WILLIAMSON
WATER & LAND ADVISORY
Adding value through sustainable & efficient use of natural resources

RILEY
CONSULTANTS

Volume 4: Analysis and Recommendations

Northland Water Storage and Use Project

NORTHLAND REGIONAL COUNCIL

WWLA0156 | Rev. 3

27 March 2020

It has been necessary to withhold some of the content in this report under section 7 of the Local Government Official Information and Meetings Act 1987 to:

- protect information where making available of the information would be likely unreasonably to prejudice the commercial position of the person who supplied or who is the subject of the information (clause (2)(b)(ii);
- protect information which is subject to an obligation of confidence where the making available of the information would be likely to prejudice the supply of similar information, or information from the same source, and it is in the public interest that such information should continue to be supplied (clause (2)(c)(i); or
- enable any local authority holding the information to carry on, without prejudice or disadvantage, negotiations (including commercial and industrial negotiations) (clause (2)(i).

Northland Water Storage and Use Project

Project no:	WWLA0156
Document title:	Analysis and Recommendations
Revision:	3
Date:	27 March 2020
Client name:	Northland Regional Council
Project manager:	Chris Frost
Author(s):	RILEY, WWLA, et. al.,
File name:	G:\My Drive\Projects\NRC\WWLA00156\Consortium\Deliverables\4 Analysis and Reccomendations\Report Vol4_Analysis_and_Recomendations_Rev3.docx

Williamson Water & Land Advisory

19 Broadway
Kaikohe
New Zealand
T +64 21 337453

Document history and status

Rev	Date	Description	By	Review	Approved
1	21 Feb 2020	First draft for client review	RILEY, WWLA		
2	26 Feb 2020	Updated following internal review	WWLA, RILEY	Jon Williamson	
3	27 Mar 2020	Updated following client and peer review comments	WWLA, RILEY	WWLA, RILEY	Jon Williamson

Distribution of copies

Rev	Date issued	Issued to	Comments
1	21 Feb 2020	Northland Regional Council	First draft for client review
2	26 Feb 2020	Northland Regional Council	Updated following internal review
3	27 Mar 2020	Northland Regional Council	Updated following client and peer review comments

Contents

1. Introduction 1
1.1 Report Structure 1
2. Uptake Potential 3
2.1 Existing Farmers and Growers 3
2.2 Wider Industry 4
2.3 Complementary Projects 5
2.4 Early Adopters 5
3. Scheme Overview 7
3.1 Kaipara 7
3.1.1 Large Storage Scenario 7
3.1.2 Distributed Storage Scenario 7
3.2 Mid-North 7
3.2.1 Large Storage Scenario 7
3.2.2 Distributed Storage Scenario 7
3.2.3 Distributed Storage Including Lake Omapere Scenarios 8
4. Social and Cultural Context 9
4.1 Socio-Economic Overview 9
4.1.1 Demographics 9
4.1.1.1 Mid-North 9
4.1.1.2 Kaipara 10
4.1.2 Closing 10
4.2 Cultural & Heritage 10
5. Approvals & Authorisations 13
5.1 Resource Consents 13
5.1.1 Planning Context 13
5.1.2 Resource Consent Requirements 15
5.1.3 Procedural Matters 17
5.1.3.1 Pre-application Meetings 17
5.1.3.2 Notification 17
5.1.4 Consent Processing Timeframes 18
5.1.5 Other Consenting Processes 19
5.2 Archaeological Authority 19
5.3 Conservation Act 1987 20
5.4 Reserves Act 1977 20
5.5 Wildlife Act 1953 21
5.6 Building Act 2004 21
6. Environmental Effects 22
6.1 Kaipara 25
6.1.1 Stream Ecology – Reservoirs 25
6.1.2 Stream Ecology – Water Takes 27

6.1.2.1 Kaihu Valley ... 27
6.1.2.2 Poutō Peninsula ... 27
6.1.3 Significant Sites ... 28
6.1.4 Sediment Effects ... 28
6.2 Mid North ... 28
6.2.1 Stream Ecology – Reservoirs ... 28
6.2.2 Significant Sites ... 29
7. Potential Benefits ... 30
7.1 Kaipara ... 30
7.1.1 Streamflow and Flood Management ... 30
7.1.2 Municipal Supply ... 30
7.1.3 Energy Generation ... 30
7.1.3.1 Hydroelectric Generation Potential ... 30
7.1.3.2 Other Renewable Energy Sources ... 33
7.2 Mid-North ... 34
7.2.1 Streamflow and Flood Management ... 34
7.2.2 Municipal Supply ... 34
7.2.3 Energy Generation ... 35
7.2.3.1 Hydroelectric generation potential ... 35
7.2.3.2 Other Sources ... 36
8. Scheme Supply Performance and Management ... 37
8.1 Scheme Reliability ... 37
8.2 Certainty of Supply ... 40
8.3 Constraints on Supply ... 42
8.4 Storage Management ... 42
9. Economic Analysis ... 45
9.1 Data Sources ... 45
9.2 Affordability of the Schemes ... 46
9.2.1 Methodology ... 46
9.2.2 Results ... 47
9.2.2.1 Kiwifruit ... 47
9.2.2.2 Avocado ... 48
9.2.2.3 Citrus ... 49
9.2.2.4 Blueberries ... 50
9.2.2.5 Commercial Vegetable Production ... 51
9.3 Scheme Configuration Performance Assessment ... 52
9.3.1 Methodology ... 52
9.3.2 Results ... 53
10. Uncertainty and Risk Analysis ... 55
10.1 Project Complexity ... 55
10.2 Critical Flaws ... 55

10.3 Risk and Uncertainty 56
11. Discussion 58
11.1 Cost Comparison between Single vs Distributed Storage 58
11.1.1 Capital Only Costs 58
11.1.2 Net Present Value Analysis 59
11.2 Key Scheme Optimisation Considerations 60
11.2.1 Storage Selection 61
11.2.2 Scheme and Storage Sizing 64
11.2.3 Pipe Routes and Sizing 64
11.2.4 Water Requirements 64
11.3 Possible Optimised Scheme Outcome 64
11.3.1 Kaipara 65
11.3.2 Mid-North 65
11.4 Scheme and Component Prioritisation 66
11.4.1 Kaipara 66
11.4.2 Mid-North 67
11.5 Uptake 68
11.6 Comparison to Existing Northland Horticulture Schemes 68
11.6.1 Maungatapere Irrigation Scheme 69
11.6.2 Kerikeri Irrigation Scheme 69
11.6.3 Comparative cost of water 69
11.7 Land Acquisition 69
12. Progressive Development Sequencing 71
12.1 Kaipara 71
12.2 Mid-North 74
13. Summary and Conclusions 78
14. References 81

Table of Figures

Figure 1. Mid-North study area locality. 2
Figure 2. Kaipara study area locality. 2
Figure 3. Kaipara Large Storage scheme overview. (Refer A3 attachment at rear). 7
Figure 4. Kaipara Distributed Storage scheme overview. (Refer A3 attachment at rear). 7
Figure 5. Mid-North Large Storage scheme overview. (Refer A3 attachment at rear). 7
Figure 6. Mid-North Distributed Storage scheme overview. (Refer A3 attachment at rear). 8
Figure 7. Mid-North Distributed Storage Including Lake Omapere scheme overview. (Refer A3 attachment at rear). 8
Figure 8. Relationship of statutory planning documentation. From: Regional Policy Statement for Northland 2016. 13
Figure 9. Standard processing timeframes. 18
Figure 10. Risk matrix example. 22
Figure 11. NRC Water Priority Areas and Biodiversity Wetlands. (Refer A3 attachment at rear). 28
Figure 12. Example flow duration curve [redacted] (orange is flow generation). 31
Figure 13. Adopted Kaipara irrigation demand profile. 32
Figure 14. Example fluctuations in reservoir level and water balance across a typical year i[redacted] Large Storage Scenario. 32
Figure 15. Adopted Mid-North irrigation demand profile. 35
Figure 16. Example fluctuations in reservoir level and water balance across a typical year i[redacted] Large Storage Scenario. 35
Figure 17. Kaipara Distributed: Scheme reliability as a function of increased supply area. 39
Figure 18. Mid-North Distributed: Scheme reliability as a function of increased supply area. 39
Figure 19. Kaipara Distributed: Certainty of supply through supply season. 41
Figure 20. Mid-North Distributed, Certainty of Supply through supply season. 41
Figure 21. Kaipara Distributed: Certainty of supply with storage management applied. 43
Figure 22. Kaipara Distributed: Comparison of unmanaged vs managed storage. 43
Figure 23. Mid North Distributed: Certainty of supply with storage management applied. 44
Figure 24. Mid North Distributed: Comparison of unmanaged vs managed storage. 44
Figure 25. Comparison of scheme NPV. 54
Figure 26. Comparison of scheme IRR. 54
Figure 27. Cost per cubic meter stored for Mid-North storage options. 61
Figure 28. Construction cost for Mid-North storage options. 62
Figure 29. Cost per cubic meter stored for Kaipara storage options. 63
Figure 30. Construction cost for Kaipara storage options. 63
Figure 31. Kaipara Example Staged Development Sequence. (Refer A3 attachment at rear). 71
Figure 32. Kaipara Example Staged Development Sequence. (Refer A3 attachment at rear). 75

1. Introduction

Williamson Water & Land Advisory (WWLA) was commissioned as the lead contractor with partners Riley Consultants and a number of other experts by Northland Regional Council (NRC) in August 2019 to undertake the Northland Water Storage & Use Project (NWSUP): Pre-feasibility Demand Assessment and Design Study.

NRC has previously undertaken two studies[1] that identified two areas within the Mid-North and Kaipara worthy of further investigation for potential irrigation and water supply through reservoir storage. These areas are being investigated in conjunction with the Far North District Council (FNDC) and Kaipara District Council (KDC) respectively, with support from the Provincial Growth Fund (PGF).

This Pre-feasibility Demand Assessment and Design Study is the next phase in the investigation of viable water storage and water use infrastructure within the Mid-North (**Figure 1**) and Kaipara areas (**Figure 2**).

The goal of the project is to allow environmental improvement and economic development to occur within the water use command areas, with a net positive socio-economic impact to the surrounding local communities.

The following suite of reports have been prepared to determine the viability of potential schemes:

1. ***Volume 1:*** Command Area Refinement;
2. ***Volume 2:*** Water Resources Assessment;
3. ***Volume 3:*** Conceptual Design and Costing; and
4. ***Volume 4:*** Analysis and Recommendations (**this report**).

1.1 Report Structure

This report discusses the social, cultural and environmental considerations of the project, and provides recommendations for future phases of the project.

This report is structured as follows and comprises:

- uptake potential (**Section 2**);
- overview of the proposed schemes (**Section 3**);
- description of the project's social and cultural context (**Section 4**);
- approvals and authorisations (**Section 5**);
- environmental effects (**Section 6**);
- description of potential benefits (**Section 7**);
- scheme supply and performance management (**Section 8**);
- economic analysis (**Section 9**);
- uncertainty and risk analysis (**Section 10**);
- project discussion (**Section 11**);
- project development sequencing (**Section 12**) and
- summary and conclusions (**Section 13**).

[1] Opus (2015) Northland Strategic Irrigation Infrastructure Study & Opus (2017) Scoping of Irrigation Scheme Options in Northland.

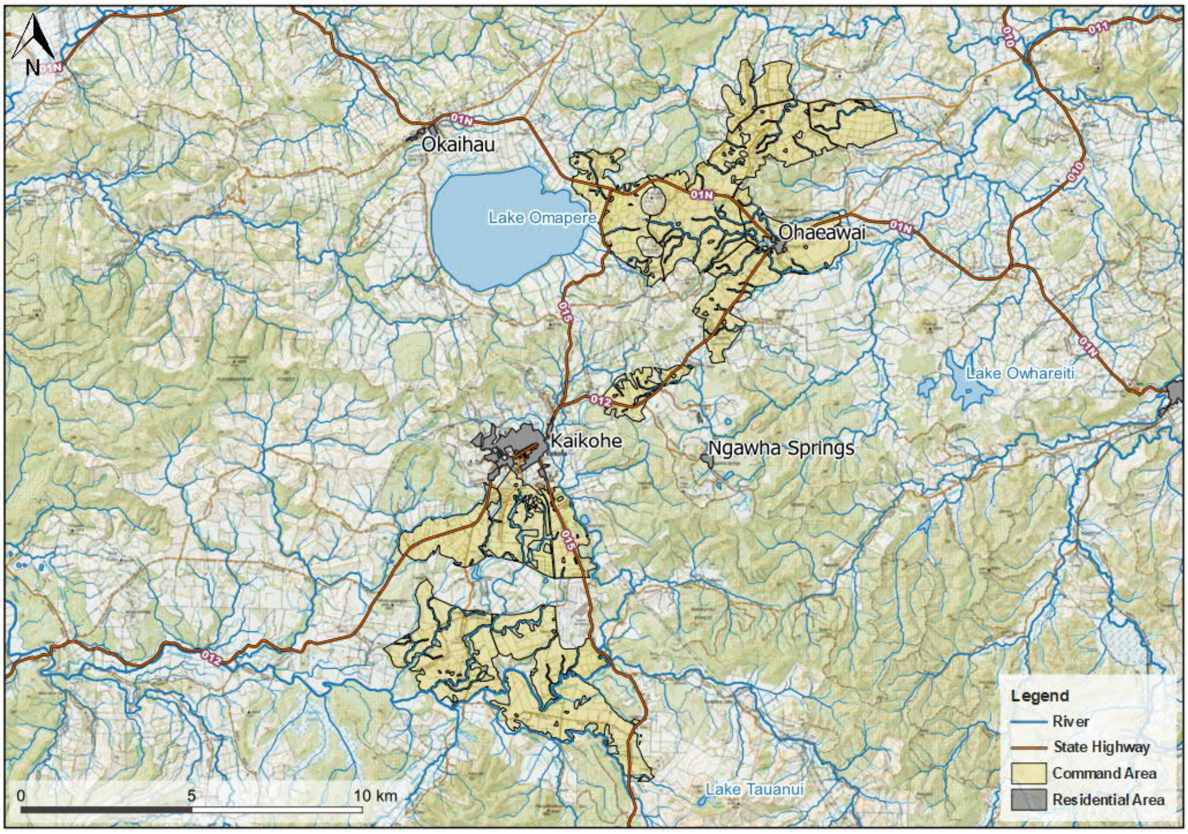

Figure 1. Mid-North study area locality.

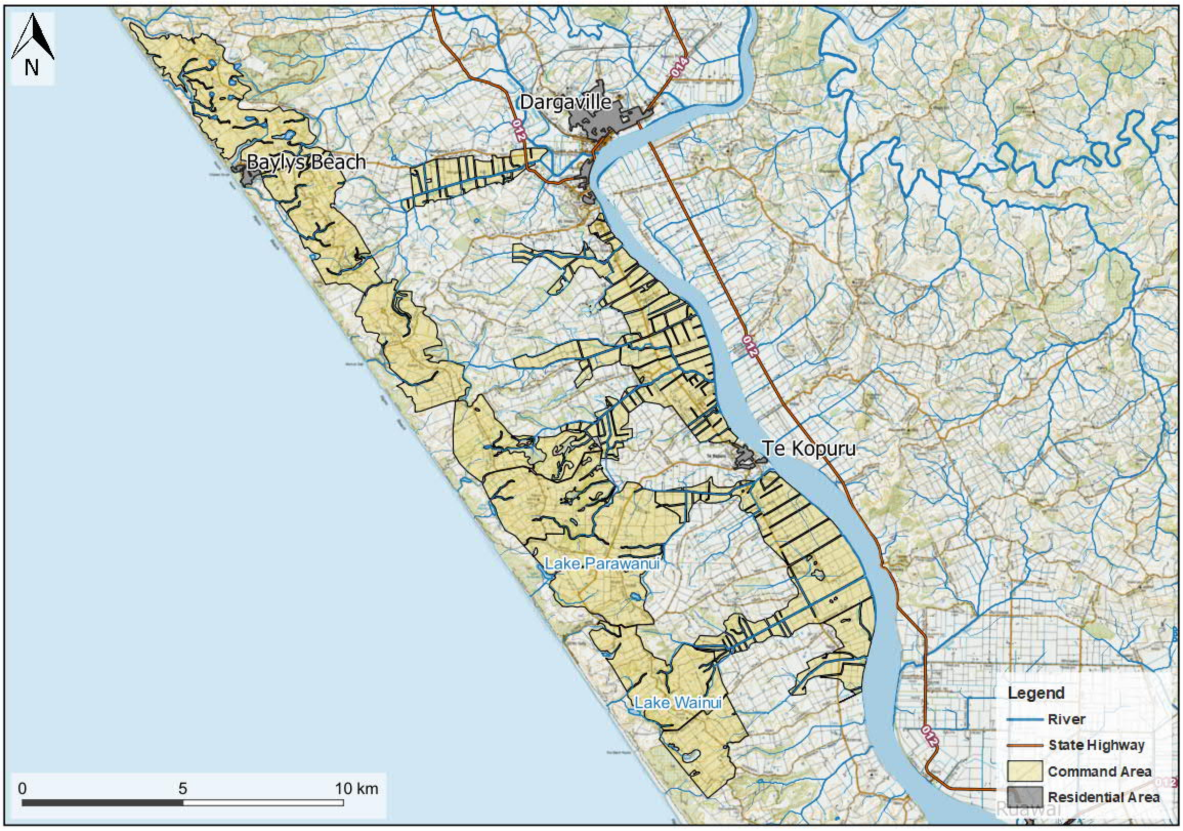

Figure 2. Kaipara study area locality.

2. Uptake Potential

The investment criteria of the PGF clearly stipulates that:

Projects will be prioritised that support Māori to achieve higher returns from their land by addressing access to water. There are catchments where Māori have undeveloped land but low levels of access to water, which creates a barrier to Māori land development.

Section 5.2 in Volume 1 identifies the areas of Maori Freehold Land (MFL) within the areas of interest and clearly indicates a significant area within the Mid North, however less MFL in the specific area of interest in the Kaipara. It is however understood that there is considerably more land owned by Maori in general titles in both areas which also factors into the PGF criteria above.

Ensuring that water was delivered to Maori owned land was considered during conceptual design, however that does not necessarily mean there will be uptake, as water to the orchard or farm gate is only a small but important part of the formula required to transition to a higher value land use such as horticulture.

There is unlikely to be significant uptake from Maori within either area in the short term due to a myriad of challenges and considerations - principally capital and expertise required, which will require innovative solutions to overcome. In many instances there is going to be the need to collectivise land holdings to achieve viable enterprise scale.

The sort of approach that was adopted in Te Kaha could be a viable way forward[2].

They key to maximising the opportunity for Maori is making water available to as wide an area as practical. This will facilitate early uptake on those properties that are ready to proceed, rather than waiting for a critical mass of MFL uptake.

2.1 Existing Farmers and Growers

Face to face discussions were had on site with approximately forty of the larger landowners with suitable horticulture land, as well as ad-hoc meetings throughout the two districts of interest over the duration of this project. As alluded to in Section 5.3 of Volume 1, specific questions were utilised to gain insight into uptake interest, however much of the discussion ended up being directed to the water storage work undertaken over the past 50 years in Northland to get to where we are today.

This provides a very clear indication that uptake is not going to occur rapidly, which is not surprising given this project is essentially being driven currently by central and local government, rather than local farmers and growers. Steady uptake will occur through the realisation that this project could deliver significant benefits to the community and wider region.

Several landowners had identified that their land had horticulture potential, specifically within the Mid-North, and were actively evaluating options prior to this project being discussed with them. These landowners were few and far between with most having not considered "what if" a reliable water supply was available. This was then compounded by a generally wide gap in understanding of the horticulture sector and the opportunities that may exist.

There was a consensus amongst the landowners that if water was available, most of the *"growers"* would be the next owners of the land and not the *"farmers"* that currently reside.

What was clearly evident is that early and wider uptake, specifically in the Kaipara, will be heavily dependent upon enabling water to be utilised in an environmentally conscience way with pastoral farming systems should it

---

[2] https://www.newshub.co.nz/home/rural/2019/05/government-to-invest-in-eastern-bay-of-plenty-horticulture-project.html

be deemed affordable to enable time and a mechanism to transition to other higher value land uses. Whilst the indicative costs of the scheme are likely prohibitive for most pastoral farmers, essentially regulating this use, it is clear that existing landowners would like the information made available to evaluate this themselves.

As alluded to in various other sections of this report, criteria around this project's funding and the direction of freshwater management in New Zealand, is causing considerable uncertainty about how, if at all, a new community water storage scheme would integrate within communities that are currently predominantly in ruminant agriculture. Until this is clarified this will be have a significant impact upon the potential uptake.

2.2 Wider Industry

There is strong interest in this project from the wider primary sector, and the belief that there is significant potential to grow horticulture in the region if more water storage was available.

This is because global demand for plant-based foods and horticulture is expected to grow strongly in the longer-term. Future opportunities for added-value foods from Northland are arising from an increasing shift by consumers to focus on nutrition, wellness and plant-based foods, sustainable food production systems with a light footprint on the environment, and equity for food producing communities. Consumer preferences are expected to trend more towards plant-based foods and "flexitarian" lifestyles, creating significant opportunities for Northland to expand and develop plant-based foods, oils, beverages and protein sources with light environmental footprints.

Northland is well placed to grow these horticultural products and benefit economically from these markets if there can be greater certainty of water supply.

Examples of horticulture industries sales growth forecasts include:

- Zespri currently has a strong growth target for kiwifruit, increasing its global sales from approximately $2.0B to $4.5B by 2025.
- New Zealand Avocado has an industry strategy to triple productivity and to quadruple sales revenue to $280M by 2023.
- The international berry fruit market demand is growing rapidly. In the UK, blueberries have seen a 53% increase in sales over the past year.
- There is increasing international and domestic interest in new crop types including subtropical horticultural fruits, nuts and vegetables.

Investors are looking for new land areas suitable for horticulture. To meet this growing demand, new land areas must be brought into horticultural production, while at the same time increasing the productivity of existing land areas. As a consequence, there has been a recent trend observed in Northland of new investors entering the region with multi-million-dollar investments of capital into horticulture developments. It is reasonable to see this continue as part of a trend for international global investment into food security and plant-based foods in suitable growing areas. Also, with increasing encroachment of urban areas onto key horticulture growing areas around South Auckland and other urban areas, new growing regions such as Northland are needed to supply domestic and global market demand.

Northland is well placed to grow and supply more horticulture products if water supply was more certain. It has climate and soils that are generally well suited for expanding horticultural production. In coming decades, Northland is projected to be warmer (by up to 1.1℃ by 2040 and 3.1℃ by 2090) with fewer frosts and more droughts in some parts. Food production landscapes are likely to be a more diverse mosaic of crops and land uses in the future. Future climatic conditions could create future market opportunities for food from Northland in subtropical fruit and foods, plant-based foods, oils, beverages, alternative proteins and indigenous Māori branded foods.

Removing uncertainty of future water supply in Northland for horticulture is a necessary pre-requisite for future external and local investors to direct time and energy to develop further options in Northland.

There was a large willingness to assist this water storage project by both industry bodies and vertically integrated businesses who export produce. Both of these parties will be integral to the success of any new developments and also potentially for linkages to out of town developers with large amounts of capital looking to set up business within the region.

Other constraints to this expansion identified by horticulture industry participants in the region include talent and management skills, labour supply and transportation infrastructure. There are initiatives underway in Northland (by the Horticulture Capability Group, Ministry of Social Development and Ministry of Business Innovation and Employment) to attract more people into careers in horticulture to reduce the constraint of a talent and labour supply so that horticulture can grow.

Appendix A provides a record of discussions and thoughts of various horticulture industry participants that provide valuable insight.

2.3 Complementary Projects

There are currently a number of projects underway that also have PGF support that could potentially play a significant role moving forward for this project, namely:

- Omapere Rangihamama Ahuwhenua (vineyard development on multiple blocks near Kaikohe);
- Ngawha Innovation and Enterprise Park; and
- Kaipara Kai.

In the instance of the Ngawha Innovation and Enterprise Park and Kaipara Kai, these two projects both could play an integral part in stimulating demand and ultimately uptake for these projects.

In addition to this we understand that MPI have been funding studies within the Kaipara for Maori Trusts or Entities to evaluate alternative land use options which will likely indicate various options that require water.

2.4 Early Adopters

Uptake potential in the short term is essential to understanding where water is required first, playing a large part in the staging process of the distributed scheme options.

Table 1 lists enterprises considered of specific interest as potential early adopters.

Table 1. Potential Early Adopters.

Party	Description	Likely Area
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

3. Scheme Overview

Overview descriptions of each of the proposed scheme scenarios are provided below. Full descriptions of each scheme scenario are provided in the Volume 3: Conceptual Design and Costing report.

3.1 Kaipara

3.1.1 Large Storage Scenario

This scenario consists of single storage reservoir located at [redacted] of the command area that supplies the entire command area (**Figure 3**). The reservoir will be filled through direct upstream catchment inflows and a combined low and high flow take from [redacted].

Figure 3. Kaipara Large Storage scheme overview. (Refer A3 attachment at rear).

3.1.2 Distributed Storage Scenario

This scenario consists of [redacted] located along the [redacted] (**Figure 4**), equivalent to the same total volume [redacted] used for the Kaipara Large Storage scheme. The reservoirs will be filled through [redacted] and a [redacted], which is transferred between reservoirs through cascade filling [redacted].

Figure 4. Kaipara Distributed Storage scheme overview. (Refer A3 attachment at rear).

3.2 Mid-North

3.2.1 Large Storage Scenario

The Mid-North Large Storage scheme utilises [redacted] section of the scheme and [redacted] section of the scheme as shown in **Figure 5**. [redacted]

Figure 5. Mid-North Large Storage scheme overview. (Refer A3 attachment at rear).

3.2.2 Distributed Storage Scenario

The Mid-North Distributed scenario consists of [redacted], spatially distributed across three essentially individual mini-schemes collectively supplying the full Mid-North command area, as shown in **Figure 6**. [redacted].

The [redacted]

[redacted]

[redacted]

Figure 6. Mid-North Distributed Storage scheme overview. (Refer A3 attachment at rear).

3.2.3 Distributed Storage Including Lake Omapere Scenarios

[redacted].

Figure 7. Mid-North Distributed Storage Including Lake Omapere scheme overview. (Refer A3 attachment at rear).

4. Social and Cultural Context

4.1 Socio-Economic Overview

Northland is a regional economy that has yet to perform as well relative to other New Zealand regions and relative to its resource base.

The regional economy was impacted by the previous Global Financial Crisis (e.g. a large reduction in tourists from the UK and the USA) and some significant climatic events, both severe storms and drought conditions.

The Far North and Kaipara districts have similar economic structures, with a strong focus on primary production.

The areas of the Kaipara which feature in the project falls entirely on Tai Tokerau Northland's west coast on rolling farmlands. Farming is the main industry here, with dairy, meat production and kumara (sweet potato) all featuring heavily. The district is the rohe[3] of Ngati Whatua, Te Roroa, and Te Uri o Hau Iwi.

The Mid-North is a predominantly rural area with several small settlements. Land is used largely for beef and dairy farming, horticulture and forestry. The Mid-North is within the rohe of Ngapuhi Iwi.

4.1.1 Demographics

4.1.1.1 Mid-North

Statistics captured as part of the 2013 Census of the Mid-North shows that the majority of the population identify as Maori in the Kaikohe and Ngapuhi-Kaikou areas, compared with the Okaihau, Waimate North, and Ohaewai areas of the Mid-North where European is the most common ethnic group.

Age data shows that there is a higher proportion of people aged over 65 in the Ohaewai and Waimate North areas compared to the areas of Okaihau, Kaikohe and Ngapuhi-Kaikou, which show significantly higher proportion of those aged 15 years and under. Kaikohe in particular has a median age of 28.5 years compared with the Far North median of 43.3 years.

A person living in the Ohaewai area is 25% more likely to hold a qualification than a person living in Kaikohe. Of those holding a qualification in Ohaewai, 15.1% hold a bachelor's degree or higher when compared to 6.3% of those living in Kaikohe. Okaihau and Ngapuhi-Kaikou sit in between these two disparities.

The most common occupational group in Okaihau, Ngapuhi-Kaikou, and Ohaewai is 'managers'. Given the largely rural nature of these communities, work is likely to be based around farming, while significant education facilities will also contribute to the nature and availability of employment opportunity in places like Okaihau. The most common occupational group in Kaikohe is 'labourer'.

Both Okaihau and Ohaewai have similar income profiles in terms of earnings over $50,000 and median income levels. All income statistics in these two places are higher than those in Kaikohe and Ngapuhi-Kaikou and are fairly consistent with the national income statistics. Kaikohe in particular is disproportionately dissimilar to all other Mid-North places of the Project area and nationally in terms of the population receiving annual earnings of less than $20,000 at 55.45% of those people surveyed aged 15 years or over (the national statistic is 38.2%).

[3] The territory or boundaries of iwi (tribes).

4.1.1.2 Kaipara

The Project area covers both Kaipara Coast and Maungaru while the towns of Dargaville and Te Kopuru may also benefit from the Project.

The population in all of these areas most commonly identify as European. This is reflective of the overall Kaipara area where 84.2% of people identify as European followed by 23.1% as Maori.

The population is fairly young in this area with all places recording a median age of around 44 years. Dargaville and Te Kopuru have the higher proportions of an aging population of the Project areas with Dargaville having a higher population of over 65's compared to the rest of the Kaipara District as well. However, this has not come at the expense of a younger population with a reasonably well sized population of under 15-year old's comparatively to the rest of the Kaipara District.

Over half of the population aged 15 years or over hold qualifications in these areas, with the population in Maungaru outstripping the Kaipara District at 71.2% when compared to 68.7%. However, when compared to the rest of the Kaipara District, Maungaru has lower rates of bachelor's degrees or higher qualifications at 7.9% compared to 8.9%. This is in contrast to Kaipara Coastal which has 9.1% of people aged 15 years and over who do hold a Bachelor's degree or higher.

The most common occupation in Te Kopuru and Dargaville is 'labourer' while 'manager' is the most common occupation in Maungaru and Kaipara Coast.

Te Kopuru has the lowest median income out of the areas identified. Furthermore, similar to Kaikohe, Te Kopuru has the majority of the population earning less than $20,000 per annum.

4.1.2 Closing

These basic statistics illustrate societal disproportions of employment (current and future), higher education levels, and income between areas within the Districts themselves.

Kaikohe and Te Kopuru present similar statistics when it comes to qualifications, income, and occupation. However, Kaikohe has a significantly younger population with a median age of 28.5 years compared with the other areas of the Project but also the national median of 38 years. This points to a larger working population requiring employment opportunity.

The towns of both areas tend to contain a high proportion of the labour market while the rural outskirt places contain managers. This labour force distribution is likely attributable to the pastoral and horticultural land uses of these areas. Furthermore, the occupational circumstance of the place tends to match the statistics surrounding qualifications and types of qualifications.

4.2 Cultural & Heritage

Iwi and hapū have a kinship relationship with the natural environment, including fresh water, through shared whakapapa.

Iwi and hapū recognise the importance of fresh water in supporting a healthy ecosystem, including human health, and have a reciprocal obligation as kaitiaki to protect freshwater quality.

In 2007, the Freshwater Iwi Leaders Group formed to advance the interests of all iwi in relation to freshwater through direct engagement with the Crown. By 2009, many Iwi had joined with others to collaborate around freshwater management through the Land and Water Forum (LAWF). In 2011, the NPSFM was gazetted requiring that the 'overall quality of fresh water' in all regions of the country be maintained or improved and that the life-supporting capacity of water bodies including their associated ecosystems is safeguarded. In 2014, the NPSFM was updated, including a National Objectives Framework and national bottom lines for water quality. Safeguarding water bodies for human health for recreation added alongside requirements for ecosystem health. The NPSFM as it stands now provides a clear statement that in using water you must also provide for Te Hauora o te Taiao (the health of the environment), Te Hauora o te Wai (the health of the waterbody) and Te Hauora o te Tangata (the health of the people). Hence, the NPSFM specifies that the management of freshwater that recognises Te Mana o te Wai is a matter of national importance.

Eleven iwi planning documents have been lodged with NRC, and the relevant content of them must be taken into account in regional plan preparation and changes. Iwi management plans allow tangata whenua the unique advantage of addressing mātauranga Maori from a Maori paradigm unconstrained by the scope of western process and associated legislative structure. If addressed correctly, they also provide resource developers with information on the system of kaitiaki which exists for that particular hapū. There is a lot of variation in the scope of the iwi planning documents lodged with the NRC but then many have a common approach and identify similar issues and concerns around governance and management of natural and physical resources.

In reference to all eleven iwi planning documents, the following matters have been recognised as being of significance to tangata whenua. The feasibility of a water storage and use proposal would be reliant on it being able to respond positively to these matters:

- Effective and early participation of tangata whenua in resource development proposals is necessary to ensure that Maori concepts, values and practices are included in resource management processes and subsequent decisions.
- Wetlands provided resources such as food and weaving materials, and supported nursery environments for a range of freshwater species. Consequently, the importance of wetlands to Māori mean that there is often a stronger requirement for the protection and restoration of such environments affected by development proposals.
- Taonga species such as tuna rely on provision of fish passage in waterbodies which connect the mountains to the sea to complete their life-cycles. They are also a species in decline.
- While the general nature and extent of tangata whenua rights to fresh water have yet to be fully determined, specific water bodies have historic and unextinguished rights. An example is Lake Omapere where ownership of the water body was recognised by the Māori Land Court. These rights must be upheld.
- Heritage resources are not limited to Māori heritage. However, Māori heritage is by far the most extensive and most vulnerable of heritage resources. While the HNZPTA requires the absolute protection of archaeology and heritage from destruction, in practise, this often does not happen. A conservative approach to activities such as earthworks would therefore assist in reducing the harm that can occur through destruction of unrecorded sites of archaeological and heritage significance.
- Land administered by Te Ture Whenua Māori Act 1993 is subject to many constraints. Māori land is frequently undeveloped because of the constraints of Māori land law and now much of this land has mature native regrowth cover, with consequent development constraints comparative to other more developed land in general title.
- Land provided as part of a Treaty settlement may have development potential but can be excluded from consideration of feasibility if coarse screening of water use potential is applied.

Cultural Impact Assessments are a common assessment undertaken in the resource consent context to assess the effects of development proposals on tangata whenua. A CIA outlines the cultural values, beliefs, traditions and taonga that may be affected by a proposal. Recommendations of ways to avoid, remedy, or mitigate adverse effects on the values, beliefs, traditions and taonga identified are also an important aspect of the CIA process. Equally, final decisions on the acceptability of the effects of development proposals are also key determinants to whether future oppositions would be likely (i.e., appeals).

While the CIA process helps to uncover recommendations on the effects of resource use and development to Maori, many of the issues around land and freshwater management cannot be progressed without a concurrent and substantive discussion with Māori about their rights and interests in freshwater under the Treaty of Waitangi.

5. Approvals & Authorisations

5.1 Resource Consents

5.1.1 Planning Context

The Resource Management Act 1991 (the RMA) is New Zealand's primary environmental legislation. The purpose of this RMA is to promote the sustainable management of natural and physical resources. Sustainable management, in terms of the RMA, means, managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while:

- Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations;
- Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
- Avoiding, remedying, or mitigating any adverse effects of activities on the environment.

The RMA encompasses three broad components to give effect to its purpose, and the diagram in **Figure 8** illustrates how this is achieved.

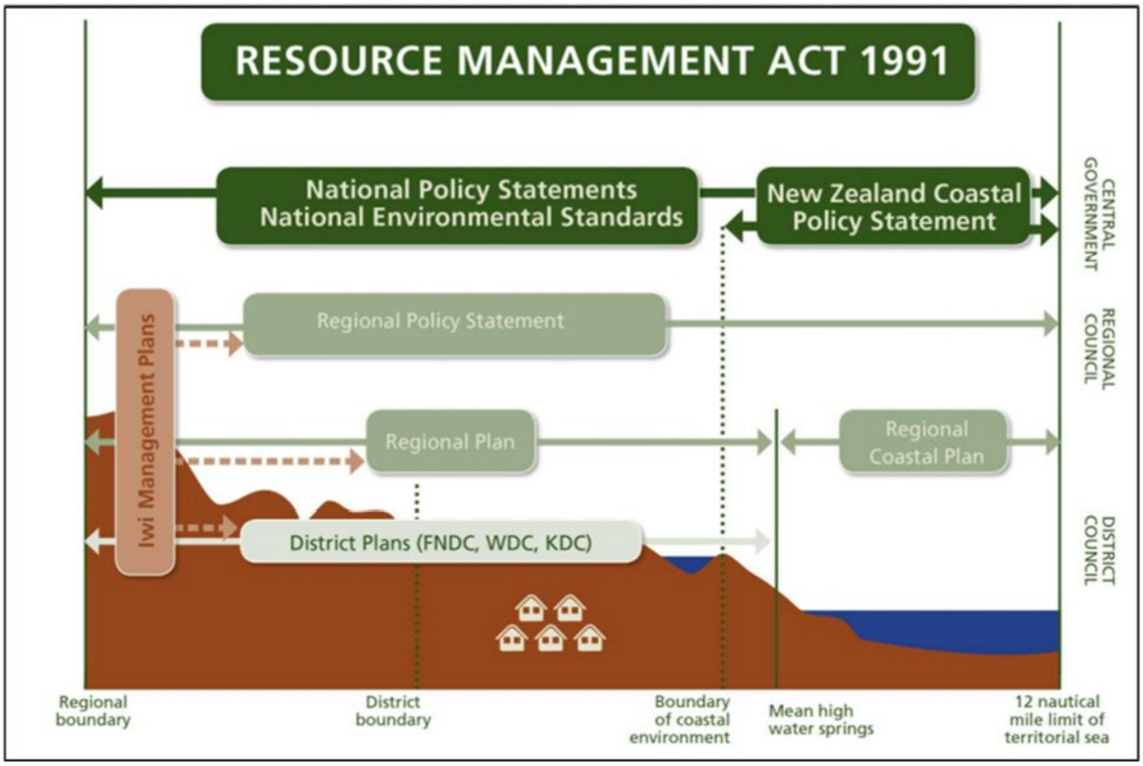

Figure 8. **Relationship of statutory planning documentation.** From: Regional Policy Statement for Northland 2016.

The statutory planning documents that fall under the RMA and are relevant to this Project are listed as follows:

- Resource Management (National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS);
- Regional Policy Statement for Northland 2016 (RPS);

- Regional Water and Soil Plan for Northland 2004 (RWSP);
- Proposed Regional Plan for Northland (Appeals Version – 29 July 2019) (PRPN);
- Far North District Plan 2009 (FNDP); and
- Kaipara District Plan 2013 (KDP).

While Iwi planning documents are not statutory instruments, they do have statutory weight under the RMA. Recognition under the RMA is only available if the document has been recognised by an iwi authority and that it has been lodged with the relevant local authority. Only the Te Uri o Hau Settlement Trust - *Te Uri o Hau Kaitiakitanga O Te Taiao 2012*, document has so far achieved this.

Plan Maps are used to identify specific planning requirements relative to a property or receiving environment. The following summarises the relevant Plan Map information applicable to the subject sites in the Kaipara and Mid-North

In the Kaipara, the following mapped information applies to the project areas:

- [redacted]

In the Mid-North, the following mapped information applies to the project areas;

- [redacted]

The following provides background as to what the mapping references mean for development.

Rural (Production) Zones

Rural zones recognise and provide for land use associated with rural production activity. The zone is characterised by lower density of development and generally larger site sizes, so there is a perception that the

[4] As defined in Section 315 Local Government Act 1974.
[5] See Appendix 5 of the FNDP

likelihood of adverse effects occurring from activities is less than it may be in more densely settled areas, or at least that adverse effects are more easily “absorbed” within sites. The consequence is that controls on activities in the rural environment generally enable a wide range of complementary rural activities to occur whilst avoiding, remedying, or mitigating any adverse effects on the environment.

Drainage Districts

These are statutorily recognised areas that district councils have rights and responsibilities for managing land drainage within. Land drainage activities include culverts, drains, flood gates, bunds and stop banks.

Erosion-Prone Land

Land defined as Land Use Capability (LUC) units 6e17, 6e19, 7e1 - 7e10, 8e1 - 8e3, and 8s1 are defined as erosion-prone land. The LUC units are generally depicted in the New Zealand Land Resource Inventory (NZLRI).

River Management Units

The National Policy Statement for Freshwater Management 2014 (Amended 2017) (NPS-FM) requires that regional councils establish Freshwater Management Units (FMUs) to manage freshwater quantity and quality. The NPS-FM defines a FMU as a water body, multiple water bodies, or any part of a water body determined by a regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management purposes. Excepting the Kaihu River intake, all of the storage sites are within the FMU classification of ‘Small River’ which according to the method of classification, are those rivers with mean flow below 20 m^3/s but also based on broad differences in flow regimes and the influence of changes on hydraulic habitat and reliability of supply on water users, and ecological and natural character values.

Priority Catchments

Objectives and policies, supported by rules to improve fresh and coastal water, have been inserted into the PRPN for Priority Catchments. The regulatory approach seeks to reduce impacts of sediment on fresh and coastal waters by addressing hillslope erosion in respective catchment plans. The Waitangi River catchment is one of these Priority Catchments.

Crown Riverbed

Some New Zealand lakebeds and riverbeds are Crown property and are managed by Land Information New Zealand (LINZ) on behalf of the Commissioner of Crown Lands (CCL). An activity involving a riverbed identified as Crown property may require the permission of the CCL.

5.1.2 Resource Consent Requirements

Table 2 provides a high-level overview of the activities that will require approvals under these documents[6].

[6] The RWSP is referenced only where appeals have been lodged specifically with regard to the relevant rule. In all other cases, all rules that are not subject to appeal must now be treated as operative pursuant to section 86F of the Resource Management Act 1991.

Table 2. Consent activity summaries and likely classifications.

Activity	Likely overall classification	Relevant documents	Deciding authorities
Geotechnical investigation temporary bore constructions.	Permitted	PRPN	NRC
Excavation and fill activities (including for pipework not in road or road designation).	Discretionary Consent	RWSP, PRPN, FNDP, KDP, NESCS	NRC, FNDC, KDC
Noise, setbacks, heights in relation to boundaries	Permitted	FNDP, KDP	FNDC, KDC
Aboveground utility services for the supply of electricity	Permitted	FNDP, KDP	FNDC, KDC
Impermeable surfaces	Permitted[7]	FNDP, KDP	FNDC, KDC
Pump shed structures	Permitted	FNDP, KDP	FNDC, KDC
Pipework structures inground and above ground	Permitted	FNDP, KDP	FNDC, KDC
Temporary site office during construction (portacom).	Exempt Permitted	FNDP KDP	FNDC KDC
Vegetation clearance in the Mid-North may exceed permissible thresholds as most valleys are vegetated with mature indigenous vegetation.	Discretionary Consent	RWSP, PRPN, FNDP	NRC, FNDC
Vegetation clearance in the Kaipara is not likely to exceed any of the permissible thresholds as most of the sites identified are covered in exotic vegetation such as pampas, gorse, and pine.	Permitted	KDP	KDC
The use, erection, reconstruction, placement, alteration or extension of a dam in the bed of a river, any associated disturbance of the bed of a river or lake and deposition of material on the bed, and the associated damming and diversion of water.	Discretionary Consent	PRPN	NRC
The use, erection, reconstruction, placement, alteration, or extension of a structure in, on, under or over the bed of a lake or river, that is part of a significant wetland.	Non complying	PRPN RWSP	NRC
Discharge of spillway water from water reservoirs.	Permitted	PRPN	NRC
The taking and use of water from a river when the flow in the river is above the median flow.	Restricted Discretionary Discretionary	PRPN RWSP	NRC
The taking of water from an instream dam.	Non complying Discretionary	PRPN RWSP	NRC
Releases of water to augment watercourse flows for subsequent consumptive taking.	Permitted	PRPN	NRC
Augmentation takes from watercourses for consumptive use (use to be confirmed).	Discretionary Consent	PRPN	NRC
Discharge of site runoff and collected stormwater during construction (earthworks and vegetation clearance).	Discretionary Consent	PRPN, RWSP	NRC
Activities within drainage district which do not impede the functional integrity of the drainage district or which does not impede access required for maintenance purposes.	Permitted	PRPN, RWSP	NRC

[7] Although in the case of [redacted], the proposed onsite development causes the impermeable surface rule in the FNDP to be breached.

The activities identified above are classified as either permitted, restricted discretionary, or discretionary activities.

Bundling resource consent activities is generally considered appropriate where the activities for which consents are being sought overlap to such an extent that they cannot be realistically or properly separated. As such, it is anticipated that the applications will be considered as a bundle on the basis of the most stringent activity classification – being discretionary.

5.1.3 Procedural Matters

5.1.3.1 Pre-application Meetings

At least one pre-application meeting with the consenting authorities will be necessary.

Recommendations should be made to consenting authorities to undertake a joint process and that the consenting process is contracted out to a consultant planner agreed by all parties at the pre-application meeting.

It is also recommended that an independent commissioner is assigned at the same time to make both the notification and substantive decisions.

5.1.3.2 Notification

The notification levels of a consenting process are public notification, limited notification, or non-notification.

Public notification is mandatory where:

- A determination that the activity will have or is likely to have adverse effects on the environment that are more than minor is made by the consenting authority; or
- The applicant requests public notification; or
- A request from the consenting authority to the applicant to provide further information is refused; or
- The consenting authority considers that special circumstances exist.

Subject to the management measures proposed in **Table 4**, a decision to publicly notify a suite of applications due to adverse effects can be avoided. Furthermore, no special circumstances are known to exist with regard to the proposal, in particular, that pre-application requests will include that all delegated decision-making would be made by an independent commissioner.

Limited notification is mandatory where persons deemed to be affected in a minor or more than minor manner do not give their written approval to a proposal.

Persons who may be considered affected include:

- Landowners or occupiers who are not the applicant where the infrastructure will be located and where operating water levels encroach;
- Landowners and occupiers within the path of water flow in the event of a complete dam failure;
- Network utility operators;
- Mana whenua (local hapū and marae);
- Department of Conservation (DoC) as statutory advocates;

- Local and state highway controlling authorities.

Consultation with these parties should be undertaken in order to understand their views about the proposals and to request their written approvals.

Non-notification would occur where neither the mandatory requirements for public or limited notification are met.

In concluding, if suitable consultation is undertaken resulting in all affected party written approvals being obtained, a non-notified application suite is possible. The special circumstance provision under the notification sections of the RMA can be overcome through assignment of independents.

However, it is expected that the most likely eventuality is limited notification because in most cases not all affected persons will give written approval. This should not limit the consultation undertaken however.

5.1.4 Consent Processing Timeframes

The standard processing timeframes are set out as presented in **Figure 9**.

Figure 9. Standard processing timeframes.

A non-notified consent application must be decided upon no later than 20 working days from the acceptance of the application for processing by the consenting authority. However, a hearing may still be requested as a non-notified application, at which point, a decision must be released no later than 15 working days after the end of the hearing.

It is noted that all consent processing is subject to a 10-working day period where the consenting authority may return an application as incomplete pursuant to Section 88 of the RMA.

All of the abovementioned statutory timeframes may be exceeded where:

- Further information or report is requested;
- Time extensions are applied;

- Approval is being sought from affected persons;
- The matter is referred to mediation; and
- An application is suspended.

5.1.5 Other Consenting Processes

There is a process available to applicants to request that the relevant consent authority allows the application to be determined by the Environment Court instead of by the consent authority.

This request must be made by an applicant in the period starting on the day on which the application is made, and ending five working days after the date on which the period for submissions on the application closes.

The applicant must make the request electronically or in writing on the prescribed form.

If the consent authority decides not to notify the application, such a request must be returned.

5.2 Archaeological Authority

Recorded and unrecorded sites are subject to the Heritage New Zealand Pouhere Taonga Act 2014 (HNZPTA). All archaeological sites, whether recorded or not, are protected and it is illegal to destroy or modify an archaeological site without an authority under Section 44 of the HNZPTA.

The HNZPTA covers all recorded and unrecorded archaeological sites (where reasonable cause exists to suspect that there are unrecorded archaeological sites).

Archaeological sites are defined in Section 6 of the HNZPTA as:

(a) Any place in New Zealand, including any building or structure (or part of a building or structure), that:

(i) Was associated with human activity that occurred before 1900 or is the site of the wreck of any vessel where the wreck occurred before 1900; and

(ii) Provides or may provide, through investigation by archaeological methods, evidence relating to the history of New Zealand; and

(b) Includes a site for which a declaration is made under section 43(1).

The HNZPTA requires that an archaeological authority be obtained from Heritage NZ to damage, destroy or modify an archaeological site prior to any earthworks within the vicinity of a known archaeological site, or in an area where there is reasonable cause to suspect that there may be an archaeological site.

A search of the Heritage New Zealand Pouhere Taonga register found that there are no known heritage sites or buildings in the vicinity of the Kaipara or Mid-North sites or distribution. However, review of the NZ Archaeological Association (NZAA) recording scheme site shows that most storage and distribution sites are near to recorded sites. Site MN02 is likely to be most impacted by a site being present that is of archaeological significance, followed by MN03 and MN05.

An approved archaeologist with Northland specific experience and relationships will be needed to undertake a more in-depth initial screen of the NZAA database after which further site-specific advice can be given with regard to the need for and likelihood of gaining archaeological authority from HNZPT.

5.3 Conservation Act 1987

The Conservation Act 1987 (CAct) was created to promote the conservation of New Zealand's natural and historic resources. The Department of Conservation (DoC) was established to administer the CAct. There are many functions given to DoC under the CAct, with the most relevant functions to this project being those associated with:

- the administration and management of all conservation areas and natural historic resources;
- the preservation so far as is practicable all indigenous freshwater fisheries, and protection of recreational freshwater fisheries and freshwater fish habitats; and
- the advocacy of the conservation of natural and historic resources generally.

Statements of general policy and conservation management strategies, conservation management plans, and freshwater fisheries management plans may apply to some of the sites to achieve the purpose of the CAct.

None of the sites encounter land held by DoC for conservation purposes.

The taking or destroying of freshwater fish must be authorised by DoC of the appropriate Fish and Game Council under the CAct, including for ecological survey or for translocations.

Other than the above, there are no other obligations under this legislation for the project activities.

5.4 Reserves Act 1977

The Reserves Act 1977 (RAct) is administered by DoC for the purpose of:

(a) providing, for the preservation and management for the benefit and enjoyment of the public, areas of New Zealand possessing—

(i) recreational use or potential, whether active or passive; or

(ii) wildlife; or

(iii) indigenous flora or fauna; or

(iv) environmental and landscape amenity or interest; or

(v) natural, scenic, historic, cultural, archaeological, biological, geological, scientific, educational, community, or other special features or value:

(b) ensuring, as far as possible, the survival of all indigenous species of flora and fauna, both rare and commonplace, in their natural communities and habitats, and the preservation of representative samples of all classes of natural ecosystems and landscape which in the aggregate originally gave New Zealand its own recognisable character:

(c) ensuring, as far as possible, the preservation of access for the public to and along the sea coast, its bays and inlets and offshore islands, lakeshores, and riverbanks, and fostering and promoting the preservation of the natural character of the coastal environment and of the margins of lakes and rivers and the protection of them from unnecessary subdivision and development.

The RAct is relevant where land has been set aside as described above. Our preliminary review suggests there is at least one site on the Wairoro Stream in the Mid-North where water intake and conveyance infrastructure may require access to and across an esplanade reserve. No other reserve land has been identified for the other sites.

The Protected Natural Areas Programme (PNAP) was established in 1982 to implement Section 3(b) of the RAct for:

"Ensuring, as far as possible, the survival of all indigenous species of flora and fauna, both rare and commonplace, in their natural communities and habitats, and the preservation of representative examples of all classes of natural ecosystems and landscape which in the aggregate originally gave New Zealand its own recognisable character".

MN10 will require clearance of a finger of the Kopenui Stream Remmants PNAP site (P05036) while MN14 is surrounded by the Rakautao Bush PNAP (P05031). The presence of these PNAP sites gives reasonable expectation that DoC would be considered an affected person and will need to be consulted, and that greater ecological assessment should be directed to sites near to or within these PNAP.

5.5 Wildlife Act 1953

The Wildlife Act deals with the protection and control of wild animals and birds and the management of game. Most species of wildlife (including mammals, birds, reptiles and amphibians), native or introduced, are absolutely protected under the Act. No-one may kill or have in their possession any such bird or animal, unless they have a permit. The necessary permits will need to be identified by the ecologist based upon species likely to be present.

The WAct also sets out provisions relating to Wildlife Sanctuaries; Wildlife Refuges; Wildlife Management Reserves; and Wildlife Districts. No such categories of land are encountered under any of the storage and distribution scenarios in either the Mid-North or the Kaipara.

5.6 Building Act 2004

In addition to the resource consent requirements outlined earlier, all of the reservoir embankments chosen in the concept designs are considered to be Large Dams in accordance with the NZ Building Act 2004, i.e. has a height of ≥4 m and holds more than 20,000 m^3 of water or other fluid. A building consent will therefore need to be obtained from the relevant Building Consent Authority, in this instance Waikato Regional Council (administers all dam building consents across the North Island).

Based on our experience with Large Dam projects, various levels of design input are required at different project stages. In some cases, there is flexibility around the level of documentation required for a given project stage. A typical arrangement is set out in **Table 3**.

Table 3. Typical engineering design and documentation stages for large dams.

Ref	Document	Resource Consent	Building Consent
1	Input to AEE	Yes	
2	Dam break assessment	Yes	Yes
3	Drawings	Overview only	Yes
4	Construction specification	No	Yes
5	Design report	Overview only	Yes

6. Environmental Effects

This section summarises the actual or potential environmental effects of land and water use and development as well as discharges and recommendations to address such effects.

The meaning of 'effect' is described in Section 3 RMA as including any:

- Positive or adverse effect;
- Temporary or permanent effect;
- Past, present, or future effect;
- Cumulative effect that arises over time or in combination with other effects;
- Potential effect of high probability;
- Potential effect of low probability that has a high potential impact.

The RMA uses the word 'effects' to mean 'effects on the environment', so this narrows the range of effects that are relevant to the considerations of RMA decision-makers.

The RMA's definition of 'environment' recognises that biophysical, social, and economic matters are linked. The definition in Section 2 RMA states;

Environment includes -

(a) ecosystems and their constituent parts, including people and communities; and

(b) all natural and physical resources; and

(c) amenity values; and

(d) the social, economic, aesthetic, and cultural conditions which affect the matters stated in paragraphs (a) to (c) or which are affected by those matters

A traffic light risk matrix approach has been used to illustrate the potential for risk associated with each effect (**Figure 10**).

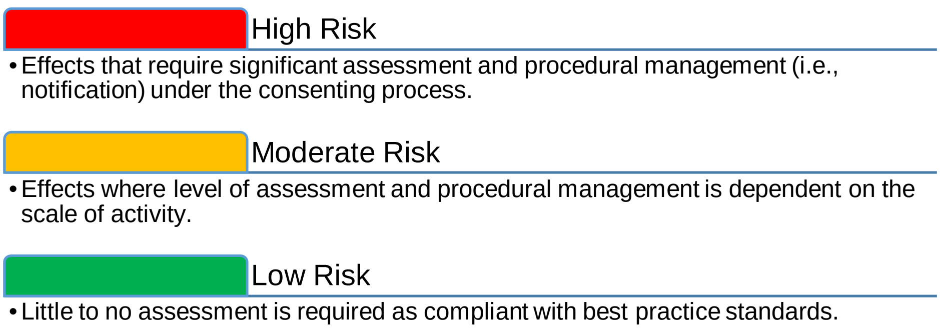

Figure 10. Risk matrix example.

Table 4. Summary assessment of effects and management approach and associated risk to the project objectives.

Effect	Description	Management	Risk
Noise	Construction noise will be required to comply with NZS 6803:1999. NZS 6803:1999 has been prepared in such a way that recognises that the public will tolerate higher noise levels associated with construction because it is of a limited duration (14 calendar days or less than 20 working days). The surrounding area is all zoned Rural with most sites being located some distance from residential dwelling houses.	A Construction Management Plan (CMP) shall be prepared by the Contractor to ensure that typical, short-term and long-term duration noise emissions comply with the standard as is relevant to the receiving environment.	
Air Quality	Some very minor localised discharges of dust to air are anticipated.	The CMP will contain management measures to control discharges of dust so that they are not objectionable or offensive beyond the work site.	
Terrestrial Ecology	Initial screening has identified potential for terrestrial habitat of ecological significance. constraints associated with the construction works and operation of the upgraded intersection.	Terrestrial ecological management measures may be required and implemented through special consent conditions.	
Aquatic Ecology	There is likely to be fish species present in the, and while many of the sites and their lower catchments are degraded, there is still some shading and variation in river bed composition which provides habitat to fish and invertebrates.	An Ecology Management Plan to be prepared for each site to ensure that existing habitat is either maintained or enhanced, noting there is ability to use an offset approach. The construction methodology can incorporate temporary dam and divert practices to minimise sedimentation and to allow for any translocations. The ecologist will advise of any need for inspection of the waterway area prior to the instream work commencing and any need for ongoing monitoring.	
Construction Stormwater	Construction stormwater has the potential to contain fines and sediment. Neither of the Regional Plans have specific discharge standards. However, in both regional plans, discharges must not cause the quality of the receiving waterbody to decline due to a discharge.	The CMP to document how construction stormwater will be managed to avoid adverse effects of sedimentation on receiving waterbodies and flooding of neighbouring properties.	
River Dynamics – Instream work and structures	Work instream can affect how a watercourse behaves. As such, hydraulic design will need to address the effects of barriers in watercourses, erosion, and scour, overtopping and spill, and dam-break.	Liaison with NRC's river management team should be conducted early on in the design phase. Cross-collaboration may be required with NRC's River Engineering team and the Building Consent authority (Waikato Regional Council) to manage roles and expectations around aspects such as dam-break and the management of the risk associated with this.	
Water Quantity	The control of water flows from dams and augmentation activities can have positive effects for the community, the ecology and instream values of a river. However, the activities can modify naturally variable flow regimes in terms of: (a) Long periods of low or high flow, which may adversely affect natural and human uses and other people using a river, and the stability of river beds and banks; and (c) The rates of change of flow, which may adversely affect natural and human uses of a river.	The passing of appropriate flows may be required to ensure that any adverse effects downstream of the reservoir are remedied or mitigated. The appropriateness of these flows must account for the nature and the flow requirements of any natural and human use values that exist, and other uses of water that occur downstream of the activity. On top of managed flows will be a quantity of water to be released to augment flow for consumptive taking at selected sites downstream. Mechanisms must be identified which are able to	

		confirm that the quantity of water discharged to augment natural flows is the quantity that is taken at the downstream site and that no other abstractors access this water aside from those granted access. Minimum flows will be applied at the point of take and any downstream flow recorder sites, as determined by the Regional Council. The 7-Day MALF at flow recorder sites will be determined using the lowest average river flow for any consecutive seven-day period for each year of record. The MALF for other sites, for which no measured flow data exists, will be determined through gauging of river flows correlated with water level monitoring sites, flow modelling or flow recorded sites. The Regional Council will have discretion over the location and method for the gauging.	
Reporting and monitoring of water takes	The taking of water is required to be measured and reported on in accordance with the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010.	A device or system which is capable of measuring the volume of water taken to within ± 5% for piped takes or ±10% for open channel takes should be identified in the application documentation as this gives confidence that the take will be suitably measured. Reporting of the water taken should be via telemetry given the sensitivity of the waterbody to reductions in flow due to consumptive taking.	
Culture & Heritage	Maori and their relationship with their culture, traditions and with their ancestral lands, water sites, waahi tapu and other taonga shall be recognised and provided for. Policy D.1.1 of the PRPN requires that resource consent applications include an analysis of the effects of an activity on tangata whenua and their taonga if certain outcomes may be likely such as, adverse effects on mahinga kai and access to mahinga kai, adverse effects on indigenous biodiversity where it impacts on the ability of tangata whenua to carry out cultural and traditional activities, and adverse effects on Sites and Areas of Significance to Tangata Whenua mapped in the Regional Plan (refer I 'Maps').	A cultural impact assessment (CIA) is a common assessment undertaken in a resource consent context to assess the effects on tangata whenua. CIA's are normally undertaken or mandated by the tangata whenua groups and are usually carried out by a representative of the affected hapū or iwi who has knowledge of the cultural values, beliefs and taonga of that group as well as an understanding of the scope and likely effects of the development. The content of the CIA will be reviewed and any issues with practical implementation will be discussed with tangata whenua through the appropriate channels.	
Social Impacts	A social impact may be positive or negative and is a response to change. Impacts can include impacts on people's way of life, societal cohesion, sense of community, how people use a space, their relationships with the biophysical environment and resources, spiritual and cultural beliefs, quality of the living environment and amenity, family, health and wellbeing, material wellbeing, personal and property rights, fears and aspirations, and/or political system.	The identification and management of social impacts across the life of the Project are being factored into the design and the process. Furthermore, a comprehensive record of Consultation and Public Engagement will be contained in a Consultation Report to be included with the applications.	
Economic Impacts	The high-level aspiration of this project is to provide new reliable water supplies that help lift the prosperity and wellbeing of local communities. A more sustainable water supply is needed to foster the continued expansion of horticulture and protect the environment.	Further economic analysis is being conducted and will be appropriate to include in an AEE to provide a balanced view of the Project.	

Contaminated Land	Excavation of soil will be required but contamination is not anticipated to be present at most sites.	A Preliminary Site Investigation can be used to exclude the NESCS from being considered applicable to the pieces of land where land disturbance is proposed.	
Rural character and amenity	While water storage is an anticipated activity in the rural zone, large water storage is not anticipated. The landscape visual effects of the proposal are transitory and include those effects visible during construction, those visible during final stages of establishment, and the long-term presence of the facility in the receiving environment. The potential for adverse visual and landscape effect is during construction.	Landscape and visual impacts are likely unavoidable during construction. A landscape architect will need to be involved to advise the magnitude of the temporary effects on landscape and visual amenity at this stage. Their advice will need to extend to mitigation measures which will ensure that, over the longer-term, the temporary effect on landscape and visual amenity is remedied.	

The main risk areas where this conclusion may change is in the areas of river hydrology, ecology, and culture and heritage.

With regard to river hydrology, the variations in flow will need to remain suitable to the natural and ecological values present as well as for human use values, such as the mauri of the water in the case of puna (spring) poka wai (swimming hole), and existing allocations or discharges, which rely on certain flow rates.

The preliminary ecological impact assessment highlights that most sites are heavily degraded while some areas may contain significant indigenous flora and fauna but that overall catchment health and circumstance may actually limit the physical presence of such species. Physical site surveys undertaken using agreed methodology would be the most appropriate mechanism of confirming the presence of such values. Decisions would need to be made as to whether the effects of the construction and operation of the scheme on these values can be avoided, remedied, or mitigated or if none of these are possible, that offset or compensation is considered.

Culture and heritage are particularly rich in the sites currently identified; however, most sites are not likely to directly affect a recorded archaeological site.

The Treaty of Waitangi/Te Tiriti o Waitangi is the underlying foundation of the Crown–iwi/ hapū relationship with regard to freshwater resources. Addressing tangata whenua values and interests across all of the well-beings, and including the involvement of iwi and hapū in the overall management of fresh water, are key to giving effect to the Treaty of Waitangi. Iwi and hapū have a kinship relationship with the natural environment, including fresh water, through shared whakapapa. Iwi and hapū recognise the importance of fresh water in supporting a healthy ecosystem, including human health, and have a reciprocal obligation as kaitiaki to protect freshwater quality.

In concluding, the effects which may potentially or actually arise from the construction and operation of the various schemes should not be considered to be more than minor in an overall broad judgement based on weighing of the relevant RMA factors (particularly those in Part 2 RMA), subject to measures which avoid, remedy, or mitigate adverse effects first, or which offset or compensate for the effects secondly. Currently, no adverse effects have been identified as particularly limiting to any of the sites as the above.

6.1 Kaipara

6.1.1 Stream Ecology – Reservoirs

[redacted]. The catchments of these streams are dominated by pastoral land use, with some pockets of plantation forestry.

The stream systems downstream of the proposed reservoir locations appear to have been heavily modified; aerial imagery and topographic maps indicate extensively straightened drainage channels, and Local Council documents describe the presence of tidal gates at the mouths of the systems where they meet the Wairoa River estuary. This type of stream management is typically to facilitate drainage for pastoral land use in lowland river flats.

Based on experience of similar systems, large extents of these streams will resemble ‘drains’, characterised by straight-sided, overly deep channels with low instream habitat quality and diversity. In addition, the tidal gates will be affecting flow regimes in the lower parts of the stream systems and are likely to be acting as barriers to fish migration to some degree.

As a consequence, such stream systems typically have a depauperate fauna, dominated by tolerant, generalist invertebrate taxa and a restricted range of native fish. However, the upper reaches on the eastern side of the Poutō ‘ridge’ appear to have some natural drainage features that may support more diverse biological communities.

Whilst the lakes of the Poutō peninsula have been relatively well studied, little is known about the streams that drain this area (NRC, 2017). For example, no records of freshwater invertebrates have been found for these streams, nor direct fish records at any of the reservoir sites.

There are fish records from nearby streams on the peninsula (i.e. Tauhara River, Okaro Creek, Waimamaku Creek, Te Hopai Stream and Makaka Creek) in the New Zealand Freshwater Fish Database (NZFFD). Across all five streams, three native species have been recorded (inanga, redfin bully and shortfin eel) and two exotic pest species (mosquitofish and catfish).

The most important of these native species from a management perspective is the inanga because it is considered ‘at risk – declining’ under the New Zealand Freshwater Fish conservation rankings (Dunn et al, 2018). The relevance of this species to the potential reservoir locations needs to be established, but inanga do not penetrate far inland naturally and are poor climbers, which means they are vulnerable to instream barriers to movement (McDowell, 2000). Therefore, inanga might not be present at the proposed reservoir sites.

However, depending on the extent of fish passage allowed by the tidal gates, they may be present in the streams and drains downstream of the proposed reservoir locations. Therefore, any changes in flow regimes as a result of impoundment or water extraction from the drains will need to be assessed. Within reason, inanga are resilient to changes in water flow regimes and quality, with their declining abundance associated with a reduction in suitable spawning habitat.

Inanga spawn in lower, tidal reaches of coastal streams and any potential negative effects from the reservoirs may be mitigated by enhancement of spawning areas. Improving the spawning habitat for inanga is likely to have a greater benefit than any flow regime changes from the impoundment reservoirs or water extraction from the drains.

Overall, from a fish passage perspective, the locations of the reservoirs in the upper reaches of these stream systems, the existing tidal gates together with the depauperate fish fauna that are likely to be present, indicate that any effects of the scheme are likely to be low. Nevertheless, this is an issue that requires appropriate assessment to ensure any effects are identified and managed, and to address any concerns raised by interested stakeholders (i.e. Department of Conservation, Fish and Game).

From a freshwater biodiversity perspective, the stream systems are expected to currently support populations of generalist freshwater invertebrates (reflecting the degraded habitat). These generalist invertebrates are equally as common in degraded streams as they are in standing water bodies, so any effects of the reservoirs on these communities is also expected to be low. Obviously, these assessments need to be confirmed by a detailed site assessment.

6.1.2 Stream Ecology – Water Takes

6.1.2.1 Kaihu Valley

[redacted] The tributaries of the Kaihu River rise in the Marlborough Forest, Kaihu Forest and Trounson Kauri Park before passing through Kaihu Gorge and flowing across a pastoral landscape.

NRC have a routine monitoring station at Kaihu Gorge and describe the river as having good water quality and ecology at this location, but the quality reduces as the river flows through the pastoral areas downstream of the Gorge (NRC, 2019).

Above the Gorge the river has diverse invertebrate communities typical of good water quality and habitat and it is expected that this community will reduce in diversity downstream from the Gorge.

There are records of fourteen fish species from the Kaihu River, with four species of conservation interest. The records include lamprey (threatened – nationally vulnerable), and three 'at risk – declining' species (longfin eel, inanga and torrent fish). All of these species migrate from freshwater to sea to complete their life cycles, with changes in hydrology one of the triggers for this migration.

[redacted], so there will be no effects on the higher quality habitats in the upper reaches of the streams, but the operation of the water take may have to be designed to minimise effects on the migration triggers for the native fish living in [redacted] reaches of the river. This may involve reducing takes during the peak migration periods for certain fish species.

6.1.2.2 Poutō Peninsula

The most important native species from a management perspective is the inanga because it is considered 'at risk – declining' under the New Zealand Freshwater Fish conservation rankings (Dunn et al, 2018). The relevance of this species to the potential reservoir locations needs to be established, but inanga do not penetrate far inland naturally and are poor climbers, which means they are vulnerable to instream barriers to movement (McDowell, 2006). Therefore, inanga might not be present at the proposed reservoir sites.

However, depending on the extent of fish passage allowed by the tidal gates, they may be present in the streams and drains downstream of the proposed reservoir locations. Therefore, any changes in flow regimes as a result of impoundment or water extraction from the drains will need to be assessed. Within reason, inanga are resilient to changes in water flow regimes and quality, with their declining abundance associated with a reduction in suitable spawning habitat. Inanga spawn in lower, tidal reaches of coastal streams and any potential negative effects from the reservoirs may be mitigated by enhancement of spawning areas. Improving the spawning habitat for inanga is likely to have a greater benefit than any flow regime changes from the impoundment reservoirs or water extraction from the drains.

The most important issue to consider when taking water from [redacted] are the potential effects on inanga spawning. Inanga spawn on riparian vegetation in the tidal reaches of streams and drains in autumn (March-May). The spawning is associated with spring tides, where the fish lay their eggs in vegetation on the banks during one spring tide, the eggs develop in the damp vegetation and are washed back into the stream during subsequent spring tides. The effects of the proposed reservoirs and takes can be minimised by improving the vegetation on the banks and not taking water during the important spawning periods for inanga (i.e. spring tides between March and May).

6.1.3 Significant Sites

As with the fish communities, there are no significant areas of native biodiversity identified within the footprint of any of the proposed reservoirs. However, there are two areas of biodiversity recognised by NRC that may be relevant and require a detailed assessment if the project were to proceed.

First, there is a site that [redacted] is listed in the Northland Biodiversity Ranking assessment based on the 'ecosystem rarity' criteria. This area (site 17881) is listed as WF 11, which is described as 'Kauri, Podocarp, broadleaf forest' with some associated herbaceous freshwater vegetation. Whilst this site is outside of the reservoir's footprint, it is in close proximity to the reservoir and we will need to assess the potential effects of the reservoir on this area. It should be noted that the effects of a large body of water nearby could be positive through providing additional freshwater habitat for native birds and increasing the local water table.

Second, there is a wetland recognised for its biodiversity in the lower area of the Tatararaiki Drain Flats next to Creamery Road. Whilst the wetland is recognised by NRC, it is not listed as one of the top 150 wetlands in Northland. Based on a desktop analysis, there doesn't appear to be a direct hydrological connection between the streams/drains downstream of the proposed reservoir location and the wetland, but this should be ground-truthed to allow an assessment of the effect of any hydrology changes on this wetland. Based on Local Council records, there is a tidal gate upstream of this wetland, which indicates that it already exists within a modified flow regime.

Overall, there are no significant areas of biodiversity within the footprint of the proposed reservoirs, but there are two areas nearby that require further investigation (**Figure 11**). The nature of any effect on these biodiversity areas may be positive though provision of additional aquatic habitat nearby for native species.

Figure 11. NRC Water Priority Areas and Biodiversity Wetlands. (Refer A3 attachment at rear).

6.1.4 Sediment Effects

The location of the proposed reservoirs [redacted] means there are only relatively small areas of land above the reservoirs where fine sediment can be generated. Where excessive sediment generation may be an issue, this can be managed through retirement and planting of critical source areas, or use of sediment traps in key areas of the catchment.

In addition, retiring areas of land above the proposed reservoirs from intensive production would also likely have a positive effect on the water quality in the reservoirs. De-intensifying parts of the contributing catchments would reduce nutrient inputs to the reservoirs and therefore reduce the likelihood of nuisance plant or algal blooms.

6.2 Mid North

6.2.1 Stream Ecology – Reservoirs

The proposed reservoirs [redacted] The catchments of these streams are dominated by pastoral land use, with some pockets of plantation forestry.

There are records of thirteen native fish species from the [redacted], with six species of conservation interest. The river records include lamprey (threatened – nationally vulnerable), and three 'at risk – declining' species (longfin eel, inanga and torrentfish). All of these species migrate from freshwater to sea to completer their life cycles, with changes in hydrology one of the triggers for this migration.

However, the biggest issue that will need to be investigated and managed is the presence of mudfish in both catchments, including the Northland mudfish (threatened – nationally vulnerable) and Black mudfish (at-risk). The mudfish species are typically found in wetlands, or slow flowing streams within wetland-like channels. The potential presence of these species represents the biggest constraint to the Mid-North water storage schemes. If they were found within the footprint of one of the proposed reservoirs, it would add significant complications to the consenting process and likely attract attention from interested stakeholders (e.g. NRC, DOC and Fish & Game).

From a fish passage perspective, the locations of the reservoirs [redacted] reduce the magnitude of potential effects on fish passage, but given the diversity of fish species [redacted] and that some of them commonly use headwater stream habitat, there is likely to be some impacts on fish passage that will need to be managed if the proposed reservoirs are developed.

6.2.2 Significant Sites

There are no significant areas of native biodiversity identified within the footprint of any of the proposed reservoirs. However, there are numerous areas of biodiversity recognised by NRC that are relevant to the potential reservoir locations and require a detailed assessment if the project were to proceed.

Given that the Mid-North reservoirs are located in larger catchments than the Kaipara options, there are numerous recognised biodiversity areas downstream of the reservoirs that require assessment for potential effects.

In addition, there are two proposed locations that have recognised areas above the proposed reservoirs. This potentially means the reservoirs could have a greater impact on biodiversity as they could affect fish passage to these areas and also change the hydrology of such areas from the impoundment of water. These are:

[redacted]

- There is a relatively long extent of stream upstream of the reservoir (~8 km) which could be affected by fish passage issues, with some of the habitat appearing to be in good condition from a desktop assessment.
- There are three areas of wetland recognised by NRC above this proposed reservoir location. The effects of any change in hydrology need to be fully assessed.

[redacted]

- There is a relatively long extent of stream upstream of the reservoir (~10 km) which could be affected by fish passage issues, with some of the habitat appearing to be in good condition from a desktop assessment.
- There is an NRC 'Top 150' wetland above this reservoir location [redacted]) that could potentially be affected by hydrological changes and fish passage issues. The status as a 'top 150' would likely result in much greater attention at this location, with a more interest from interested stakeholders.

7. Potential Benefits

7.1 Kaipara

The following sections detail the potential impacts and benefits of the reservoirs and distribution schemes in the Kaipara.

7.1.1 Streamflow and Flood Management

Harvesting streamflow in a storage reservoir enables some degree of downstream flow regime control. The ability to control downstream flow (within associated consent conditions) through either the harvesting or release of streamflow enables benefits such as augmentation of summer low flow through the release of stored water, or flood attenuation through storage of flood flows, during drought and flood periods respectively.

Given the already modified nature of the downstream flow regimes through channel straightening and construction of drainage networks, and the resilience of fish species such as Inanga to change in flow regime (**Section 6.1.1**), the potential benefits of low flow augmentation in the Kaipara is considered minor.

As the proposed storage reservoirs of the Kaipara [redacted], there is only limited ability to capture and attenuate flood flows. Nevertheless, when below maximum capacity the reservoirs will be able to reduce downstream flood flows through either the harvesting of the entire flood volume, or partial harvesting of the flood volume. An additional benefit of harvesting high flows in the upper reaches of the stream catchment is that it reduces the volume of flow entering the land drainage scheme downstream of the reservoir. Therefore, essentially increasing the drainage capacity available to alleviate surface flooding of the poorly drained peat and gley soils of the eastern Poutō Peninsula flats.

7.1.2 Municipal Supply

Both the Large Storage and Distributed Storage options provide solutions [redacted]) that have distribution network coming within approximately 5 kilometres of Dargaville's Water Treatment Plant. Broad assumptions have been made to include for allowances in scheme storage for the requirements of Dargaville and associated growth over the next 50 years.

Both the above options are comparative in terms preference with neither having significant benefit to the other.

Assuming the KDC are willing to contribute to the cost of developing the storage, and the additional distribution link, there is a real opportunity to secure a water supply to meet the short and long term needs of Dargaville, whilst enabling growth of industry that requires a reliable supply of water to establish within the community.

7.1.3 Energy Generation

The identification and scoping of potential alternative energy sources capable of supplying or offsetting the Kaipara Scheme is worth considering in future stages of work given its comparatively high energy costs.

7.1.3.1 Hydroelectric Generation Potential

A preliminary cost-benefit analysis has been undertaken to evaluate the hydroelectric generating potential for each of the reservoir sites.

The assessment was based on residual flow estimates for catchments upstream of reservoirs (developed in Volume 2: Water Resources), projected irrigation demand profile, reservoir stage/storage relationships, generation efficiencies, costings revenue.

The system proposed would involve several, low head and low flow turbines housed within the main conduit through the embankment. Irrigation demand profiles were developed for each region using the average of the various crop types expected for the region (**Figure 13**). A total generation efficiency of 85% was `applied, accounting for 92% turbine efficiency, 96% generation efficiency and 96% transmission efficiency. Capital costs for generation infrastructure were calculated based on historic rates and a cassette approach whereby multiple standard turbines are utilised to match total discharge capacity, and assumes that transmission infrastructure has already been accounted for in the reservoir and pump-station costings. Generation potential estimates were calculated on an average annual basis.

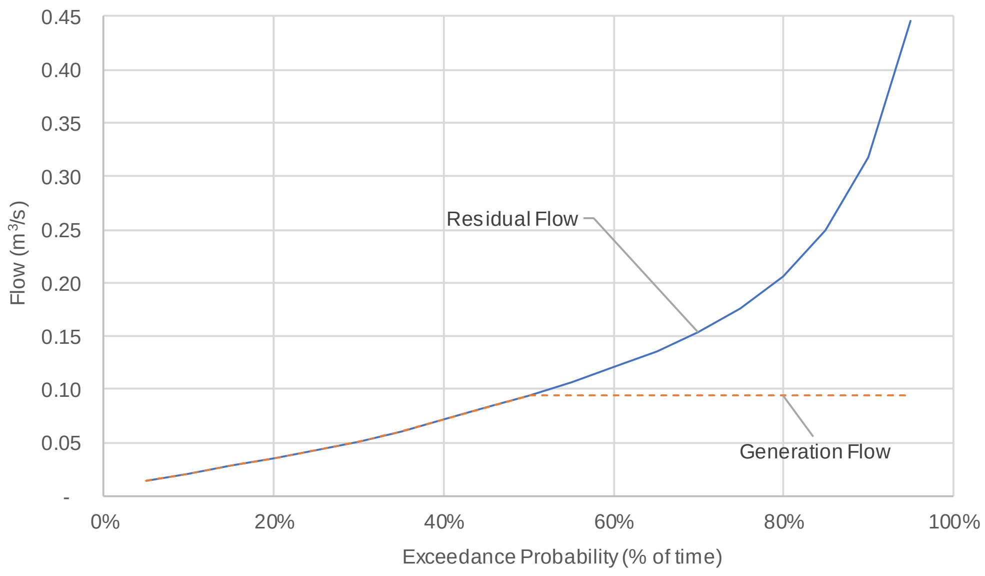

Figure 12. Example flow duration curve for [redacted] (orange is flow generation).

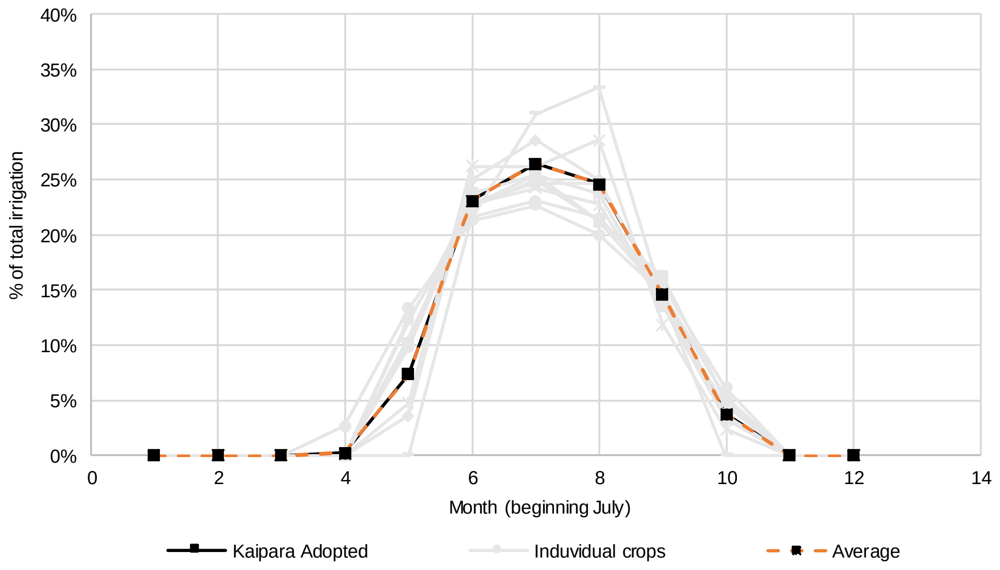

Figure 13. Adopted Kaipara irrigation demand profile.

To determine the available pressure head for generation, a simple storage water balance model was utilised (**Figure 14**). The storage volume (shown in dark blue) therefore reduces during the irrigation season as water is drawn off (light blue), and refills through a combination of local (grey) and remote (green) refill. This model adopted average inflow and use conditions to define the average combination of pressure head and discharge from which generation could be produced.

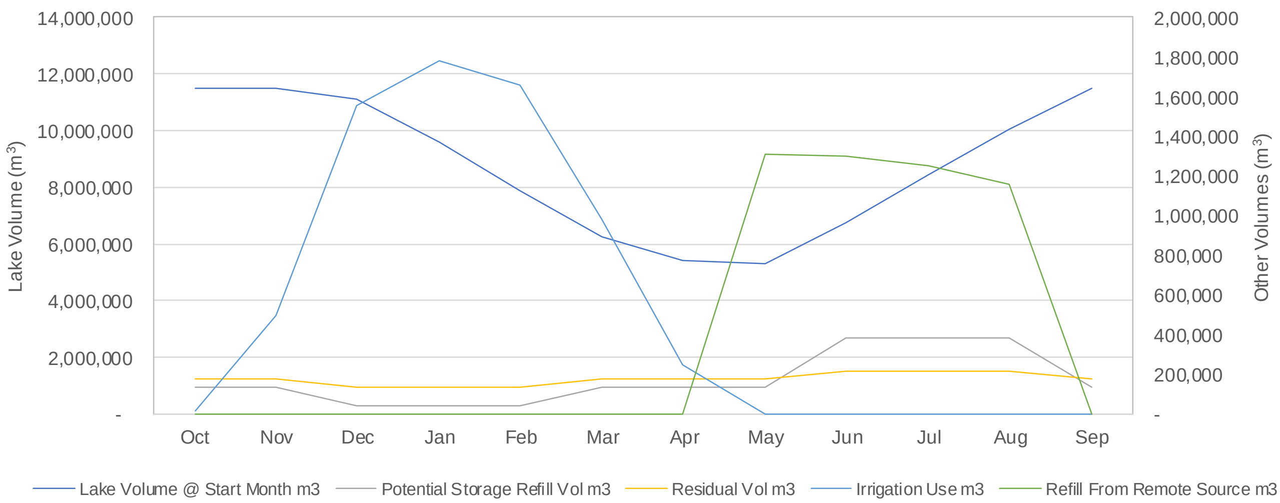

Figure 14. Example fluctuations in reservoir level and water balance across a typical year i[redacted] Scenario.

Table 5 summarises the results, which suggest that [redacted] has the greatest potential for hydro generation owing to their larger storages and/or larger catchments (and hence residual flow). There is the potential to generate additional electricity if the reservoir levels are appropriately (i.e. if reservoir levels are drawn down prior to spilling).

It should be noted that a return on investment of less than 10% is considered undesirable owing to a typical turbine design life of 10 years for small units and associated operational and maintenance costs.

Table 5. Generation summary and potential income.

Reservoir	Installed Capacity (kW)	Capital Cost ($000)	Annual Generation kWh	Annual potential income ($000)	ROI (%)	Notes
Kaipara Large Storage						
[redacted]	12.0	70	6,700	7.8	11	
Kaipara Distributed Storage						
[redacted]	8.3	64	2,000	2.3	3	Empty in Jan - Jun
[redacted]	26.0	93	2,700	7.9	9	
[redacted]	6.3	60	3,900	4.4	7	
[redacted]	2.1	53	700	0.8	2	

Based on the minimum target ROI of 10% only [redacted] achieves this. As a single installation, overheads in terms of operational, maintenance and administration further impact on viability. It is therefore considered unlikely that hydro-generation will be worthwhile as part of the project. There may however be interest from 3rd parties such as the local lines company as they already have comparable operation, maintenance and administration capacity in place.

7.1.3.2 Other Renewable Energy Sources

Wind generated energy could serve as an efficient way of balancing/transferring storage between reservoir sites in the Kaipara Distributed Scheme as the timing of transfer is often not critical as it is from one storage to another. Transfers can therefore potentially cater for the intermittent nature of wind generation. There is less opportunity for the Large Storage option as refill needs to occur when stream flow is available and as such cannot wait for energy from wind.

We understand that several studies have looked at potential wind farms along the Kaipara Coast including at Ahipara, Glinks Hill and further north.

These projects highlight the potential wind resource available along the coast.

Solar panels dedicated to pump stations are also possible, and are likely to be more advantages for remote areas where the cost of new transmission is high. These could be combined with battery storage facilities. Like wind, solar energy also aligns better with the Distributed Storage option where storage transfer can be timed to occur periods of generation, i.e. during daylight hours.

Aligning storage transfers with any intermittent generation may however induce a need to increase pipe capacity as transfers are occurring over shorter periods and hence will need to be at higher rates. However, in season where the storages were only partially used, there may be sufficient time during which intermittent renewable energy is available to complete storage transfers. In high use seasons then, energy from the grid would then address any shortfall from local intermittent renewable generation.

We also understand that tidal generation was assessed in the Kaipara Harbour as part of the proposed Kaipara Tidal Power Station in 2011.

7.2 Mid-North

The following sections detail the potential impacts and benefits of the reservoirs and distribution schemes in the Mid-North.

7.2.1 Streamflow and Flood Management

As described in **Section 7.1.1** for the Kaipara, the presence of storage reservoirs enables the ability to control the downstream flow regime (within any consent conditions), enabling management of low and flood flows.

One of the key features of the Mid-North Distributed Storage scheme is that [redacted]

As the transfers of water between storage [redacted] or the direct supply to irrigators from [redacted] will occur during the summer months, the transfers will augment summer low flows.

Similar to in the Kaipara, when below maximum capacity the reservoirs will also be able to reduce downstream flood flows through either the harvesting of the entire flood volume, or partial harvesting of the flood volume. However, as the proposed reservoirs are typically located in the upper catchment reaches, the potential to attenuate and mitigate flood flows downstream is considered limited. It is also noted, none of the catchments of the proposed reservoirs are listed as River Flood Hazard Zones by NRC.

7.2.2 Municipal Supply

Both the Large Storage and two Distributed Storage options make allowance for the current and future water needs for Kaikohe, as well as a nominal [redacted] In the instance of the Large Storage option [redacted], water is allowed to be distributed to the [redacted] edge of Kaikohe where additional infrastructure would be required at council expense to get to the council treatment plant. In the instance of the two distributed options both of these allow for water to be supplied directly to the council's [redacted] via a pipeline from [redacted] making this option must more preferable as part of the municipal supply. This same pipe route is to be also utilised for filling [redacted] years where it does not fill by gravity.

Assuming the FNDC are willing to contribute to the cost of developing the storage, and associated pipeline, there is a real opportunity to secure a water supply to meet the short- and long-term needs of Kaikohe [redacted] through a collaborative approach as part of this project.

7.2.3 Energy Generation

7.2.3.1 Hydroelectric generation potential

The same process as outlined in **Section 7.1.3** was followed to evaluate hydroelectric generation potential in the Mid-North.

The adopted irrigation demand profile is presented in **Figure 15**.

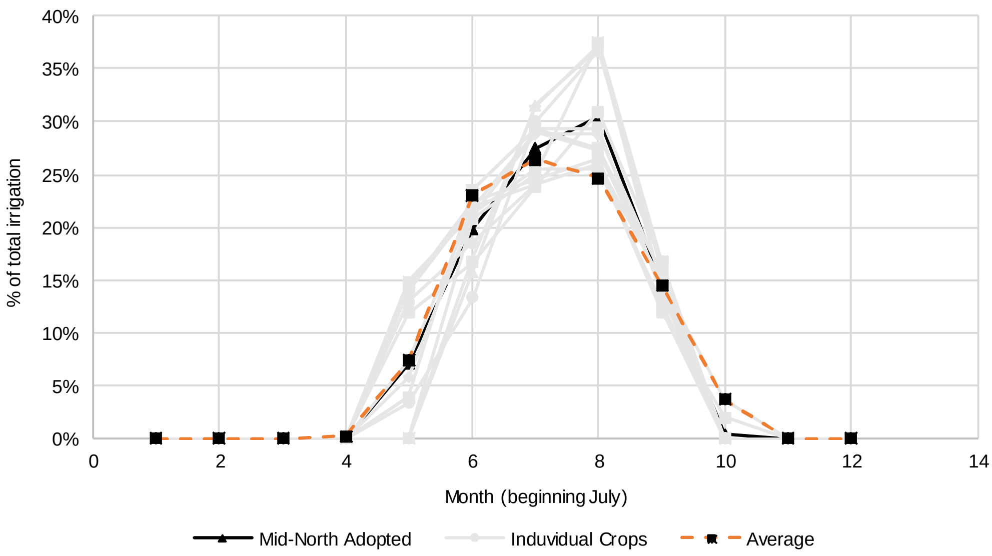

Figure 15. Adopted Mid-North irrigation demand profile.

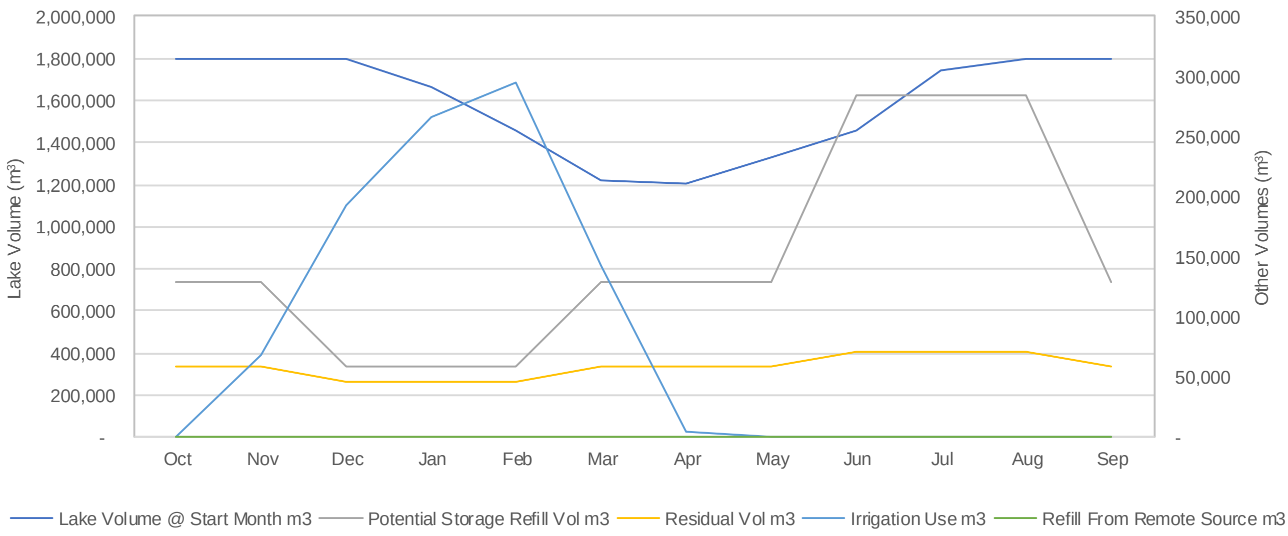

Figure 16. Example fluctuations in reservoir level and water balance across a typical year in [redacted]

Table 6 summarises the results. As with the Kaipara study area, sites with the greater catchment/residual flow [redacted] are seen to have the greatest potential.

Table 6. Generation summary and potential income.

Reservoir	Installed Capacity (kW)	Capital Cost ($000)	Annual Generation kWh	Annual potential income ($000)	ROI (%)	Notes
Mid-North Large Storage						
[redacted]	4.1	57	2,300	2.7	5	
[redacted]	24.7	91	16,600	17.7	20	
Mid-North Distributed Storage						
[redacted]	0.9	52	400	0.5	1	
[redacted]	0.9	51	400	0.5	1	
[redacted]	4.1	57	2,400	2.7	5	
[redacted]	14.0	73	8,800	8.9	14	
[redacted]	2.0	53	600	0.7	1	Empty in Mar – Apr
[redacted]	8.0	63	3,100	3.5	6	Empty in Mar – Apr
[redacted]	2.6	54	700	0.8	2	Empty in Feb - May

The ROI and scale of generation from [redacted] may be attractive, however consideration would need to be given to associated overheads which would only serve to bring the ROI down and is potentially an unwelcome distraction to the project. As indicated above, there may however be interest from a 3rd party such as the local lines company.

7.2.3.2 Other Sources

There may be the potential for geothermal generation near the middle of the scheme, [redacted] where we understand previous studies have been undertaken.

Wind is less likely to be of significant potential in the Mid-North however solar could be a realistic option. Solar could contribute to reducing the need for external energy use both during direct irrigation supply and for any transfers between storages. If Lake Omapere was includes as a storage, transfers from the lake to scheme storages could utilise solar energy at least at some level.

8. Scheme Supply Performance and Management

Achieving a balance between irrigation scheme cost and performance in terms of supply to the user, is a vital aspect in defining scheme viability and encouraging uptake. Understanding this relationship is also necessary to inform subsequent design and optimisation stages.

A key factor in a user's decision on whether to take up irrigation is the quantum, reliability and certainty of supply they will receive. This in turn impacts on uptake. If the performance of the scheme is poor, it may not provide a level of supply security that is adequate to generate uptake irrespective of the cost. Similarly, schemes with very high security of supply might come at a cost that is a significant barrier to uptake.

The cost of a scheme and hence cost to end user is a function of the level of supply security provided. More importantly, the function of "supply security" is not linear in terms of impact on scheme cost. Providing even modest increases in the security of supply will induce significant increases in cost. It is not unusual for the last 5-10% of scheme reliability (refer definition below) to induce between a 50% and 100% increase in scheme cost. This does not indicate that a lower reliability is the better option, as below a certain level of reliability users will simply not take up use as they have no certainty that their needs will be met.

This section discusses the impact of various aspects of scheme performance in terms of security of supply. It examines the potential impact on cost incurred by adjusting these performance metrics. These can be used in subsequent stages to refine the best combination of security of supply vs cost to user.

8.1 Scheme Reliability

The performance of irrigation schemes is typically expressed in terms of reliability of supply.

Scheme reliability, as an overall measure of scheme performance is defined as:

***The percentage of demand met*, which in practical terms equates to "Volume of Supply / Volume of Demand".**

Early in the pre-feasibility study it was recognised that the ability to fill the storages from local sources would be a significant constraint. This is due to the modest sources of potential supply in and around the command area, and the requirement to maintain up to median flow within the source streams. As such, an initial supply reliability of 19 out of 20 years was adopted to size storages and associated supply areas. Because in the 1-year in 20 that supply is curtailed, supply still occurs most of the time, adopting this approach results in an overall reliability significantly greater than 19/20 or 95%.

The overall scheme reliability is provided in **Table 7**. This shows the relatively high level of security of supply provided by the current design concepts, particularly for the distributed schemes. The design concepts as currently developed for the Kaipara and Mid-North currently have comparatively high reliability. This is because the development sequence firstly needs to ensure that each component within the scheme can support an appropriate level of supply without inducing unacceptable constraints of other components. This tends to induce a level of over design which can be optimised and refined in subsequent design stages.

Irrigation scheme reliability nationally typically falls between 92% and 97% on average. Schemes such as proposed in Northland that contain a high proportion of storage can and do operate toward the lower end of this range, or even lower. This supports the view that there is potential to refine and optimise the schemes in later development stages whilst still delivering an appropriate level of reliability.

Table 7. Overall scheme reliability.

	Kaipara		Mid-North	
	Large	**Distributed**	**Large**	**Distributed**
Average	97.5%	99.4%	97.7%	99.0%
Max Demand	82.1%	98.6%	72.6%	83.2%

With the pre-feasibility scheme layouts defined, the simplest way of testing the impact on cost of changes in scheme reliability is to alter the area supplied from the same scheme. This spreads the supply across a smaller or larger area, and in doing so increases or decreases the overall scheme reliability.

Because the area included for supply in the scheme layout is only a portion of the total area within the potential command area, modest change to the area supplied do not change the overall scheme footprint. Rather, each zone within the command area is presumed to develop slightly more or less irrigated land. By not changing the scheme footprint and configuration as the supply area is altered, the scheme components are largely unchanged apart from minor adjustments to pipe and pump station capacity and hence cost.

Across the two regions and two scenarios the combined costs of dams and intakes range from 35% to 70% of the cost. These components are unchanged by modest increases or decreases in supply area, as it is through not altering these components that reliability is impacted. The cost of pipes and pumps will change but at less than a direct ratio.

An increase in supply area (and hence demand) of 10% will induce between a 5 and 10% increase in price of these components. Therefore, overall an increase in supply area of 10% will induce between a 1.5 and 6.5% increase in price with 3.5 to 4% being the most typical outcome from a 10% change in area. For simplicity therefore a change in end user cost of 6% is adopted for every 10% change in area.

With scheme costs only modestly impacted, changing the supply area predominantly results in a direct change in cost per hectare. The cost implication of increasing or decreasing scheme reliability can therefore be determined as a variation in cost per hectare.

In subsequent design stages, as the scale and distribution of potential demand becomes more defined, scheme components such as storage volume would also be adjusted to refine the optimal cost vs reliability point.

Since the derived scheme layouts produce high levels of reliability, for this assessment, the supply area and hence demand have been increased by up to 30% to test the impact on overall reliability, as exemplified for the Kaipara Distributed scheme option in **Figure 17**.

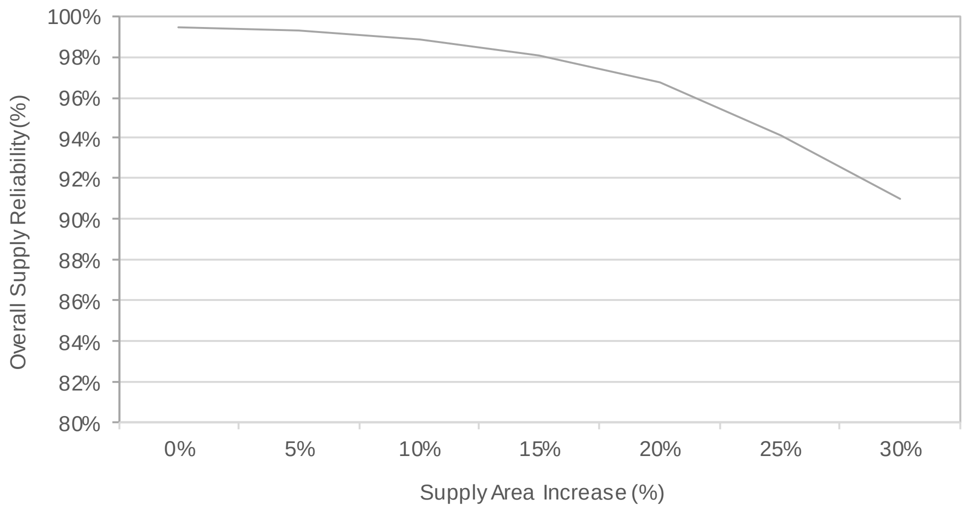

Figure 17. Kaipara Distributed: Scheme reliability as a function of increased supply area.

Figure 17 suggests that the scheme supply area in the Kaipara could be increased by 15-20%, from the same scheme configuration, whilst still retaining a good level of reliability (>95%), or even further by 20-25% whilst retaining an adequate relatability (>92%). This would equate to a reduction in cost to the end user of 9-12% for a good reliability or 12-15% for an adequate reliability.

It also indicates that, during progressive development of the scheme, the area supplied by each development phase could be temporarily oversubscribed by an additional 10-15% at the cost of interim reliability. This defers expenditure on subsequent phases and means there is an increased established user base for when the nest stage is developed.

A similar pattern exists for the Mid-North (**Figure 18**) with the potential increase supply area lying between 10-12% to retain a good level of reliability and up to 16% before reliability starts to fall to levels that may be unacceptable. This therefore equates to a potential 6-10% in cost savings to users.

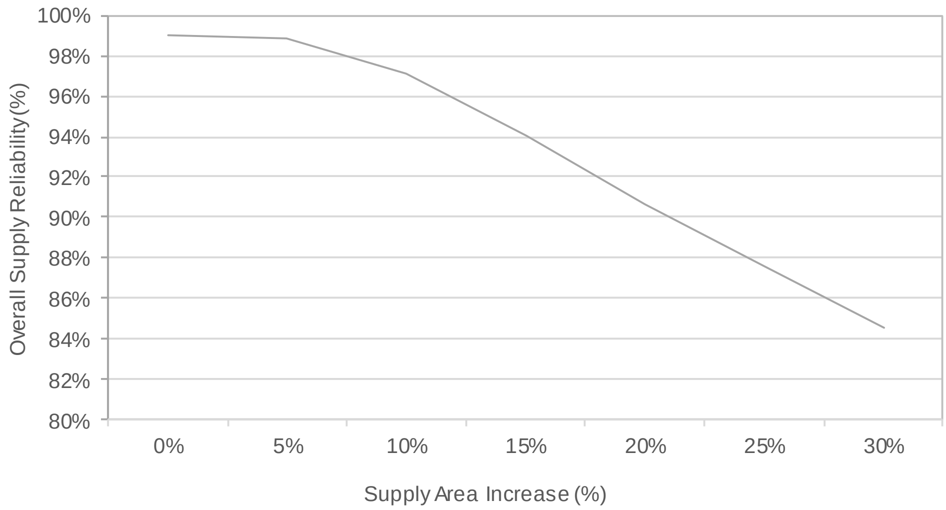

Figure 18. Mid-North Distributed: Scheme reliability as a function of increased supply area.

8.2 Certainty of Supply

The shortfall with reliability, as a performance metric, is that it provides little insight to the user as to how certain it is that at least some supply will be provided. For example, an overall reliability of 95% can equally mean that the scheme's demand:

1. is fully met 95% of the time, but no supply occurs the remaining 5% of the time;
2. is fully met 50% of the time, but constrained by up to 10% of the demand the other 50% of the time; or
3. any other combination.

If in the first case, while curtailment is infrequent, there is little warning as to when the 5% of non-supply occurs. There is therefore little certainty to the end user, and this will affect how they manage their operation and the potential value it produces. It is also more likely to adversely impact uptake. In the second case, the user knows that while supply will be curtailed frequently (50% of the time) it never falls below 90% of demand. The second case therefore provides a high level of supply certainty, which in turns improves the ability of the end user to manage their operation.

Certainty of supply is therefore defined as:

The probability that at any point in time, supply exceeds a certain percentage of demand.

Certainty of supply is linked to reliability, as lower reliability will induce more periods of curtailed supply and hence the certainty of that supply is reduced. A high reliability however does not necessarily ensure a high level of supply certainty.

Certainty of supply is also relevant in terms of when in the season curtailment may be of greater or lesser likelihood. Early in the season it may be more tolerable to have lower certainty of supply as the ability to recover though the season is greater. Similarly, toward the end of the season lower certainty may be more tolerable. Through the middle of the season however, a higher level of certainty is typically desirable.

At a pre-feasibility level, a simple way of demonstrating certainty of supply is to look at the probability that supply is fully met at different times of the season. For convenience a monthly timestep was been adopted.

Using the Kaipara Distributed option as an example, **Figure 19** demonstrates the average certainty of supply achieved in each month through the season, for a range of base and increased supply areas (plus 10%, plus 20%, and plus 30%). As the scheme is storage based, and in the absence of any supply rationing within the season, the scheme simply meets all demand until the storage is depleted. This means any deficit in supply is most likely to occur late in the season. The average certainty also represents the percentage of time in the month that supply is fully met.

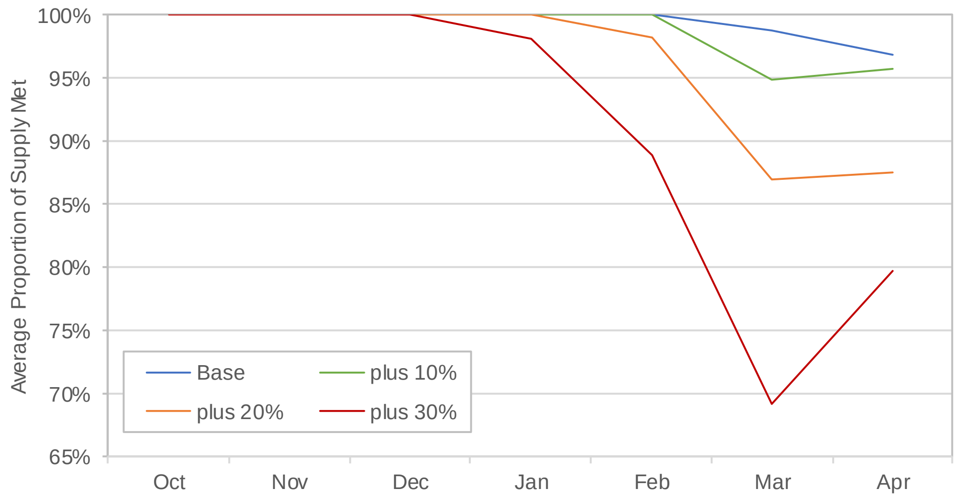

Figure 19. Kaipara Distributed: Certainty of supply through supply season.

For example, in March for the plus 20% supply area case, 86% of demand is met. Without storage management this means 86% of the demand volume is fully met, and 14% of volume is not. As for the reliability figures above, this analysis indicates that a Base +20% area is likely to provide a realistic level of supply certainty.

Supply certainty in the Mid-North scheme (**Figure 20**) is generally better than for Kaipara, but reduced certainty occurs earlier in the season so the impact on users may be more significant. The analysis does however once again suggest that up to a Base + 20% supply area may be acceptable.

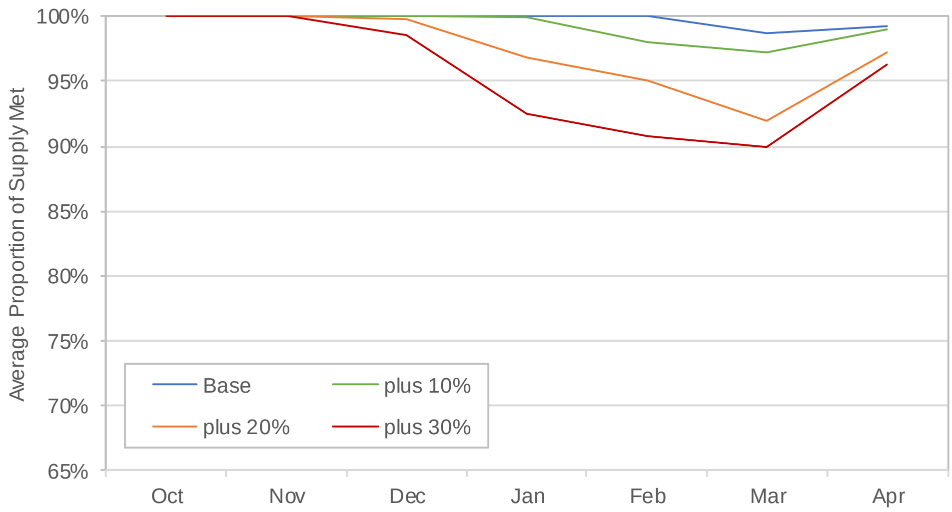

Figure 20. Mid-North Distributed, Certainty of Supply through supply season.

8.3 Constraints on Supply

The ability to supply is also a function of constraints within the scheme design. These may be due to natural aspects such as the source of water, or physical design aspects such as distribution capacity. As noted, sources of supply in and around the scheme areas are relatively modest with little direct supply available during the supply season. This has driven the need for a storage-based model.

For the purpose of this stage of the design process the constraint on scheme supply capacity has been purposely dominated by storage volume. The volume in storage therefore largely defines scheme supply capacity, subject to the level of reliability and certainty of supply deemed appropriate. Other potential constraints such as pipe capacity are removed through assuming some escalation in costs as supply areas increase.

In later stages it is likely that additional constraints will be designed into the system, such as conveyance capacity, to optimise scheme economics. For example, it may be more cost effective to reduce pipe sizing, inducing a constraint on peak capacity, but off-set the impact of this by adding small scale localised storages that augment supply during periods of peak demand.

8.4 Storage Management

Because the schemes are storage based, how the storages are utilised influences the supply to the users, and in particular the certainty of supply throughout the season. If all demand is met by the storage as it occurs, there will be a risk in high demand years that at some point the supply will run out. This is clear from **Figure 21** and **Figure 23** where certainty is 100% early in the season and progressively reduces later in the season as storage depletes.

It is normal therefore to adopt a set of storage management rules that induce some curtailment earlier in the season if the rate of use starts to induce an unacceptable risk of complete curtailment later in the season. This has the effect of reducing the overall reliability of the scheme by at times inducing curtailment early on in the season that is subsequently found to be unnecessary. This is done however to increase the certainty of supply particularly at critical times within the season and therefore manage the risk of significant shortfalls in supply.

A simple storage management has been applied to the same supply scenarios to provide an example of how supply certainty might be managed through the season. During subsequent development stages this can be refined to provide for the particular requirements of each demand area such as crop requirements. The simple approach is to provide a storage use profile through the season, that should the storage fall below, supply is progressively curtailed to increase certainty later in the season.

Figure 20 highlights how a storage-based scheme provides significantly enhanced opportunity to manage the certainty of supply to the end user throughout the season. These results for a managed storage are directly compared in **Figure 18** to those of an unmanaged storage provided in **Figure 21** to demonstrate the change. To avoid complexity only the ‘plus 20%’ and ‘plus 30%’ cases are shown.

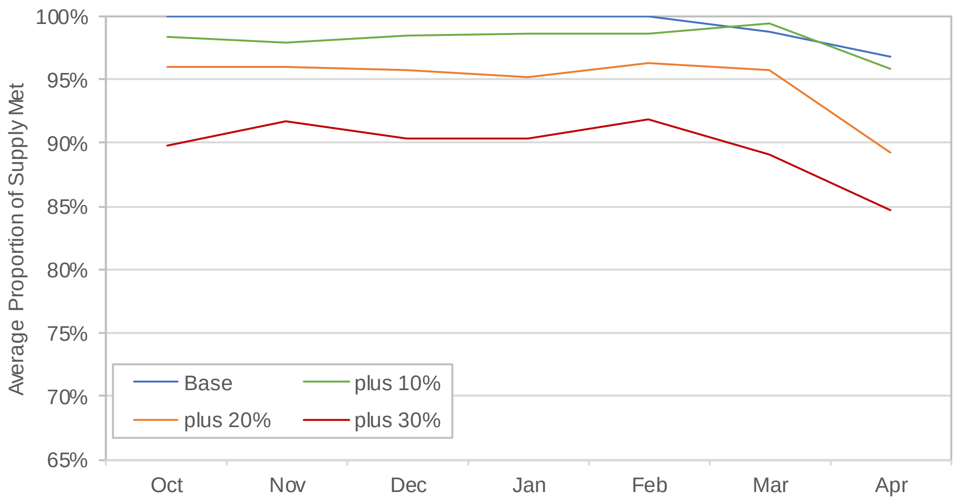

Figure 21. Kaipara Distributed: Certainty of supply with storage management applied.

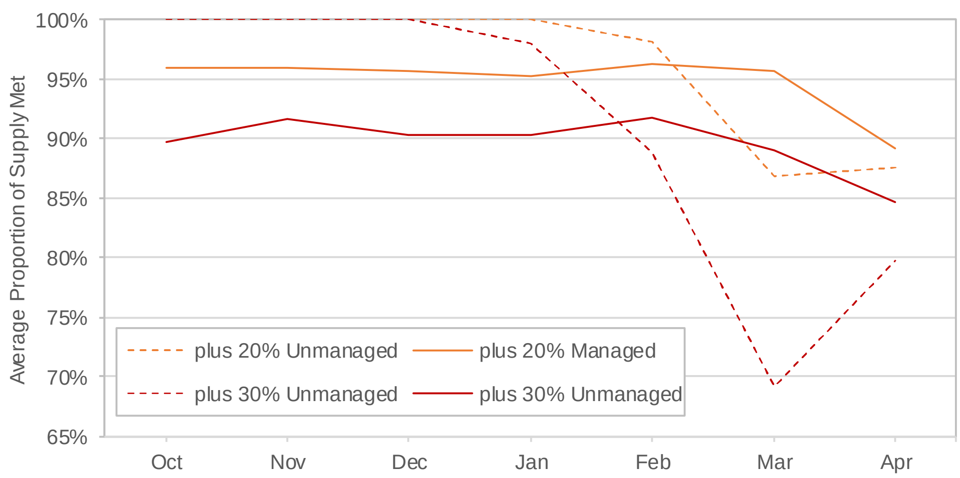

Figure 22. Kaipara Distributed: Comparison of unmanaged vs managed storage.

Figure 23 and **Figure 24** present the same information for the Mid-North Distribute Storage scenario.

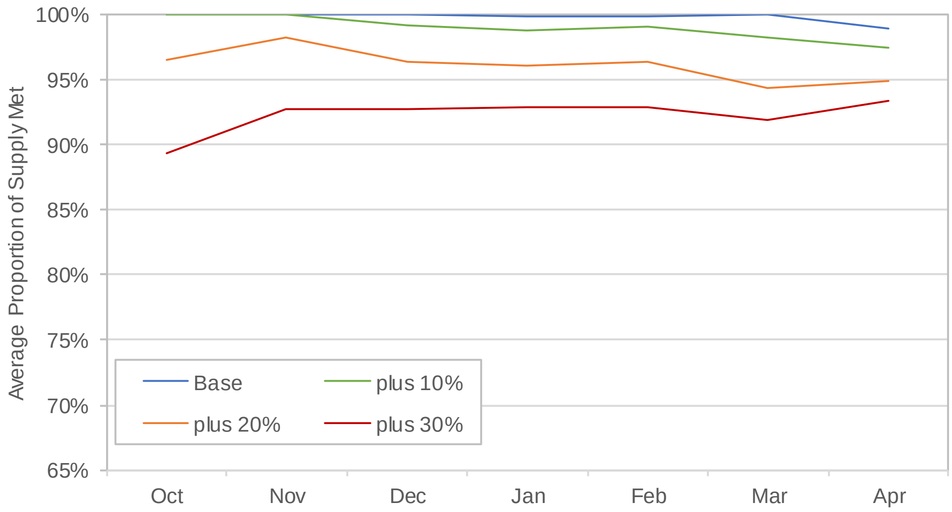

Figure 23. Mid North Distributed: Certainty of supply with storage management applied.

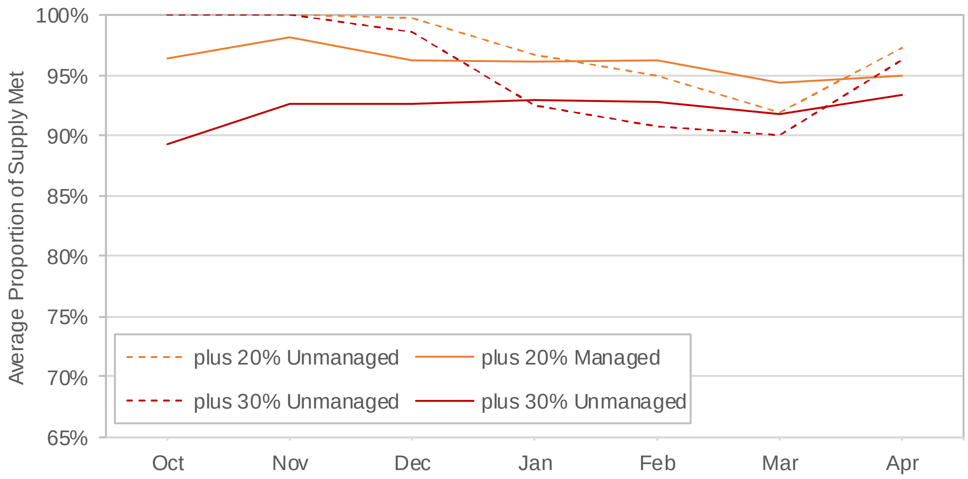

Figure 24. Mid North Distributed: Comparison of unmanaged vs managed storage.

Storage management effectively re-distributes uncertainty across the season. For demonstration purposes a management regime that delivers a relatively flat certainty has been adopted. Where during the season higher certainty is required, a more customised profile would be possible.

It is important to reiterate that while some curtailment in supply might now occur due to storage management throughout the season, rather than just toward the end of the season, the end user largely gets to decide how this curtailment occurs. For example, 90% supply may mean supply is met 9 out of 10 days, or 90% continuously. Because supply is from a storage, the choice of either of these (or alternative) has no impact on storage management or certainty of supply later in the season. This ability to choose is almost entirely due to the schemes being storage based.

9. Economic Analysis

9.1 Data Sources

The assessment of the relative performance of the range of different possible scheme configurations was carried out across three scenarios. These scenarios were chosen by the project team as being appropriate to test the range of scenarios possible.

These scheme scenarios are shown in **Table 8**.

Table 8. Scheme scenarios.

Scenario	Uptake profile (years)	Tree Crop (%)	Arable (%)
A	10	25	75
B	20	50	50
C	30	75	25

The tree crop definition has been used for the three tree crops of Kiwifruit, Avocado and Citrus and the arable definition has been used to portray a mix of Blueberries and Commercial Vegetable Production (CVP).

The two distribution areas being Kaipara and the Mid-North have been designed and costed as being supplied by a large storage dam (Large Storage) and by a number of smaller dams which are then able to distribute (Distributed Storage) the available water to the areas close to the storage facilities.

The fifth option, a Distributed Scheme including Lake Omapere, has been modelled albeit with a greater deal of uncertainty around viability of utilising this source.

The scheme therefore has been designed in five different configurations:

- Kaipara Large Storage;
- Kaipara Distributed Storage;
- Mid-North Large Storage;
- Mid-North Distributed Storage; and
- Mid-North Distributed Storage Including Lake Omapere.

The costings of these five options are as show in **Table 9**.

Table 9. Area supplied and the cost of the five supply options.

	Kaipara Large Storage	Kaipara Distributed Storage	Mid-North Large Storage	Mid-North Distributed Storage	Mid-North Distributed – Lake Omapere
Area Supplied	3,700	3,700	2,700	2,700	2700
Capital Cost ($/ha)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Operational Costs ($/ha/annum)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

9.2 Affordability of the Schemes

The affordability of the scheme has been tested across the five major land use options of:

- Kiwifruit;
- Avocado;
- Citrus;
- Blueberries; and
- Commercial Vegetable Production (CVP).

9.2.1 Methodology

All of the land uses have been set up so that their financial performance starts when they are planted and continues through to the end of year 10 when they have all reached their mature yield. In the analysis we have assumed that 40% of the capital cost is funded by equity and 60% is funded by debt. Debt is funded at 6% interest rate and capital repayments start in Year 4 and are repaid over a 10-year repayment schedule that has equal annual repayments.

Development costs include the cost of establishment of the crop as well as the developer paying the total cost of the capital to develop the irrigation scheme.

Each of the budgets has sufficient capital available to the owner to cover the cost of working capital so there is no interest cost on working capital included in the budget.

Each budget has been tested by use of a Net Present Value (NPV) analysis and an Internal Rate of Return (IRR) in order to ensure that both of the measures are positive and therefore are worthwhile proceeding with. The NPV has been calculated over a 30-year period with a Discount Rate of 6%.

Each of the financial performances that are presented in this report relate to the performance in the Kaipara Large Storage option. It should be noted that the financial performance of the other options do not vary significantly from the option reported here.

In **Table 10** we show a range of measures which are able to indicate the costs induced by the scheme development and the costs induced by the development of each option on the land:

- in the first row the proportion of the expenditure on the development of the irrigation scheme compared against the total on farm development expenditure.
- In the second row we show the irrigation scheme annual operating costs as a proportion of the total annual running costs: and
- In the third row we show the total debt servicing costs of the irrigation scheme development and the development on the land as a proportion of the Gross Revenue from the operation. This is measured at the point that the operation reaches its peak production.

Table 10. Costs induced by the scheme development and the costs induced by the development of each option on the land.

	Kiwifruit	Avocado	Citrus	Blueberries	CVP
Irrigation Capital Costs	4%	24%	30%	5%	36%
Irrigation Running Costs	3%	9%	4%	1%	3%
Servicing Costs	34%	9%	10%	17%	8%

What we can conclude from **Table 10** is that:

- The irrigation capital costs are a very small portion of the total costs for the very capital intensive developments such as Kiwifruit and Blueberries, but even in the other three it is not a significant proportion of the capital costs.
- Annual irrigation running costs are not a significant proportion of the total running costs in any of the scenarios.
- The debt servicing costs of the development are not a significant proportion (<10%) of the Gross Revenue for Avocados, Citrus and CVP but are a more significant proportion of the Gross Revenue for Kiwifruit and Blueberries.

9.2.2 Results

9.2.2.1 Kiwifruit

The kiwifruit budget follows the assumptions made in the ANZ's review of the state of the Kiwifruit industry[8] . The financial performance of the Kiwifruit budget is shown in **Table 11**. The full 10-year cashflow is included as **Appendix B.**

Table 11. Financial performance of the Kiwifruit budget.

Category	Value
Development Costs ($/ha)	413,409
Gross Revenue ($/ha/ann)	119,000
Growing Costs ($/ha/ann)	40,987
Debt Servicing Costs ($/ha/ann)	33,880
Net Return ($/ha/ann)	44,133
Payback period (years)	10
NPV ($/ha)	296,264
IRR (%)	10%

It should be noted that the cost of the irrigation scheme both in the total capital at 4% and the annual irrigation scheme operational costs at 3% are insignificant in terms of the total establishment cost and ongoing running cost of a Kiwifruit orchard. The irrigation scheme is easily affordable under the assumptions made.

[8] https://comms.anz.co.nz › anz20702-Kiwifruit-white-paper-2019-11

To test this assumption we have also carried out a sensitivity test on the two major income factors; total yield and the orchard gate return for kiwifruit as shown in **Table 12**. Please note that the performance of the standard orchard as modelled is highlighted in the table.

Table 12. Sensitivity of net return ($/ha/ann) to variation of total yield (trays / ha) and orchard gate return ($ / tray).

Yield (trays/ha) **($/tray)**	**11,000**	**12,500**	**14,000**	**15,500**	**17,000**
7.5	7,633	18,883	30,133	41,383	52,633
8.0	13,133	25,133	37,133	49,133	61,133
8.5	18,633	31,383	44,133	56,883	69,633
9.0	24,133	37,633	51,133	64,633	78,133
9.5	29,633	43,883	58,133	72,383	86,633

The sensitivity analysis shows that Kiwifruit remains profitable in all situations but in the lower yield and price scenarios the returns would be lower than what would be ideal.

9.2.2.2 Avocado

The avocado budget follows the assumptions made in the ANZ's[9] feature article on the economics of growing avocados. The financial performance of the Avocado budget is shown in **Table 13**. The full 10-year cashflow is included as **Appendix B.**

Table 13. Financial performance of the Avocado budget.

Category	**Value**
Development Costs ($/ha)	63,159
Gross Revenue ($/ha/ann)	63,580
Growing Costs ($/ha/ann)	15,497
Debt Servicing Costs ($/ha/ann)	5,481
Net Return ($/ha/ann)	42,602
Payback period (years)	7
NPV ($/ha)	311,097
IRR (%)	19%

It should be noted that while the development costs of the irrigation scheme, at 25% of the total establishment costs, are significant in terms of the total cost of development of the avocado orchard, however the returns are sufficient to achieve an excellent net return and a very good IRR.

To test this assumption, we have also carried out a sensitivity test on the two major income factors - total yield and the orchard gate return for avocado as shown in **Table 14**. Please note that the performance of the standard orchard as modelled is highlighted in the table.

[9] ANZ Agrifocus (March 2018): Avocados - Holy Guacamole.

Table 14. Sensitivity of net return ($/ha/ann) to variation of total yield (trays / ha) and orchard gate return ($ / tray).

Yield (trays/ha) / ($/tray)	2,500	3,000	3,364	4,000	4,500
15	16,522	24,022	29,482	39,022	46,522
17	21,522	30,022	36,210	47,022	55,522
19	26,272	35,722	42,602	54,622	64,072
21	31,522	42,022	49,666	63,022	73,522
23	36,522	48,022	56,394	71,022	82,522

It should be noted that the sensitivity analysis carried out on the avocado orchard shows satisfactory performance across the full range of assumptions made.

9.2.2.3 Citrus

The citrus budget has been compiled from data The AgriBusiness Group hold, which has been updated to reflect the current situation as to pricing available from the Citrus New Zealand website[10]. The financial performance of the citrus budget is shown in **Table 15**. The full 10-year cashflow is included as **Appendix B.**

Table 15. Financial performance of the Citrus budget.

Category	Value
Development Costs ($/ha)	47,909
Gross Revenue ($/ha/ann)	42,500
Growing Costs ($/ha/ann)	31,409
Debt Servicing Costs ($/ha/ann)	4,346
Net Return ($/ha/ann)	6,745
Payback period (years)	14
NPV ($/ha/)	1,751
IRR (%)	6%

The cost of development is not well rewarded by the average performance of the citrus operation. For citrus to be included in this proposed irrigation scheme it will have to perform towards the top end of production to ensure that the investment is on par with alternative development options.

To test this assumption, we have also carried out a sensitivity test on the two major income factors - total yield and the orchard gate return for Citrus as shown in **Table 16**. Please note that the performance of the standard orchard as modelled is highlighted in the table.

[10] https://www.citrus.co.nz/.

Table 16. Sensitivity of net return ($/ha/ann) to variation of total yield (kg / ha) and orchard gate return ($ / kg).

Yield (trays/ha) ($/tray)	25,000	30,000	34,000	40,000	45,000
0.75	-17,005	-13,255	-10,255	-5,755	-2,005
1.00	-10,755	-5,755	-1,755	4,245	9,245
1.25	-4,505	1,745	6,745	14,245	20,495
1.50	1,745	9,245	15,245	24,245	31,745
1.75	7,995	16,745	23,745	34,245	42,995

The sensitivity analysis shows that Citrus production only gives a satisfactory return on the development expenditure when it performs at the top end of expected production and it receives higher than expected returns.

9.2.2.4 Blueberries

The blueberry budget utilises the fairly limited financial information that is available on the Miro website[11]. A number of assumptions have had to be made in order to construct the blueberry cashflow. We believe that the assumptions made are sufficient to include blueberries in this pre-feasibility assessment. The financial performance of the Blueberry budget is shown in **Table 17**. The full 10-year cashflow is included as **Appendix B**.

Table 17. Financial performance of the Blueberries budget.

Category	Value
Development Costs ($/ha)	313,409
Gross Revenue ($/ha/ann)	165,000
Growing Costs ($/ha/ann)	95,987
Debt Servicing Costs ($/ha/ann)	25,322
Net Return ($/ha/ann)	43,691
Payback period (years)	10
NPV ($/ha)	280,047
IRR (%)	11%

It should be noted that the cost of the irrigation scheme both in the total capital at 5% and the irrigation scheme operational costs at 1% are insignificant in terms of the total establishment cost and ongoing running cost of a Blueberry orchard. The irrigation scheme is easily affordable under the assumptions made.

To test this assumption, we have also carried out a sensitivity test on the two major income factors total yield and the price received for blueberries as shown **Table 18**. Please note that the performance of the standard orchard as modelled is highlighted in the table.

[11] https://www.miroberries.com/

Table 18. Sensitivity of Gross return ($/ha/ann) to variation of total yield (% variability from the average) and the price (Gross Return).

Gross Revenue ($/ha) / Yield Variability Proportion of average yield.	135,000	150,000	165,000	180,000	195,000
0.8	-13,309	191	13,691	27,191	40,691
0.9	-1,309	13,691	28,691	43,691	58,691
1	10,691	27,191	43,691	60,191	76,691
1.1	22,691	40,691	58,691	76,691	94,691
1.2	34,691	54,191	73,691	93,191	112,691

The sensitivity analysis shows that Blueberries remain profitable in the upper end of the yield and price parameters.

9.2.2.5 Commercial Vegetable Production

The Commercial Vegetable Production budget has been compiled out of data held by The AgriBusiness Group, which has been updated to reflect the slightly higher returns that can be expected by growing the various crops in Northland i.e. to grow at a time when they are not traditionally grown further south. The financial performance of the CVP budget is shown in **Table 19**. The full 10-year cashflow is included as **Appendix B**.

Table 19. Financial performance of Commercial Vegetables.

Category	Value
Development Costs ($/ha)	28,409
Gross Revenue ($/ha/ann)	41,678
Growing Costs ($/ha/ann)	28,909
Debt Servicing Costs ($/ha/ann)	3,218
Net Return ($/ha/ann)	9,551
Payback period (years)	4
NPV ($/ha)	110,077
IRR (%)	22%

The sensitivity analysis shows that CVP production only gives a satisfactory return on the development expenditure when it performs at the top end of expected productivity and it has lower than expected growing costs.

9.3 Scheme Configuration Performance Assessment

9.3.1 Methodology

The mix of the different land uses adopted in this analysis has been derived by a combination of considering the financial returns from each enterprise, the amount of that land use currently in Northland, and the capital cost of entry into that land use.

The final mix of land uses is shown in **Table 20**.

Table 20. Land use mixes adopted.

Land Use	Tree Crop	Arable
Kiwifruit	45%	-
Avocado	50%	-
Citrus	5%	
Blueberries	-	10%
CVP	-	90%

In order to spread the uptake scenarios out over the 10, 20, and 30-year periods the uptake was assumed to be highest in the first third of the period and then to diminish as the time period extended out. The assumptions as to uptake are shown in **Table 21**.

Table 21. Assumptions as to uptake (% / year).

Year	Scenario A	Scenario B	Scenario C
1	40	30	20
2	10	5	3
3	10	5	3
4	7.5	5	3
5	7	5	3
6	5	5	3
7	5	5	3
8	5	4	3
9	5	3	3
10	5	3	3
11	-	3	3
12	-	3	3
13	-	3	3
14	-	3	3
15	-	3	3
16	-	3	2.5
17	-	3	2.5
18	-	3	2.5
19	-	3	2.5
20	-	3	2.5

Year	Scenario A	Scenario B	Scenario C
21	-	-	2.5
22	-	-	2.5
23	-	-	2.5
24	-	-	2.5
25	-	-	2.5
26	-	-	2.5
27	-	-	2.5
28	-	-	2.5
29	-	-	2.5
30	-	-	2.5

Scenario A depicts a situation where the schemes are relatively attractive and it is all taken up within 10-years.

Scenario B depicts a situation whereby the scheme is relatively attractive with approximately 70% being taken up in the first 10 years but then the uptake is slow for the next 10-years.

Scenario C depicts a situation where the scheme is not very attractive and so initial uptake is low and then it continues slowly for the next 20 or so years.

9.3.2 Results

The financial returns results over 30 years are reported for both NPV and IRR in order to reflect the differences caused by the variations in both the capital and running costs, uptake profile, and the land use mix.

The results of this analysis are shown in **Table 22**.Error! Reference source not found.

Table 22. Financial return scenario analysis results.

Scheme	Scenario A		Scenario B		Scenario C	
	NPV ($M)	IRR	NPV ($M)	IRR		
Kaipara Large Storage	345.33	11.5%	554.40	14.0%	326.53	13.3%
Kaipara Distributed Storage	332.50	11.1%	482.51	13.3%	308.75	11.0%
Mid North Large Storage	380.49	16.6%	432.83	14.5%	236.88	11.3%
Mid North Distributed Storage	342.68	14.6%	408.44	14.0%	198.33	10.0%
Mid North Distributed Storage – Lake Omapere	372.50	16.3%	534.02	24.8%	346.60	18.0%

Figure 25 and **Figure 26** provides comparison of the NPV and IRR between the various scenarios, respectively. It is difficult to make comparisons or to draw significant conclusions between the three different scenarios depicted because of the significant differences in both the rate of uptake and the crop mixes used across the scenarios. What can be concluded from both the NPV and the IRR results is that across the wide range of

options modelled in this economic analysis they all show a significantly positive NPV and are all within an acceptable range of IRR results to indicate that within the parameters used and the assumptions made in the modelling, the project is able to exhibit positive economic worth.

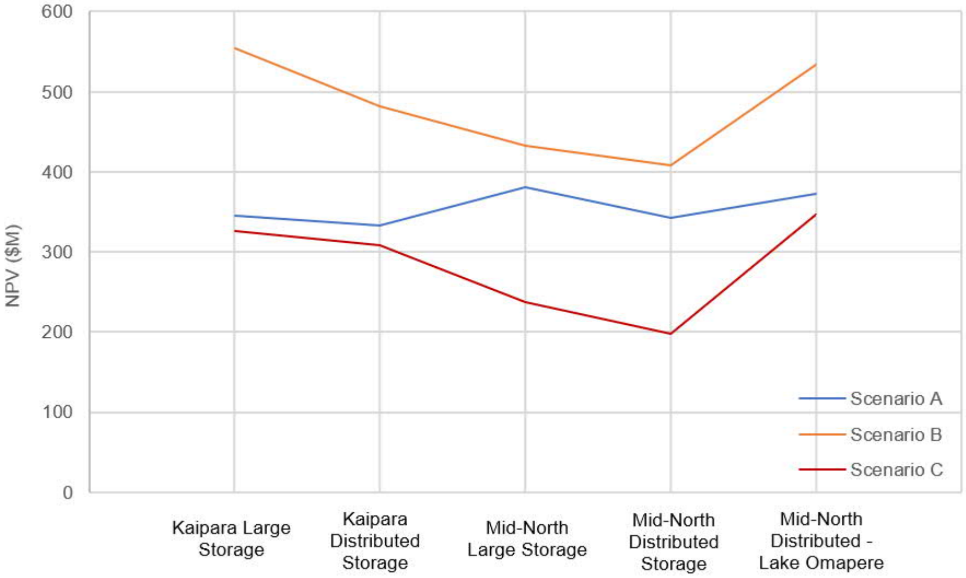

Figure 25. Comparison of scheme NPV.

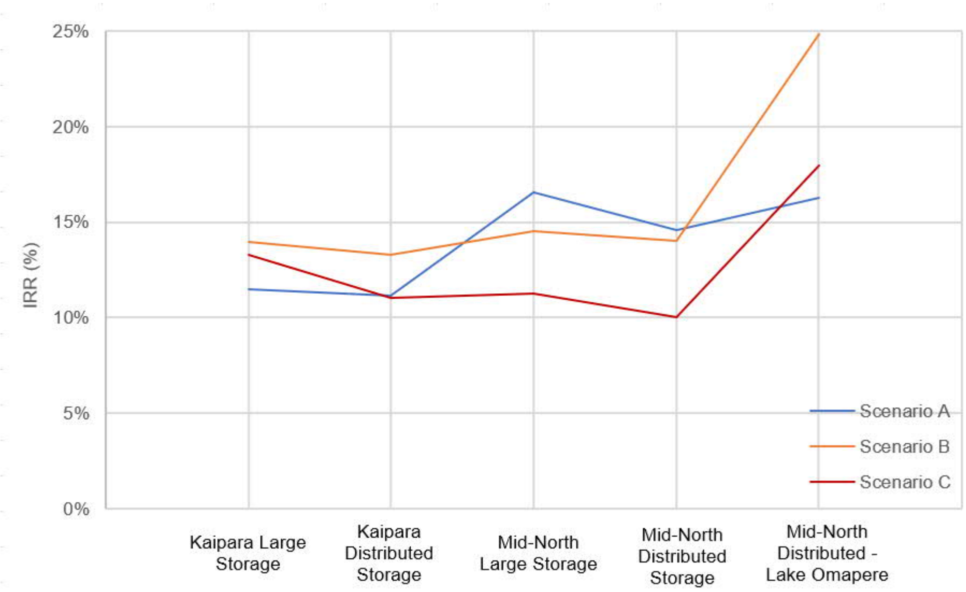

Figure 26. Comparison of scheme IRR.

10. Uncertainty and Risk Analysis

10.1 Project Complexity

Complex projects such as irrigation schemes will always have a broad and potentially significant range of risks. The complexity of an irrigation project, and hence the range and scope of the risks, arises from three main factors:

1. They are extensive in terms of overall footprint, and hence traves a significant amount of land and the related diversity, of land use, value and community needs. While individual components may be small there are many of them and this increases the probability that risks associated with accessing land will occur.
2. They involve a wider range of different components that must work in an integrated and efficient manner. The integrated nature means the inability to secure any one component within the scheme can place the whole scheme at risk.
3. They must develop their own "market" (end users) in parallel with "supply" infrastructure and associated aspects. This means both project development and market development risks must be managed.

10.2 Critical Flaws

A key focus for this pre-feasibility project was the identification of critical flaws. Identifying these early reduces the potential for later significant re-work to be required. Undiscovered critical flaws can induce significant delays and costs or even render a project unviable. Potentially of more importance however is they can erode support both from potential users, who might choose to "do their own thing", and equity partners.

Through the process adopted in this pre-feasibility project, potential critical flaws have been avoided by filtering out scheme features, configurations and components that are most likely to induce an unacceptable level of risk. The schemes are relatively small in terms of comparable infrastructure, as such addressing major risks head-on is most likely cost prohibitive, hence an approach of avoiding the highest risks and critical flaws has been adopted. This means critical flaws in the context of this project includes risks that could induce unacceptably high cost, delays or community resistance. The key aspects of the assessment utilised to achieve this includes:

1. Apply pre-filtering to potential storage sites to avoid land or areas of particular significance. This reduces the probability of any site being found to be unacceptable at a later stage.
2. Undertake a "Multi-Criteria Assessment" (MCA) on the long-list of potential storage sites to ensure that sites with the best combination of physical characteristics and low risk are preferentially advanced.
3. Utilise existing road corridors wherever practical for conveyance infrastructure. This reduce the risk associated with land access. Further the adoption of a fully piped system allows, if needed, problematic areas to be traversed around.
4. Adopt a "bookends" approach that utilise two extreme but plausible design configuration for each area. This reduces both the probability and consequence of any individual component rendering the entire scheme unviable.

Through adopting this approach, while a broad range of risks and uncertainties remain, many of which will continue to remain through the development phases, none have been identified that are currently deemed to be critical in terms of overall scheme viability.

10.3 Risk and Uncertainty

It is important to distinguish between risks and uncertainty. In simply terms risks are known and can therefore be largely quantified. Uncertainties are unknown and as such cannot be directly quantified. While uncertainties are frequently assigned an equivalent risk, these are largely based on comparable industry examples and specialist knowledge. Hence, they are not specific to the project and as such need to be treated with caution as they may be under or over-represented within the risks being managed within the project

Part of the role of a pre-feasibility level assessment is to endeavour to identified risks and uncertainties. This is important as actions taken in subsequent stages will be different for uncertainty vs risk. Uncertainties need to be transformed in the quantifiable risks. A significant portion of future investigations and assessment, particularly during the feasibility phase, will focus on changing uncertainty to risk. They can then be given the appropriate level of focus going forward commensurate with risks of similar magnitude.

Risks in comparison, while also receiving specific focus, will involve consideration of a range of measures including avoiding, managing or mitigating each risk. A key aspect of this is the understanding the risk often moves rather than measurably changes. Reducing a risk in one area often increases risk in another, so finding the right balance for the project is key.

The duality or uncertainty and risk has been recognised and managed through this project firstly through the same measures used to avoid critical flaws. In addition, the following processes have also been adopted:

1. The overlapping skillsets and depth of experience across the project consortium provides a continuous and ongoing reality check on uncertainty and risk and in particular the relative attention being given to different uncertainties and risks.
2. Project costs include both a Contingency, largely to account for risk and minor items, and an Uncertainty provision. These collectively provide a band within project costs are most likely to fall.
3. Retaining a high level of flexibility within the design concepts to enable adjustments to be made that minimise or avoid risk and are adoptable to quantified uncertainty.

The most significant uncertainties identified through the pre-feasibility stage include:

1. Site specific geotechnical conditions. This is particularly relevant to the storage sites. The dam design concepts adopted are adaptable across the anticipated ground conditions. The actual site-specific considerations will however influence structure size and layouts and hence costs.
2. Land access. There is a high level of uncertainty associated with access land. Flexibility has been retained in the design concepts to enable adjustments to be made once uncertainty has been quantified in terms of risk.
3. Uptake. The appetite for irrigation and rate of uptake is a major uncertainty. The inclusion of the Distributed Storage scenario is key in providing a potential risk management tool once the desire for and uptake expectations are better understood.

It is anticipated these, and other uncertainties, will transfer to quantifiable risks as addition investigation and assessments are advanced.

Key risks already able to be quantified, at least to a preliminary level, include:

1. Gaining necessary consent, including Resource and Building Consent.
2. Community support. Ensuring the scheme is acceptable to the local community and stakeholders.
3. Funding. Securing adequate funding to deliver the scheme.

4. Governance. Ensuring that effective and relevant governance is applied and that this updated as the needs of the project evolves.
5. Ownership Structure. An effective ownership structure is established that is that is flexible over time to remain effective through, development, delivery and operation.

   These will all need to be managed through subsequent stages with consideration as to where best ownership of each risk is best assigned.

11. Discussion

Environmental and consenting issues were minimised through the pre-feasibility project phase via the iterative scheme selection process undertaken. This therefore implies that any residual issues are not unique to the specific scheme configuration, rather the development of any scheme within these communities.

11.1 Cost Comparison between Single vs Distributed Storage

A predominant risk to irrigation schemes is lack of timely uptake by users, the implication of which being uncertainty over re-financing or payback on the investment made. Where schemes rely on the bulk of the scheme being built before any supply can occur, risk exists both in terms of access to funding due to the scale of funds being greater before any income is realised, and security of income to funders, which is associated with uptake risk.

This pre-feasibility study has purposely examined two scenarios that are intended to represent the likely “bookends” between which an optimised scenario can ultimately be developed in subsequent stages of this project.

The Large Storage scenarios seek to provide a likely lower limit on total scheme cost through capturing economies of scale particularly in dam location and scale. This scenario however limits the ability to progressively develop the scheme over time.

The Distributed Storage scenarios by comparison seek to compartmentalise the overall scheme so that they could be developed in a progressive manner. This assists by reducing the quantum of funds required for each stage, potentially even allowing recycling of funds, as well as limiting the absolute risk associated with uptake by ongoing progressing with subsequent stages when the uptake demand had been confirmed. Further, if the progression can be sequenced to target the most desirable land in terms of first uptake, then the first stage is de-risked and subsequent components can be added in response to demand growth.

Development of the Large Storage scenario therefore would be undertaken largely on the anticipation of future uptake often projected a long way into the future. In comparison, the Distributed Storage seeks to balance both anticipated and real demand growth against progressive investment with each phase projected over a shorter timeframe.

11.1.1 Capital Only Costs

Table 23 sets out the comparative capital costs of each option inclusive of design, preliminary and general (P&G) and contingency allowances. However, this does not account for financing discounts that would apply to deferred expenditure due to staging, which will be addressed later.

Table 23. Capital cost comparison.

Components	Kaipara ($000)		Mid-North ($000)		
	Large Storage	Distributed Storage	Large Storage	Distributed Storage	Distributed Storage (Lake Omapere)
Intakes	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Pump-stations	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Reservoirs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Piping	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Transmission	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]					[redacted]
Design, Supervision, Contingency & P&G	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total ($000s)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

The two scenarios in the Kaipara are remarkably similar in terms of costs with the only major difference being storage, which is not surprising giver multiple smaller storages are almost always going to be more expensive than single larger storage.

The three Mid-North Scenarios are substantially different though with a wide range in development costings predominately driven by the higher cost of storage.

Table 24 indicates the distribution of capital cost within each scheme option.

Table 24. Percentage scheme component cost.

Components	Kaipara		Mid-North		
	Large Storage	Distributed Storage	Large Storage	Distributed Storage	Distributed Storage (Lake Omapere)
Intakes	2%	2%	2%	4%	5%
Pump-stations	16%	11%	11%	11%	12%
Reservoirs	30%	43%	50%	68%	29%
Piping	52%	44%	36%	17%	25%
Transmission	0%	0%	2%	1%	2%
Lake Omapere Restoration					32%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

11.1.2 Net Present Value Analysis

As alluded to above, to account for the discounting that occurs with deferred expenditure for the distributed storage scenarios, both in terms of the cost of financing and savings in operations and maintenance, a high-level Net Present Value (NPV) analysis has been undertaken on the two bookends. The assumptions used in the NPV analysis include:

- Evaluation period – 30 years;
- Real discount rate – 6%;
- Maintenance costs (% of capital to date) – 2.5%;
- Operational costs – as stated in Section 8 of the Volume 3 Report for each Scheme;
- Distributed Storage Staging: Year 1 – 50%; Year 10 – 25%; Year 20 – 25%; and
- Large Storage Staging: Year 1 – 100%.

The results provided in **Table 25** indicates that infrastructure staging is not providing a significant impact on the overall cost differential of the schemes. For the Kaipara options, staging as part of the Distributed Storage scheme results in a net [redacted] premium compared to the Large Storage options, but the advantage it does provide is lower capital for the first stage. This enables uptake risk to be managed.

In the Mid-North, staging has not overcome the significant higher capital costs, with the Large Storage option providing a [redacted] advantage over the 30-year evaluation period. However, if Lake Omapere is included with Distributed Storage this provides a [redacted] advantage over the Large Storage option in the Mid-North.

As alluded to above, it is noted however that this analysis does not directly consider risk during the period of uptake or in fact uptake certainty itself. The ability to stage development with the Distributed Storage scenario provides a significant level of risk mitigation that it not available with the Large Storage scenario.

Table 25. Capital cost comparison using NPV framework.

Components	Kaipara ($M)		Mid-North ($M)		
	Large Storage	Distributed Storage	Large Storage	Distributed Storage	Distributed Storage (Lake Omapere)
Capital only	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
NPV cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Operational costs at full development	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Life cycle costs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Overall Difference		[redacted]		[redacted]	[redacted]

11.2 Key Scheme Optimisation Considerations

The concepts generated within this study provide a sound foundation to build upon within the following feasibility stage which will better determine the optimal configurations once questions identified above, including the balance between reliability, certainty and affordability are addressed.

As the project has progressed the project team have identified various areas where optimisation in future stages will result in improved project outcomes. These are outlined in the section below.

11.2.1 Storage Selection

As outlined in **Section 11.1.1** the cost of storage is the main difference in cost between the various options. In the Mid-North Distributed option in particular, the cost of storage almost single handily doubles the cost of the scheme comparted to the larger storage option.

If consideration was given to swapping out some of the smaller expensive storage sites with some slightly larger sites, it is likely that a more cost-effective distributed solution could be determined.

For example, **Figure 27** and **Figure 28** demonstrate the comparative cost per cubic meter of water stored and capital cost, respectively, against reservoir storage volume. The lines represent cost profile showing the incremental capital cost with increasing reservoir size for [redacted] (orange line) and [redacted] (blue line). At maximum volume were the more cost-effective Large Storage sites considered in the Mid-North.

[redacted]

Figure 27. Cost per cubic meter stored for Mid-North storage options.

[redacted]

Reservoir Volume [m^3]

Figure 28. Construction cost for Mid-North storage options.

This clearly indicates that the sites currently under consideration, whilst conveniently spatially located around the command area, do come with a cost premium over the larger single storage solutions and therefore impact significantly upon the capital cost of the scheme in the Mid-North.

Whilst it is evident that storage construction is considerably more cost effective in the Kaipara on a volume stored basis, careful consideration needs to be given in parallel to the relative merits of:

- strategic location of storage for water harvesting and buffer storage; and
- the cash-flow benefits of deferred expenditure through staging.

There were many sites within the Kaipara that were relatively similar in nature and could provide viable alternatives should the currently selected sites be deemed unsuitable for some reason.

Figure 29 and **Figure 30** show the comparative cost curves for the storage sites in the Kaipara.

[redacted]

Figure 29. Cost per cubic meter stored for Kaipara storage options.

[redacted]

Figure 30. Construction cost for Kaipara storage options.

We note that [redacted] is considerably more expensive than the other sites albeit still relatively good value compared to the Mid-North sites.

11.2.2 Scheme and Storage Sizing

The methodology adopted in the development of the conceptual schemes essentially consisted of determining the required volume of water to meet requirements of specific area of horticulture, following which a series of sources and storages were located to fulfil the need.

Now that preferable storage sites are better understood, there is the potential to revisit the scheme size to better match the most efficient storage locations from both a construction and refilling perspective.

For example, the most cost-effective size [redacted] is approximately [redacted] which closely matches the average gravity inflow. Currently this site is closer to [redacted] meaning that when fully utilised an average of [redacted] will need to be introduced.

This should not be taken as suggesting that this site should be made smaller but rather outlining the opportunity to gain efficiencies through the feasibility stage by have a close look at the relationship between the cost of storage, cost of re-filling, and the opportunity cost of additional storage as what appears as expensive additional storage may in fact be “easy” storage that can defer the need for further infrastructure.

11.2.3 Pipe Routes and Sizing

Optimising pipe sizes, routes and the use of buffer storage could make a meaningful difference to the cost of the distribution network. A major assumption has been that that pipe routes will generally follow legal roads to avoid the need for the like of pipeline easements. Practically this is less than ideal in many instances, specifically on the western edge of the Kaipara where it wiggles and has significant elevation fluctuations to follow the road along the ridgeline of the Poutō Peninsula.

Straightening and laying through flatter land could not only provide shorter but cheaper on a per metre rate for installation.

Given the lay of the land in the Kaipara where soils with the greatest horticultural potential effectively surround the potential storage sites, there could be value in considering a ring main type approach to the entire area. This may be beneficial given the uncertain locality and rate of uptake, as well as future proofing for additional storage should irrigated demand be more than the scheme had envisioned.

Further optimisation on this item is likely to yield a more efficient and cost-effective solution.

11.2.4 Water Requirements

Section 9 in the Volume 1 Command Area Refinement report identified the requirements of four proxy crops, with **Section 8** herein discussing opportunities for management of water within the scheme.

Currently, a blanket annual canopy hectare allocation of 4,000 m^3/ha and 4 mm peak daily requirement, has been adopted within both scheme areas. As further clarity is gained through the project concerning the potential land use and requirements of landowners, it is expected that there will be some opportunities to better refine water requirements in terms of both reliability and volume.

11.3 Possible Optimised Scheme Outcome

From the outset of this project it was understood that the optimum scheme solution would likely be found part way between the two design concepts (“bookends”) developed as part of the project, albeit potentially towards one end of the spectrum.

These design concepts however provide an envelope that should assist with a clear direction forward for the feasibility study. This being said, after synthesising all the information gained, discussions had, and the expert opinions from within the project consortium during this project, the following provides an outline of where we think this "sweet spot" may lie.

11.3.1 Kaipara

The optimised version of the Kaipara Scheme is very much towards the distributed end of the spectrum given cost wise it was comparative with the Large Storage option. This is heavily influenced by the cost of the storage.

As discussed in **Section 7**, the supply performance of the current design concept is high and at the upper end of what is typical for an irrigation scheme, particularly one that has a high proportion of water held in storage. Indications are that optimisation of scheme performance (i.e. accepting a lower level of service) would reduce costs to the end user by up to 15% (approx. [redacted] This is particularly relevant for a staged scheme development where each stage could operate initially at reduced service levels to reduce uptake risk. This is discussed further in **Section 12**.

Alternatively, [redacted] could be dropped without impacting upon the area serviced simply through alternative water management criteria outlined in **Section 8**. This would constitute a saving in the order of [redacted]

Similarly, the requirement of [redacted] intake and the subsequent mainline could be removed through instilling sufficient harvesting regimes within the peninsula. Whilst this may be required in the future in response to strong uptake, it equally may not. This could result in a capital cost saving now in the order of [redacted].

These two items cumulatively indicate a potential saving in the order of [redacted] in capital expenditure could be realised through the above optimisation, or the equivalent of [redacted] per farm hectare, which is in the order of [redacted] of current estimated price. In the staged example provided in **Section 12** these two components have been incorporated as the last stage of development to demonstrate the impact of including or excluding them.

11.3.2 Mid-North

There is a large difference in capital cost between the three Mid-North options with the distributed option being almost twice as expensive as the other two options.

The majority of this additional cost is in the multiple storage sites selected, which are smaller and comparably much more expensive on a $\$/m^3$ basis. Many of these sites required pumped transfers from adjacent catchments to fill, requiring additional pumping and intake infrastructure. Hence, both capital and operational costs are higher.

As discussed in **Section 8**, the supply performance of the current design concept is high and at the upper end of what is typical for an irrigation scheme, particularly one that has a high proportion of water held in storage. Indications are that optimisation of scheme performance in terms of supply would reduce costs to the end user by up to [redacted]

Alternatively, it has been observed that significant cost savings could be gained by reducing the number of storages in the distributed scheme, through replacing the more marginal storages with the two sites used in the large option albeit potentially at smaller sizes. Taking in account the spatial distribution of potential areas of demand, and the inflows of storages as highlighted in **Section 11.2.2,** the following reservoir configuration is suggested as a possibility:

- [redacted] to replace [redacted] and [redacted]
- [redacted] as per existing concept;

- [redacted] as per existing concept; and
- [redacted] to replace [redacted]) and the river take from the [redacted].

This indicates a potential saving in the order of [redacted] through the above optimisation, or the equivalent of [redacted] per farm hectare, which is in the order of [redacted] of current estimated price for the distributed option.

The suggested revised option is still unlikely to be as cost effective as the option that included [redacted], however it should be noted that that there is a level of uncertainty associated with the capital costs assumed for the restoration of the lake to its original level and measures required to ensure reliability from a quality and quantity perspective.

11.4 Scheme and Component Prioritisation

This section seeks to set out the scheme components that should be progressed first in each district in general alignment with the schemes within this report, and also the possible scenario outlined in **Section 11.3** above.

This assumes that both schemes will be progressed in parallel rather than the one which is the most cost effective or has the most political or landowner support behind it.

The key considerations to be balanced when deciding on where to start each scheme in terms of development are considered.

- Centrally located within the command area;
- large landholdings within dam footprint and adjacent meaning less land acquisition and reverse sensitivity issues, respectively;
- efficient (cost effective) storage site;
- maximise potential irrigation supply area to increase uptake;
- proximity to Urban demand;
- proximity to Maori Owned Land (a key funding criterion of the PGF);
- proximity to existing horticulture activity; and
- ability to harvest water from local stream sources.

Examples of staged scheme development are provided in **Section 12**. The initial stage in these examples seeks to achieve a balance across these considerations.

11.4.1 Kaipara

As outlined in **Section 11.1**, there is very little difference in capital or operational cost between the two Kaipara scenarios, however NPV analysis (**Section 11.1.2**) indicated a [redacted] difference when considered over a 30-year period. **Section 2.4** outlined that there was no particular area where there was a large contiguous area that were visibly seeking water more so than another area.

[redacted]

11.4.2 Mid-North

As outlined in **Section 11.1** there is a significant difference in the capital cost of the various scenarios in the Mid-North. **Section 2.4** outlined that there were several areas within this Mid-North community who were actively seeking to progress horticulture projects.

[redacted]

The challenge in the Mid-North is the spatially disconnected nature of potential early adopters

There is a real risk that prioritisation of one area over another will result in the best community outcome being lost due to threat of further land fragmentation, as has occurred within the command area of the Kerikeri irrigation scheme. [redacted]

These landowners appear to have the means and desire to move relatively fast and will likely progress with or without this project. The opportunities are described as follows.

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

11.5 Uptake

Uptake is likely to be at the slower end of the spectrum with the exception of the early adopters identified herein, whom are likely to progressed their developments independently if initial scheme stages do not meet their needs in terms of timing and costs.

Any scheme and significant land use transformation such as this project is trying to achieve, will typically suffer from the same potential challenges around the likes of access to capital, labour and skills, and markets for produce.

There are however two significant hurdles to uptake that need specific focus to find acceptable pathways forward. These are the fragmentation and ownership of land in the Mid-North, and the use of water as a component or complimentary interim part of ruminant agriculture (both in terms of this projects funding and direction of freshwater management from a national perspective).

There is a strong concentration of Maori Owned Land around Kaikohe in particular. Whilst providing access to water to this land is a priority of the PGF, it is quite certain that uptake will not occur at any great rate without significant external assistance.

Lifestyle block intrusion into the Waimate North and adjacent areas will inadvertently create reverse sensitivity challenges for land use change, as well as the smaller land holdings considered less desirable for horticulture developments due to scale.

Through discussions with landowners there was a sense of uncertainty around proposed changes to freshwater management in New Zealand and what it would mean for them, and if land conversion would even be an option moving forward.

Similarly the funding criteria associated with this project stipulates *"Water storage will not be used to increase the intensity of ruminant agriculture".* Combined with the above this has led to the general understanding that water cannot be utilised to support irrigation upon pastoral farming operations.

These two items immediately above absolutely must be clarified as soon as practical. If it was clearly understood that water would be available for appropriate tactical use upon pastoral farming systems, and as part of a land use transformation period, there is likely to be significantly greater uptake.

11.6 Comparison to Existing Northland Horticulture Schemes

The Northland Strategic Irrigation Infrastructure Study, completed in 2015, estimated that present day value of construction of the Maungatapere and Kerikeri Irrigation Schemes as $66M and $42M, respectively. These figures were inclusive of on farm development.

This study indicated the two schemes were designed to service a combined area of [redacted], which equates to an average cost of approximately [redacted] in 2015. Considering that almost all on farm irrigation is understood to be fixed, micro, or drip irrigation ranging in cost from approximately [redacted] per hectare, these schemes are comparative from a capital cost perspective to the schemes proposed as part of this project.

These schemes were both constructed by the Ministry of Works with funding from the New Zealand Government.

11.6.1 Maungatapere Irrigation Scheme

[redacted]

http://mpewaterco.co.nz/

11.6.2 Kerikeri Irrigation Scheme

[redacted]

http://keriirrigation.co.nz/

11.6.3 Comparative cost of water

Taking into account the metrics above, the cost of accessing 4,000 m^3 in a single irrigation season from the Kerikeri Irrigation scheme would be approximately [redacted] per m^3. This is inflated by the higher charge applied to the volume of water sought over 3000 m^3/pa. If usage is capped at 3000 m^3/pa the cost would equate to [redacted] per m^3.

Similarly, the cost of accessing the same quantity of water on the Maungatapere scheme would cost approximately [redacted] per m^3.

Whilst the operational costs within this report for the proposed schemes have been averaged across a 10 year horizon it is clearly evident that [redacted] will be more expensive to operate than Kerikeri, but almost certainly significantly cheaper than the Maungatapere scheme, likely by a factor of [redacted]

11.7 Land Acquisition

Whilst outside of scope of this report, land acquisition will play a major part in the timing and success of this project as it progresses.

Two sites are considered to potentially be under significant pressure due to the demand for lifestyle blocks. These sites and [redacted], which potentially form an integral part of the optimum scheme solution moving forward without any desirable alternative options readily available in the immediate area.

These sites should be prioritised for obtaining conditional land acquisition agreements.

Another real option worth noting for different reasons is [redacted]

12. Progressive Development Sequencing

The following provides an indicative progressive or 'staged' development scenario for each irrigation area. The predominant reason for this is to demonstrate how the risk to scheme viability associated with uptake can be partially mitigated through staged development.

The sequencing of stages and associated components in these examples has been developed with the objective of achieving a relatively constant cost per hectare throughout the progressive development. This reduces the need for cross-subsidisation between supply areas and development stages.

The term 'staged' has been adopted in this discussion, however it is important to recognise that the actual sequence of stages is relatively flexible with only the initial and final components largely fixed within any given development sequence. Hence, while these examples are presented as a particular sequence, depending on the spatial distribution and rate of uptake, it is possible for many stages in the sequence to be swapped around, combined together or even sub-divided further.

Because staging involves deferring scheme components until they are needed, and hence spreads cost, the Distributed Storage scheme has been used as the basis for these examples. The Large Storage scenario by comparison needs to be largely built in a single stage.

12.1 Kaipara

Given the elongated nature of the potential supply area, staged development logically would start somewhere in the middle portion of the potential supply area. It would then progressively expand in subsequent development stages to the north and south.

Figure 31. Kaipara Example Staged Development Sequence. (Refer A3 attachment at rear).

Stage 1 – Initial Components

This example is based around developing [redacted] as the first storage. [redacted] is approximately centralised within the centre of the potential irrigation area. This initial development stage is therefore to:

- Build storage [redacted]) and supply pipelines (plus pumps etc) to reach the adjacent Zones [redacted] to the north and south.
- Utilise self-filling from dam catchment (0.5 Mm^3, 1:10 dry) plus a small pump station intake from the low land drains (Zone 6) to augment (up to 1.0 Mm^3 depending on use per season).

The area within these first Zones that can be supplied by [redacted] approximately 380 hectares, which is 44% of the potential supply area (870 ha) within the connected Zones. The potential area linked is purposefully much larger than what the storage can supply so that:

- Uptake can occur on multiple fronts; and
- Water demand will be less initially due to immature crops.

The area that could be supplied can be increased to circa. 460 hectares (55% of connected area) if the reliability of supply is reduced to 95%. This level of reliability is considered reasonable especially during development stages. It could even be pushed further to around 92% reliability and therefore deliver to circa 500 ha (57%).

Crop development timelines and associated progressive increase in water demand as they mature will mean that the areas supplied could be greater while demand the demand per hectare is less. The next storage is therefore triggered, at least in part, by the increasing demand from already committed crops as well as new supply areas.

A total of 600-700 hectares of supply area is therefore considered achievable as a Stage 1 command area fed from [redacted] presuming additional storage is added prior to crops reaching full maturity. If further storage is not added (i.e. no further irrigation development occurs beyond this stage) then adding localised small scale storage would be sufficient to bring this potentially over-committed supply area back up to an acceptable long-term supply reliability.

Stage 2 – Urban Water Supply

While the supply of Urban water from a completed full scheme would more likely be provided from [redacted] it can also be achieved early in a progressive development through a connection off the supply into Zone 5 which in turn can be connected to [redacted]. While labelled as Stage 2, this could equally be undertaken with Stage 1.

There is likely to be spare capacity (in the early years) within the irrigation supply system and hence this can be used as part of the link to the urban demand. There would however be a need for some additional piping [redacted]) and this has been assumed to be an additional cost. It is likely however that this cost would be partially offset by reduced pipe costs elsewhere however this has not been presumed.

The urban link also brings Zone 5 on-line (80 ha) but as there is no increase in storage, there is no more actual supply available. It would however increase the potential area and hence likely to increase the rate of uptake.

Depending on urban demand, the area that can be supplied for irrigation is consequentially reduced. As noted above this is however be more about when the next storage is triggered (as crops mature) rather than constraining supply area.

Stage 3 – Additional Storage and Supply Zones

The next main component is to add [redacted] is likely to be the most flexible storage site so differing the building of [redacted] until the development is well established will significantly improve the ability to optimise the size of [redacted] Stage 3 therefore consists of the following aspects:

- [redacted] is constructed [redacted]) and filled from local catchment [redacted]) and a second low land drain intake and pump station [redacted]
- Link to the established components by bringing Zone 7 online.
- Add Zones 2,3 adjacent to [redacted] to the north.
- Add Zone 11 to the south as [redacted] will take over some of the load from [redacted] which can then be reassigned.

Collectively Stage 3 this adds 790 ha bringing the total command area to 1,750 ha (67% of total) of which circa 1,500 could be supplied, as fully mature crops and high reliability. With a lower reliability of 95% this increases the area to 1,800 ha or more than the available area within the connected Zones. Presuming however that the urban supply is connected this would reduce the potential supply area by approximately 100 to 150 ha.

Presuming the development of this phase is a few years after the first, it can be assumed that the demand from the first phase is reaching 100% (crop maturity). Hence there would be:

- 600 to 700 ha at or near full demand;
- 100 to 150 ha equivalent from Urban demand; and
- 950 to 1,100 under development with increasing demand as crops mature.

Stage 4 – Additional Supply Zones

The [redacted] Stage 3 above broadly balances supply areas to storage. It may be beneficial, depending on the distribution of uptake interest, to increase the potential supply area by adding further Zones before building the next storage. Hence, Stage 4 is almost a sub-stage of Stage 3 that can be developed at the same time or delayed.

- Add Zones 12 and 13 to the south.

Stage 4 adds 390 ha and means that the two completed storages could increase the area under development to around 1,400 ha (plus the 600-700 already developed) and meet the demand from this area until crop maturity reaches 75% of that from a fully mature crop. At such the timing of the third storage would need to be such as to provide for the final 25% from maturing crops and to bring on additional area.

Stage 5 – Additional Storage

The next storage to be built in this progressive development example is [redacted] (or alternatively [redacted] if it proves to be a better site or large storage is sought). This includes:

- Build [redacted] to [redacted] filled locally [redacted] and via third low land drains pump-station [redacted]
- Connect Zones 1 and 4 to the north.
- Connect Zones 14 and 15 to the south.

Adding [redacted] releases demand from [redacted] allowing it to now feed Zones 1 and 4 to the north. [redacted] also provides for Zones 14 and 15 to the south. This means the full command area is now connected (2,600 ha).

Supply reliability across the full area would stay at 95% once full demand was reached if no further storage was added, and, local refill sources proved to be enough.

Stage 6 – Final "Reliability" Storage

Since the full supply areas is achieved at the end of Stage 5, Stage 6 is primarily about increasing reliability should this be deemed necessary. The final components are the last storage and the link to [redacted]

- Build [redacted], adding [redacted]); and
- Build main river intake and pipeline.

If 95% reliability is sufficient and storage management across the first three storages can provide adequate supply certainty, then there seems little value in adding this last stage unless further supply area (infill) was viable. For example, a further 800 to 900 ha at 95% reliability (beyond 2,600) could be added by building these components if supply could be catered for within the pipe-network.

Overall Summary

A summary of the progressive development plan and associated costs for the Kaipara are presented in **Table 26**.

Table 26. Kaipara summary of progressive development.

Item	Cost ($000)					
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Intakes	[redacted]		[redacted]		[redacted]	[redacted]
Pump Station	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
Reservoirs	[redacted]		[redacted]		[redacted]	[redacted]
Pipes	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Transmission	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Sub-totals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Des, Constr, Cont	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
P&G	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Totals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cost/ha ($000) Base	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
Cost/ha ($000) @ 95% Reliability	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]

Apart from the initial stage which includes storage provisions for the subsequent urban supply, an almost consistent cost per hectare is achieved. If a third of the cost of Stage 1 was assigned to urban supply, then this stage would have approximately the same cost per hectare for irrigation as subsequent stages.

The total cost for a staged developed scheme is approximately [redacted] higher than if the Distributed scheme is built as a single development. The increase in cost arises from additional pipework for the Urban supply (Stage 2), and small storage refill pump stations and associated pipe connections (Stages 1,3 & 5), required before the main river source is connected (Stage 6).

12.2 Mid-North

The potential supply area is more disaggregated than in the Kaipara. This naturally lends itself to developing almost standalone supply areas, or “sub-schemes” that are aggregated overtime. This in turn means that, while an example staged sequence is provided below, the individual areas could be progressed in a variety of orders or multiple at a time.

Figure 32. Kaipara Example Staged Development Sequence. (Refer A3 attachment at rear).

Stage 1 – Initial Components

Due primarily to potential demonstrable early uptake the first storage to be built is assumed to be [redacted]. This initial development is therefore to:

- Build storage [redacted] and supply pipelines (plus pumps etc) to reach the adjacent Zones (7, 9, & 11) to the south.
- Utilise self-filling from dam catchment [redacted]) plus stream intake and riser ([redacted] depending on use per season).

The area within these first zones that could be supplied from [redacted] is 190 ha, which is 64% of the potential supply area (290 ha) within these first connected zones. [redacted] The potential area linked is purposefully much larger than what the storage can supply so that:

- Uptake can occur on multiple fronts; and
- Water demand will be less initially due to immature crops.

The area that could be supplied can be increased to circa. 210 Ha (71% of connected area) if reliability is reduced to 95% or 225Ha at 92% reliability. [redacted], then the portion available for irrigation is reduced to 130 ha to 150 ha assuming fully established crops. It is presumed that scheme costs are proportioned accordingly so that the reduced irrigation area does not incur disproportionate supply costs.

Crop development timelines and associated progressive increase in water demand as they mature, will mean that the areas supplied could be greater while the demand per hectare is less. The next storage is therefore triggered, at least in part, by the increasing demand from already committed crops as well as new supply areas.

The inclusion of Urban supply will of course reduce the potential supply area or advance the need for the next storage and interconnection between zones.

Stage 2 – Urban Water Supply

Supply of Urban water is from [redacted] in a completed Distributed Storage scheme. Hence this phase incurs minimal additional components or costs, beyond minor pipe work and valving, from those already constructed. While shown here as a separate stage it can be done at the same time as Stage 1, or equally at a later time.

Stage 3 – Additional Storage and Supply Zones

The next main component added in this example sequence is [redacted] [redacted] is broadly centralised within much of the potential command areas to the north east. It is also a potential inter-connection location from any possible future [redacted]. Initially Stage 3 would be a separate standalone sub-scheme and as such could be shifted in terms of the order of sequencing. The components are:

- [redacted] constructed [redacted] and filled from local catchment [redacted]) and a remote stream source [redacted].
- Connection to Zones, 1 & 2 and approx. 50% of Zones 3,6 & 8.

Stage 3 adds 610 ha of which up to 450 ha (74% of potential supply area in the connected zones) could be supplied from [redacted] assuming fully mature crops and high reliability. Adopting a lower 95% reliability increases the area to 520 ha (83% of potential supply area in the connected zones).

These zones have been chosen as they are the closest to the potential source however there is no reason they could not be substituted for a different zone such as zone 5 where there may be immediate demand.

Similarly, at this point [redacted] and [redacted] could be plumbed together to enable further land to supported near Kaikohe without the need to move immediately to stage 4.

Stage 4 – Additional Storage and Supply Zones

The next stage in this sequencing example would be to add [redacted] sites. [redacted] These two storages allow supply to advance into the southernmost zones. Initially this would also be a separate standalone sub-scheme and as such could also be shifted in terms of the order of sequencing. The components are:

- [redacted] is constructed [redacted] and filled from local catchment [redacted]).
- [redacted]
- Connection to Zones, 10, 12, 13 and 14.

Stage 4 adds 580 ha of which up to 450 ha (78% of potential supply area in the connected zones) could be supplied from the two storages assuming fully mature crops and high reliability. Adopting a lower 95% reliability increases the area to 520 ha (90% of potential supply area in the connected zones).

This stage could alternatively be developed in distinct stages or be used to supply a greater volume of water into zones 9 and 11 should demand require.

Stage 5 – Additional Storage and Supply Zones

The next stage would be to add [redacted] and [redacted] sites, or alternatively a single larger [redacted] site. These two storages allow supply into the easternmost zones. While this could also be advanced as a standalone sub-scheme, if [redacted] (Stage 3) and associated zones were already operating interconnection with these areas would occur at the same time. The components are;

- [redacted] (or alternative) is constructed [redacted] and filled from local catchment [redacted] plus stream intakes [redacted]
- Connection to Zones, 4 & 5.
- Inter-connect to [redacted] and supply other 50% of zones 3, 6 & 8.

Stage 5 adds the last 420Ha of which up to 400 ha (96% of potential supply area in the connected zones) could be supplied from the two storages assuming fully mature crops and high reliability. A lower 95% reliability increases the area to 470Ha or 50Ha more than the potential supply area in the connected zones allow further development in zones already connected to [redacted].

Stage 6 – Final Storages and Inter-connections

Collectively the above stages supply 78% of the total potential area at high reliability. At a lower but acceptable 95% reliability the above stages supply 90% of the total potential supply area.

The components in the last stage therefore increase the potential supply area slightly (190 ha) and if required lift scheme reliability. These components include;

- [redacted] and filled from local catchments.
- Interconnect to Zones rest of scheme.

Overall Summary

A summary of the progressive development plan and associated costs for the Mid-North are presented in **Table 26**.

Table 27. Mid-North summary of progressive development.

Item	Cost ($000)					
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Intakes	[redacted]		[redacted]	[redacted]	[redacted]	
Pump Station	[redacted]		[redacted]	[redacted]	[redacted]	
Reservoirs	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
Pipes	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Transmission	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Sub-totals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Des, Constr, Cont	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
P&G	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Totals	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cost/ha ($000) Base	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
Cost/ha ($000) @ 95% Reliability	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]

Apart from the initial stage which includes storage provisions for [redacted], an almost consistent cost per hectare is achieved. Because these other uses reduce the potential irrigation supply area in Stage 1, if approximately half of the cost for Stage 1 was assigned to these other uses, then this stage would have the same cost per hectare for irrigation as subsequent stages.

The total cost for a staged developed scheme is approximately [redacted] higher than if the Distributed scheme is built as a single development. The increase in cost arises from additional pipework and pump stations required to allow sub-schemes (Stage 3, 4 and 5) to operate initially in isolation.

13. Summary and Conclusions

The first three volumes of this study have essentially scoped, undertaken pre-feasibility design and costed five potential scheme configurations, two in the Kaipara and three in the Mid-North. These represent two reasonable, but outer bookends between which an optimal scenario is anticipated to sit. These limits therefore form the pre-feasibility envelop from which subsequent stages will derive final optimised schemes.

Through the process adopted, potential critical flaws have been avoided by filtering out scheme features that are most likely to induce an unacceptable level of risk. As relatively small schemes, it is cost prohibitive in most cases to tackle very high risks directly, hence an approach of avoiding the highest risks and critical flaws has been adopted. As such, while many risks and uncertainties remain, many of which will continue to remain through the development phases, none have been identified that are currently deemed to be critical in terms of overall scheme viability.

The schemes are also consistent with the investment principals of the Provincial Growth Fund regarding water storage.

This volume, essentially testing the viability of these schemes at a high level from a consentability and affordability perspective, identified the following:

- Through exclusion of the most sensitive areas from the start, and focussing upon high flow harvesting of water to small storages, there is unlikely to be any significant consenting issues that cannot be managed or mitigated;
- The indicative costings of the scheme appear to be affordable to a variety of horticulture uses; and
- There is a demand for this project, albeit uptake is likely to be fragmented and slow, however should not be unexpected within two communities facing significant challenges.

In addition to this, the followed key observations have been made:

- There are real opportunities to address municipal water supply issues through allowance within storage and distribution networks in both districts. Both scheme areas include storage opportunities within realistic supply proximity to their respective urban centres.
- Excluding land use change, there is the ability for some positive environmental outcomes in both areas but not significant.
- Any hydro-potential opportunities are minimal and even if advanced should not directly influence overall scheme design, rather be added as once the design is optimised for water supply.
- A scheme in the Kaipara is likely to be much easier to consent than the Mid-North due to environmental reasons.
- In the Kaipara a scheme is likely to have positive impacts upon climate change adaptation during the wetter months through removal of water from the drainage scheme catchments as well as a higher value irrigated land uses requiring and being able to afford a higher level of drainage scheme performance.
- In the Mid-North, the land adjacent to [redacted] has the most demonstrable activity occurring on it that will drive a need for water storage for horticulture and other uses however focus needs to be wider to ensure that the community best outcome is not compromised by other early adopters independently progressing developments.
- In the Mid-North, the availability of Lake Omapere as a water source has potentially significant positive impacts in regard to the cost per hectare should it be proven to be viable.
- Whilst possibly not required if Lake Omapere is proven viable, it should be noted that [redacted] is the most cost-effective piece of storage identified in the Mid-North, albeit not immediately adjacent to the command

area. [redacted]

- In the Mid-North there are clusters of exiting landowners eager to advance irrigation. The Distributed Storage design concept is consistent with potentially advancing these areas early whist still integrating them in the wider scheme over time.
- The ability to use water as a part of a pastoral farming system, albeit with restrictions on use, will be critical to gaining support, and enabling land use transformation, in the Kaipara in particular.
- There is a strong likelihood that there will be threatened or protected species present on one or more of the many potential site identified i.e. mudfish habitat. Early identification of such sites would be highly beneficial from a scheme master planning perspective i.e. investigate further or focus efforts elsewhere.

In regard to prioritisation of effort moving forward, this project must capitalise upon momentum created by this project in both areas and ensure that it aligns with timing expectations of potential early adopters. In understanding the desire to improve community social and economic wellbeing as soon as possible by storage and distribution network construction, early construction works can both help by demonstrating intent, and potentially hinder by becoming a distraction from the ultimate development.

Through careful management we suggest following as priority areas/works:

- Progress both landowner and wider community liaison to manage risks associated with land access, community resistance and the proliferation of miss-information.
- Seek to progress [redacted] towards construction as fast as practical [redacted] This progress however should be undertaken with a clear understanding of how this component would integrate into the overall scheme.
- Enter into discussions with [redacted] Ideally, opportunities for collaboration and/or shared infrastructure will be identified. This would include consideration of both interim (while other components are still under development) and permanent solutions.
- Progress discussions [redacted] It is important to progress these in parallel with other scheme components as there is potential for both these areas to be serviced from same location initially as uptake grows and be integrated in the wider scheme in later stages.
- Progress Kaipara distributed scheme in its entirety as quickly as practical to meet pending needs to Dargaville as a co-benefit. This would include development of staging scenarios that balance uptake potential, cost to users with project risks.

Taking into account the discussion in **Section 11**, the following tables provide a summary of the potential schemes following the completion of this study.

Table 28. Scheme cost comparison.

Description	Kaipara		Mid-North		
	Large Storage	Distributed Storage	Large Storage	Distributed Storage	Distributed Storage (Lake Omapere)
Total Capital Cost Mid-Point and Range (incl land and +/- 15% uncertainty)	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]
Irrigable Area - Farm	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Irrigable Area - Canopy	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cost Midpoint and Range ($/ha) Farm	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]
Cost Midpoint and Range ($/ha) Canopy	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]

Table 29. Potential optimised scheme costs.

Description	Kaipara	Mid-North
Capital Cost ($000s) +/- 15%)	[redacted]	[redacted]
Irrigable Area - Farm	[redacted]	[redacted]
Irrigable Area - Canopy	[redacted]	[redacted]
Cost Range ($/ha) Farm	[redacted]	[redacted]
Cost Range ($/ha) Canopy	[redacted]	[redacted]

Table 30. Potential initial stage costs.

Description	Kaipara	Mid-North
Capital Cost ($000s) +/- 15%)	[redacted]	[redacted]
Irrigable Area - Farm	[redacted]	[redacted]
Irrigable Area - Canopy	[redacted]	[redacted]
Cost Range ($/ha) Farm	[redacted]	[redacted]
Cost Range ($/ha) Canopy	[redacted]	[redacted]

14. References

ANZ, 2019. Kiwifruit Industry Insights Update 2019 Invest Opportunities and Challenged. Prepared by Client Insights Commercial & Agri. February 2019. *Accessed from: https://comms.anz.co.nz › anz20702-Kiwifruit-white-paper-2019-11*

Dunn, R.N, Allibone, R.M., Gloss, G.P., Crow, S.K., David, B.O., Goodman, J.M., Griffiths, M., Jack., D.C., Ling, N., Waters, J.M., Rolfe, J.R. 2017. Conservation status of New Zealand freshwater fishes. New Zealand Threat Classification Series 24. Department of Conservation.

Landcare Research NZ Ltd. 2000 NZLRI Land Use Capability.

McDowell, 2000. New Zealand Freshwater Fishes. Reed Books, Auckland

Ministry of Business, Innovation and Employment, 2004. Building Act 2004. Public Act 2004 No 27.

Ministry for the Environment. 2014. National Policy Statement for Freshwater Management. Updated August 2017.

New Zealand Government, 1953. Wildlife Act 1953. Reprint as at 21 December 2018. Public Act 1953 No 31.

New Zealand Government, 1977. Reserves Act 1977. Reprint as at 21 December 2018. Public Act 1977 No 66.

New Zealand Government, 1987. Conservation Act 1987. Reprint as at 22 October 2019. Public Act 1987 No 65.

New Zealand Government, 2014. Heritage New Zealand Pouhere Taonga Act 2018. Reprint as at 12 November 2018. Public Act 2014 No 26.

Northland Regional Council, 2019. Proposed Regional Plan for Northland. Appeals Version – 29 July 2019.

Opus, 2015. Northland Strategic Irrigation Infrastructure Study. Consultancy report prepared for Northland Regional Council. December 2015.

Opus, 2017. Scoping of Irrigation Scheme Options in Northland. Consultancy report prepared for Northland Regional Council.

Opus, 2019. Development of a Strategy to Restore Lake Omapere. Consultancy report prepared for Lake Omapere Trust and Te Aranga Hou Marae Trust.

Appendix A. Industry Engagement

Interviewee	What markets, crops and land uses do you see as having growth potential for Northland?	Who will the major players and growers be if there is to be successful uptake within Northland of a Water Storage Scheme?	Other than water what barriers do you perceive to growth in the horticulture industry in Northland? What other infrastructure is needed?	Do you have any thoughts on what "low hanging fruit" may be?	Is there any sort of support you could offer for this project? What support is required to ensure project success?
[redacted]	[redacted] HortNZ some years back did a great article, which listed the results for crops per hectare [redacted] As one of the fundamental challenges I see if that making the land/irrigation available is great, but if there is not sufficient return on the crops grown, then where with the value come from? [redacted] are heading for some trouble ahead in kiwifruit as costs for labour and post-harvest services rise to meet investment required, this will see a softening of returns, leaving some recent purchasers exposed from the leverage point of view??? Berries is an unknown for me, as I am very unfamiliar, I am told that demand is growing worldwide, so maybe there is something here. Avocados need are real push on market development, as even last year, Aussie prices crashed for a period, which turned some people off picking, although, maybe production is dropping in BOP, and increasing in Northland, so supply will be the same. You are more aware than I on the potential for domestic market vegetables from the reason as Pukekohe gets turned into houses, and you may also know what types of returns these rowers make, and whether they are viable or not. Citrus is a real no go area from what I understand, very hard to make ends meet due to heavy reliance on local market, which has been flooded. Apples, I have no idea… [redacted] but is there any potential up here? What about Hi tech hothouses in Northland, high production low foot print, lower labour requirement?	We have seen the face of hort in Northland change from Mom and Pop to more corporate farming with limited partnerships and syndicated type organisations (MyFarm). There are still a handful of mom and pops coming to town for purchases, and they tend to be cashed up dairy farmers, and will run as absentee owner. The somewhat meagre returns from hort/ag are nonetheless attractive to those with European money, who suffer low/negative interest rates, and are happy for a 4% to 6% return on investment despite risk. [redacted] Maori have huge potential here, and I have done some worked [redacted] on a unique investor model that allows Maori land and investors to come together, this did not gain traction at the time, and I still believe the model is workable, as it has been successful in other regions. Is there an opportunity in all this to provide higher quality drinking water along a proposed network, which would dovetail into the governments work around the 3 waters? This is a long shot I know, but some lateral thinking may provide additional leverage	Labour is going to be an ongoing problem, despite its value being increased significantly, the quality is somewhat un changed – a lot of regions have many more RSE workers per hort employee, than Northland. [redacted] so initiatives to increase quality of local labour, or more RSE would overcome the barriers, as clearly this affects margins if labour is expensive, with the obligation to top up to min wage regardless of output. Maybe also senior expertise, [redacted], finding the right people with the right experience is harder than it should be, it seems more like an employee's market, than an employer's market at this point, so need to be mindful of this. The rail link here is non-existent really, with tunnels too narrow to carry containers, so reliance on trucking has some risks in the future with the sector reporting a lack of drivers despite the trucks being available. Marketing of the opportunities for the region in this type of scheme outside the benefits to the growers, needs to be promoted, recently we saw a potential Tegal chicken factory in Dargaville passed over due to local reaction, in an area where the economic circumstances are crying out for this type of investment. Northland can be the home to some more environmentally conscious residence, whom may object to more intense activity in their area.	I have huge belief in the potential for kiwifruit in Kaikohe [redacted] it has higher winter chill units, and I think once proven for Kiwifruit it could really go off. Also, politically this area needs the boost, so could be a good source of alternate funding available	I would be keen to offer support on this project given my background [redacted] particularly in modelling and taking a strategic view, researching reporting, managing
[redacted]	The normal ones: Kiwifruit, avocado, persimmons, berries, Tamarillos, citrus and perhaps some new ones bananas and other tropical fruits. Apart from apples and stone fruit the list is endless ... just about. There may be some vegetable options such as early potato but that would depend on what and whether water quality could be maintained	Area dependent - who is already in location and who can be attracted to the area for growing / Iwi joint venture. [redacted]	Water quality, pack housing and good roading plus a permissive regulatory regime from Council that enables. Water storage options will also be important and need to be Council enabled.	Vegetables may be a strong option especially if there is development money to build leaf green houses and novel fruits - buts that's a long road	[redacted] not geared to support such projects other than to ensure as far as possible Council plans enable growth - we are doing that at present.

[redacted]	Kumara definitely in the Kaipara on the flats. Also potentially covered cropping.	There is a trend to grower entities getting bigger. Want to see local iwi getting more involved. Water would attract investment to get growth. Need corporate investment to attract capital.	Labour is the most important. That's what is missing currently for kumara. Water would help crop yields.	There could be more expansion of kumara if there could be more control of climate and nature. That is where water could help.	There is a united regional grower network in Kaipara. [redacted].
[redacted]	[redacted] berries. Allow whatever is high-value. [redacted]. Water for berries is key. [redacted] about lifting Māori land productivity and opportunities for people. Adding water would help Northland a lot.	Māori are significant players and growers because there is so much unproductive land. [redacted] The Māori Land Service report is a useful document as a reference to who owns what.	Labour and skills. Māori learning high value practices. Extra labour and automation. Infrastructure in the form of packhouses, post-harvest facilities and supply chains and cool stores to get product to Auckland, which will be the primary distribution hub.	Berries. Avocados have grown up north but needs care. Grow things that grow well and have supply chain infrastructure around you.	[redacted] be kept abreast of development and could be a contributor to technical design. No financial support but can provide information on water requirements and growing systems.
[redacted]	Land use: Berries have a large potential. There is obviously the kiwifruit & avocado growth that we are in the midst of. Honey / bees is another growth area. Also, herb like plants as the awareness of their healing properties increases.	Those that can afford it! There are numerous big players coming into the mid & far north at the moment and I would imagine this would open their horizons beyond existing investments.	Cool storage, packing facilities, transport to the market, cost of labour increases, reliable labour supply	listed above in #1 in terms of potential land use. Tapping into other water organisations such as Taipa Water Supply Ltd, Doubtless Bay Water, Kerikeri Irrigation Company etc could assist with brainstorming	I'm happy to be used as a sounding board or attend meetings to help the study progress. Obviously being collaborative to all wider stakeholders will ensure success but will also slow the process down.
[redacted]	Avocado, Kiwifruit, berries. All Asian markets	Growers & investors in these industries	Transportation, roading & sea transport. Labour-skilled & unskilled. Housing for labour. Education facilities for families involved in horticulture. Accommodation for visitors to these industries. Capital investment-the need for capital prior to production. Consistency of rulings around water, chemicals e.g. copper in soils, grants		[redacted] is trying to provide support in capability building, visibility of opportunities highlighting industry growth. Sharing simple messaging around what can be done or us being done. Documenting water requirements at an industry level so all on the same page
[redacted]	Currently the NZ kiwifruit industry has strong growth projections and therefore strong supply signals for increased hectares of kiwifruit being planted in NZ. As Northland is one of the industry's current growing regions, it is seen as a place by existing kiwifruit growers (either from the region or from other kiwifruit growing regions) for new plantings of kiwifruit. Kerikeri in particular has had tranches of newly issued Gold3 licence purchased by growers with the intent of planting in that region.	Don't know the irrigation requirements of individual growers in the Northland region.	I expect Northland will be like other kiwifruit growing regions in NZ that as volumes increase finding labour for the growing and harvest seasons will become increasingly difficult, particularly if other crops are developed which have similar labour timings as kiwifruit.		Happy to share in more detail the future growth prospects for the NZ kiwifruit industry as a pointer to how that growth might flow into the Northland region.
[redacted]	Avocado is the most pressing and urgent and is gaining real momentum. Early-season supply market gardening in general has good potential.	Existing growers, including [redacted] Iwi will be players in Far North.	Collaboration and cooperation over workforce development will be big, growers collaborating to get stable workforces, 10-months of stable employment, cooperative networks, investment and equity. Iwi are risk averse, won't leverage off equity. Geographic isolation and transport across the value chain are constraints. Environmental values are changing and there is a hold-up to consents. Need to find solutions. The wider needs of people are also important. Skills are needed in governance, management, growing and marketing.	Collective iwi are proposing a PGF application for water storage in the Far North, using dips in land to store water.	Long-term value assessments of environmental gains, triple bottom line assessments, a way to value long-term environmental outcomes.
[redacted]	[redacted] potatoes. [redacted]		Haven't given a lot of thought to extending footprint in Northland. Constraints are reliable labour to do manual work, freight time and costs for 4 - 4.5 hours to Auckland. While soils are good volcanic rocks are a limiting factor for annual cropping and cultivation of horticultural crops. This would not be as much of a problem for perennial horticultural crops. The advantage of the north is its earliness for the cropping season.	The logistics is a constraint	Be kept in the loop.

[redacted]	Huge potential for cropping bananas, Lucuma and pineapples minimal water requirements for the latter two	Sorry not my area	Rail freight to Auckland	I would put all Shrub, Cane and Vine fruits into this category	[redacted] currently we have a number of Dairy farmers planting bananas to utilize effluent run off and to utilize marginal land, [redacted]
[redacted]	Heaps. Annual and perennial horticulture. Now, and increasingly into the future. There's magic climate, and where there's less-than-magic soils there's mitigation options. Also, not wholescale change like MVDT getting out of dairying, but dispersed pockets of magic land across many enterprises that in sum constitute an industry. Also, hemp, CBD cannabis, and hops.	Major industries. Horticulture NZ, Avos NZ, and Veges NZ, Berries. Plus, simply businesses e.g. MVDT, private hort companies, & Maori entities	Supply chain infrastructure. Packhouses & cool stores, not monocultural, but shared across industries. Labour (RSE?) extension services	Avocados. [redacted]	
[redacted]	[redacted]	We have seen the emergence of a number of large-scale growers in Avocado and Kiwifruit in recent years, with 300H Avocado planted near the Kaipara, 400 H planted/owned around Houhora, another development around 120H and the start of a potential 600 H development around the same area. [redacted] We work with a number of Iwi at present in the wider Northland region, these include successful orchards at full production as well as projects at different stages of development. The key beneficiaries of a strong water distribution scheme would include, Iwi, organisations like Pamu, [redacted] who can work with any group looking to further the horticultural interest, wider international partners who can have a greater reliance on New Zealand produce the more we can development regional supply. NZ and potentially overseas Investment funds and of course private Mum and Dad investors who form the core of the fruit Seeka manage. Water is already a point of concern for both the 25 odd orchardists involved in the far north water issues and for many more that have looked on awaiting a resolution.	With the an expanding and so far successful presence of major horticultural development in Northland comes the need for a strong developing workforce to support this, we work hard at present to keep and grow enough staff to manage the orchards that exist now- and by the time the long list that are developing or considering it- including the above - a major skilled and temporary labour shortage is likely. This workforce could come from the local regions through initiatives around basic horticultural courses through to small business loans to support the subset of trades needed to build and support bigger orchards and wider offshoot business. Developing a model that drives employment from the region while allowing overseas people to ensure labour constraints do not prohibit growth though emerging shortages (this will get worse in coming years) is a big task and challenge but fundamental to further investment. Accommodation – particularly in the far north for temporary employees as during harvest labour is a constant challenge.	Supporting return to work schemes as I understand many potential employees may not have worked for some time. Supporting network capability from Spark/Vodafone etc as it can be a major negative to functional business in the north	[redacted] support young people looking to build a career path in our industry through cadet ships and [redacted] happy to further support bringing motivated people into our business. Working with Iwi to provide free, land suitability assessments, project scope options, timing and cost models, technical support through development
[redacted]	The first thing is that Northland is not one region. What might be right for Te Hiku may not be right for the regions around Whangarei. What you do need to do is go for your comparative advantage given the land and water resources you have. Early season vegetables, fruits, berries and other crops may be the way forward. Kiwifruit despite the high costs of getting into the industry is definitely a play worth considering. I would be careful about avocados since there are risks around a boom bust cycle. The situation is too fluid at the moment to get a proper reading on their long-term potential. But do not forget about livestock farming since it is an important feature of the regional economy. You may have to change the way dairy farmers are managed (i.e., low	It will depend where the water storage is. The real issue around durable storage is the slow take up rates by farmers early on. It takes some time before they can be persuaded to invest. So, you need to factor that into any planning since it is unlikely that you will get 90% take up in the first 10 years. Unfortunately, this is the story about innovation – it is inherently uncertain. Build it and they might come and then again, they might not.		Stick to your knitting. I think many of the players know what they have to do. I certainly found that when I talked to growers – I would suggest things and they would shoot holes in it because they were miles ahead of me in their thinking. If you look around it is the market gardeners, berry growers, kiwifruit growers, avocado growers (at the moment) who are going well. The issue is what do they need to expand? I think supporting the types of growers who are going well today is not a bad starting point.	We have done some reports here and there which might be of use. I'll see what I can dig up. Always happy to have a chat.

	inputs, better land management etc) but don't write them off. They all contribute.				
[redacted]	What are you selling and how much will you make from it? Too many times we see failures in large ventures that have not fully considered how to produce cashflow and gain experience to pilot some of these opportunities at a manageable scale before scaling up. Of course there are lots of different opportunities but it depends on having the whole business sorted out from direct experience. All Horticulture is difficult because you have to work from the market end backwards. Too many businesses have failed from not working these things through from first principles. In my view it is not water that has been the key limitation for development; it is direct experience and commitment. So, putting the water on provides some more opportunities but they not be in some of the permanent tree crops. I would consider the demand for plant-based products to be a good driver; but I would probably be looking to invest initially in a machine harvestable commodity crop at sufficient scale to return cashflow in a safe market. It may be worth investigating grains and seeds, potentially quinoa or even barley? Hemp is an option; for oil and other products. Oats have some potential I understand from looking at the numbers and the significant increase in demand for oat milk. Then experience can be gained alongside cashflow for a gradual evolution into higher value opportunities with the cashflow to back up pilots at smaller scale. Organic growth is the key.	Existing investors will potentially look at moving in but it is difficult to see how successful they will be at any scale. Most sensible people will start small and learn how to do it from first principles. Obviously the Government is keen to enable development for iwi. That would be great for Northland if the right structures to manage the business were set up. Look at the successful models we have in NZ and examine how important culture is to them. Hard work and direct experience are in my view the best way to develop the right culture for success. I'm not being negative about the irrigation infrastructure but I don't think it is the key limitation. Horticulture is pretty tricky to get right because of the need to: - develop the market in the first instance; - put in the capital for crop development and machinery; making sure not to underestimate post-harvest processing packaging and transport. - Develop the labour resource and the management structures to guide production and harvest/process crops.	1. Entrepreneurship: The experience and determination to put all the pieces together; and a willingness to invest everything in the project for it to succeed. 2. Skilled labour and technical support in terms of crop management and land preparation. 3. A market development process to investigate the economics and explore different options within a budget. The only other option is for somebody to walk in with a business model, like Fonterra or Zespri. If there is someone who will take the product away at the gate that is much easier. 4. A plan for moving from current practice; to establishing cashflow in some proven and low risk low capital crop at scale; to increasingly testing at pilot scale some higher value opportunities.	A cash crop at scale might be the obvious answer. One where not a lot of infrastructure is needed and processing / market development costs are low. That's how a lot of us got started in melons, squash and other field crops. You develop the basic skills and move on. If it doesn't work the machinery can be sold and there is less risk to investment. Don't forget that for tree crops and other initiatives like glass and tunnel houses there is a lot of capital tied up in development. Significant shelter is required; drainage and site preparation. Buildings are expensive and take time to install. In the meantime, the land can be used to create cashflow with vegetable crops or another "processed product" option in my view.	I think the advice I'm giving here is about the most productive thing I can do at present; with my other commitments [redacted] I'm seriously concerned at the idea that lots of money can be spent on something that will potentially fail if done on a big scale. I don't honestly think the money spent in basic water infrastructure would be wasted in the long term: but in the short term many businesses may fail. The infrastructure they left behind may be of interest to a canny buyer; as we have seen in Canterbury with centre pivot development. But the profits may not accrue to the initial investors. My interest would probably grow if I saw the right steps being taken at the right scale to develop the human capacity for horticultural development. I think if options are broad enough for the irrigation infrastructure and development is well considered (in line with the approach I have suggested) the risk of failure can be managed.
[redacted]	Starting with markets, there are opportunities for both domestic and export-oriented crops for Northland. Firstly, on the domestic side, Northland is proximal to Auckland and given the climate can extend the season for suitable existing crops grown further South, as well as grow other crops not so well-suited further crops. For example, the region can provide an extended growing season for crops such as kumara, speciality potatoes, melons, squash, berry fruit, citrus and avocado that are already well-established further South. Access to the right genetics can also open up new options such as low chill stone fruit, which allow the availability of higher quality early season produce. A low chill stone fruit industry has been successfully developed in South East Queensland. Other specially crops, such as cherimoya are better suited to the Northland climate than when grown further	Increasingly, investment funds partnering with grower management companies are becoming a new way of scaling growth opportunities in horticulture. For example, MyFarm, the NZ Super Fund, Kakareki Fund. Also, the other major investment is coming from Maori Investment funds, Maori LLP's and the Te Tumu Paeroa partnering with Maori land owners. For crops grown to extend supply windows, larger scale marketer/grower groups such as Wilcox and sons, Ball Brothers, Seeka and T&G have been and are likely to continue investing as the Water Storage Scheme develops. Multinational value chains such as Driscoll's Berryfruit, or locally NZ Gourmet are potential options.	Improved air, sea and road networks to support timely logistics for harvested produce. Processing and packing infrastructure. Training and re-training options to produce a skilled workforce. Strengthen of regional communications infrastructure. Improved access to regional, national and international R&D and innovation capability and technology spill-in.	Certainly, seeing if [redacted] could place a strategic focus on the region in relation to bring forward their early market window with new genetics and also learnings from offshore in regions that may have similarities to Northland, such as the Southern parts of Italy and Jeiju Island in Korea. Feasibility of new high value processed such as watermelon juice should be explored. Also, some feasibility of the local animal forage crop market options. The low chill stone fruit option, given the success in South East Queensland, and possibly Cherimoya, also given the success of the closely related custard apple in South East Queensland.	Certainly, can assist with regard to accessing and tapping into networks locally and globally for expertise, technology and market options, as well as strategic thinking.

	South. For export markets, expansion of crops such as avocado show promise, but need to be cognisant of the market window that they are servicing. In this case, the bulk of the current export opportunity is focused on the late season gaps of November - January, which may create postharvest quality issues for the earlier maturing Northland crop. Growth opportunities exist for kiwifruit, and there could be a regional advantage as Zespri focuses on new genetics to bring forward its marketing window, including new red and novel cultivars. Globally, crops such as persimmon that are well adapted to the region are experiencing growth. Citrus crops, such as mandarin have developed in the region for export. A large genetic resource of citrus is located at the Kerikeri site, and there could be opportunities to identify speciality citrus crops for markets in Asia. Another crop type worth considering is the production of speciality animal fodder crops such as lucerne or sorghum given the vulnerability of the Far North region to shortages in animal feed due to drought. New speciality process crop opportunities that build on the regions environmental advantages could also be considered. For example, the production of water melon juice that is challenging coconut water has been pasteurised using pulsed electric field technologies that enables a fresh taste and extended shelf-life. Regarding growth potential, the global demand for fresh produce is growing at a rate of about 7% per annum. The challenge for the Northland region is how to access suitable value chains to capitalise on this growth. For example, in the case for kiwifruit, Zespri can provide a well-built integrated value chain, has articulated growth potential, is seeking early supply and has a pipeline of new genetics that could be suited to the region. In contrast, for new speciality crops such as cherimoya, that is well suited and has grown market demand, no New Zealand-based value chain exists. For crops that can use the region to extend market windows, such as avocado, berry fruit, citrus, and potato, value chains currently exist for servicing growth in both the domestic and export markets. Opportunities could also exist, to partner with offshore value chains looking to expand their supply and geographic footprint. For example, the recent investment from Chinese companies in Australia to supply Camellia oil, a non-traditional crop for Australia, but could also be suited to Northland. Other processed oil crops such as oil and avocado are also potential options.				

[redacted]	Nothing better than kumara that I have found, [redacted]. Maize and other field crops are a real option, to reduce the environmental footprint of our dairy sheep and beef farmers currently reliant on PKE. Using water with an effluent concentrate as a base to fertigation could transform the district. Water would in my view definitely transform the economy of the district but in my view it would be better utilised to allow for finishing to occur so that the meatworks does not have a glut and a shortage: the district has been significantly harmed by increasing droughts and this has really sapped farmers capital. [redacted]	I think the thing to realise is that horticulture will come from water; it just won't (and should not) happen overnight. [redacted] Those things (and other horticultural options) only look viable if allowed to grow on the back of what is being done now being done better; and water is required for that (but probably not at the rates being proposed for a scheme). In my view the development of the higher value horticulture options will happen through locals trying and piloting new things. They are the ones who will make it happen. The water will cause change as locals take opportunities over time; but they will only take those opportunities if cashflow is good because generally local farmers are debt strapped into what they do now because of the droughts we have had.	The farmers and growers need capital; so cashflow to release debt is the sensible ask. So, the irrigation scheme should not be focussed just on horticulture; because to get that to happen then existing systems will need to deliver better returns to allow the investment in infrastructure to grow and process crops.	Fixing what we have going on now with the water provided - to improve the environmental outcomes and the cash returns on the existing systems. That way you can migrate to the higher value options with cashflow in support.	Already involved and would struggle to offer more with my current commitments to [redacted] but if local meetings are required, they are easier for me to attend.
[redacted]	[redacted] salad greens [redacted]. The growing conditions were difficult - there were a lot of things we had not appreciated; including the way the pans are structured; soil and the wetness to work ground in the winter. [redacted].	In my mind; if it was to be us the relationship between the scheme provider and the landowner; and the business culture of these two entities is critical to whether we could consider it or not. The business culture would need to enable our business to function within a clear and transparent set of rules for it to work well; with mutual respect being evident in the way the relationship is managed.	Water is required but I think in our case shelter from wind was a key issue as well. Transport not so much of a concern for our high value products: when you get down to a kilo rate on a truck full of our products it looks reasonable. Getting the right labour would also be critical to success. I think the key thing required would be some certainty of tenure and a degree of self-determination about how we manage the growing.	I'm not so certain about what could be considered low hanging fruit.	n/a
[redacted]	[redacted] there is potential to grow many of the crops we'd be interested in up in Northland; as long as we had shelter and water. But I'm not sure I would be looking at growing more of what we do now up there because the markets are pretty full. It would have to be something new.	Potentially we would look at it; depends on what the due diligence told us about the option. At the moment we are looking at land within 50-100km of [redacted]. The transport issues would need to be sorted; given we supply either to Auckland or a port for export. Our major concerns would be the quality of logistics into our destinations as opposed to getting to our existing processing facility [redacted]	Labour is pretty crucial - and the ability to obtain water; although we can manage without in some cases by looking at what we plant elsewhere and balancing production to fit the timing required for entrance to the market.	There are potentially good opportunities for vegetable production; but sorting the export market would be key.	n/a
[redacted]	When you and I started with [redacted] about ten years back we both noted that water was likely to be a key constraint or enabler going forward and it is pleasing to see where this has got to. Like the others you have interviewed I'm not convinced it will happen overnight. I'm still a firm believer in the potential for more avocadoes. NZ is less than 1% of world supply. World demand has increased by 17% and production has only increased by 3%. Some of those	Things are getting more and more corporate with the scale of new plantings. So, in my view syndication is becoming the key to developing; and I do think it will be locals who get in and do that. It will require syndication to attract the capital required.	[redacted]. I think we will see a lot more horticulture in Northland but over the next 20-30 years - not the next 5 years. Obviously, labour is an issue at all levels but it is also the speed of capital and the technology to develop (new rootstock, varieties) that will slow things down.	Yes, I do think that the kiwifruit and avocado models will continue to provide growth at a steady rate. The comment about pilots and test sites leads me to think there should be some facility or research site that provides opportunities for people to test at pilot scale would be incredibly useful. It would give the banks confidence to invest if they can see a working model.	Retired sorry.

	soils in the Mid-North (Red Hill soils may be more problematic with slope) will potentially benefit from the new varieties. If you had talked to me about our traditional rootstocks some of those volcanics appear a little tight - but new rootstocks such as Dusa, Bounty and Lattice may be better in these areas. Whatever it is; in my view there must be a solid export market - our domestic market is too small and the impact on existing growers providing domestic would be very bad if there was too much profit. It is easy to grow a crop if you have the right climate, soil and water but growing it at a profit is key and the margins need to be high to support that. I understand tamarillos are showing some potential and maybe they should be looked at because reported returns are high.				
[redacted]	[redacted] think one of the main opportunities is doing what we do now better with the security of water. If we can have the security of water it will generate more wealth into the local community who can then look to develop the higher value returns in a more considered fashion.	I think that know about some of the objectives the Government have is to support the local community in development. I'm not sure that you will find external processors and operators who will be prepared to entertain the sorts of partnerships envisaged to share the profits as the local community might envisage. So, I think it is locals who will need to step up to the plate and I think they can and will over time - but not immediately for a number of critical reasons.	Access to Capital: Local people will struggle to attract investors in the current market without giving up a significant proportion of the wealth being shared. Institutional investors are also particularly vulnerable to regulatory risk and there is an increasing unwillingness to put forward money on certain models that are unproven or known to be higher risk from an environmental perspective. You must also have an exit strategy for a successful investment model; and you will have to factor in the lower resale value of an untested model in a remote region such as Northland. Access to people: The labour force is in a formative state. The middle level of management is almost completely missing: leaders; agronomists, managers, post-harvest specialists and technicians providing specialist services. These are the people who have to dedicate themselves 24/7 to a horticultural business to make it a success. That has to be built over time. Access to support infrastructure: [redacted] Post-harvest and processing infrastructure: [redacted], we need to add as much value as possible to the product at source through processing and post-harvest; and maintain that value through the proper cool chain to market.	Improving what we have to provide the baseflow and the time to develop the labour force with the right skills. That will mean investment can be attracted to grow the higher value opportunities and will support local communities to retain the wealth.	Happy to be available by phone if you are interested in more information about my answers.

			Temperature is often a critical factor. Water regulations may be a key stumbling block: If consent is required and may be turned down you will struggle to allow that on land you own as the value of land will decrease with a declined application. The new water regulations requiring consent will also be a key problem in attracting an institutional investor like a bank.		

Appendix B. Crop Cashflow

Kiwifruit Cashflow

Kaipara Large Storage										
Revenue	-	-	25,500	55,250	85,000	119,000	119,000	119,000	119,000	119,000
Growing Costs	6,000	7,000	11,000	20,000	33,000	40,000	40,000	40,000	40,000	40,000
Capital Debt Servicing Costs	17,787	17,787	17,787	17,787	16,278	14,770	13,261	11,752	10,243	8,735
Capital Repayment Costs				25,145	25,145	25,145	25,145	25,145	25,145	25,145
Irrigation Operating Expenditure	987	987	987	987	987	987	987	987	987	987
Nett Result	-24,774	-25,774	-4,274	-8,669	9,590	38,099	39,607	41,116	42,625	44,133
Cash Flow	50,226	24,452	20,178	11,509	21,099	59,198	98,805	139,921	182,546	226,679
-	1	2	3	4	5	6	7	8	9	10
494,082	6,987	7,987	11,987	20,987	33,987	40,987	40,987	40,987	40,987	40,987
	-	-	25,500	55,250	85,000	119,000	119,000	119,000	119,000	119,000
-494,082	**-6,987**	**-7,987**	**13,513**	**34,263**	**51,013**	**78,013**	**78,013**	**78,013**	**78,013**	**78,013**
Payback	-501,069	-509,056	-495,543	-461,280	-410,267	-332,254	-254,241	-176,228	-98,215	-20,202
NPV	296,264									
IRR	10.0%									

Avocado Cashflow

Kaipara Large Storage										
Revenue	-	-	1,720	10,603	24,721	35,324	49,442	50,860	52,977	63,580
Growing Costs	7,750	4,500	6,300	11,150	10,550	13,850	14,700	11,450	14,900	14,510
Capital Debt Servicing Costs	2,838	2,838	2,838	2,838	2,590	2,342	2,095	1,847	1,599	1,351
Capital Repayment Costs				4,130	4,130	4,130	4,130	4,130	4,130	4,130
Irrigation Operating Expenditure	987	987	987	987	987	987	987	987	987	987
Nett Result	-11,575	-8,325	-8,405	-8,502	6,464	14,015	27,531	32,446	31,361	42,602
Cash Flow	-1,575	-9,900	-18,305	-26,807	-20,343	-6,328	21,203	53,649	85,010	127,612
-	1	2	3	4	5	6	7	8	9	10
78,832	8,737	5,487	7,287	12,137	11,537	14,837	15,687	12,437	15,887	15,497
	-	-	1,720	10,603	24,721	35,324	49,442	50,860	52,977	63,580
-78,832	**-8,737**	**-5,487**	**-5,567**	**-1,534**	**13,184**	**20,487**	**33,755**	**38,423**	**37,090**	**48,083**
Payback	-87,569	-93,056	-98,623	-100,157	-86,973	-66,486	-32,730	5,693	42,782	90,865
NPV	311,097									
IRR	18.7%									

Citrus Cashflow

Kaipara Large Storage										
Revenue	-	-	3,125	7,500	15,000	22,500	30,000	35,000	40,000	42,500
Growing Costs	6,997	7,719	8,674	11,902	15,908	20,062	23,812	27,072	29,172	30,422
Capital Debt Servicing Costs	2,289	2,289	2,289	2,289	2,096	1,903	1,710	1,517	1,324	1,132
Capital Repayment Costs				3,215	3,215	3,215	3,215	3,215	3,215	3,215
Irrigation Operating Expenditure	987	987	987	987	987	987	987	987	987	987
Nett Result	-10,273	-10,995	-8,824	-10,893	-7,206	-3,667	276	2,209	5,302	6,745
Cash Flow	-273	-11,268	-20,092	-30,985	-38,191	-41,858	-41,582	-39,374	-34,072	-27,327
-	1	2	3	4	5	6	7	8	9	10
63,582	7,984	8,706	9,661	12,889	16,895	21,049	24,799	28,059	30,159	31,409
	-	-	3,125	7,500	15,000	22,500	30,000	35,000	40,000	42,500
-63,582	**-7,984**	**-8,706**	**-6,536**	**-5,389**	**-1,895**	**1,451**	**5,201**	**6,941**	**9,841**	**11,091**
Payback	-71,566	-80,272	-86,807	-92,196	-94,091	-92,640	-87,439	-80,498	-70,657	-59,566
NPV	1,751									
IRR	6.1%									

Blueberry Cashflow

Kaipara Large Storage										
Revenue	-	-	41,250	82,500	123,750	148,500	165,000	165,000	165,000	165,000
Growing Costs	10,000	10,000	30,000	50,000	70,000	144,000	95,000	95,000	95,000	95,000
Capital Debt Servicing Costs	13,083	13,083	13,083	13,083	12,159	11,030	9,902	8,774	7,646	6,517
Capital Repayment Costs				18,805	18,805	18,805	18,805	18,805	18,805	18,805
Irrigation Operating Expenditure	987	987	987	987	987	987	987	987	987	987
Nett Result	-24,070	-24,070	-2,820	-374	21,800	-26,322	40,306	41,435	42,563	43,691
Cash Flow	25,930	1,861	-959	-1,333	20,466	-5,856	34,451	75,885	118,448	162,140
-	1	2	3	4	5	6	7	8	9	10
369,082	10,987	10,987	30,987	50,987	70,987	144,987	95,987	95,987	95,987	95,987
	-	-	41,250	82,500	123,750	148,500	165,000	165,000	165,000	165,000
-369,082	**-10,987**	**-10,987**	**10,263**	**31,513**	**52,763**	**3,513**	**69,013**	**69,013**	**69,013**	**69,013**
Payback	-380,069	-391,056	-380,793	-349,280	-296,517	-293,004	-223,991	-154,978	-85,965	-16,952
NPV	280,047									
IRR	10.6%									

CVP Cashflow

Kaipara Large Storage										
Revenue	41,678	41,678	41,678	41,678	41,678	41,678	41,678	41,678	41,678	41,678
Growing Costs	27,922	27,922	27,922	27,922	27,922	27,922	27,922	27,922	27,922	27,922
Capital Debt Servicing Costs	1,923	1,923	1,923	1,923	2,025	1,922	1,820	1,718	1,616	1,513
Capital Repayment Costs				1,705	1,705	1,705	1,705	1,705	1,705	1,705
Irrigation Operating Expenditure	987	987	987	987	987	987	987	987	987	987
Nett Result	10,846	10,846	10,846	9,142	9,040	9,142	9,244	9,347	9,449	9,551
Cash Flow	35,846	46,693	57,539	66,681	75,720	84,862	94,107	103,453	112,902	122,454
-	1	2	3	4	5	6	7	8	9	10
59,082	28,909	28,909	28,909	28,909	28,909	28,909	28,909	28,909	28,909	28,909
	41,678	41,678	41,678	41,678	41,678	41,678	41,678	41,678	41,678	41,678
-59,082	**12,769**	**12,769**	**12,769**	**12,769**	**12,769**	**12,769**	**12,769**	**12,769**	**12,769**	**12,769**
Payback	-46,313	-33,544	-20,775	-8,006	4,763	17,532	30,301	43,070	55,839	68,608
NPV	110,077									
IRR	21.6%									

[redacted]

[redacted]

[redacted]