purpose projects – urban water projects can combine wastewater reuse, wetlands restoration, recreational and educational opportunities, and MAR.

Benefits of Managed Aquifer Recharge include:

- Makes use of a natural storage reservoir
- Evaporation losses of above ground storage is avoided
- Multiple purposes/benefits

Costs:

- Uncertainty about the variability of the aquifer's geological profile. Significant investigation is required, likely comparable to above ground storage if not more.

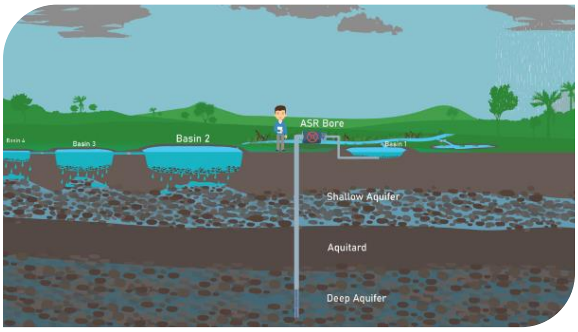


Figure 34 Managed Aquifer Recharge mimics nature by taking water when river levels are high and supplement aquifers

Water reuse

The term water reuse is used to cover terms such as water recycling, water recovery, wastewater reuse etc. For the large part, water reuse relates to reclaiming the 'water' in wastewaters for reuse.

For any discharge of treated wastewater to land, such as farm dairy effluent, water reuse is already happening. The land provides the final treatment of the pathogens, nutrients and other contaminants and the treated wastewater drains down into the water table thus entering the hydrologic cycle. It might enter a groundwater aquifer, effectively recharging it, or it may travel laterally to intersect with a surface water body.

Irrigation of treated sewage wastewater has been a practice for centuries but in modern times, human health concerns have restricted its use. But new and emerging technology is such that it is possible to achieve potable reuse, and this is likely to be increasingly possible in the future.

Centralised wastewater treatment plants are convenient locations to provide the additional treatment needed to return the water back to a state that it is suitable for potable water, or for uses other that drinking and cooking. However, it requires a dual distribution network back to the city's water supply network or other networks for reuse. Highly treated wastewater could also be integrated with Managed Aquifer Recharge or desalination plants.

At a household level, greywater, from showers, baths or laundries, recycling is already being promoted. It can be used for watering the garden or be used to flush the toilet. Various commercial products are available. A report prepared for the Ministry of Health however, concluded that recycling does not reduce water use and is therefore not the most efficient means of managing water.

Figure 35 Capturing rainwater or reusing grey water in the garden helps reduce demand on freshwater supplies

Benefits of water reuse include:

- Reduces the volume of wastewater discharges to water
- Treated water able to be used for activities that do not require high quality, such as irrigation, toilet flushing, laundry
- May offset the need for new supplies

Costs:

- Treatment costs
- Infrastructure and distribution networks to get treated water to locality of use
- Health risks

Seawater Desalination

Seawater desalination is the process of removing salts and minerals from seawater. The two main methods of desalination include a thermal process where the water is heated and the steam is collected, and reverse osmosis where the water is pushed through a membrane to remove salts and other impurities. Reverse osmosis is the most common commercial method.

Figure 36: Desalination plant

The process is expensive and requires very high energy inputs. Melbourne's desalination plant costs $3bUS and is a backup supply. The purified water is treated to meet the required water quality standards. The waste product brine is usually discharged back into the sea but requires high-mixing conditions to avoid a plume on low oxygen brine sitting on the bottom of the sea, causing adverse environmental effects.

Benefits of desalination include:

- New water
- Independent of climatic conditions

Costs:

- High Energy inputs
- Waste Discharges and Environmental Effects
- High capital and operational costs

References

1 https://www.hbrc.govt.nz/documents-and-forms/rrmp/

2 See the following link for further information on the National Policy Statement for Freshwater Management: https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-freshwater-management/

3 *ibid*.

4 See https://environment.govt.nz/what-government-is-doing/key-initiatives/resource-management-system-reform/overview/

5 https://environment.govt.nz/publications/essential-freshwater-te-mana-o-te-wai-factsheet/

6 *ibid*. See Part 1, cl. 1.3 (3) and (4) of the NPSFM.

7 1A. New resource management legislation: Top 10 things to know : Russell McVeagh

8 https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_FinalDraft_Chapter04.pdf

9 AR5 Nobel et al (2014), Pg. 635 AR6, Chapter 4

10 1CCATWG, 2017; MfE and StatsNz, 2021

11 1Hendy et al., 2018; WaterNz, 2018; Paulik et al., 2019b.

12 1MfE, 2020b

13 1MfE, 2020a; MfE, 2020b; MfE, 2020c (11.4.2).

14 1Parsons et al., 2021.

15 Source NIWA, November 2020, Climate Change projections and impacts for Tairawhiti and Hawke's Bay

16 See NIWA, 2020: https://www.hbrc.govt.nz/assets/Document-Library/Reports/Climate-change-projections-and-impacts-for-Tairawhiti-and-Hawkes-Bay.pdf

17 NIWA Client report (hbrc.govt.nz)

18 https://www2.deloitte.com/content/dam/Deloitte/nz/Documents/about-deloitte/nz-turning-point-report.pdf

19 See https://www.hbrc.govt.nz/hawkes-bay/projects/regional-water-security-programme/

20 See also the Ministry for Primary Industry's discussion of the regulatory context for water availability and security in https://www.mpi.govt.nz/water-availability-and-security/ pp 18-23

21 https://environment.govt.nz/what-government-is-doing/key-initiatives/resource-management-system-reform/overview/

22 https://threewaters.govt.nz/

23 https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/emissions-budgets-and-the-emissions-reduction-plan/

24 https://environment.govt.nz/publications/aotearoa-new-zealands-first-national-adaptation-plan/

25 UN System of Environmental-Economic Accounting (SEEA) - Water (also referred to as SEEA-Water) was adopted by the United Nations Statistical Commission in 2012 as the international statistical standard for environmental-economic accounts.

26 https://www.hbrc.govt.nz/assets/Document-Library/Reports/Hawkes-Bay-Region-Water-Security-Economic-Impact-Assessment-Report-17-July-2020.pdf

27 At 64% of the abstraction, actual use of water by agriculture in the region in this period is lower than national figures for allocated volumes, which estimate that 81% of water in New Zealand is allocated to agricultural use. New Zealand's fresh waters: values, state, trends and human impacts Peter Gluckman, Office of the Prime Minister's Chief Science Advisor (New Zealand) https://cpb-ap-se2.wpmucdn.com/blogs.auckland.ac.nz/dist/f/688/files/2020/02/PMCSA-Freshwater-Report.pdf

https://www.nber.org/papers/w23343 Growing, Shrinking, and Long Run Economic Performance: Historical Perspectives on Economic Development Stephen Broadberry and John Joseph Wallis Oxford University Nuffield

28 College – which identifies improved long term economic performance with reductions in the rate and frequency of shrinking rather than an increase in rates of growth – and the importance that institutions that treat everyone the same by moving from a system of identity rules to a system of impersonal rules.

29 Research to uncover crucial knowledge on braided rivers » Lincoln Agritech

30 https://informedfutures.org/wp-content/uploads/The-Future-of-Food-The-Primary-Sector.pdf p10

31 https://www.mpi.govt.nz/water-availability-and-security/

32 https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/

32 Leading edge CHB orchard - BayBuzz

34 The Opuha dam was completed in 1998 https://www.opuhawater.co.nz/about-us/history-of-the-dam-project and the next significant project has been the Waimea Dam https://waimeawater.nz/ itself a 20 years project.

35 https://www.nzgeo.com/stories/unpacking-ruataniwha/

36 https://times-age.co.nz/water-storage-consents-sink-scheme/

37 https://www.hbrc.govt.nz/hawkes-bay/projects/regional-water-security-programme/managed-aquifer-recharge/

38 Earlier this year the noted historian, philosopher and author Yuval Noah Harari observed "The Covid year has exposed an even more important limitation of our scientific and technological power. Science cannot replace politics. When we come to decide on policy, we have to take into account many interests and values, and since there is no scientific way to determine which interests and values are more important, there is no scientific way to decide what we should do. " https://www.ft.com/content/f1b30f2c-84aa-4595-84f2-7816796d6841

39 Howard Perlman, USGS, Jack Cook, Woods Hole Oceanographic Institution, Adam Neiman, Data source: Igor Shiklomanov http://ga.water.usgs.gov/edu/earthhowmuch.html

40 http://ga.water.usgs.gov/edu/waterdistribution.html

41 See Stancu and Jollands, 2021: Hawkes Bay Region Physical Supply and Use Water Accounts.

42 See https://environment.govt.nz/assets/Publications/Files/environment-aotearoa-2019.pdf

43 See https://environment.govt.nz/assets/Publications/Files/our-freshwater-2020.pdf.

44 See action 3.12 https://www.hbrc.govt.nz/assets/Document-Library/Strategies/HB-Land-and-Water-Management-Strategy.pdf

45 See, for example, the case of water bottling - https://www.hbrc.govt.nz/services/water-management/water-bottling/

46 Flows within the environment will be identified in the asset accounts (next project phase).

47 The key data source for the supply and use numbers was the HBRC telemetered data and resource consents database. Data was also sourced through engagement and input from water managers, and consents and compliance teams from the regional council and districts – as well as directly from industry (see Stancu and Jollands, 2021). *It should be noted that "permitted" water takes are also not included or accounted for in the supply/use numbers.*

48 In this report the term 'Agriculture' encompasses cropping, dairying, pastoral farming, fruit/vegetable/packhouses, nurseries, orchard, stockyard, and vineyard use. See Stancu and Jollands, 2021.

49 https://www.genesisenergy.co.nz/getmedia/07aa19ef-cdd4-47ce-8085-f3014c22e921/Waikaremoana-map-and-cross-section-and-photos-about-us_NEW.aspx

50 See McDonald et al. 2021: Hawkes Bay Region Water Demand Projections – report prepared for the Hawkes Bay Regional Council. The population projections utilised in the report are based on Statistics New Zealand's 2018 sub-national population projections, medium series (2018 Base) – see https://www.stats.govt.nz/information-releases/subnational-population-projections-2018base2048

51 RCP 4.5 is more likely than not to result in global temperature rise between 2 degrees C, and 3 degrees C, by 2100 https://en.m.wikipedia.org/wiki/Representative_Concentration_Pathway

52 See Tonkin & Taylor, 2009: Prefeasibility Study of Water Augmentation Opportunities – Ruataniwha Plains; and Tonkin & Taylor, 2011: Ngaruroro Water Augmentation Scheme – Prefeasibility Study Report.

53 A matter worth noting here regarding the end use of the water relates to water taken for bottling and export. This has brought the matter into the public arena over the last 10 years or so. The views of many are that water bottling companies are getting water for free and making a profit on it by selling it overseas. As stated, regional councils are currently limited to assessing the effects of the take, not the purpose for which it is taken, and it cannot charge for the water per se only the recovery of the costs of environmental management and monitoring.

54 https://environment.govt.nz/assets/Publications/Files/rm-panel-review-report-web.pdf

55 Freshwater Scarcity and the RMA: Developing Legal Tools to Achieve Efficient Outcomes (Ben Methven) https://www.otago.ac.nz/law/research/journals/otago734258.pdf.

56 For example, see these articles for an insight into the iwi/Māori rights and interests that exist in relation to freshwater: https://www.stuff.co.nz/pou-tiaki/124146137/ngti-kahungunu-joins-ngi-tahu-in-court-action-seeking-rangatiratanga-over-freshwater and https://www.nzherald.co.nz/hawkes-bay-today/news/ngati-kahungunu-joins-ngai-tahus-claim-for-shared-control-of-freshwater-with-the-crown/ZIEUMZLNQQIK4WFAXQG3RDXXZ4/

[57] https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=4358

[58] https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=2369

[59] http://www.legislation.govt.nz/regulation/public/2020/0176/latest/LMS351161.html

Kānoa
Regional Economic Development
& Investment Unit

HAWKE'S BAY
REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI