Appendix 4

Wastewater Servicing (SCO Consulting)

To	The District Planning Team	**26 January 2024**
From	Clinton Cantrell – SCO Consulting Ltd	
Subject	Private Plan Change 83, The Rise – Wastewater Infrastructure Planning and Funding	

1. INTRODUCTION

1.1 In response to Private Plan Change 83: The Rise Limited (**PPC83**) I have been asked by the District Planning Team at Kaipara District Council (**Council**) to provide advice on issues relating to wastewater capacity in Mangawhai, and the ability of the Mangawhai Community Wastewater Scheme (**MCWWS**) to service PPC83.

1.2 This memorandum addresses the following matters:

(a) How wastewater is currently treated in Mangawhai;
(b) How much capacity is remaining in the existing treatment wastewater treatment plant (**WWTP**);
(c) How much extra capacity is to be delivered through planned upgrades;
(d) How much capacity is there in the conveyance network, and will a new pump station be needed;
(e) Is there sufficient existing and/or short-term programmed capacity in both conveyancing and the wastewater treatment plant to take the flows from PPC83, including when combined with possible growth from Mangawhai Central;
(f) If not are there any other solutions e.g. holding tanks on-site and off-peak pumping? Or a staging rule that limits the number of households to match capacity until upgrades occur?; and
(g) For larger lots, what's the minimum site size required for private septic tanks – does the Northland Regional Plan set minimums?

2. SUMMARY

2.1 Mangawhai is serviced by the MCWWS. The MCWWS was first commissioned in 2009 to reduce reliance on septic tanks and improve the water quality of the Mangawhai Estuary. The existing Mangawhai Wastewater Treatment Plant (**WWTP**) has a current design capacity for 3,000 connections (residential equivalent). As of December 2023, approximately 2,764 connections are served by the WWTP, with the WWTP expected to reach capacity by around mid to late 2024.

2.2 The Council requires all new development in urban Mangawhai to connect to the MCWWS, and encourages existing development to also connect, due to the improved environmental outcomes from connecting, and on the basis this will result in lower average costs.

2.3 The Council is currently implementing a staged upgrade plan to address near and longer term capacity needs at the WWTP. This plan was presented to and approved by Council in October of 2023. The plan was developed by a consortium of consulting experts who completed the peer review of the 2022 master plan. This consortium includes Hunter H2O (owned by Beca) and SCO Consulting Ltd. The staged upgrade plan approved by the Council will result in the following WWTP capacity increases:

(a) The current number of connections to the WWTP is 2,764, with a current WWTP capacity of 3,000 connections;

(b) In the near term, the capacity of the WWTP will be upgraded to 3,550 connections by mid-2024; and

(c) This capacity will be upgraded to 5,470 connections by 2026/2027 through the discharge of treated wastewater to the Mangawhai Golf course.

2.4 As set out above, following completion of the Near Term upgrades to the Mangawhai WWTP (anticipated to be by the middle of this year) the capacity of the WWTP will increase to around 3,550 connections. This is sufficient to meet growth from PPC83. In the medium term, the capacity of the MCWWS is expected to be upgraded to capacity for 5,470 connections, through the discharge of treated wastewater at the Mangawhai Golf Club (expected to be completed in 2026/2027). This will provide capacity for a further 2,700 connections in Mangawhai. This will provide significant further capacity for growth in Mangawhai and sufficient capacity to service growth from PPC83 (380 connections), development at Mangawhai Central (estimated at 1,000 connections) as well as from other future plan changes.

3. THE MANGAWHAI COMMUNITY WASTEWATER SCHEME, ITS CAPACITY, AND PLANNED FUTURE UPGRADES

Overview

3.1 The Council's planning in relation to the MCWWS WWTP is currently summarised in a document dated 3 October 2023 titled "Mangawhai CWWTP Options Report Peer Review" completed by Beca Hunter H2O. This was a peer review of the Mangawhai WWTP master plan completed by WSP in 2022. The peer review report and associated recommended upgrade path was presented to Council in October of 2023. The peer review Strategy and recommendations has received the endorsement of Elected Members to progress this planning and implement the proposed Stage 1 upgrades due for completion in mid-2024. A copy of the peer review Strategy is **attached** to my evidence as **Attachment A**. The recommendations from this report were presented to Council in September of 2023, and are summarised in the "Mangawhai Wastewater Scheme Report" attached to my evidence as **Attachment B**. An extract from the Minutes of the recommendations and approval by Elected Members in October of 2023 is **attached** to my evidence as **Attachment C**.

3.2 The Council's planning in relation to the MCWWS wastewater network is currently summarised in the 16 Dec 2022 "Wastewater Servicing Strategy – Issue 2" report. A copy of this report is **attached** to my evidence as **Attachment D**. This report includes details around planned upgrades to the wastewater network where the PPC83 development would connect.

3.3 The MCWWS was first commissioned in 2009 to service Mangawhai Village and Mangawhai Heads. The key driver for commissioning the scheme in 2009 was to reduce reliance on septic tanks and improve the water quality of the Mangawhai Estuary.

3.4 When the MCWWS was first commissioned in 2009, approximately 800 properties connected. As of October 2023, there were 2,764 properties connected.

3.5 In terms of the general layout of the MCWWS, wastewater is currently collected from connected properties in Mangawhai Village and Mangawhai Heads, and treated at the Council's WWTP on the western side of Thelma Road South within the Mangawhai reserve area (Lot 2 DP 450057) before being piped approximately 12kms to the Council's 65-hectare effluent disposal field at Brown Road farm. **Attached** to my evidence as **Attachment E** is a map showing the location of the wastewater treatment plant and the current area served by MCWWS. **Attached** to my evidence as **Attachment F** is an aerial photograph of Mangawhai WWTP. The plan change area lies approximately 2.4 km north of the wastewater treatment plant and it is planned that growth in the site will be serviced by the MCWWS. **Attachment G** provides a map of the MCWWS system showing the location of the proposed development area.

3.6 The Council requires all new development in urban Mangawhai to connect to the MCWWS, and encourages existing development to also connect, due to the improved environmental outcomes from connecting, and on the basis this will result in lower average costs. For existing large lots currently serviced by on-site treatment systems, Council may require connection to the public system upon subdivision of these lots.

3.7 The Council intends, over time, to progressively upgrade the capacity of the MCWWS from 3,000 to 3,550 and then 5,470 connections – as per **Attachment B**.

3.8 Under the Council's infrastructure Strategy 2021-2051 the Council is planning to service all growth in Mangawhai using the MCWWS, and is planning to progressively increase the capacity of the MCWWS, as required, in response to population growth.

How is wastewater currently treated at Mangawhai?

3.9 Currently wastewater is treated via the following processes which collectively achieve a Class B level of water quality and comply with the current discharge consent limits:

(a) Preliminary screening and grit removal.

(b) Biological nutrient removal via two Cyclic Activated Sludge System (**CASS**) tanks which address nutrients and organic materials, along with other wastewater constituents.

(c) A third tank is being completed which will initially serve as a peak flow balance tank, but will be converted to a third CASS tank as part of the longer-term upgrade plans. This is expected to occur in 2026/2027.

(d) Removal of sludge which is then dewatered and hauled to a disposal site.

(e) Final filtration with sand filters and disinfection with sodium hypochlorite.

(f) Treated effluent is then pump approximately 12 km to the Brown Farm site where it is discharged into a large holding dam and finally irrigated to land.

(g) Longer-term capacity upgrades planned for delivery by 2026/2027 will include the addition of ultrafiltration and UV disinfection to achieve a triple barrier disinfection system which is required as part of enhancing the quality to an A-grade water quality classification. This is in alignment with future plans to send higher quality treated effluent to the adjacent Mangawhai Golf Course for irrigation use.

How much capacity is currently remaining at the WWTP ?

3.10 The existing WWTP has a designed capacity for 3,000 connections. At present there are approximately 2,764 properties connected to the treatment plant – resulting in an estimated remaining capacity for 236 further connections. KDC recently completed an optimization of the current treatment plant in preparation for near-term capacity upgrades which will be implemented in mid-2024, further improving the existing treatment plant performance and effluent quality.

How much extra capacity is to be delivered through planned upgrades?

3.11 The near-term upgrades will increase the treatment plant capacity of the WWTP from 3,000 to 3,550 connections. The near-term upgrades to achieve this will be implemented by mid-2024. This primarily consist of installing an inDENSE system, which will boost the WWTP's capacity by addressing current limits on solids handling capacity in the CASS reactors. The inDENSE system required to complete this upgrade has already been purchased and is being shipped to New Zealand now. Installation will commence in March of 2024, with commissioning and completion expected by June of 2024.

3.12 Beyond the near-term upgrades, KDC have developed plans for additional plant upgrades which includes sending treated effluent to the adjacent golf course which will increase the overall plant capacity to 5,470 connections. Use of the golf course for irrigation of treated effluent will require a resource consent. These planned upgrades are currently programmed to be implemented by 2026/2027. This planned additional capacity is more than sufficient for development proposed for both PPC83 and Mangawhai Central.

How much capacity is there in the conveyance network? Will it need a new pump station?

3.13 In terms of the capacity of the conveyance network (i.e. pipes), **attached** to my evidence as **Attachment H** is a map which shows a general schematic of how wastewater flows from the plan change area would be conveyed through KDC's network to the Mangawhai WWTP.

3.14 The existing network at the proposed point of connection along Jack Boyd Drive consists of a 150mm gravity sewer which traverses approximately 360m down to KDC Pump Station K. From Pump Station K wastewater flows are pumped approximately 2.1 km to the WWTP.

3.15 At maximum development of 380 properties, the estimated peak design wastewater flow is 18.5 l/s. This is based on KDC engineering design standards and the following key assumptions:

(a) Average of 4 people per property;

(b) Average water use per person of 210 litres per day discharged to wastewater system; and

(c) Wet weather peaking factor of 5 applied to daily average dry weather flows.

3.16 It is worth noting that the actual peak wastewater flows from the PPC83 development may be lower than estimates derived from using KDC engineering standards for the following reasons:

(a) Properties on rain tank water supplies typically use less than 210 litres per person per day based on multiple studies of systems around New Zealand.

(b) If this development were to be serviced with a pressure sewer system (grinder pump units for each home), the peak wet weather flows could be substantially lower – as wet weather peaking factors for pressure sewer systems are normally well below 5. There is much less leakage in pressure sewer systems, especially of the property connections to the grinder pump units are constructed to be watertight following quality plumbing practices.

3.17 The existing 150mm wastewater gravity sewer network to Pump Station K has insufficient capacity to convey the PPC83 peak development flows based on the standard KDC engineering design standards. Pump Station K has a tested capacity of approximately 45 litres/second, and recent modelling shows the current peak wet weather flows into the pump station at approximately 20 l/s. Based on this, Pump Station K has a remaining additional capacity of around 20 to 25 litres/second, which is sufficient for the PPC83 estimated peak wastewater flows.

3.18 As discussed in the **attached** 2022 Wastewater Servicing Strategy (**Attachment D**), KDC has developed plans to upgrade the wastewater gravity sewer along Jack Boyd Drive, and increase the pumping capacity at Pump Station K. This is discussed in more detail in the following section.

4. IS THERE SUFFICIENT EXISTING AND/OR PLANNED CAPACITY IN BOTH THE WWTP AND CONVEYANCING TO SERVICE PRIVATE PLAN CHANGE 83

WWTP Capacity

4.1 As set out in the plan change documents, full development of the plan change area is expected to yield an additional 380 connections to be serviced by the WWTP. Based on existing remaining capacity of approximately 236 connections and additional capacity for another 550 connections resulting from near term upgrades that will be completed in mid-2024, the WWTP appears to have sufficient capacity for the maximum potential property yield from this development.

4.2 In the medium term, the capacity of the MCWWS is expected to be upgraded to capacity for 5,470 connections, through the discharge of treated wastewater at the Mangawhai Golf Club (expected to be completed in 2026/2027). This will provide capacity for a further 2,700 connections in Mangawhai. This will provide significant further capacity for growth in Mangawhai and sufficient capacity to service growth from PPC83 (380 connections), development at Mangawhai Central (estimated at 1,000 connections) as well as from other future plan changes.

Conveyance Network Capacity

4.3 As noted in the Wastewater Servicing Strategy (**Attachment D**), KDC has assessed the wastewater network which will serve planned development including PPC83. This includes the areas which drain to Pump Station K, which as of 2021 serves approximately 491 connections. Growth projections to 2051 show a total of 509 new connections being developed in that time period, taking the total number of connections to Pump Station K to 1,000 (Table 3-1 from **Attachment D**). Based on the 2051 ultimate development estimates, KDC have developed upgrade plans for the gravity sewer along Jack Boyd Drive and Pump Station K as follows:

(a) Install 360m of 225mm gravity sewer along Jack Boyd Drive to Pump Station K.
(b) Upgrade pumps at Pump Station K (rising main has sufficient capacity).

4.4 In terms of servicing the estimated 380 new connections from PPC83, the upgrade of the gravity sewer along Jack Boyd Drive will be required. This upgrade can be negotiated by KDC and the PPC83 developer in terms of a funding and delivery arrangement. The upgrade of Pump Station K is likely not needed until after the PPC83 development is completed, but is a straightforward project with a low capital cost estimate of around $50K.

4.5 In summary, KDC's plans for upgrade at the wastewater treatment plant and the conveyance network appear to be well planned and will provide sufficient capacity for the development proposed by PPC83. The staging of upgrades for the WWTP reflect industry best practice for providing needed capacity in advance of planned development – without over-capitalizing and ending up with stranded capacity that isn't utilized. The same is true for the proposed network upgrades.

Are there any other solutions e.g. holding tanks on-site or private treatment systems? Or a staging rule that limits the number of households to match capacity until upgrades occur?

4.6 I now address possible alternative solutions for wastewater servicing of the plan change area, in the event that there is not sufficient capacity in the MCWWS at the time of subdivision or development.

4.7 Overall, the use of wastewater holding tanks or staging of development to address near-term capacity is likely not needed due to the current status of the wastewater treatment plant and near-term upgrades due for completion by mid-2024. Holding tanks can be used as an interim measure but are not ideal due to issues of potential septicity, odour and corrosion risk where the flows enter the public network. This can be mitigated by arranging tanker trucks to transport the stored wastewater to the treatment plant. Staging of development is a preferred means of managing capacity limits, but as stated is likely not needed.

4.8 In the alternative, the implementation of a single private community treatment plant that would service PPC83 is an option with the following key constraints:

(a) Ability to obtain a discharge consent and an acceptable treated effluent discharge pathway (e.g. direct discharge to waterway, drip irrigation, etc);
(b) Agreed plan for long-term treatment system ownership, operations, maintenance and consent compliance oversight; and
(c) Ability to supply required power to operate system.

For larger lots, what's the minimum site size required for private septic tanks – does the Northland Regional Plan set minimums?

4.9 I now briefly address regional council requirements for onsite wastewater disposal, in the event that there is not sufficient capacity in the MCWWS at the time of subdivision or development, and onsite wastewater disposal was instead provided.

4.10 The Proposed Regional Plan for Northland 2017 contains rules for discharging treated wastewater to land. It does not specify standards for minimum lot sizes. The Operative Kaipara District Plan 2013 contains standards for minimum lot sizes as regards on-site wastewater systems that apply to residential and rural subdivision as follows:

4.11 Subdivision within the Residential Zone is a Controlled Activity if it meets the following terms for a subdivision:

- Every proposed allotment has a minimum net site area of 600m2, where a connection to reticulated wastewater infrastructure is available (excluding Network Utility Allotments); or

- Every proposed allotment has a minimum net site area of 3,000m2, where no connection to reticulated wastewater infrastructure is available (excluding Network Utility Allotments).

4.12 If more than 10 lots are being created, Integrated Development subdivision is a Discretionary Activity where it complies with the following:

- Where a connection to reticulated wastewater infrastructure is available, the number of total lots obtainable shall be an average of at least 1 lot per 500m2 of the parent title in the Residential Zone, with a minimum net site area of 375m² per lot; or

- Where a connection to reticulated wastewater infrastructure is not available, the number of total lots obtainable shall be an average of at least 1 lot per 3,000m2 of the parent title in the Residential Zone, with a minimum net site area of 2,000m² per lot; or

- Where a connection to reticulated wastewater infrastructure is not available, but a private wastewater system is proposed to be established to serve all lots within the subdivision, the number of total lots obtainable shall be an average of at least 1 lot per 500m2 of the parent title (excluding area required for wastewater or access lots) in the Residential Zone, with a minimum net site area of 375m² per lot.

ATTACHMENT A

Executive Summary

Kaipara District Council (KDC) operates the sewerage assets for the Mangawhai area which includes sewerage reticulation, Community Wastewater Treatment Plant (CWWTP) and a transfer pipeline to the Lincoln Downs farm. The Lincoln Downs Farm is commonly referred to as Browns Farm.

The current CWWTP includes a cyclic activated sludge (CASS) process followed by filtration and chlorine disinfection. Sludge produced from the plant is dewatered on site.

Beca Hunter H2O was engaged to undertake a peer review of the upgrade options for the CWWTP. WSP previously had explored treatment options and recommended a membrane bioreactor (MBR) process with reuse on the nearby golf course. The MBR process was selected as it could produce a class A effluent required for unrestricted reuse.

Since this time a project team led by SCO consulting has been developing the overall upgrade strategy. The strategy has evolved with class A effluent being beneficially reused on the golf course. Excess effluent in winter or wet weather is planned to be discharge at a new location with a new resource consent and with some being directed to the current Browns Farm irrigation system. This will provide more operational flexibility in low irrigation demand and high flow periods.

A plant capacity assessment was undertaken to assess when the upgrade needed to occur. The current plants capacity will be exceeded by summer of 2024. There is a significant driver to address the capacity in the short term.

For the class A reuse option WSP restricted the review to one option. However, Class A can be provided in other processes configurations. Two alternative options were considered along with the MBR option which included:

- **CASS.** Expanding the existing CASS activated sludge process with extra CASS units to meet capacity combined with a downstream class A system including ultrafiltration, ultraviolet and chlorination disinfection.
- **Continuous**. Continuous activated sludge process with gravity clarifiers combined downstream with a downstream class A system including ultrafiltration, ultraviolet and chlorination disinfection. The current CASS reactors would be converted to continuous bioreactors.

For both the CASS and continuous options the inDense system was considered as a sub option. This system is used to improve the performance of systems which rely on gravity settling in the activated sludge reactor.

Of the two additional options CASS with in Dense was the preferred approach. It was less complex and used less energy and is more likely to meet the immediate capacity restriction in 2024. Therefore, the CASS option was assessed in more detail and its capital cost assessed independently by Alta.

WSP estimated the MBR option previously to be $34.5 M by 2026. Alta's estimate was $23.5 M by 2026 for the CASS option which represented a considerable saving. An assessment of key operating costs (power, chemicals and key replacement items) indicates the CASS option was 65% of the cost the MBR approach.

Based on a consideration of each option it was considered the CASS upgrade approach with inDense represented the most optimal approach as it:

- Reuses most of the plant infrastructure and is a well proven technology that is well known to KDC.
- Represents capital and operations cost savings.
- Does not present significant construction risk. The bioreactors structures required are already in place.
- Can be staged with progressive roll out of extra capacity and does not produce stranded assets. The CASS option is more flexible to have capacity added quicker to handle the imminent lack of capacity by 2024. The other options involve significant works which will require more time and it is likely capacity will be exceeded before the option is ready.

- Has the lowest construction commissioning risk and hence capital cost risk. There is no major change to how the process operates. The other options require significant additional recycles and process units on a small brownfield site.

Based on the operating and capital savings and other factors described above it is recommended the CASS option with inDense be adopted.

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Glossary of Terms

ADWF	Average dry weather flow
BOD	Biochemical oxygen demand over 5 days
COD	Chemical oxygen demand
DO	Dissolved oxygen
EBPR	Enhanced biological phosphorus removal
CWWTP	Community wastewater treatment plant
MLSS	Mixed Liquor Suspended Solids
NH_3-N	Ammonia as nitrogen
NO_3	Nitrate
NO_2	Nitrite
TKN	Total Kjeldahl nitrogen which is the ammonia and organic nitrogen only
TDS	Total dissolved solids
TN	Total nitrogen
TP	Total phosphorus
TSS	Total suspended solids
LRV	Log reduction value
PAO	Polyphosphate accumulating organisms
PE	Persons equivalent
PO_4-P	Phosphate as phosphorus
KDC	Kaipara District Council
NOx	Oxidised nitrogen (nitrate + nitrite) as nitrogen
SRT	Solids retention time
SVI	Sludge volume index
UV	Ultraviolet
WAS	Waste activated sludge

1 Project Overview

1.1 Background

Downer operates the Community wastewater treatment plant (CWWTP) for Kaipara District Council (KDC) which treats sewage from the towns of Mangawhai heads and Mangawhai. The treated effluent is pumped to a farm commonly referred to as Browns farm for land discharge through an irrigation system. The Mangawhai CWWTP catchment area experiences a large influx of tourists during the Christmas and New Year's period with the treatment plant beginning to exhibit symptoms of capacity exceedance during these peak tourist periods.

Previously KDC engaged WSP to conduct an options assessment to investigate the best approach to address the capacity constraints at Mangawhai CWWTP. The findings from this investigation were that the plant will reach capacity between 2025 to 2028 depending on growth. Their preferred upgrade option was to convert the cyclic activated sludge (CASS) reactors to a membrane bioreactor process (MBR) to meet the Victorian EPA guideline for water recycling. This involved conversion of the CASS reactors to continuous reactors and installation of an immersed membrane reactor.

Since this time a project team led by SCO consulting has been developing the overall upgrade strategy further. The strategy has evolved with class A effluent being beneficially reused on the golf course. However, excess effluent in winter or wet weather is planned to be discharge at a new location with a new resource consent and with some being directed to the current Browns Farm irrigation system. This will provide more operational flexibility in low irrigation demand and high flow periods.

1.2 Project Purpose

KDC have engaged Beca HunterH2O in collaboration with SCO to undertake a peer review of the WSP options assessment prior to further design development. This report will develop and compare treatment options and present the potential risks with each option. A capacity review and suggested way forward will also be presented which will be compared to the preferred option from WSP's options report.

1.3 Overview of Plant

Mangawhai is in the KDC area and the operations are managed by Downer. The operations contract consists of management of the treatment plant and the effluent discharge to Browns Farm. The treatment plant consists of the following treatment systems:

- Inlet Screening via sieve screens with capacity up to 160 L/s.
- Two CASS reactors configured as follows:
  - A hydraulically mixed selector and air mixed anoxic zone which is 22% of the volume of each CASS reactor. The third zone is a large open rectangular structure with diffused aeration installed over the entire floor area.
  - Diffused aeration and blower system to provide aeration to the anoxic (periodic) and third zone of the CASS.
  - Wasting is conducted during the settle phase via a waste pump.
  - A 4.4 m decant weir is used to decant clear effluent to the intermediate storage tank
  - Each CASS operates based on a cycle. The total cycle length is typically 4 hours consisting of 120 minutes react (aerobic), 60 minutes settle, 55 minutes decant and 5 minutes idle time prior to restarting the cycle.
- Decant storage tank that collects decanted effluent from the CASS reactors and pumps decanted effluent to the pressure filters.
- Four pressure filters with dual media with a capacity of 6.5 L/s/filter.

- Liquid chlorine is dosed into the filtered effluent to provide disinfection prior to being pumped to Browns Farm for irrigation.
- Waste sludge is collected in the sludge holding and is dewatered using a rotary drainage deck and belt filter press. The flocculant for dewatering is liquid polymer.
- A balance tank the same size as a CASS reactor.

A new balance tank and screen system has been constructed in 2022 and recently commenced commissioning in April 2023. Up to 100 L/s from the catchment is directed a new sieve screen. The balance tank is to enable the plant to periodically receive higher instantaneous flows. The balance tank is of identical dimensions to the other two CASS reactors. This tank could be readily converted to a CASS reactor if needed.

As part of Downer's operations contract there is a requirement to manage the effluent discharge at Browns Farm. This report is limited to an options assessment of the CWWTP only.

1.4 Overview of Key Issues

The catchment area for Mangawhai CWWTP experiences highly variable population loadings. During the Christmas holiday peak period the population in Mangawhai can be 3.5 times higher than then non tourist off peak period. Based on a capacity assessment conducted as part of this project, the plant's capacity will be exceeded in the summer of 2024. Exceedance of the capacity can cause the decant to draw solids into the decant storage tank and cause excessive backwashing of the filters or complete bypass.

WSP noted in their report that capacity is exceeded between 2025 to 2028 depending on growth.

1.5 Basis of Design

The section below outlines the key design basis for both influent and effluent. All options were assessed against these criteria.

1.5.1 Population and Flow Growth

In 2021 WSP undertook sewage quality testing from 20/12/21 to 16/1/22 to assess the load over the peak tourist period and to develop the design basis for the plant. This report included population projections. The population projections were prepared for the Mangawhai sewerage catchment by Formative and adopted by WSP. The projections are shown in Table 1. WSP combined this information in their basis of design report. These projections included a new care home and commercial area.

Formative and WSP developed flow projections based of connection projections using following basis:

- Off peak 1.33 PE/connection and 201 L/PE/d
- Peak tourist 4.88 PE/connection and 113 L/PE/d

The flow projections are provided in Table 1. These projections have been adopted for this options study.

Table 1 – Mangawhai Population and Flow Growth Projections by Formative

Year	Total PE		Dry Weather Flow (m³/d)		Peak Wet Weather Flow (L/s) 5 x peak dry weather flow
	Off Peak	Peak	Off Peak	Peak	
2021	3,193	11,751	813	1,333	77
2023	4,191	14,014	769	1,564	90
2028	5,597	18,032	1,045	2,051	119
2033	6,741	21,774	1,255	2,471	143
2038	7,609	24,665	1,414	2,793	162
2043	8,266	26,849	1,534	3,037	176
2048	8,662	28,170	1,607	3,184	184
2051	8,900	28,963	1,650	3,272	189
Ultimate 2051	9,164	29,777	1,695	3,362	195

1.5.2 Sewage Loads

We adopted the following sewage loading per PE to calculate the influent load over time to the CWWTP:

- Chemical oxygen demand (COD) 125 g/PE/d.
- Total Kjeldahl nitrogen (TKN) 12 g/PE/d.
- Total phosphorus (TP) 2.3 g/PE/d.
- Inorganic suspended solids (ISS) 8 g/PE/d.

These align with the values noted in the WSP basis of design report. Slightly different parameters have been used (i.e. COD and ISS and opposed to BOD and TSS) which better align with the requirements of process models. However, they are equivalent to the values WSP adopted.

There is no monitoring available to know what type of organics are present in the sewage. Therefore, typical domestic sewage values were used for the key COD and TKN fractions which are outlined below:

- Fraction of COD which is biodegradable and particulate = 0.2
- Fraction of COD which is unbiodegradable and soluble = 0.07
- Fraction of COD which is biodegradable and soluble = 0.15
- Fraction of TKN which is unbiodegradable and soluble = 0.03

1.5.3 Approach to Assessing Load Impacts over the Peak Tourist Period

To better understand the peak tourist load, Beca Hunter H2O undertook an extensive testing regime from late 2022 to early 2023. This supplemented a similar shorter review of sewage loads by WSP over 2021 to 2022. This assessment identified there is a sharp increase in load over Christmas as outlined in Table 1. However, the load is not constant and occurs for a short period and tails off in January. The results from the two sampling periods are provided in Appendix A.

The data collected to date is not comprehensive and does not cover the full tourist period. However, it provides a good basis for understanding the high load periods between Christmas and early January. To estimate the load over the whole holiday period where concentration data is not available, we have produced estimates of the concentrations for periods where data is not available. The values chosen were based on a review of available data.

While the load is high over Christmas to early January period (up to 3.5 times load increase per day), the load increase is not sustained. Activated sludge processes operate over a long solids retention time (SRT) of 15 to 20 days and short-term load increase don't often have a major impact. This presents a challenge to assess the required size of any bioreactor. Steady state modelling approaches often used in plant design will overestimate the infrastructure size as they assume the loading is constant over many SRT periods. To overcome this, we used the Biowin dynamic simulator and modelled the sludge production to enable us to size the activated sludge process. This was undertaken at an initial 20-day SRT entering the peak period. As the load increased the SRT setting was reduced to 15 days which is acceptable for ammonia removal at the higher temperatures in December and January. This modelling indicated the plant sludge inventory increase would be in the range 1.4 to 1.7 times the level prior to Christmas. The more recent and extensive sampling in 2022 to 2023 indicated the sludge increase could be much lower near 1.3 times.

All options were sized based on a sludge inventory increase in the activated sludge plant in the order 1.5 times the off-peak inventory.

It is recommended sewage sampling continue next holiday period and extend from Christmas day to the end of the holiday period (late January). This will ensure the plant is appropriately sized based a good understanding of how the peak loads are presented to the plant over time.

1.6 Effluent Quality

Mangawhai CWWTP currently has a resource consent discharge agreement with the parameters detailed in Table 2. The resource consent notes the plant shall include a granular filtration system and disinfection system. The filtration system must be designed to remove helminths.

The requirements of the consent are outlined in Table 2. The average is based on the last 6 results. The median and 90%ile is based on the last 12 results.

Table 2 – Mangawhai CWWTP Resource Consent Discharge Parameters

Parameter	Units	Median	Average	90th Percentile
Group A – Weekly Sampling				
E. coli	MPN/100 mL	10		100
Total Dissolved Solids (TDS)	mg/l		500	
Total Nitrogen (TN)	mg/l		30	
Total Phosphorous (TP)	mg/l		15	
Total Suspended Solids (TSS)	mg/l		10	
Carbonaceous Biochemical Oxygen Demand (cBOD)	mg/l		10	

1.7 Future Effluent Quality Limits

The Browns Farm irrigation fields are nearing capacity, the plan is to produce a class A effluent and reuse it on the Mangawhai Golf Club in future. Class A allows for unrestricted use of effluent. Excess effluent in wet weather or colder months may need to be discharged to the estuary with a new consent.

It is likely the nutrient levels will need to be lower than the current consent for both golf course sustainable use and estuary discharge. Estuary discharge may need to be significantly lower (i.e. < 5 mg/L TN) and require an additional treatment process at the CWWTP or processes such as artificial wetlands at the golf course prior to discharge.

We have assessed the options based on meeting an average TN of less than 10 mg/L and a degree of biological phosphorus removal (~ < 3 mg/L) as it is acceptable for irrigation. The CWWTP can be designed for a much lower median TN of 3 mg/L which is considered the limit of technology, however this presents capital cost challenges and it increases the complexity of operation.

If required additional process can be added to each plant option to improve TN and TP removal. In the case of TN this can be modifications to the MBR and continuous reactors or a bolt on Moving Bed Bioreactor (MBBR) process. Alum or iron salts can be added to the existing options to remove phosphorus in the reactors to 1 mg/L median with no impact on capacity.

It is considered to have greater community acceptance to use constructed wetlands to polish effluent if needed for discharge. If this approach is used additional processes the CWWTP will not be required.

1.7.1 Class A Requirements and Recommended Technology Approach

The project has adopted the requirements of the Victorian EPA guidelines for water recycling. This effluent reuse class allows for unrestricted reuse. The requirements are summarised in .

Table 3 – Class A Victorian Health Guidelines Effluent Quality Requirements

Requirement	Class A
E. Coli median (CFU/100 mL)	<1
BOD median(mg/L)	<10
TSS median (mg/L)	<5
pH range	6 - 9
Turbidity median (NTU)	<2
Virus Log Removal	5
Protozoa Log Removal	3.5
Bacteria Log Removal	4

A key requirement of guidelines is the whole process is to meet certain log reduction values (LRV's). LRV's are values given to each unit operation and represent the number of 10 fold reductions (i.e. 1 log = 10 times reduction and 2 log = 10 x 10 = 100 times reduction).

Three pathogens are nominated which include bacteria, protozoa and viruses. Treatment technologies remove each pathogen differently. Table 4 outlines what can be practically expected from each unit operation. The likely total LRV for two options involving membrane and granular media filtration are presented in this table.

To meet the class A LRV requirement a minimum of filtration, UV and chlorination is required. UV is required in combination with filtration and chlorination as it has an ability to easily inactive protozoa. Whereas membrane filtration and chlorination alone cannot meet the LRV for protozoa together.

Granular media filtration can struggle to achieve LRVs without significant investment in monitoring and control. LRVs can be claimed for protozoa if strict turbidity limits are met which can be hard to achieve. For example, a 2.5 log LRV for protozoa is possible with a 90%ile turbidity of < 0.3 NTU. For viruses the LRVs are typically low.

It is likely activated sludge processes with granular media filtration combined with UV and chlorination will struggle to reliably meet the class A LRV requirements. However, ultra-filtration (UF) membranes processes with either MBR or tertiary membranes, UV and chlorination will readily meet the Class A requirement. Therefore, the options in this report only considered ultrafiltration as the filtration barrier.

From our experience the capital cost of membrane versus granular media options is similar. Adopting a membrane approach provides superior LRV removal overall for a similar cost.

Table 4 – Typical LRV's for Unit Operations

Process Treatment Stage	LRV Virus	LRV Protozoa	LRV Bacteria	Comment
Bioreactor	0	0	0	Validation required to claim LRV- Likely 0.5 Bacteria.
MBR (Mixed Liquor)	1.5	2	4	MBR Can claim the listed LRV's however, can also challenge test to claim more if required.
Granular media filtration (Current Operation)	0	0	0	Requires validation testing to claim protozoa or virus LRVs
Pressure Filtration (UF)	1.5	2	4	This covers both tertiary pressure membranes.
Chlorination	4	0	4	Maximum possible claim under Victorian guidelines. This can readily be achieved with free chlorination of filtered effluent.
UV Disinfection	0.5	3.5	3.5	In line with UV dose as specified by suppliers to meet cryptosporidium removal. Higher doses can be used to target greater removal at much higher cost
Total LRVs for Process Configurations versus Class A Requirement				
MBR/Tertiary Membranes + UV+ chlorine	6	5.5	11.5	Exceeds compliance requirements
Granular Media Filter + UV + chlorine	4.5	3.5	7.5	Possible compliance issues with viruses.
Required Victorian Guideline Class A Requirement	**5.0**	**3.5**	**4**	

1.7.1 Helminth Removal

Helminths are a parasitic worm that can infect animals exposed to irrigated with effluent. Processes that can remove the helminth ova (i.e. eggs) are required by the consent and most reuse guidelines where animals graze on irrigated land. The Victorian EPA guidelines recommend 4 log removal of helminths. The consent does not specifically quote a removal value, just the filters must remove helminths.

Adoption of ultrafiltration will provide effective removal and ensure this requirement is met if reuse continues to occur at Brown's Farm.

In some options below bypass of the Class A filtration system is expected to occur in wet weather. If treated flows which bypass filtration occur and the effluent is irrigated with animal present, additional helminth barriers are recommended. For Browns Farm it is recommended 25 days (allowed in the Victorian guidelines) of pond storage be used prior to irrigation. This will mean some volume in the current dam will need to be reserved for helminth removal.

Helminth removal is not considered necessary for the golf course reuse. However, it will be achieved as the recommend class A filtration system (UF membranes) will meet the 4-log removal requirement.

2 Current Plant Capacity

A plant capacity assessment has concluded the plant will reach capacity in the Summer of 2024. The capacity is limited by how fast sludge can settle in the CASS. It needs to settle fast enough to avoid sludge being decanted. The high loading in the peak tourist period produces too high a solids concentration to allow effective settling.

Another concern is the sludge is bulking in nature. This can also slow the sludge settling rate. Bulking is measured using the sludge volume index (SVI) and has been historically high near 200 ml/g. Typically in most plants this is less than 150 ml/g. A separate plant audit report prepared by Beca HunterH2O addresses this issue and potential solutions to improve SVI.

3 Upgrade Options

3.1 Options Considered

The MBR option was the preferred option from the review of options completed by WSP. However, they only considered one class A option which was MBR. The filtration step needed for class A can be provided in other processes configurations other than MBR. Two alternative options were considered along with MBR which included continuing with the CASS approach and using the existing CASS reactors with gravity clarifiers. Both alternative options reuse most of the infrastructure onsite.

The three upgrade options that were considered included:

- **CASS.** The CASS activated sludge process (extra CASS units to meet capacity) combined downstream with ultrafiltration, UV and chlorination disinfection.
- **Continuous**. Continuous activated sludge process with gravity clarifiers combined downstream with ultrafiltration, UV and chlorination disinfection.
- **MBR**. Continuous activated sludge process with immersed membranes for activated sludge separation. This is knowns as the membrane bioreactor process (MBR). The MBR process is combined downstream with UV disinfection and chlorination disinfection.

For both the CASS and continuous options the inDense system was considered as a sub option. This system is used to improve the performance of systems which rely on gravity settling in the activated sludge reactor. The technology uses a series of hydro cyclones to select for denser floc forming bacteria. It relies on establishing biological phosphorus removal bacteria which produce denser bacteria. Overall, this process can significantly improve the sludge volume index (SVI) to values less than 90 ml/g. This ensures the sludge settles faster and increases the capacity of decant weirs or gravity clarifiers.

The inDense process is currently being trialled at Mangere WWTP and has significantly improved the SVI.

3.2 Configuration of Flows for each Option

The Class A processes (filtration, UV and chlorine) was sized for 2.5 x design peak ADWF. Note the sewage is designed to pass 5 x design peak ADWF to the plant. It has assumed the excess wet weather storm flow (above 2.5 times design peak ADWF) will receive secondary treatment follow by chlorine disinfection for CASS and continuous options only. This effluent which bypasses the Class A system will be suitable for grade B uses only such as Browns Farm or discharge.

CASS and continuous options can use either a storm cycle or solids contact bypass to treat storm flows and not change the size of the clarification system. This provides a degree of contact stabilisation with activated sludge at high flows. MBR cannot achieve this and either needs to bypass dilute sewage or provide membranes capable of treating all flows. In the case of MBR, membranes were provided for the full storm peak flow treatment.

3.2.1 CASS Option

3.2.1.1 Overview of the Option

In this option the upgrade is for continued operation of the existing CASS reactors and installation of new CASS reactors to meet capacity as detailed below in upgrade staging. The advantage of this option is that minor modifications can be made to the existing CASS reactors to increase capacity. In all options there has been a modification to increase the decant weir length from 4.4 m to 6 m to allow more process throughput. The increase in weir length increases the area of clear water zone under the weir which lowers the decant approach velocity. This enables the weir to handle more flow before sludge scouring occurs.

3.2.1.2 Staging of the CASS Upgrade

CASS options with and without inDense are presented in Table 5. The upgrade can be staged by progressively adding more CASS reactors which will provide more capacity as growth occurs. The staging is outlined below.

Table 5 – Staged Upgrade Capacities for the CASS Option

CASS		CASS with inDense	
Number of CASS Units	**Provides Capacity to**	**Number of CASS Units**	**Provides Capacity to**
2x CASS units (Current Operation)	2024 (2921 connections)	2x CASS units	2028 (3550 connections)
3x CASS Units + additional Sludge Balance Tank	2042 (5132 connections)	3x CASS Units + additional Sludge Balance Tank	2047 (5464 connections)
4xCASS Units	Ultimate (5672 connections)		

Conversion of the existing balance tank onsite to an extra CASS reactor will almost meet the ultimate capacity with inDense. This is a significant advantage for this option as it considerably reduces the construction of new major infrastructure on site.

Beca Hunter H2O’s calculations agree with those presented in WSP’s report of requiring four CASS reactors for 5000 connections. However, our modification of increasing the weir length will mean that three CASS units will meet 5000 connection capacity and 4 will meet the ultimate capacity at 2052.

Presented below are the staging steps for both CASS and CASS with inDense.

CASS Staging with inDense

If inDense is implemented the following upgrades are required in the following times:

1. Refurbish the existing CASS decant weirs to increase the length and implement inDense by the end of 2024.
2. Retrofit the existing balance tank as an extra CASS system and add the class A system (UF + UV+ chlorination) and construct the golf course pump station by 2028.
3. Construct a new CASS reactor by 2047.

CASS Only Staging

For CASS only the following upgrades are required in the following times:.

1. Refurbish the existing CASS decant weirs to increase the length and retrofit the existing balance tank as a new CASS reactor by the end of 2024.
2. Add the class A system (UF + UV+ chlorination) and construct the golf course pump station by 2028.
3. Construct a new CASS reactor by 2042.

The staging and site footprint requirements for this upgrade are presented below in Figure 1.

Figure 1 – CASS Staging and Footprint Diagram

3.2.2 Continuous Option

In this option the operating level of the CASS reactors will be set at the current top water and a fixed weir established. The internals of the reactor will be modified, and the size of the unaerated zone extended. The aerobic part of the reactor would aerate continuously, and mixed liquor would flow over the fixed weir to settle and separate in two new circular clarifiers. This option requires construction of 2x 20 m diameter clarifiers to separate solids. Return activated sludge (RAS) from the clarifiers will be pumped back and evenly split to each bioreactor.

It is proposed to operate this process in solids contact mode in wet weather. This involves bypassing flows above 3 times peak average design flow to a flocculation zone with sludge post the reactor and then through the clarifiers. This approach provides effective storm treatment of high flows up to 5 x peak average design flow.

Like the CASS option this option would benefit from implementation of inDense with a reduction in clarifier size from 20 to 17 m diameter being the major impact. The upgrade stages are presented below in Table 6.

Table 6 – Staged Upgrade Capacities for the Continuous Option

Continuous (Clarifiers) 2 x 20 m diameter		Continuous (Clarifiers) inDense 2 x 17 m diameter	
Number of CASS units converted to bioreactors	**Provides Capacity to**	**Number of CASS units converted to bioreactors**	**Provides Capacity to**
2x CASS unit converted reactors and 2x 20 m Clarifiers	2039 (4874 connections)	3x CASS unit converted reactors and 2x 17 m clarifiers	Ultimate (5672 connections)
3x CASS unit converted reactors and 2x 20 m Clarifiers	Ultimate (5672 connections)		

This new option presented in Table 6 provides an opportunity to convert the current intermittent process to a continuous process reuse. The advantage of this option is no further signification bioreactor construction is needed as the balance tank can be converted to a reactor.

There is the option of constructing two smaller clarifiers now (2 x 16.3 m diameter) to further stage construction at the initial stage (i.e. 2 CASS reactor and 2 clarifiers). However, this brings forward the final upgrade significantly from 2039 to 2033 for only a minor change in clarifier size.

For this option two clarifiers required for the ultimate capacity need to be constructed at the start of the construction period. This would need to occur to promptly given the current plant’s capacity is likely to be exceeded in 2024.

To deliver this option, the following stages are recommended:

1. Convert the existing balance tank as a new CASS reactor to allow for the existing CASS reactors to be converted. Refurbish the existing CASS decant weirs to increase the length.
1. Construct the clarifiers (as soon as practical).
2. Convert the existing CASS reactors to continuous reactors.
3. Add the class A system (UF + UV+ chlorination) and construct the golf course pump station by 2028.

The key disadvantage of this option compared to the CASS option is conversion of the current balance tank to a CASS reactor is required to provide capacity to construct the option. Later this CASS reactor will be redundant and be converted to a continuous reactor.

The staging and site footprint requirements for this upgrade are presented below in Figure 2.

Figure 2 – Continuous Staging and Site Footprint diagram

3.2.3 MBR

The supplier Du Pont worked Beca HunterH2O to develop a membrane solution for this option. The WSP options report showed the membrane system schematically, however no sizing information was provided. For this option to fully explore the complexity we sized the membrane trains with the supplier to enable us to position it on the site.

The MBR is very similar to the continuous option with the same bioreactor configuration used. The key differences are as follows:

- Finer screening to less than 2 mm is required included the need for grit removal prior to the bioreactor. A high level of redundancy of screening is required with a minimum of two screen recommended. Note only one is installed currently. This is a key warranty requirement for immersed membranes. They are subject to fouling and damage from screenings and grit that pass the inlet works.
- A much higher internal RAS flow is needed clear the immersed membranes of mixed liquor. The RAS needs to operate near 3 compared to 1 times inflow for the continuous process with clarifiers. This adds to the complexity of this option as a high flow return stream needs to be fed through a brownfield site to the current CASS structures.
- Separate to the current CASS reactor a smaller separate set of train reactor tanks needs to be constructed to house the immersed membranes. These trains need to be elevated above the current CASS reactor to ensure the trains do not overtop if the RAS pumping system fails.
- Six trains 5.1 m long by 4.1 m wide and 2.45 m deep are required for the ultimate capacity.
- A full standby generator is recommended to power the inlet works, bioreactor and membranes. This is recommended as the MBR processes will not fail safe hydraulicly on power failure and the reactor can overtop.

Six MBR trains are required to provide flow turndown from peak flow (5 x peak tourist ADWF) to current minimum diurnal flow.

The bioreactor will be converted to a continuous reactor in a similar way to the continuous option with constant aeration. With MBR only two CASS reactors are required for the ultimate capacity. However, the existing balance tank will need to be converted to a bioreactor to enable it to be run as a MBR process so one other CASS reactor can be converted. The third CASS will not be required, however could function as a balance tank, or be converted to a bioreactor to provide further redundancy in future.

There is the potential to stage the membrane trains. Only 5 trains with membrane internals are required initially for loads up to 2038. With a further 6th train required after 2038. However, it is recommended the civil structure for the whole 6 trains be provided now. It will be very difficult to construct a separate small train in 2038 and integrate it with the plant.

A key challenge with the MBR trains is they will be position above the current bioreactors which are several meters above the ground. The floor of the MBR trains would be above the current ground level and require a raised structure with the floor some meters above ground level. This will present construction challenges.

In summary an MBR process while using much of the current infrastructure will require a major investment with most of the ultimate capacity required to be constructed now.

To deliver the MBR option the following upgrade staging is recommended.

1. Build the MBR trains, RAS, clean in place chemical dosing and new inlet works with fine screens and grit removal.
2. Convert the existing balance tank to a bioreactor for operation with the MBR trains.
3. Run on one bioreactor with the MBR and shut down both CASS reactors. Operations on one bioreactor is only recommended for the non-tourist period.
4. Convert on of the two CASS reactor to a bioreactor and connect it to the MBR process.
5. Add the class A system (UV+ chlorination) and construct the golf course pump station by 2028.

The staging and site footprint requirements for this upgrade are presented below in Figure 3.

Figure 3– MBR Staging and Site Footprint Diagram

3.3 Operations Cost Comparison

Key operating costs for each option (power, chemicals and limited maintenance items) have been developed to compare options. A summary is provided in .

Table 7 – Comparable Costs for Upgrade Options for Mangawhai CWWTP at 2033

		CASS	Continuous	MBR
OPEX Class A	Power ($0.2/kWh)	$118K/yr	$146K/yr	$159K/yr
	Chemicals (Disinfection and clean in place)	$24K/yr	$24K/yr	$33K/yr
	Maintenance and Replacements (Membranes, Diffusers, UV Lamp replacement)	$53K/yr	$54K/yr	$117K/yr
	Total	**$195K/yr**	**$223K/yr**	**$309K/yr**

The lowest operating cost is the CASS process. This is driven by the activated sludge process which has low energy use compared to the other two options which require more recycle pumping and other items in the case of MBR.

The MBR process represent the highest operating cost. This cost difference is due to the need to air scour the membrane trains and provide additional chemical cleaning. The clean in place requirements are higher for MBR then the UF membranes used for the other options. More chemical is required to be dosed into the larger volumetric trains of the MBR process.

All membranes have a finite life in the order of 10 years for all options considered. However, up to four times more membrane area is required for MBR due to its lower design flux need to treat all flows. Therefore, over a 10-year period the membrane replacement cost will be higher. This is reflected in the higher annualise maintenance cost below.

3.4 Recommended Approach and Capital Cost

Based on a consideration of each option and operations costs it was considered the CASS upgrade approach with inDense represented the most optimal approach as it:

- Reuses most of the plant infrastructure and is a well proven technology that is well known to KDC.
- Represents the lowest operations costs.
- Does not present significant construction risk. The bioreactors structures required are already in place. The balance tank has been designed with identical dimensions to the other CASS units.
- Can be staged with progressive roll out of extra capacity and does not produce stranded assets. The CASS option is more flexible to have capacity added quicker to handle the imminent lack of capacity by 2024. The other options involve significant works which will require more time and it is likely capacity will be exceeded before the option is ready.
- Has the lowest construction commissioning risk and hence capital cost risk. There is no major change to how the process operates. The other options require significant additional recycles and process units on a small brownfield site.

WSP estimated the MBR option previously to be $34.5 M by 2026. Alta was engaged by KDC to assess the cost of the CASS option. Their estimate was $23.5 M by 2026 which represented a considerable saving.

Based on the operating and capital savings and other factors described above it is recommended the CASS option with inDense be adopted.

4 Summary and Recommendations

Beca Hunter H2O was engaged to undertake a peer review of the upgrade options for the Mangawhai CWWTP. WSP previously had explored treatment options and recommended an MBR process, production of a class A effluent and reuse on the local golf course.

Since this time a project team led by SCO consulting has been developing the overall upgrade strategy further. The strategy has evolved with class A effluent being beneficially reused on the golf course. Excess effluent in winter or wet weather is planned to be discharge at a new location with a new resource consent and with some being directed to the current Browns Farm irrigation system. This will provide more operational flexibility in low irrigation demand and high flow periods.

A plant capacity assessment was undertaken to assess when the upgrade needed to occur. The current plants capacity will be exceeded by summer of 2024. There is a significant driver to address the capacity in the short term.

For the Class A reuse option WSP restricted the review to one option. However, Class A can be provided in other processes configurations. Two alternative options were considered along with MBR option which included:

- **CASS.** Expanding the existing CASS activated sludge process with extra CASS units combined with downstream ultrafiltration, UV and chlorination disinfection.
- **Continuous**. Continuous activated sludge process with gravity clarifiers combined downstream with ultrafiltration, UV and chlorination disinfection. The current CASS reactors would be converted to continuous bioreactors.

For both the CASS and continuous options the inDense system was considered as a sub option. This system is used to improve the performance of systems which rely on gravity settling in the activated sludge reactor.

Of the two additional options CASS with inDense was the preferred approach. It was less complex and used less energy and is more likely to meet the immediate capacity restriction in 2024. Therefore, the CASS option was assessed in more detail and its capital cost assessed independently by Alta.

WSP estimated the MBR option previously to be $34.5 M by 2026. Alta's estimate was $23.5 M by 2026 for the CASS option which represented a considerable saving. An assessment of key operating costs (power, chemicals and key replacement items) indicates the CASS option was 65% of the cost the MBR approach.

Based on a consideration of each option the CASS upgrade approach with inDense represented the most optimal approach as it:

- Reuses most of the plant infrastructure and is a well prove technology that is well known to KDC.
- Represents the lowest capital and operations cost.
- Does not present significant construction risk. The bioreactor structures required are already in place.
- Can be staged with progressive roll out of extra capacity and does not produce stranded assets. The CASS option is more flexible to have capacity added quicker to handle the imminent lack of capacity by 2024. The other options involve significant works which will require more time and it is likely capacity will be exceeded before the option is ready.
- Has the lowest construction commissioning risk and hence capital cost risk. There is no major change to how the process operates. The other options require significant additional recycles and process units on a small brownfield site.

Based on the operating and capital savings and other factors described above it is recommended the CASS option with inDense be adopted.

It is recommended sewage sampling continue next holiday period and extend from Christmas day to the end of the holiday period (late January). This will ensure the plant is appropriately sized based on a good understanding of how the peak loads are presented to the plant over time.

5 References

EPA Victoria, Victorian guideline for water recycling, Mary 2021

WSP, Mangawhai Community Wastewater Treatment Plant: Future Options Development, 2019

WSP, Mangawhai Community Wastewater Treatment Plant Growth Strategy: Basis of Design for Wastewater Treatment and Disposal, August 2022

Appendix A. Peak Period Sampling Results

WSP Sampling over 2021-2022 Christmas Period

Date	Flow	Rain'	Concentration (mg/l)						
	(m_3/d)	Mm/d	BOD	COD	TSS	NH_3	TKN	DRP	TP
20/12/2021	803	0	250	640	247	59.2	74	6.9	10
29/12/2021	1,274	1	550	1,400	628	85.5	116	9.4	13
1/01/2022	1,391	0	510	1,400	645	86	110	10	13
5/01/2022	1,079	0	530	1,600	667	87.3	116	9.4	14
12/01/2022	867	0	230	780	378	62.4	83.3	7.4	13
17/01/2022	777	0	400	1,200	475	75.8	96.2	8.7	13
24/01/2022	680	4.04	260	590	135	87.6	101	9.7	12
1/02/2022	670	3.535	270	970	300	78.5	92.1	8.4	11
14/02/2022	663	0		860	281	71.7	93.9	8	12
16/02/2022	618	0	310	1,300	500	47.5	74.7	12	19

Beca Hunter H2O sampling over the 2022-2023 Christmas Period

Date	Flow	Rain	Concentration (mg/L)					
	m3/d	mm/d	cBOD	COD	TSS	NH3	TKN	TP
22/12/2022	810	0	200	570	142	57.6	74.2	9.04
23/12/2022	869	0	170	530	163	57.7	76.8	10.9
24/12/2022	982	0	210	630	169	61.4	82.9	10
25/12/2022	950	0	180	460	127	65.6	73.2	9.8
26/12/2022	1054	0	210	490	169	76	83.9	10.8
27/12/2022	1159	0	200	540	154	74.9	82.8	10.6
28/12/2022	1238	0	200	670	186	79.4	89.9	12.4
29/12/2022	1264	0	660	1600	700	104	135	19.6
30/12/2022	1368	0	310	940	621	46.4	82.6	12.5
31/12/2022	1421	0	180	650	155	70	75.2	10.7
1/01/2023	1319	0	200	590	169	78	79.3	10.3
2/01/2023	1232	0	510	1100	484	78.6	89.7	12.4
3/01/2023	1160	0	340	760	354	70.9	89.1	10.1
4/01/2023	1090	33	370	830	435	62.8	92.2	11.9

ATTACHMENT B

Mangawhai Wastewater Scheme Briefing – September 2023 Update

Meeting: Council Briefing
Date of meeting: 6 September 2023
Reporting officer: Anin Nama, General Manager Infrastructure Services

Purpose | Ngā whāinga

To update Elected Members on the progress of the Mangawhai Wastewater Scheme since the last briefing in April 2023.

Context | Horopaki

The original Mangawhai Community Wastewater Scheme (MWWS), Master Plan Strategy was presented to Council in February 2022. Shortly after the briefing, the Mangawhai Advisory Group (MAG) was established to provide advice on further refinement of the strategy. The main purpose of the MAG was to identify viable solutions for the overall scheme in response to the growth and management of the wet weather flows experienced across Mangawhai. The Master Plan Strategy was also presented to Council at their briefing in December 2022.

The strategy identified that an investment of circa $90.5M was required over the next 10 years. Given the significant investment, staff commissioned an independent peer review to assess the master plan and conducted a value engineering assessment. The peer review has been conducted by leading experts in wastewater treatment and effluent reuse from Australia and New Zealand who have completed similar treatment system upgrades like the one proposed for Mangawhai and were successfully commissioned.

The team has been asked to confirm the lowest cost pathway for transitioning the MWWS to meet capacity for growth and enhancement of effluent quality for recycled water use at the Mangawhai Golf Course (Course). The peer review identified alternative upgrades that allow for near-term capacity upgrades with an overall capital cost savings of approximately $20M. This upgrade also minimises construction and operational risk in transitioning the treatment plant to produce class A effluent quality suitable subsurface irrigation.

The Mangawhai wastewater upgrade solutions were presented at the Council briefing on 5 April 2023. The solutions are:

- Stage 1:
  - Optimise the treatment plant
  - Design inDENSE system
  - Implement the inDENSE system

- Stage 2:
  - Design upgrades of the inlet screen, convert the balance tank to a third cyclic activated sludge system (CASS) biological reactor unit and the second inDENSE system
  - Design the ultra-filtration system with UV disinfection system
  - Resource Consent application for the subsurface irrigation
  - Resource Consent application for Brown Road farm

- Stage 3:
  - Golf Course subsurface irrigation
  - Brown Road Farm irrigation optimisation

At the September Council meeting, approval will be sought for the design and implementation of the stage 1 works and the design of stages 2 and 3.

Discussion | Ngā kōrerorero

The following items provide an update on the progress from the last Council briefing, including investigations, ongoing work to optimise the treatment plant, ensuring capacity for growth, resolving the effluent pond structural integrity, and managing the odour issues at the Brown Road Farm effluent irrigation system.

Growth projections and available capacity

The existing Mangawhai Wastewater Treatment Plant (WWTP) has a design capacity for 3,000 connections (residential equivalent). To date, approximately 2,764 connections are served by the WWTP, with the plant reaching capacity by mid to late 2024.

Optimisation and staged WWTP upgrades

Stage 1 works have commenced with the technical team identifying operational issues impacting the performance of the plant. Over the last three weeks, the technical team has managed to resolve these issues by optimising the plant's performance and removing the stress points. The next phase is to design and implement the inDENSE system, increasing the plant's capacity to 3,550 connections. The system allows the plant to tolerate higher flows and loads without compromising the plant's performance. The same technology is being used successfully by Watercare at their Mangere and Warkworth treatment plants. The design is planned to commence in September 2023, with construction planned for early 2024. Technical staff from Watercare are providing advice on the inDENSE system.

It is proposed that the design works (to shovel ready) commence on the stage 2 works for upgrading the inlet works, converting the balance tank to a third CASS biological reactor unit, installing the second inDENSE systems and the ultra-filtration system with UV disinfection system to produce class A effluent. The construction of the works will be delivered by Wai Tāmaki ki Te Hiku (Entity A). The upgrade will bring the capacity to 5,470 connections estimated to be sufficient to cater for growth through to 2047.

Disposal Brown Road Farm

The existing Brown Road Farm will reach capacity by 2026. In addition, there have been several operational issues with the pond with residents complaining of hydrogen sulphide odour and alleged health problems due to the presence of the odour. Given this, the matter has been referred to the Public Health Medicine Specialist/ Medical Officer of Health from Ngā Tai Ora - Public Health Northland. We will update Council and continue to update residents as more information becomes available.

The pond is currently being drained under emergency works. This process has included extensive consultation, monitoring, and sampling to assess the environmental impacts on the stream where the treated wastewater is being discharged. As the pond is being drained, it has become apparent the pond liner is leaking and affecting the structural integrity of the pond. The pond will be fully drained by the end of August and repairs will commence in September 2023.

In the future, the Brown Road Farm irrigation system will be reduced, and the current spraying operation will be replaced with either a wetland system or subsurface irrigation. The long-term treated effluent disposal options will include both the Brown Road Farm and the Golf Course.

Mangawhai Golf Course subsurface irrigation

It is proposed from 2026 the treated wastewater is directed to parts of the Golf Course using subsurface irrigation. Currently, several boreholes and groundwater monitoring probes have been installed and will be monitored over the next 12 months. It is proposed that the design works (to shovel ready) commence on the subsurface irrigation system. The construction of the works will be delivered by Wai Tāmaki ki Te Hiku (Entity A).

KAIPARA DISTRICT

Network upgrades

As growth occurs, new pipelines and pump stations or upgrades will be required over the next 10 - 30 years.

Project estimate

The table below sets the estimated cost for the Mangawhai Wastewater Scheme.

Stage 1 - Mangawhai WWTP near term capacity upgrades		
Element	**Description**	**Estimated Cost (P95)**
inDENSE design & implementation	Construction and commissioning of the inDENSE system	$735,000
Sub Total		**$735,000**
Stage 2 - Mangawhai WWTP Long-term capacity upgrades plus Class A enhancement		
Element	**Description**	**Estimated Cost (P95)**
Design & implementation of Stage 2 upgrades	Design of balance tank conversion to 3rd CASS unit with inDENSE, and Class A system	$21,725,000
Sub Total		**$21,725,000**
Stage 3 - Browns Farm and Golf Course effluent irrigation systems		
Element	**Description**	**Estimated Cost (P95)**
Concept design and consent plan development	Concept design of golf course and Browns Farm (enhancement) irrigation systems	
Consent application and consultation	Consultation and consenting for golf course and enhanced Browns Farm systems	
Detailed design	Detailed design of golf course and Browns Farm systems	
Implementation	Construction and commissioning of golf course and Browns Farm systems	
Design & implementation of Stage 3 upgrades		$24,450,000
Sub Total		**$24,450,000**
Network Upgrades		
Network Upgrades		**Estimated Cost (P95)**
Sub Total		**$25,000,000**
Total		**$71,910,000**

Project implementation

It is proposed that stage 1 implementation works will be delivered by June 2024. The remaining stages 2 and 3 will be transferred to Wai Tāmaki ki Te Hiku (Entity A) to deliver.

Next steps | E whaiake nei

The following next steps are envisaged:

1. Seek Council approval at the September 2023 meeting for the technical team to design and implement the stage 1 works and the design of stages 2 and 3.

2. Complete ongoing optimisation of the Mangawhai Wastewater Treatment Plant by the end of September 2023.

3. Complete the repairs of the Brown Road Farm’s effluent irrigation dam.

ATTACHMENT C

5.2 Mangawhai Wastewater Scheme Stage 1 and 2 Approval – October 2023

Moved: Cr Howard
Seconded: Cr Lambeth

That the Kaipara District Council:

a) Approves stages 1 and 2 for the Mangawhai Wastewater Scheme Project, including the suppliers and individual estimated contract values as listed in Attachment J (provided in full in the public excluded agenda), for a total sum of up to $1.705m (Excluding GST).

b) Notes that the funding for this project has been set aside in the 2021/31 Long Term Plan and 2023/24 Annual Plan.

c) Delegates to the Chief Executive the authority to approve the procurement plan, the professional services agreement with the consortia, and the purchase agreement with World Water Works Inc for the inDENSE system and the installation of the inDENSE by Bellcon Ltd.

Carried

ATTACHMENT D

Project Number: 1-14129.33

Mangawhai Wastewater Modelling

Wastewater Servicing Strategy

16 December 2022

CONFIDENTIAL

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Document Details:

Date: 16 December 2022
Reference: 1-14129.33
Status: Final

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Charlotte Mills
Principal Engineer

Approved for release by

Richard Pearson
Senior Civil Engineer

Document History and Status

Revision	Date	Author	Reviewed by	Approved by	Status
1	21/05/2022	Mark de Lange	Charlotte Mills	Alastair King	Final
2	4/10/2022	Mark de Lange	Charlotte Mills	Richard Pearson	Draft
3	16/12/2022	Mark de Lange	Charlotte Mills	Richard Pearson	Final

Revision Details

Revision	Details
1	Assessment of future development areas
2	Ultimate growth system performance assessment sections added
3	Upgrades phasing poster added as Appendix D

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Acronyms and Definitions

Term	Definition	Context for this Project
ADWF	Average Dry Weather Flow	
ARI	Average Recurrence Interval	Estimate of the average period in years between the occurrences of a flood or rainfall event.
GIS	Geographic Information System	Data format of geospatial information input to modelling
High DWF Profile	High Dry Weather Flow Wastewater Profile	Calibrated dry weather wastewater discharge profile corresponding to peak summertime population.
Low DWF Profile	High Dry Weather Flow Wastewater Profile	Calibrated dry weather wastewater discharge profile corresponding to the permanent population.
ICM	Integrated Catchment Modelling	The modelling software used for this project (InfoWorks ICM)
LiDAR	Light Detection and Ranging	Remote sensing method used to develop ground surface used in modelling.
PDWF	Peak Dry Weather Flow	Measure of peak daily flow in the wastewater network.
PWWF	Peak Wet Weather Flow	Measure of peak flows in the wastewater network as a result of rainfall ingress.
MCWS	Mangawhai Community Wastewater Scheme	Common scheme name
CWWTP	Mangawhai Community Wastewater Treatment Plant	Common wastewater treatment plant name
NZTM	New Zealand Transverse Mercator 2000	Model coordinate system.
WWTP	Wastewater treatment plant	Treatment facility for all wastewater conveyed by the MCWS.

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Disclaimers and Limitations

This report ('**Report**') has been prepared by WSP exclusively for Kaipara District Council ('**Client**') in relation to the wastewater servicing strategy for Mangawhai ('**Purpose**') and in accordance with the Offer of Service dated 18 March 2022. The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

In preparing the Report, WSP has relied upon data, surveys, analyses, designs, plans and other information ('**Client Data'**) provided by or on behalf of the Client. Except as otherwise stated in the Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable in relation to incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

1 Executive Summary

WSP were engaged by Kaipara District Council (KDC) to apply the hydraulic model of the Mangawhai Community Wastewater Scheme (MCWS or the scheme) for use in planning network upgrades to accommodate growth.

Assessment of Development Areas

As a first stage of this assessment, WSP conducted a detailed review of projected future connections to the MCWS as provided by Formative. This involved sub-diving future growth areas and loading them to the appropriate gravity sewers and pump stations.

Ultimate Growth System Performance Assessment

After sub-diving the growth areas, three ultimate growth scenarios for the year 2051 were defined in the in the model and system performance assessment was completed for each. Three scenarios were used as a both to assess the system under a range of flow scenarios and to choose the scenario that best aligned with design flows used in design of the CCWWTP .

The three growth scenarios assessed included the following:

- **No Reticulated Water:** 2051 flows based on current per capita wastewater discharges.
- **Reticulated Water for New Development:** 2051 flows based on current per capita wastewater discharges for existing development and as per KDC's Engineering Design Standards for new growth.
- **Catchment-Wide Reticulated Water:** 2051 flows as per KDC's Engineering Design Standards for all properties.

A summary of modelled network performance for the three ultimate growth scenarios assessed is presented in Table 1-1.

Table 1-1: Summary of System Performance for Ultimate Growth Scenarios

Scenario	Scenario 1 (Low Flow)	Scenario 2 (Medium Flow)	Scenario 3 (High Flow)
DWF Volume to CWWTP (m^3 per day)	2,850	4,000	5,190
WWF Volume to CWWTP (m^3)	4,150	5,900	7,100
WWF Network Spill Volume (m^3)	26	292	596
Network Deficiencies			
Campbell Park Youth Camp Gravity Surcharge (PS-F catchment)	160 m of surcharge with 19 m^3 spill	160 m of surcharge with 22 m^3 spill	160 m of surcharge with 39 m^3 spill
Jack Body Drive Gravity Surcharge (PS-K catchment)	70 m of surcharge, peak surcharge level within 0.5 m of surface	240 m of surcharge, peak surcharge level within 0.5 m of surface	240 m of surcharge, peak surcharge level within 0.1 m of surface

Scenario	Scenario 1 (Low Flow)	Scenario 2 (Medium Flow)	Scenario 3 (High Flow)
Seabreeze Road Gravity Surcharge (PS-C catchment)	210 m of surcharge, peak surcharge level > 1 m from surface	210 m of surcharge, peak surcharge level > 1 m from surface	290 m of surcharge, peak surcharge level > 1 m from surface
Pump Station Deficiencies			
No. of Pump Stations Under Capacity at PWWF	7	6	8
No. of Pump Stations Under Capacity Resulting in Overflows at PWWF	1	2	3

Scenario 2 was carried forward into upgrade optioneering. The medium flow scenario was selected as it best aligns with peak inflows to the wastewater treatment plant described in the *Mangawhai CCWWTP Growth Strategy: Basis of Design for Wastewater Treatment and Disposal* (WSP 2022).

Development of Network Upgrades and Cost Estimates

Network upgrades were developed for ultimate growth (Scenario 2) and interim growth models were developed to determine the phasing of each upgrade. Table 1-2 presents a summary of network upgrades, including phasing, priority and a 95th percentile cost estimate.

An upgrade priority has been assigned to each project. Priority rankings are defined as follows:

- **High** – Upgrade resolves a network deficiency that is predicted to result in network overflows or there is no existing reticulation to connect to.
- **Medium** – Upgrade resolves a network deficiency that is predicted to result in surcharge of the gravity network, with the maximum water level within 0.5 m of the ground surface.
- **Low** – Upgrade resolves a network deficiency that is predicted to result in surcharge of the gravity network, with the maximum water level greater than 0.5 m of the ground surface.

'Class 5' cost estimates have been developed for each option. These options include a 100% contingency (95th percentile estimate with an accuracy of -50% to + 100%) and are sufficient for long-term budgeting.

Table 1-2: Summary of MCWS Upgrades and Cost Estimates

Growth Phase	Upgrade	Details	Cost Estimate (95%ile, 2022 NZ Dollars)	Upgrade Priority
2021-2023	Upgrade gravity network through Campbell Park Youth Camp	170 m of 225 PVC pipe and 2 new manholes	$600,000	High

Growth Phase	Upgrade	Details	Cost Estimate (95%ile, 2022 NZ Dollars)	Upgrade Priority
	Upgrade gravity network on Seabreeze Road	310 m of 225 PVC pipe and 4 new manholes	$1,100,000	Low
	Upgrade gravity network on Jack Boyd Drive	360 m of 225 PVC pipe and 8 new manholes	$1,300,000	Low
	Construct New Pumping Station to Service Mangawhai Central (PS-VD)	**Phase 1:** Construct new pumping station (25 L/s) and emergency storage tank (475 m^3) Construct new rising main connecting to existing PS-VA rising main (assumed 600 m of DN250 PE100, SDR 16)	$6,800,000	High
	Diversion of PS-K direct to CWWTP	Construct DN 250 pipeline from existing PS-K rising main direct to CWWTP	$900,000	Ongoing project
2023-2028	Upgrade PS-OF and rising main	**Phase 1:** Upgrade pumps for interim capacity (140 L/s)	$1,000,000	High
2028-2033	Upgrade PS-VC and rising main (Required capacity = 16 L/s)	Construct new pumping station and emergency storage tank (150m^3) Confirm if electrics require upgrade Upgrade rising main: 125 m of DN140 PE pipe (PE100, PN 16)	$2,200,000	High
	Upgrade PS-VA and most upstream section of rising main (Required capacity = 60 L/s)	Instal new duty/ standby pumps Upgrade most upstream section (DN 150) of rising main: 990m of 200mm PVC pipe (PN16) Confirm if electrics require upgrade	$4,600,000	High
	Upgrade of Pumps at PS-K (Required capacity = 45 L/s)	Instal new duty/ standby pumps	$50,000	Low
	Upgrade rising main from PS-VD connection to PS-	Upgrade rising main from PS-VD connection to PS-	$4,290,000	Medium

Growth Phase	Upgrade	Details	Cost Estimate (95%ile, 2022 NZ Dollars)	Upgrade Priority
2033-2038	OF with 1100m of 300mm PVC (PN16)	OF with 1100m of 300mm PVC (PN16)		
	Construct New Pumping Station to Service Mangawhai Central (PS-VD)	**Phase 2:** Upgrade pumps for ultimate flow (55 L/s)	$520,000	High
	Upgrade PS-OF and rising main	**Phase 2:** Upgrade pumping station and rising main for ultimate capacity (170 L/s)	$6,200,000	High

2 Introduction

WSP recently built and calibrated a hydraulic model of the Mangawhai Community Wastewater Scheme (MCWS or the scheme) which was then applied to complete a compressive system performance assessment. Details of all previous modelling work completed by WSP are contained in the *Mangawhai Model Build, Calibration and System Performance* report (WSP 2022).

This current report provides details of modelling work completed to aid in network planning to accommodate future development in Mangawhai. Documents that have been reviewed in completing this work include the following:

- Mangawhai Wastewater Network Dwelling: Projections Methodology Technical Report (Formative 2022), see Appendix C.
- Mangawhai Community Wastewater System: Master Plan Strategy (WSP 2021)
- Kaipara District Council's Engineering Standards (KDC 2011).
- Proposed Old Waipu Road Development Wastewater Capacity Assessment memorandum (WSP 2021)

2.1 Network Overview

The MCWS provides servicing to approximately 2,100 primarily residential properties. There are two major catchments within the network; Mangawhai Heads and Mangawhai Village.

The majority of wastewater generated within the catchment is conveyed to the Mangawhai Community Wastewater Treatment Plant (CCWWTP) located on Thelma Road. Local reticulation throughout the scheme is a combination of pressure grinder pump systems, gravity network and small pumping stations. All pressure sewer CCWWTP ultimately discharge to the gravity network through which flows are conveyed to the CWWTP by gravity and the 13 larger pumping stations throughout the scheme.

Figure 2-1 presents an overview of the MCWS, including the locations of key pumping stations, rising mains and the CCWWTP. Figure 2-2 presents a schematic of the connectivity of the pumping stations.

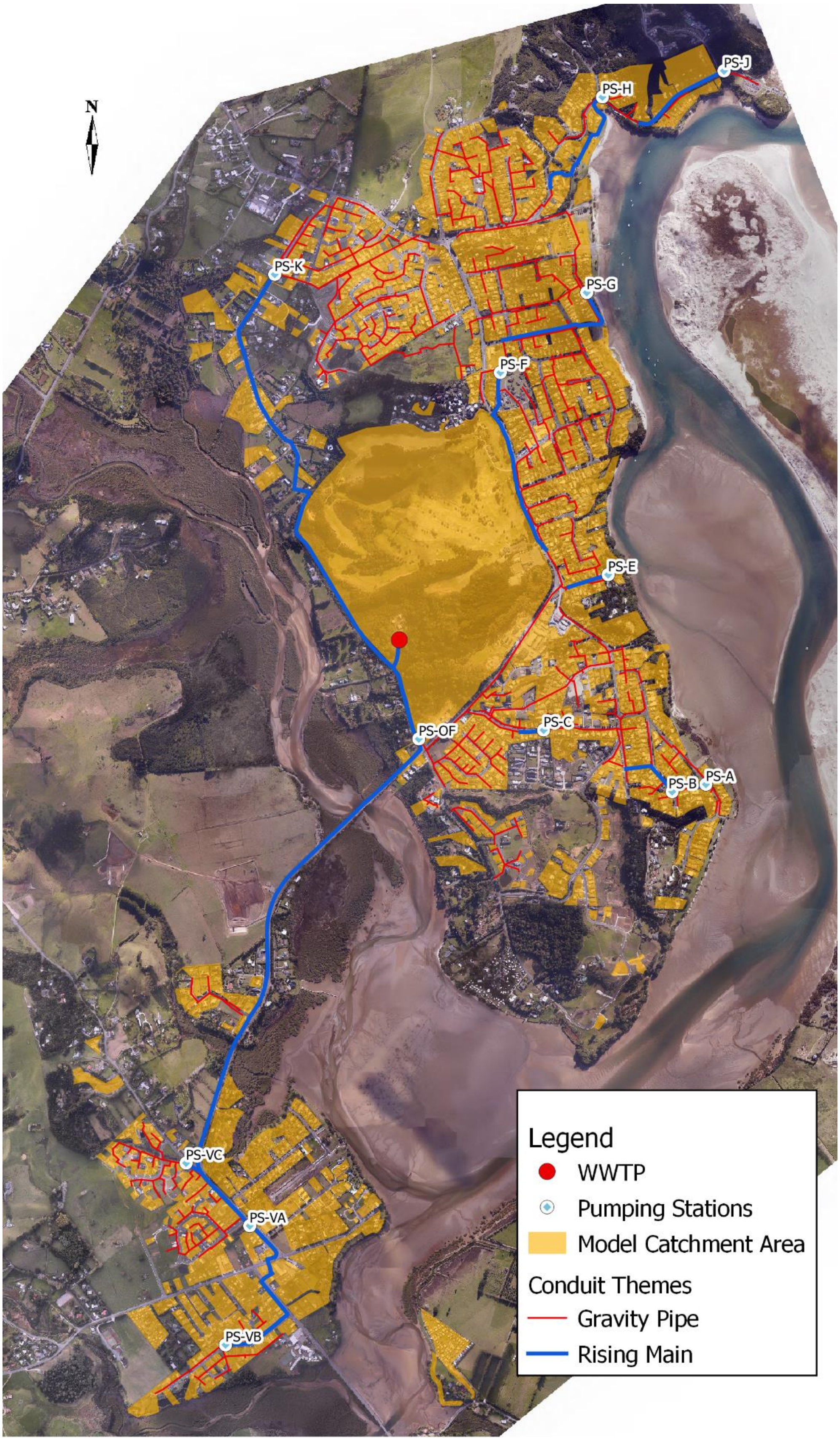

Figure 2-1: Overview of the Mangawhai Community Wastewater Scheme (pressure sewer pipes excluded)

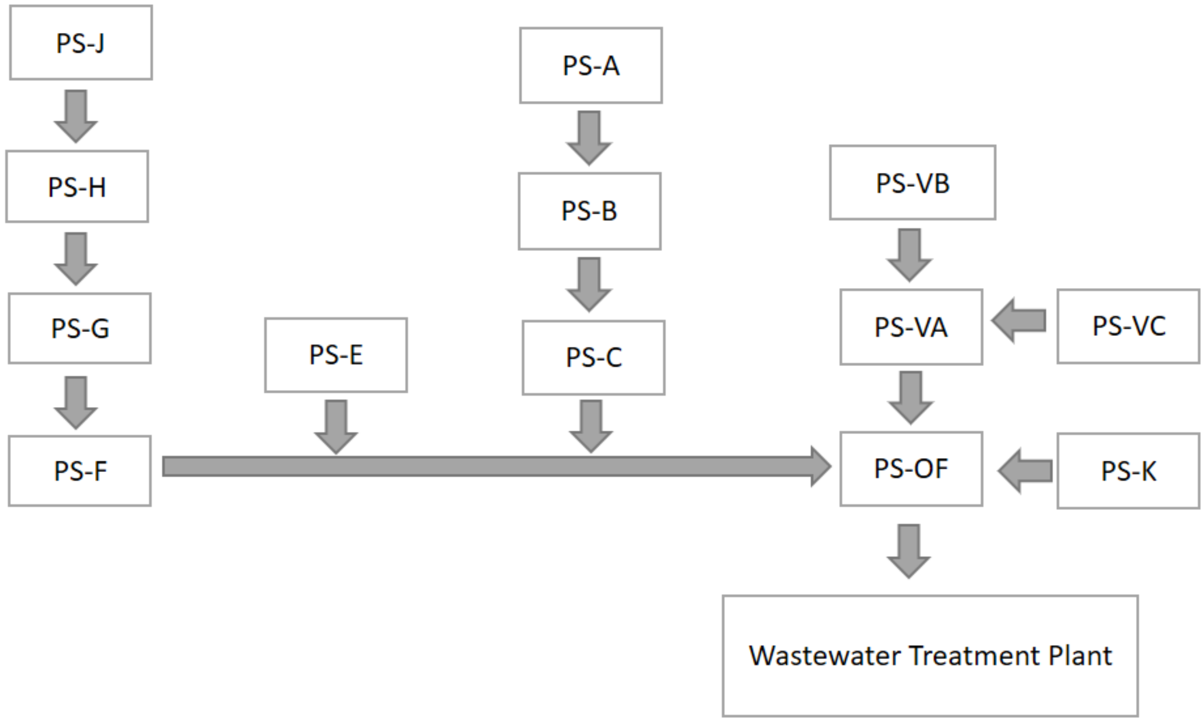

Figure 2-2: MCWS Pumping Station Connectivity Schematic

3 Future Growth Areas

3.1 Growth Areas Assessment

Growth area extents and associated future wastewater connections provided by Formative were refined in order to be incorporated into growth models. Projected future connections within each pump station catchment were provided on a yearly basis from 2021 to 2051 (Formative 2022).

The approach to extract future development areas is follows:

- GIS was used to extract areas within future pumping station catchments that are beyond the coverage of the existing network.
- New development areas were then further subdivided within pump station catchments such that local catchments could be loaded to the appropriate gravity sewers or pumping stations.
- Connection points of all subdivided growth areas into the existing network were identified (no future growth areas were connected to grinder sewer catchments but rather the nearest downstream gravity sewer or pump station).
- The number of future connections within each subdivided growth area was determined by proportionally dividing the total number of future connections in the pumping station catchment by area. This was completed for ultimate growth (2051) conditions.

3.2 Growth Areas Model Loading

Table 3-1 presents a summary of the number of existing and 2051 connections on a pump station catchment basis. In pump station catchments where there was an increase in the number of connections but no increase in coverage area of the pump station, growth is considered infill.

Table 3-1: Summary of Growth by Pump Station Catchment

PS Name	2021 Connections	2051 Connections	New Connections	Growth Type
PS-A	99	118	19	Growth
PS-B	40	55	15	Infill
PS-C	105	137	32	Growth
PS-E	77	97	20	Infill
PS-F	154	232	78	Infill
PS-G	549	613	64	Growth
PS-H	65	85	20	Growth
PS-J	48	63	15	Infill
PS-K	491	1000	509	Growth
PS-OF/CWWTP West	49	1177	1128	Growth
PS-OF/CWWTP East	384	887	503	Growth
PS-VA	465	984	519	Growth
PS-VB	85	90	5	Infill
PS-VC	90	400	310	Growth

Figure 3-1 presents an overview of loading of growth areas to this existing network. Figures 3-1 to 3-4 present close ups of loading in Mangawhai Heads and Mangawhai Village.

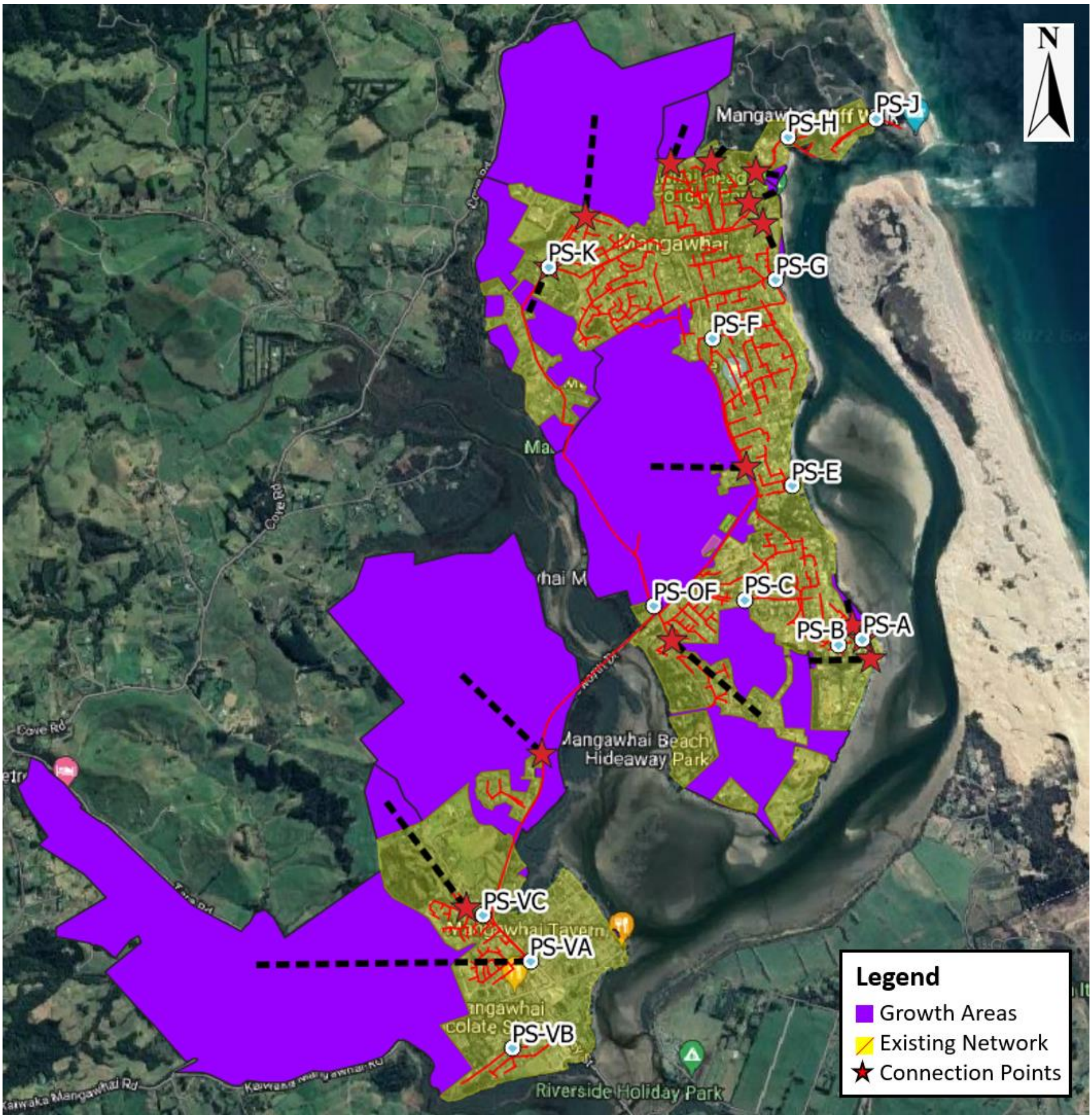

Figure 3-1: Overview of Growth Loading

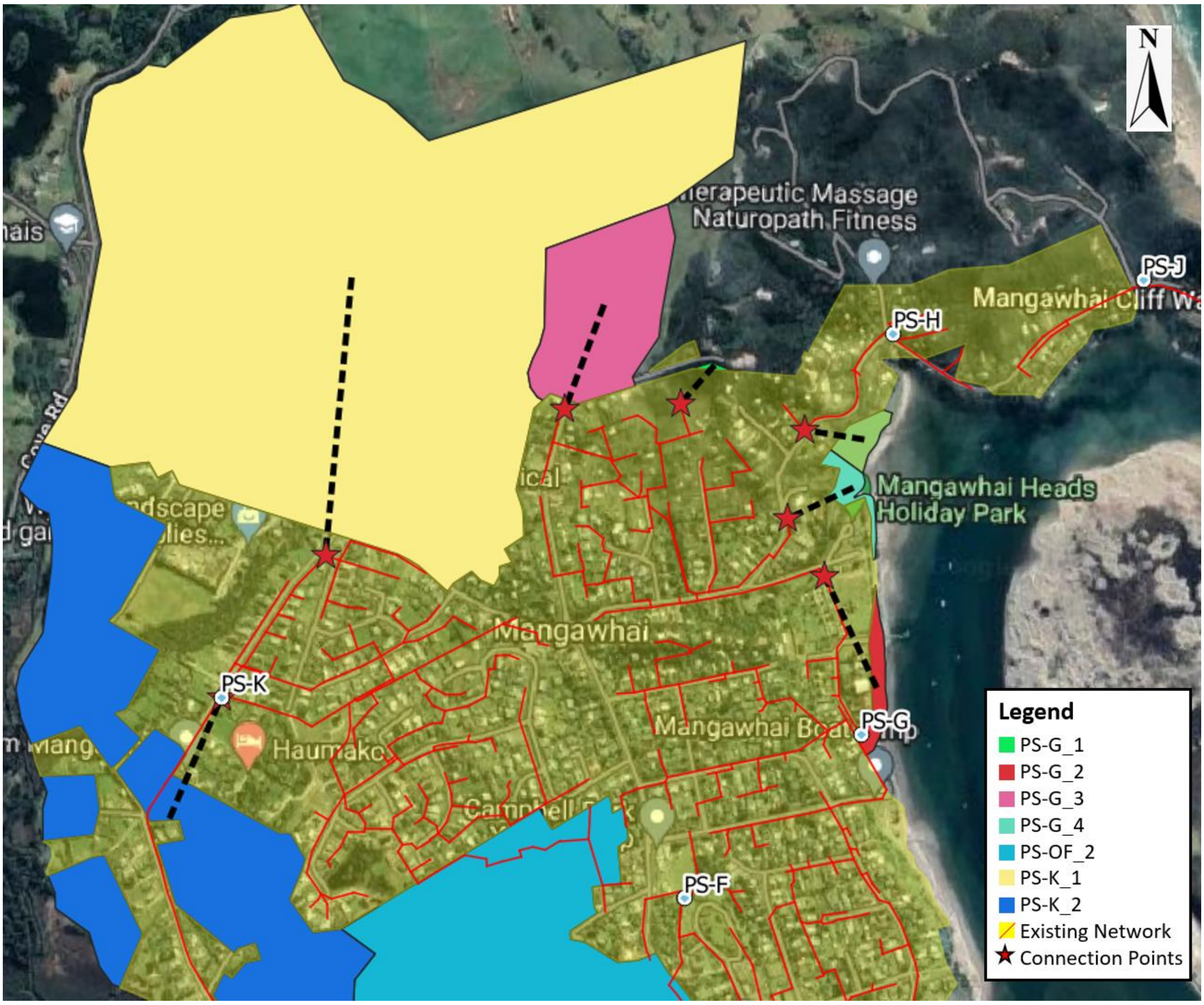

Figure 3-2: Growth Loading for North Mangawhai Heads

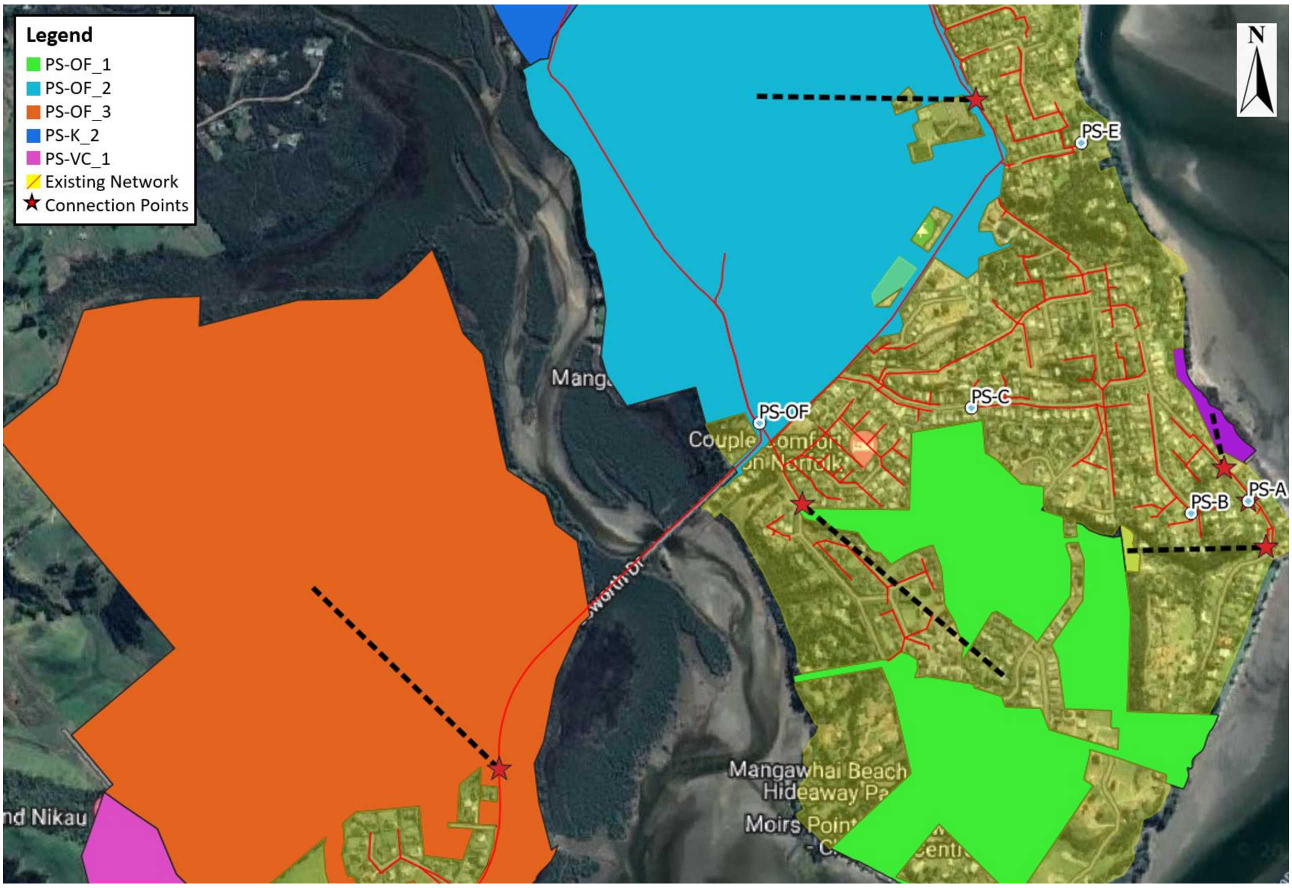

Figure 3-3: Growth Loading for South Mangawhai Heads

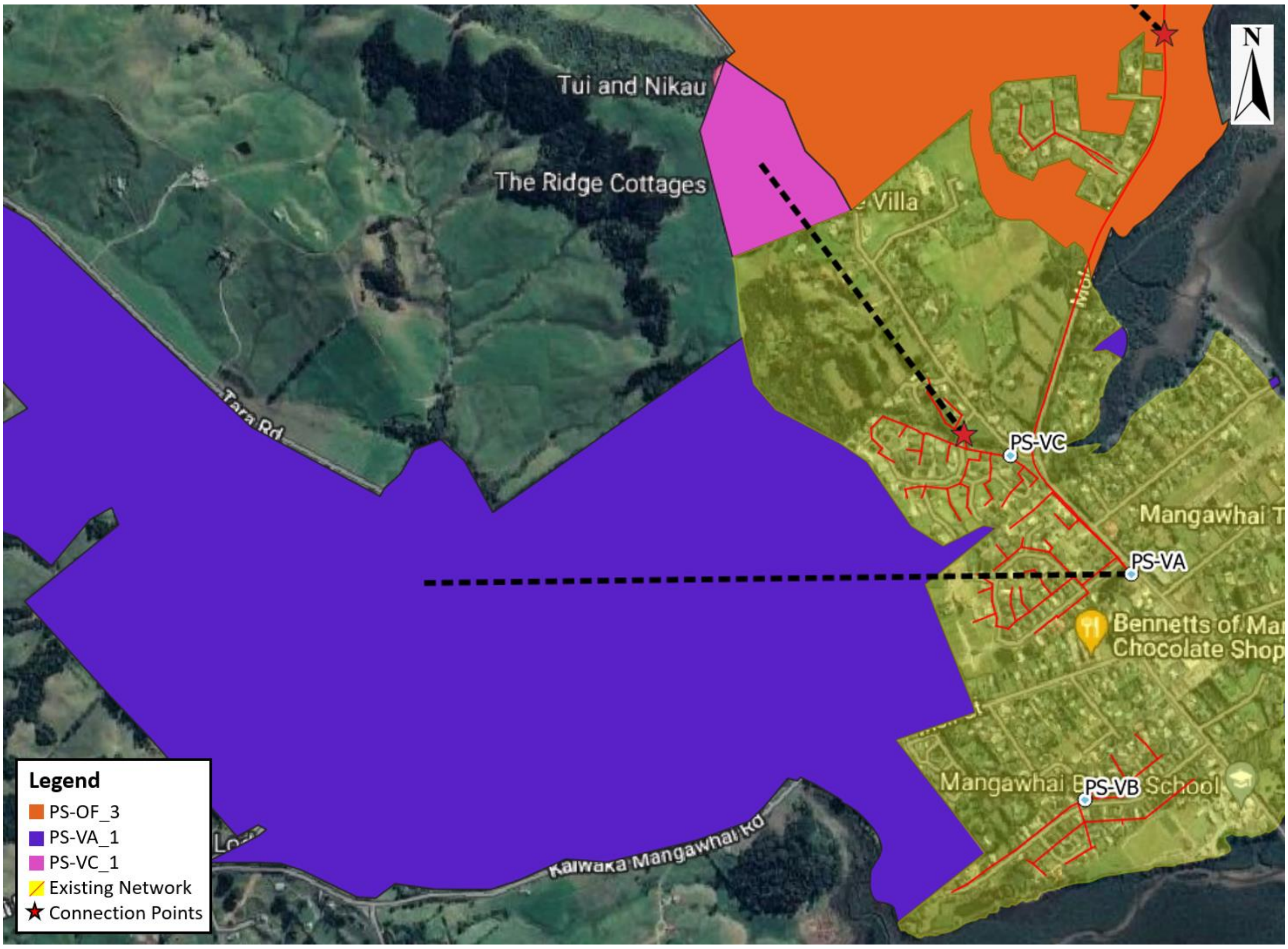

Figure 3-4: Growth Loading for Mangawhai Village

Table 3-2 presents details of the subdivided growth areas and planned connection points to the existing network.

Table 3-2: 2051 Connection Details for Network Expansion Areas

Area ID	Pump Station Catchment	Model Connection Point	Area (Ha)	2051 New Connections	Notes
PS-A_1	PS-A	20100701010919	0.36	4.2	Area serviced by pressure sewers. Loaded to the nearest downstream gravity main.
PS-A_2	PS-A	20100701010902	1.28	14.8	Area serviced by pressure sewers. Loaded to the nearest downstream gravity main.
PS-G_1	PS-G	20100701010510	0.06	0.4	Small catchment loaded to gravity network on Kanuka Place.
PS-G_2	PS-G	20100701010843	0.93	5.9	Area serviced by pressure sewers. Loaded to the nearest

Area ID	Pump Station Catchment	Model Connection Point	Area (Ha)	2051 New Connections	Notes
					downstream gravity main.
PS-G_3	PS-G	20100701010635	8.42	53.4	Loaded to gravity network on Cullen Street.
PS-G_4	PS-G	20100701011353	0.68	4.3	Area serviced by pressure sewers. Loaded to the nearest downstream gravity main.
PS-H_1	PS-H	20100701010806	0.76	20	Area serviced by pressure sewers. Loaded to the nearest downstream gravity main.
PS-K_1	PS-K	20090630124952	96.39	379	Loaded to gravity network on Thelma Road North.
PS-K_2	PS-K	PS-K_WW	33.06	130	Area serviced by pressure sewers. Loaded to PS-K.
PS-K_3	PS-K	20120309130133	10.25	150	Loaded to gravity network on Anchorage Road.
PS-OF_1	PS-OF/CWWTP East	20160115153630	47.71	350	Area serviced by pressure sewers. Loaded to the nearest downstream gravity main on Estuary Drive.
PS-OF_2	PS-OF/CWWTP West	XXXX000066	155.73	1128	Connected to PS-VA rising main on Molesworth Drive
PS-VA_1	PS-VA	PS-A_WW	208.19	519	Area serviced by pressure sewers. Loaded to PS-VA.
PS-VC_1	PS-VC	20091020155628	7.96	310	Area serviced by pressure sewers. Loaded to the nearest downstream gravity main on Kahu Drive.
Total			689.14	3072	

Table 3-3 presents details of the number of infill connections for areas where connections have increased but there is no increase in the pump station catchment area. The increased connections in these areas will be distributed evenly across the existing pump station catchments in the growth model scenarios.

Table 3-3: 2051 Connection Details for Infill Areas

PS Name	2051 New Connections
PS-B	15
PS-C	32
PS-E	20
PS-F	78
PS-J	15
PS-VB	5
Total	165

3.3 Growth Assumptions

In the above analysis and when developing growth scenarios models WSP will assume the following:

- All growth is zoned as residential and will be treated as such when modelling growth. No commercial flows have been included.
- Growth projections provided by Formative included growth in Mangawhai both within and beyond the future service area of the MCWS. Only growth within MCWS future service area will be considered in this assessment.
- Infill growth will be distributed evenly across existing pump stations catchments. Infill will only be included in catchments upstream of pump stations PS-B, PS-C, PS-E, PS-F, PS-J and PS-VB.
- The connection projections and their distribution used in this assessment are subject to the methodology and associated assumptions detailed in Formative's report.
- Three ultimate growth scenarios will be represented in the model and performance results reviewed with KDC. Following discussion with KDC, one scenario will be selected for developing network upgrades. The three growth scenarios are:
    - **No Reticulated Water:** 2051 flows based on current per capita wastewater discharges
    - **Reticulated Water for New Development:** 2051 flows based on current per capita wastewater discharges for existing development and as per KDC's Engineering Design Standards for new growth
    - **Catchment-Wide Reticulated Water:** 2051 flows as per KDC's Engineering Design Standards for all properties.

4 Ultimate Growth System Performance Assessment

4.1 Growth Scenarios

Three flow scenarios were used to assess performance of the system under ultimate growth conditions. Low, medium, and high flow growth scenarios were developed as are described in Table 4-1. In each scenario, growth within areas currently serviced by the network was added to existing model subcatchments while new subcatchments were added to represent growth in areas outside of the current service area.

Table 4-1: Detailed Scenario Descriptions

Scenario	Growth within Current Catchment Area	Growth Outside of Current Catchment Area
Scenario 1: Low Flow (No Reticulated Water)	• Flow for new connections is based on current per capita flowrates within the pump station catchment and is distributed evenly across pump station catchment • No changes to dry weather PF (calibrated diurnal pattern) • No changes to wet weather peaking factor (calibrated wet weather response)	• Flow for new connections is based per capita wastewater discharges as observed at the CWWTP (480 L/connection/day) • Dry weather PF = 2 • Wet weather PF = 2.5
Scenario 2: Medium Flow (Reticulated Water for New Development)	• Same as Scenario 1	• Flow based on KDC Standard (210 L/person/day, 4 people per connection) • Dry weather PF = 2 • Wet weather PF = 2.5
Scenario 3: High Flow (Reticulated Water for New Development)	• Flow based on KDC Standard (210 L/person/day, 4 people per connection) • No changes to dry weather PF (calibrated diurnal pattern) • No changes to wet weather peaking factor (calibrated wet weather response)	• Same as scenario 2

Note: Scenarios 1 & 2 based on additional connections from year 2021 (time of model calibration) to 2051. Scenario based on total number of connections for the year 2051.

4.2 Approach to Representing Wastewater Flows

A dynamic diurnal pattern and wet weather response has been used to represent flows from growth outside of the current catchment area. This approach allows the affect of storage and flow attenuation in the network to be represented. Figure 4-1 presents peaking factors that have been applied as are described above in Table 4-1.

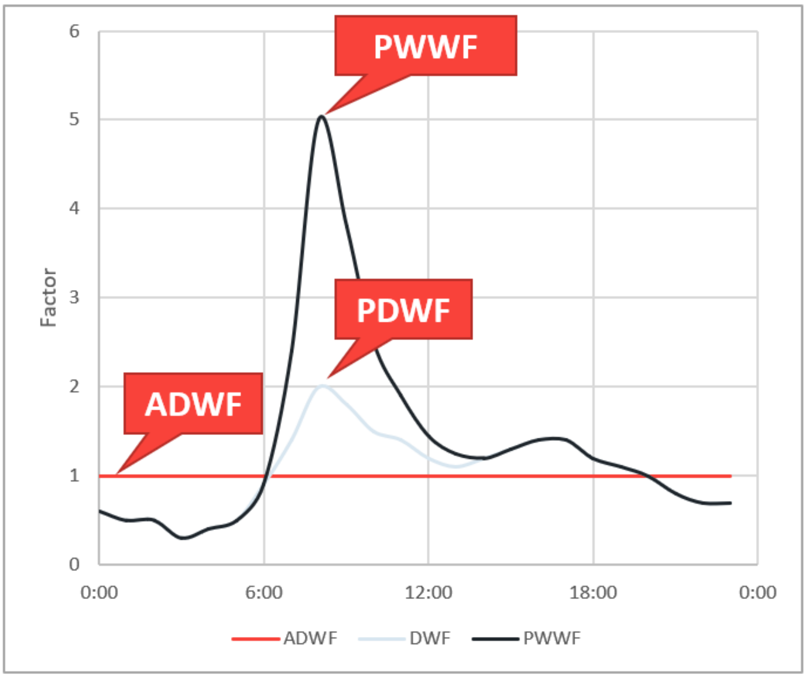

Figure 4-1: Dynamic Peaking Factors Applied in Modelling Flows from Growth Cells

4.3 Design Flows for Ultimate Growth

Wastewater design flows for new connections outside of the current catchment are presented below for each growth cell. Table 4-2 presents design flows for Scenario 1, Table 4-3 presents design flows for Scenarios 2 and 3.

Table 4-2: Scenario 1 Wastewater Design Flows for Growth Cells

Growth Cell ID	Distributed Number of Connections	Average Dry Weather Flow (L/s)	Peak Dry Weather Flow (L/s)	Peak Wet Weather Flow (L/s)
PS-A_1	4.2	0.023	0.047	0.117
PS-A_2	14.8	0.082	0.164	0.411
PS-G_1	0.4	0.002	0.004	0.011
PS-G_2	5.9	0.033	0.066	0.164
PS-G_3	53.4	0.297	0.593	1.483
PS-G_4	4.3	0.024	0.048	0.119
PS-H_1	20	0.111	0.222	0.556
PS-K_1	379	2.106	4.211	10.528
PS-K_2	130	0.722	1.444	3.611
PS-K_3	150	0.833	1.667	4.167
PS-OF_1	350	1.944	3.889	9.722
PS-OF_2	1128	6.267	12.533	31.333
PS-VA_1	519	2.883	5.767	14.417
PS-VC_1	310	1.722	3.444	8.611

Table 4-3: Scenario 2 and 3 Wastewater Design Flows for Growth Cells

Growth Cell ID	Distributed Number of Connections	Average Dry Weather Flow (L/s)	Peak Dry Weather Flow (L/s)	Peak Wet Weather Flow (L/s)
PS-A_1	4.2	0.041	0.082	0.204
PS-A_2	14.8	0.144	0.288	0.719
PS-G_1	0.4	0.004	0.008	0.019
PS-G_2	5.9	0.057	0.115	0.287
PS-G_3	53.4	0.519	1.038	2.596
PS-G_4	4.3	0.042	0.084	0.209
PS-H_1	20	0.194	0.389	0.972
PS-K_1	379	3.685	7.369	18.424
PS-K_2	130	1.264	2.528	6.319
PS-K_3	150	1.458	2.917	7.292
PS-OF_1	350	3.403	6.806	17.014
PS-OF_2	1128	10.967	21.933	54.833
PS-VA_1	519	5.046	10.092	25.229
PS-VC_1	310	3.014	6.028	15.069

4.4 Commercial Flows

Commercial flows in the Mangawhai Central development have been included in the model as design flows calculated in accordance with KDC's Standards. Table 4-4 summarizes commercial flows and identified a load point for each to the model network.

Table 4-4: Mangawhai Central Commercial Flows

Development	Land Use	Design Flow (L/s)	Connection Pont Description	Model Node
Supermarket	Industrial - Light Water Use	0.11	PS-VA rising main, just south of estuary bridge (DN 250 PVC)	XXXX000067
Commercial Building 1	Industrial - Medium Water Use	0.02		
Commercial Building 2	Industrial - Medium Water Use	0.04		
Commercial Building 3	Industrial - Medium Water Use	0.03		
Commercial Building 4	Industrial - Medium Water Use	0.11		
Commercial Building 5	Industrial - Medium Water Use	0.02		
Commercial Building 6	Industrial - Medium Water Use	0.02		
Bunnings	Industrial - Light Water Use	0.21	PS-VA rising main at approx. 78 Molesworth Drive (DN 250 PVC)	XXXX000066
Mobil Petrol Station	Industrial - Light Water Use	0.02		

4.5 Baseline Model Updates

KDC has an ongoing project to divert flows from PS-K away from PS-OF and directly to the CCWWTP inlet works. This has been represented in the model assuming the diversion pipe will be a 225 mm MDPE pipe (internal diameter = 173 mm) to match the upstream section of rising main. This new section of pipeline is 120 m long, diverting from the existing rising main path at the entrance to the CCWWTP. Figure 4-2 presents the proposed rising main diversion as presented in WSP's *PS-K Diversion to CWWTP memo* (WSP 2022).

Figure 4-2: PS-K Diversion Alignment (Indicative Only) (WSP 2022)

The outlet elevation of the diversion pipe to the CCWWTP has been assumed to be 21 m AD which is the same level as the outlet of the PS-OF rising main connection point. The existing outlet of the PS-K rising main to PS-OF is 13.92 m AD.

Following the proposed diversion, at full speed, pumps at PS-K have a predicted capacity of 34 L/s (WSP 2022).

4.6 Ultimate Growth System Performance Assessment

The following sections provide details of the system performance for the three ultimate growth scenarios described above.

4.6.1 *Design Rainfall*

As described in the *Mangawhai Wastewater Model Build, Calibration and System Performance Assessment* report (WSP 2022) the design event for the Mangawhai Heads portion of the catchment is the 10 year, 1-hour event and the design event for the Mangawhai Village portion of the catchment is the 10 year, 24-hour event (both PMP distribution). When assessing 2051 conditions climate change adjusted rainfall has been used (RCP8.5 for the period 2031-2050). 1 and 24 hour rainfall hyetographs used in assessing the ultimate growth scenarios are presented on Figure 4-3 and Figure 4-4 respectively.

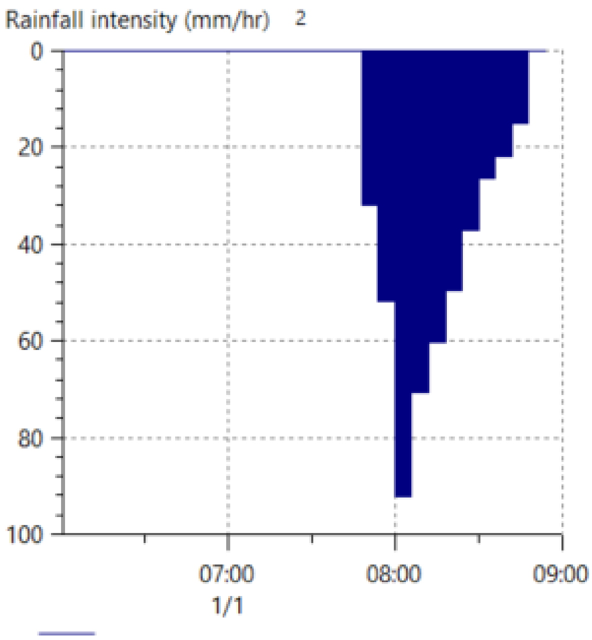

Figure 4-3: 10 Year, 1-hour Rainfall Hyetograph (RCP8.5 for the period 2031-2050)

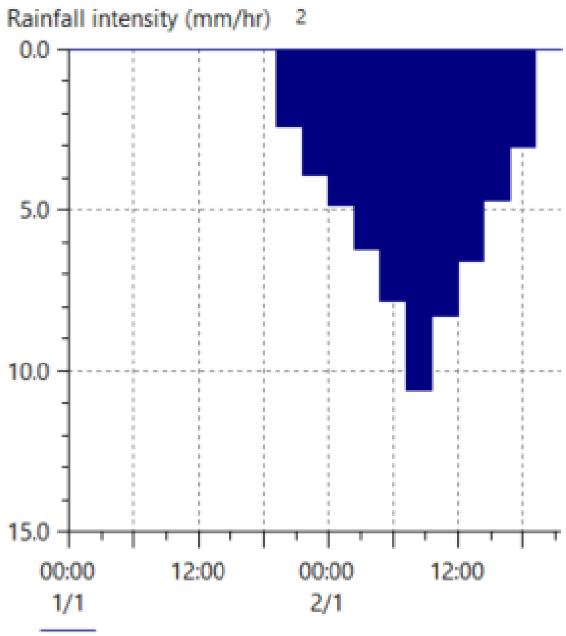

Figure 4-4: 10 Year, 24-hour Rainfall Hyetograph (RCP8.5 for the period 2031-2050)

4.6.2 Gravity Network Performance

Details of gravity network constraints, and any resulting network overflows, for each scenario are described below.

4.6.2.1 Scenario 1

The following network performance issues were identified under peak wet weather flow conditions for Scenario 1:

- **Surcharge of gravity network through Campbell Park Youth Camp with Overflows Predicted:** The gravity pipe downstream of the PS-G rising main is predicted to surcharge resulting in a predicted spill volume of 19 m^3 (Manhole ID: 20100701011238).
- **Surcharge of Gravity Network on Seabreeze Road:** Approximately 210 m of the gravity network upstream of PS-C (manhole ID: 20100701011203 to manhole ID: 20100701011413) is predicted to surcharge due to limited pipe capacity. The maximum depth of surcharge is greater than 1 m from the surface.

4.6.2.2 Scenario 2

The following network performance issues were identified under peak wet weather flow conditions for Scenario 2:

- **Surcharge of Gravity Network on Jack Body Drive:** Approximately 240 m of the gravity network upstream of PS-K is predicted to surcharge due to limited pipe capacity. No overflows are predicted however the surcharge level is within 0.5 m of the ground surface.
- **Surcharge of gravity network through Campbell Park Youth Camp with Overflows Predicted:** The gravity pipe downstream of the PS-G rising main is predicted to surcharge resulting in a predicted spill volume of 22 m^3 (Manhole ID: 20100701011238).
- **Surcharge of Gravity Network on Seabreeze Road:** Approximately 210 m of the gravity network upstream of PS-C (manhole ID: 20100701011203 to manhole ID: 20100701011413) is

predicted to surcharge due to limited pipe capacity. The maximum depth of surcharge is greater than 1 m from the surface.

4.6.2.3 Scenario 3

The following network performance issues were identified under peak wet weather flow conditions for Scenario 3:

- **Surcharge of Gravity Network on Jack Body Drive:** Approximately 240 m of the gravity network upstream of PS-K is predicted to surcharge due to limited pipe capacity. No overflows are predicted however the surcharge level is within 0.1 m of the ground surface.
- **Surcharge of gravity network through Campbell Park Youth Camp with Overflows Predicted:** The gravity pipe downstream of the PS-G rising main is predicted to surcharge resulting in a predicted spill volume of 39 m^3 (Manhole ID: 20100701011238).
- **Surcharge of Gravity Network on Seabreeze Road:** Approximately 290 m of the gravity network upstream of PS-C (manhole ID: 20100701011203 to PS-C) is predicted to surcharge due to limited pipe capacity. The maximum depth of surcharge is greater than 1 m from the surface.

4.6.3 Wastewater Treatment Plant Inflows

Table 4-5 presents predicted inflows to the CCWWTP for Scenarios 1 to 3 for dry weather flow and the design rainfall event.

Table 4-5: CCWWTP Inflows for Ultimate Growth Scenarios

Scenario		Base	Scenario 1	Scenario 2	Scenario 3
Average Dry Weather Volume (Peak Summertime) (m^3)		1,120	2,850	4,000	5,190
Wet Weather Volume 1 in 10 Year ARI (m^3)	Mangawhai Heads (1 hour event)	850	1,590	2,040	3,020
	Mangawhai Village (24 hour event)	750	2,350	3,650	3,870
	Total	1,600	3,940	5,690	6,890

4.6.4 Pump Station Performance

Table 4-6 presents modelled pump station inflows for existing and the three ultimate growth scenarios. Cell colours indicate the following:

- Yellow: Peak inflows exceed pump capacity
- Orange: Peak inflows exceed pump capacity resulting in emergency storage being used
- Red: Peak inflows exceed pump capacity resulting in network overflows

Table 4-6: Pump Station Inflows for Ultimate Growth Scenarios

PS Name	Tested Pump Capacity (L/s)	Base ADWF (L/s)	Base PDWF (L/s)	Peak Wet Weather Flow 1 in 10 Year ARI (L/s)			
				Base	Scenario 1	Scenario 2	Scenario 3
PS-A	8.0	0.3	5.3	6.3	6.8	7.7	10.5
PS-B*	8.7/ 8.6	0.4	7.9	12	13	11.6	12.9
PS-C	10.7/ 10.7	0.7	5.2	10.8	11.0	11.1	12.2
PS-E*	9.5	0.3	3.7	5.8	3.9	3.9	7.1

PS Name	Tested Pump Capacity (L/s)	Base ADWF (L/s)	Base PDWF (L/s)	Peak Wet Weather Flow 1 in 10 Year ARI (L/s)			
				Base	Scenario 1	Scenario 2	Scenario 3
PS-F*	36.1/ 35.8	3.2	11.7	22.8	26.8	27.1	27.4
PS-G	33.6/ 34.3	2.4	8.5	32	40.8	31.5	38.4
PS-H	6.9/ 7.3	0.3	8.7	16.3	17.7	18.2	18.3
PS-J*	9.5	0.1	4.3	6.1	6.1	6.0	8.2
PS-K	32.0/ 33.2	2.3	11.8	20	25.1	29.7	30.0
PS-OF	100	13.0	103.8	128.4	126	142	150
PS-VA	37.5/ 40	3.8	27.1	34.2	47.6	52.0	52.6
PS-VB* **	7.4/ 6.7	0.2	0.5	1.3	1.4	1.4	2.4
PS-VC**	7.3/ 6.6	0.2	2.5	3.7	11.0	16.0	17.2

* Pump capacity not tested and therefore pump capacity has been sourced from as built drawings

** Pump station does not have emergency storage

It is noted in Table 4-6 that peak inflows to PS-G do not increase from the low to high flow scenarios, but rather are highest for Scenario 1 and lowest for Scenario 2. This is due to the modelled timing of pump cycles at upstream pump station and in pressure sewer catchments (which have been represented simplistically). This only occurs for a short duration and does not represent a capacity constraint in the network (no rise in the wet well level is predicted).

Scenario specific details of pump station capacity constraints and resulting network overflows are described below.

4.6.4.1 Scenario 1

The following network performance issues were identified under peak wet weather flow conditions for Scenario 1:

- **PS-OF Under Capacity:** The sum of peak inflows to PS-OF is 126 L/s (tested pump capacity = 65 L/s) for the 1 hour event. No overflows are predicted however both emergency storage tanks at PS-OF are used.
- **PS-VC Under Capacity with Overflows Predicted:** Peak predicted inflows are 11.0 L/s (tested pump capacity = 7 L/s) resulting in a predicted spill of 7 m^3 from a manhole on Old Waipu Road (Manhole ID: 20091020152523)

4.6.4.2 Scenario 2

The following network performance issues were identified under peak wet weather flow conditions for Scenario 2:

- **PS-OF Under Capacity with Overflows Predicted:** The sum of peak inflows to PS-OF is 142 L/s (tested pump capacity = 65 L/s) for the 1 hour event. Both emergency storage tanks at PS-OF are used and two manholes on Estuary Drive are predicted to overflow with a spill volume of 106 m^3 (manhole IDs: 20100701011433 and 20100701011439).
- **PS-VA Under Capacity with Overflows Predicted:** Peak predicted inflows are 52.0 L/s (tested pump capacity = 40 L/s) resulting in a predicted spill of 1.7 m^3 from the wet well and emergency storage (old wet well).

- **PS-VC Under Capacity with Overflows Predicted:** Peak predicted inflows are 16.0 L/s (tested pump capacity = 7 L/s) resulting in a predicted spill of 163 m^3 from a manhole on Old Waipu Road (Manhole ID: 20091020152523)

4.6.4.3 Scenario 3

The following network performance issues were identified under peak wet weather flow conditions for Scenario 3:

- **PS-OF Under Capacity with Overflows Predicted:** The sum of peak inflows to PS-OF is 150 L/s (tested pump capacity = 65 L/s) for the 1 hour event. Both emergency storage tanks at PS-OF are used and two manholes on Estuary Drive are predicted to overflow with a spill volume of 350 m^3 (manhole IDs: 20100701011433 and 20100701011439).
- **PS-VA Under Capacity with Overflows Predicted:** Peak predicted inflows are 52.6 L/s (tested pump capacity = 40 L/s) resulting in a predicted spill of 5.5 m^3 from the wet well and emergency storage (old wet well).
- **PS-VC Under Capacity with Overflows Predicted:** Peak predicted inflows are 17.2 L/s (tested pump capacity = 7 L/s) resulting in a predicted spill of 201 m^3 from a manhole on Old Waipu Road (Manhole ID: 20091020152523).

4.7 Ultimate Growth System Performance Assessment Conclusions

A summary of network performance for the three ultimate growth scenarios assessed is presented in Table 4-7.

Table 4-7: Summary of System Performance for Ultimate Growth Scenarios

Scenario	Scenario 1	Scenario 2	Scenario 3
DWF Volume to CWWTP (m^3 per day)	2,850	4,000	5,190
WWF Volume to CWWTP (m^3)	4,150	5,900	7,100
WWF Network Spill Volume (m^3)	26	292	596
Network Deficiencies			
Campbell Park Youth Camp Gravity Surcharge (PS-F catchment)	160 m of surcharge with 19 m^3 spill	160 m of surcharge with 22 m^3 spill	160 m of surcharge with 39 m^3 spill
Jack Body Drive Gravity Surcharge (PS-K catchment)	70 m of surcharge, peak surcharge level within 0.5 m of surface	240 m of surcharge, peak surcharge level within 0.5 m of surface	240 m of surcharge, peak surcharge level within 0.1 m of surface
Seabreeze Road Gravity Surcharge (PS-C catchment)	210 m of surcharge, peak surcharge level > 1 m from surface	210 m of surcharge, peak surcharge level > 1 m from surface	290 m of surcharge, peak surcharge level > 1 m from surface
Pump Station Deficiencies			

Scenario	Scenario 1	Scenario 2	Scenario 3
No. of Pump Stations Under Capacity at PWWF	7	6	8
No. of Pump Stations Under Capacity Resulting in Overflows at PWWF	1	2	3

The following additional system performance issues were identified under existing conditions in the *Mangawhai Model Build, Calibration and System Performance* report (WSP 2022):

- Limited emergency storage (less than 8 hours dry weather flow following pump failure) was identified at pump stations PS-B, PS-F, PS-G, PS-OF and PS-VA. Limited storage at these sites will be exacerbated by growth, and additional pump stations not listed here will likely have insufficient storage capacity under ultimate flows
- At pump stations PS-B, PS-F and PS-H, network asset data indicates the overflow to storage level is below the lowest upstream manhole lid level resulting in overflows before storage is used.

Scenario 2 was carried forward into upgrade optioneering. This was agreed at a workshop with KDC held on 7 July 2022. The medium flow scenario was selected as it best aligns with peak inflows to the CCWWTP described in the *Mangawhai CCWWTP Growth Strategy: Basis of Design for Wastewater Treatment and Disposal* (WSP 2022). For the peak week in 2051 the predicted inflows to the CCWWTP presented in this document are 3,362 m^3.

5 Network Upgrades Development

Table 5-1 presents a summary of network deficiencies that were identified in the year 2051 for Scenario 2. In developing upgrade alternatives, an additional capacity constraint was identified at PS-K following the upgrade of the gravity sewer on Jack Boyd Drive, in that peak inflows exceed pump capacity. This deficiency is included in Table 5-1 and was considered when developing upgrades.

An *Upgrade Priority* has been assigned to each deficiency as follows:

- **High** – Deficiency is predicted to result in network overflows or there is no existing reticulation to connect to.
- **Medium** – Deficiency is predicted to result in surcharge of the gravity network with the maximum water level within 0.5 m of the ground surface.
- **Low** – Deficiency is predicted to result in surcharge of the gravity network with the maximum water level greater than 0.5 m of the ground surface.

Table 5-1: Network Deficiencies Carried Forward to Upgrade Optioneering

Deficiency ID	Network Deficiency	Trigger	Upgrade Priority
MP-1	Undersized gravity network through Campbell Park Youth Camp	**Existing**, gravity network is under capacity when upstream pumping station (PS-G) is running at full speed	High
MP-2	Undersized gravity network on Seabreeze Road	**Existing**, exacerbated by **growth cells** PS-A_1 and PS-A_2 coming online, and infill growth in PS-C catchment	Low
MP-3	Undersized gravity network on Jack Boyd Drive	**Growth** cell PS-K_1 coming online	Medium
MP-4	PS-VC and rising main undersized	**Growth** cell PS-VC_1 coming online	High
MP-5	PS-VA and rising main undersized	All growth cells in Mangawhai Village coming online & upgrade of PS-VC (see MP-4)	High
MP-6	No current wastewater servicing in Mangawhai Central and PS-OF undersized to service ultimate growth	**Growth** cell PS-OF_1 coming online (connecting to PS-VA rising main) and catchment wide **growth** (PS-OF)	High
MP-7	PS-K undersized	Upgrade of gravity sewer on Jack Boyd Drive (MP-3) and **growth** cells PS-K_1 and PS-K_2 coming online	Low

5.1 Upgrade Criteria

The following criteria were used in developing network upgrades:

- **New Gravity Pipes:** Sized to flow 70% full during PWWF, with a minimum pipe cover of 600 mm.
- **Pump Station Upgrades:** Capable of conveying PWWF or no increase in wet well level at PWWF (only applied at sites with pumping stations or pressure sewer catchments in contributing catchment).
- **Pump Station Rising Mains:** Sized to have a maximum velocity of 0.6 – 1.8 m/s. It was assumed upgraded rising mains will be the same material as existing pipes.
- **Pump Station Emergency Storage:** Gravity storage chamber capable of holding twelve hours average dry weather flow (based on full catchment development, as per KDC Engineering Standards).

5.2 Upgrade Cost Estimates

For each upgrade an indicative cost estimate has been developed. As the options presented in this report require substantial refinement, and may change during detailed design, there is a high level of uncertainty associated with these estimates. For the purposes of long-term budgeting, cost estimates have been developed using a methodology used by Alta Consulting. This same methodology was recently applied to assess options for the long-term disposal of effluent from the CCWWTP (Alta Consulting, 2022).

The cost estimates are suitable for a high-level options study with only a preliminary estimate of scope, known as a 'Class 5' estimate with an accuracy of -50% to + 100%. As each project is developed in more detail, the cost estimate can be refined and resultingly the accuracy will increase. Figure 1-1 present classifications of cost estimate classes as provided by Alta Consulting.

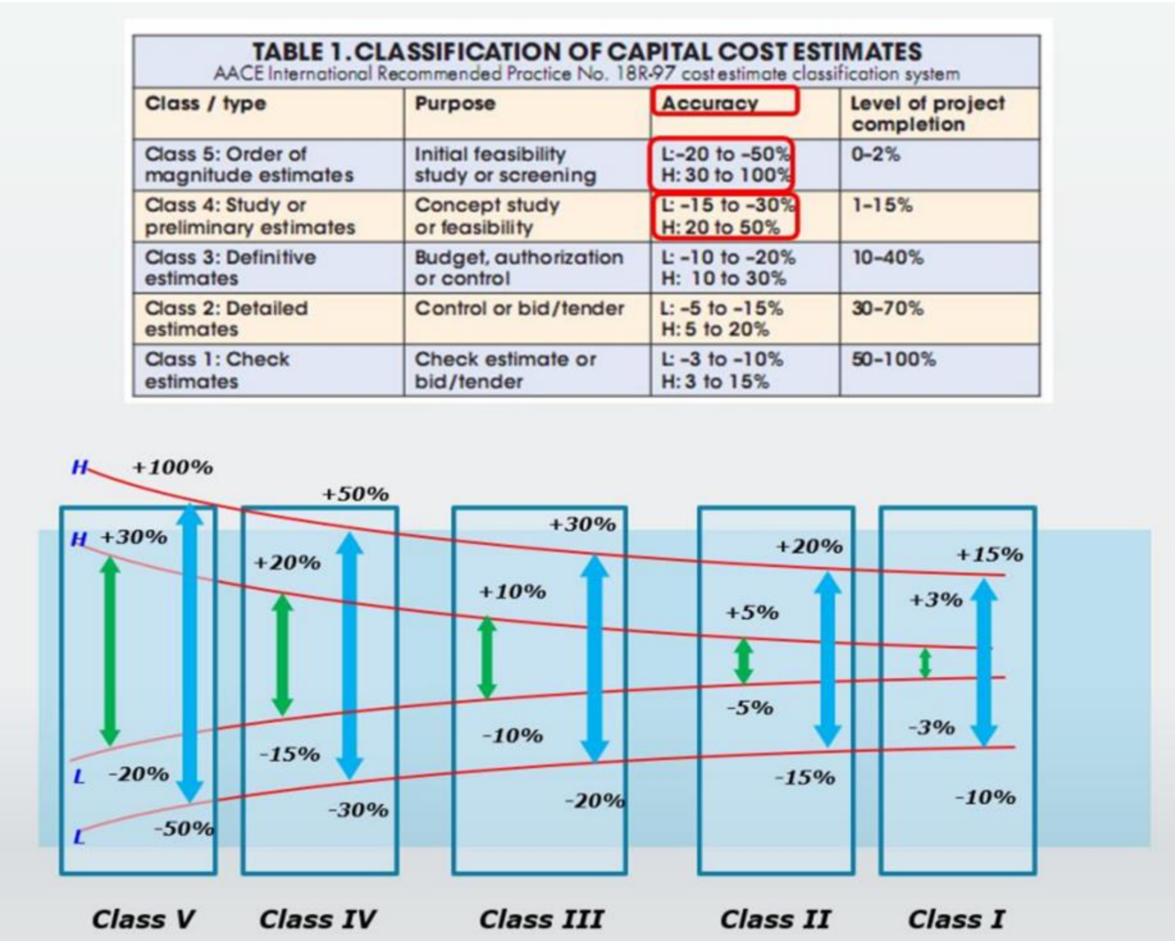

TABLE 1. CLASSIFICATION OF CAPITAL COST ESTIMATES
AACE International Recommended Practice No. 18R-97 cost estimate classification system

Class / type	Purpose	Accuracy	Level of project completion
Class 5: Order of magnitude estimates	Initial feasibility study or screening	L: -20 to -50% H: 30 to 100%	0-2%
Class 4: Study or preliminary estimates	Concept study or feasibility	L: -15 to -30% H: 20 to 50%	1-15%
Class 3: Definitive estimates	Budget, authorization or control	L: -10 to -20% H: 10 to 30%	10-40%
Class 2: Detailed estimates	Control or bid/tender	L: -5 to -15% H: 5 to 20%	30-70%
Class 1: Check estimates	Check estimate or bid/tender	L: -3 to -10% H: 3 to 15%	50-100%

Figure 1-1: Diagram of Cost Accuracy with Level of Estimation (Alta Consulting, 2022)

A Schedule of Prices for all projects is contained in Appendix B. Project Base Estimates represent the cost of project delivery including design, construction, equipment and KDC inputs. The Project Expected Estimate is the expected cost of the project, with a 40% contingency margin of safety. The 95%ile Project Estimate is the level of cost expected with a 95% certainty, and is the Project Expected Estimate with an additional 60% contingency (total contingency of 100% as per Class 5 estimate).

The 95%ile Project Estimate values for each project are presented in this section, rounded to the nearest $ 100,000.

5.3 Upgrade Descriptions

The following sections provide details of network upgrades that have been developed to resolve each network deficiency described in Table 5-1.

5.3.1 MP-1: Upgrade Gravity Network Through Campbell Park Youth Camp

Table 5-2 presents details of the network upgrade to resolve the capacity constraint in the gravity network through Campbell Park Youth Camp. Figure 5-2 presents a plan view of upgrade MP-1.

Table 5-2: Upgrade MP-1 Details

Upgrade ID	MP-1
Deficiency	Gravity network through Campbell Park Youth Camp does not have capacity when upstream pump station (PS-G) is running at full speed resulting in overflows
Upgrade Priority	High: 22 m^3 manhole spill predicted (Manhole ID: 20100701011238).
Trigger	Existing
Upgrade Details	Install 170 m of new 225 mm PVC pipe and 2 new manholes (Average depth = 3.1 m)
Cost Estimate (95%ile, 2022 NZ Dollars)	$600,000

Figure 5-2: Upgrade MP-1 Plan View

5.3.1 MP-2: Upgrade Gravity Network on Seabreeze Road

Table 5-3 presents details of the network upgrade to resolve the capacity constraint in the gravity network on Seabreeze Road. Figure 5-3 presents a plan view of upgrade MP-2.

Table 5-3: Upgrade MP-2 Details

Upgrade ID	MP-2
Deficiency	Gravity network on Seabreeze Road undersized resulting in surcharge
Upgrade Priority	Low: Maximum predicted water level is greater than 1 m from ground surface
Trigger	Existing, exacerbated by growth cells PS-A_1 and PS-A_2 coming online, and infill growth in PS-C catchment
Upgrade Details	Install 310 m of 225 mm PVC pipe and 4 new manholes (Manhole 20100701010711 to PS-C) Some pipe inverts along Seabreeze Road were not indicated in KDC GIS and therefore have been inferred. Survey may be required to confirm if this upgrade is required.
Cost Estimate (95%ile, 2022 NZ Dollars)	$1,100,000

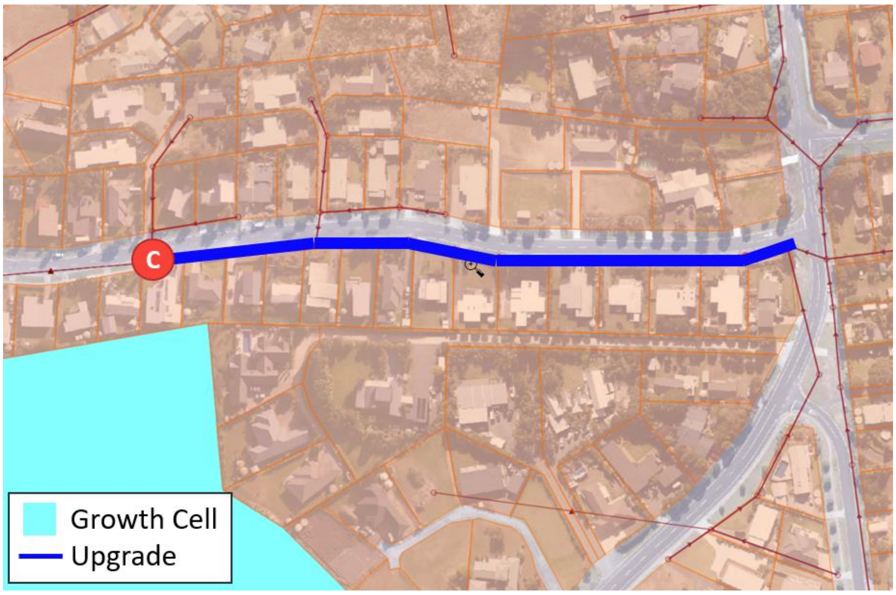

Figure 5-3: Upgrade MP-2 Plan View

5.3.1 MP-3: Upgrade Gravity Network on Jack Boyd Drive

Table 5-4 presents details of the network upgrade to resolve the capacity constraint in the gravity network on Jack Boyd Drive. Figure 5-4 presents a plan view of upgrade MP-3.

Table 5-4: Upgrade MP-3 Details

Upgrade ID	MP-3
Deficiency	Gravity network on Jack Boyd Drive undersized resulting in surcharge
Upgrade Priority	Medium: Maximum water level is within 0.5 m of ground surface
Trigger	Growth cell PS-K_1 coming online
Upgrade Details	Install 360 m of 225 mm PVC pipe and 8 new manholes (Manhole 20090630124952 to PS-K)
Cost Estimate (95%ile, 2022 NZ Dollars)	$1,300,000

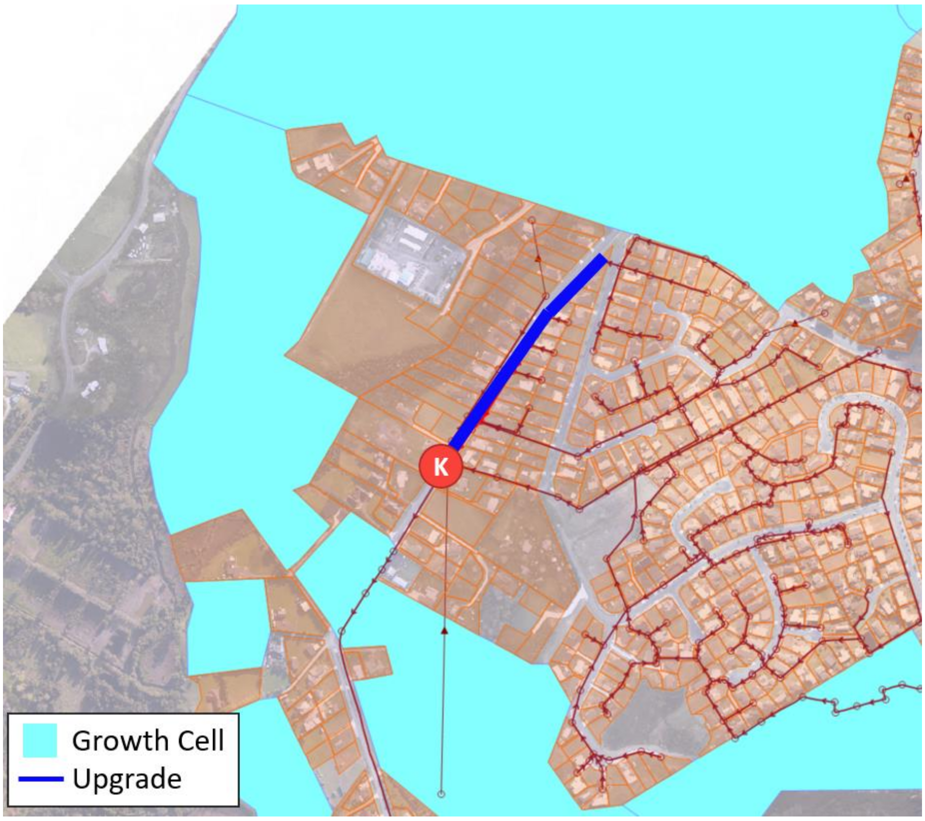

Figure 5-4: Upgrade MP-3 Plan View

5.3.2 MP-4: Upgrade PS-VC and Rising Main

Table 5-5 presents details of the network upgrade to resolve the capacity constraint at PS-VC. Figure 5-5 presents a plan view of upgrade MP-4.

Table 5-5: Upgrade MP-4 Details

Upgrade ID	MP-4
Deficiency	PS-VC undersized resulting in overflows
Upgrade Priority	High: 163 m^3 spill predicted from manhole on Old Waipu Road (Manhole ID: 20091020152523)
Trigger	Growth cell PS-VC_1 coming online
Upgrade Details	Full upgrade of PS-VC, including upgrade of pumps for PWWF (16 L/s), construction of new 2.25 m diameter wet well and construction new emergency storage tank (150 m^3). Upgrade rising main with 125 m of DN140 PE pipe (Assumed: PE100, PN 16 at depth of 1.2 m)
Cost Estimate (95%ile, 2022 NZ Dollars)	$2,200,000

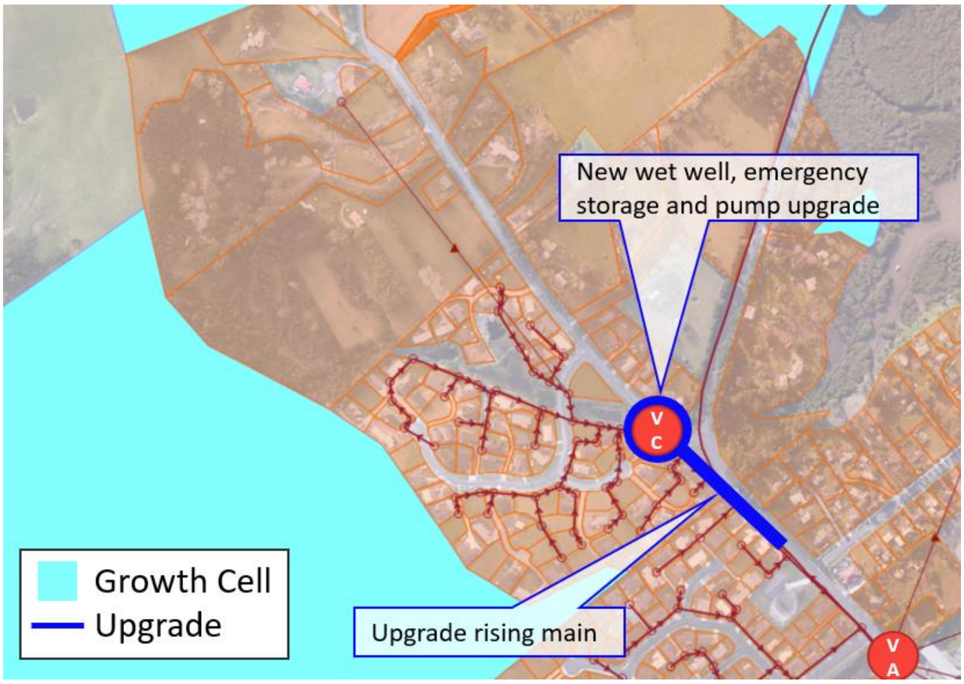

Figure 5-5: Upgrade MP-4 Plan View

5.3.3 MP-5: Upgrade PS-VA and Rising Main

Table 5-6 presents details of the network upgrade to resolve the capacity constraint at PS-VA. Figure 5-6 presents a plan view of upgrade MP-5.

Table 5-6: Upgrade MP-5 Details

Upgrade ID	MP-5
Deficiency	PS-VA undersized resulting in overflows
Upgrade Priority	High: 1.7 m^3 spill predicted from emergency storage tank
Trigger	Growth cells in Mangawhai Village coming online and upgrade of PS-VC (MP-4)
Upgrade Details	Upgrade of pumps for PWWF (60 L/s) Upgrade most upstream portion of rising main with 990m of 200 mm PVC pipe (Assumed: PN16, at depth of 1.2 m). See Appendix A for rising main sizing calculations.
Cost Estimate (95%ile, 2022 NZ Dollars)	$4,600,000

Figure 5-6: Upgrade MP-5 Plan View

5.3.1 MP-6: Upgrade of PS-VA Rising Main, PS-OF Pumps and PS-OF Rising Main

There is no current wastewater servicing in Mangawhai Village (growth cell PS-OF_2), with existing developments along Molesworth Drive connecting directly to the PS-VA rising main through small bore pressure sewer systems. Three alternatives for servicing growth in Mangawhai Village were evaluated, including:

- Construction of a new pumping station (PS-VD) outletting to the PS-VA rising main
- Construction of a new pumping station (PS-VD) outletting to PS-OF
- Construction of a new pumping station (PS-VD) outletting directly to the CWWTP

Through a workshop with KDC staff, serving Mangawhai Village through the PS-VA rising main was selected as the preferred option. This alternative consists of three components, including upgrade of the most downstream portion of the PS-VA rising main (MP-6-1), the construction of a new pump station and rising main (MP-6-2), and upgrade of PS-OF pump station and rising main (MP-6-3). The upgrade of PS-OF is required due to growth in Mangawhai Village and elsewhere in the catchment. Figure 5-7 presents a plan view of MP-6, highlighting the upgrade components. Table 5-7 to Table 5-9 present details of the network upgrade required to provide servicing to Mangawhai Village.

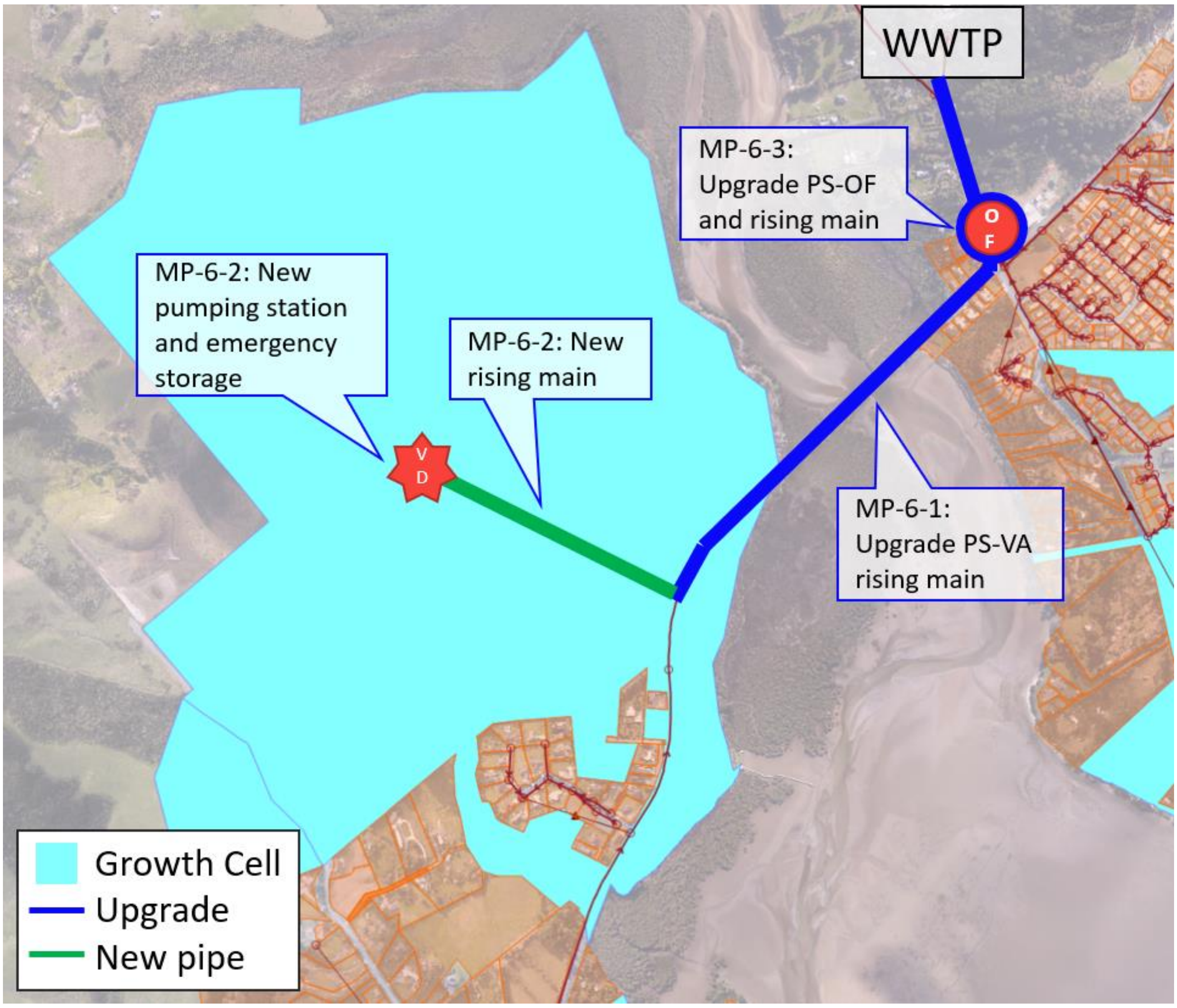

Figure 5-7: Upgrade MP-6 Plan View

Table 5-7: Upgrade MP-6-1 Details

Upgrade ID	MP-6-1
Deficiency	Peak velocity the most downstream section of the PS_VA rising main is above desired range
Upgrade Priority	Medium: Peak rising main velocity is 2.0 m/s
Trigger	Construction of new pump station (PS-VD) connecting to PS-VA rising main
Upgrade Details	Upgrade the most downstream section of PS-VA rising main with 1100 m of 300 mm PVC (Assumed: PN16 at depth of 1. 2 m). See Appendix A for rising main sizing calculations.
Cost Estimate (95%ile, 2022 NZ Dollars)	$2,000,000

Table 5-8: Upgrade MP-6-2 Details

Upgrade ID	MP-6-2
Deficiency	No current servicing
Upgrade Priority	High: No current servicing
Trigger	Growth cell PS-OF_2 coming online
Upgrade Details	Construct new pumping station (PS-VD) with capacity for PWWF (55 L/s), construct new emergency storage tank (475 m^3) and construct new rising main (Assumed: 600 m of PE100, SDR 16 pipe at depth of 1.2 m). See Appendix A for rising main sizing calculations.
Cost Estimate (95%ile, 2022 NZ Dollars)	$11,600,000

Table 5-9: Upgrade MP-6-3 Details

Upgrade ID	MP-6-3
Deficiency	PS-OF undersized resulting in overflows
Upgrade Priority	High: Substantial overflows predicted (106 m^3 prior to upgrade of PS-VA)
Trigger	Catchment wide growth
Upgrade Details	Upgrade of pumps at PS-OF for PWWF (170 L/s) Upgrade rising main with 440m of DN400 PE pipe (Assumed: PE100, SDR 16 at depth of 1.2 m). See Appendix A for rising main sizing calculations.
Cost Estimate (95%ile, 2022 NZ Dollars)	$7,200,000

5.3.2 MP-7: Upgrade PS-K

Table 5-10 presents details of the network upgrade to resolve the capacity constraint at PS-K.

Table 5-10: Upgrade MP-7 Details

Upgrade ID	MP-7
Deficiency	PS-K undersized
Upgrade Priority	Low: Maximum predicted water level is greater than 1 m from ground surface
Trigger	Growth cells PS-K_1 and PS-K_2 coming online and upgrade of gravity sewer on Jack Boyd Drive (MP-3).
Upgrade Details	Upgrade of pumps at PS-K for PWWF (45 L/s), no rising main updated is required. See Appendix A for rising main sizing calculations.
Cost Estimate	$50,000

(95%ile, 2022 NZ Dollars)	

6 Network Upgrades Phasing

Interim growth scenarios were defined in the model to determine the phasing of the network upgrades described in Section 5. The percentage of the ultimate number of wastewater connections within each pump station catchment that come online for each interim growth phase were sourced from Formative's report and are presented in Table 6-1 (Formative 2022).

Table 6-1: Assumed temporal distribution of Mangawhai dwelling growth (Figure from Formative 2022)

PS Catchment	Percentage of Ultimate Connections Coming Online						
	2021-23	2023-28	2028-33	2033-38	2038-43	2043-48	Post 2048
PS-A	50%	50%	0%	0%	0%	0%	0%
PS-B	50%	50%	0%	0%	0%	0%	0%
PS-C	50%	50%	0%	0%	0%	0%	0%
PS-E	50%	50%	0%	0%	0%	0%	0%
PS-F	20%	40%	40%	0%	0%	0%	0%
PS-G	30%	30%	40%	0%	0%	0%	0%
PS-H	50%	50%	0%	0%	0%	0%	0%
PS-J	50%	50%	0%	0%	0%	0%	0%
PS-K	15%	20%	20%	20%	20%	5%	0%
PS-OF/CWWTP West	4%	21%	24%	20%	12%	10%	6%
PS-OF/CWWTP East	5%	19%	18%	14%	10%	10%	6%
PS-VA	10%	10%	17%	17%	17%	17%	12%
PS-VB	10%	30%	40%	20%	0%	0%	0%
PS-VC	13%	22%	22%	22%	21%	0%	0%

Table 6-2 presents a summary of network performance for interim growth scenarios and highlights when a network upgrade is triggered. It is noted that the construction of PS-VD and upgrade of PS-OF have both been broken up into two phases. The constriction of PS-VD (MP-6-2) consists of the following phases:

- **Phase 1:** Construction of a new pumping station, rising main and emergency storage sized for ultimate growth. Interim pumps installed for with capacity of 25 L/s.
- **Phase 2:** Upgrade of pumps for ultimate PWWF (55 L/s).

The upgrade of PS-OF (MP-6-3) consists of the following phases:

- **Phase 1:** Upgrade of pumps for interim capacity of 140 L./s.
- **Phase 2:** Upgrade of pumps, wet well and rising main for ultimate PWWF (170 L/s).

Table 6-2 also presents upgrade costs for each project in 2022 NZ Dollars. A detailed breakdown of all costs is summarised in Appendix B.

Table 6-2: Summary of Upgrades Phasing and Cost Estimates

Upgrade ID	Upgrade	Upgrade Priority	Cost Estimate (95%ile, 2022 NZ Dollars)	Interim Growth Phase						
				2021-23	2023-28	2028-33	2033-38	2038-43	2043-48	Post 2048
MP-1	Upgrade gravity network through Campbell Park Youth Camp	High	$ 600,000	<u>Upgrade</u> Existing constraint						
MP-2	Upgrade gravity network on Seabreeze Road	Low	$1,100,000	<u>Upgrade</u> Existing constraint						
MP-3	Upgrade gravity network on Jack Boyd Drive	Low	$1,300,000	<u>Upgrade</u> Existing constraint						
MP-4	Upgrade PS-VC and rising main	High	$2,200,000	No rise in wet well level at PWWF	No rise in wet well level at PWWF	<u>Upgrade</u> 7m^3 spill volume				
MP-5	Upgrade PS-VA and upstream section of rising main	High	$4,600,000	No rise in wet well level at PWWF	No rise in wet well level at PWWF	<u>Upgrade</u> 1.2 m rise in wet well level at PWWF				
MP-6-1	Upgrade most downstream section of PS-VA rising main	<u>Medium</u>	$2,000,000				<u>Upgrade</u> Rising main vel. > 1.8 m/s after PS-VD upgrade			
MP-6-2	Construct PS-VD and rising main	<u>High</u>	<u>Stage 1:</u> $6,800,000 <u>Stage 2:</u> $4,800,000	<u>Upgrade Stage 1</u> Construct PS sized for ultimate growth, with interim pump			<u>Upgrade Stage 2</u> PWWF exceeds interim pump capacity			

Upgrade ID	Upgrade	Upgrade Priority	Cost Estimate (95%ile, 2022 NZ Dollars)	Interim Growth Phase						
				2021-23	2023-28	2028-33	2033-38	2038-43	2043-48	Post 2048
				capacity of 25 L/s			Upgrade pumps to capacity of 55 L/s and upgrade PS-VA rising main to CWWTP			
MP-6-3	Upgrade PS-OF and rising main	High	Stage 1: $1,000,000 Stage 2: $6,200,000	0.5 m rise in wet well level at PWWF	Upgrade Stage 1 Overflow to storage at PWWF Upgrade pump capacity to 140 L/s			Upgrade Stage 2 2m rise in wet well at PWWF Upgrade pumps and rising main to 170 L/s		
MP-7	Upgrade PS-K	Low	$50,000	No rise in wet well level at PWWF	No rise in wet well level at PWWF	0.3 m rise in wet well level at PWWF	Upgrade 1 m rise in wet well level at PWWF			
MP-8	PS-K diversion	High	$900,000	Diversion of PS-K direct to CWWTP						

7 Assumptions, Limitations and Recommendations

7.1 Model Limitations

- Catchments serviced by small bore pressure systems have been modelled simplistically using assumptions to replicate the peak flow and storage provided by individual pump units. Pressure systems have not been explicitly represented in the model and therefore capacity of these systems cannot be assessed. Details of assumptions that have been used in assessing these catchments are presented in the *Mangawhai Wastewater Model Build, Calibration and System Performance Assessment* report (WSP 2022).
- Pipe inverts in the model network have largely been assumed or inferred.
- As noted in the *Mangawhai Wastewater Model Build, Calibration and System Performance Assessment* report (WSP 2022), although the model has been calibrated to three wet weather events a substantial flow response was only observed for one event at most sites. This results in reduced confidence that the wet weather response for large rainfall events is represented.
- All network upgrades have been developed using the “high” dry weather flow profile. This profile represents wastewater flow during the peak summertime population in Mangawhai (calibration period from 28/12/2020 to 4/01/2021).

7.2 Exclusions

- Upgrades to small bore pressure sewer systems have not been considered in this assessment.
- Required upgrades to emergency storage have not been considered in this assessment. The *Mangawhai Wastewater Model Build, Calibration and System Performance Assessment* report noted that pump stations PS-A, PS-B, PS-C, PS-E, PS-F, PS-G, PS-H, PS-K, PS-OF and PS-VA do not meet emergency storage requirements as outlined in KDC’s Engineering Standards under existing conditions (WSP 2022),

7.3 Costing Assumptions

- The 95%ile Project Estimates are presented for all upgrades. This is the project Base Estimate, representing the cost of project delivery including design, construction, equipment plus a 40% contingency margin of safety and a further 60% contingency for the 95%ile Project Estimate (total contingency of 100% as per Class 5 estimate) as per Alta Consulting’s methodology (Alta Consulting 2022).
- All cost estimates are in 2022 NZ Dollars.
- Costs associated with working in a coastal / low lying area have not been considered in base estimates, where temporary works and trenching costs could be higher to accommodate dewatering and shoring of trenches, etc.
- The need for upgrade of electrical systems at pump stations has not been assessed in the base estimate and the existing systems were assumed to be sufficient when developing costs. There is a risk that upgrade of the local power network is required to facilitate upgrades, particularly at the higher flow pump stations.

7.4 Model Maintenance

The ongoing maintenance of a hydraulic model is critical to its successful use as a tool for both design and operational applications.

The key pre-requisites for keeping the model up to date are:

1) The introduction of a system to log all on-going changes to pumping stations, system upgrades/ renewals and new properties that are connected to the network.

2) The ability to validate the models created, initially at a strategic level using data recorded at pumping stations, the CWWTP and rain gauges (currently no rainfall gauges installed within the catchment), thus providing an indication of the degree of continued calibration within defined limits.

Suggested timescales for key milestones in a typical model maintenance programme are presented in Table 7-1 below. However, the timescales will be dependent on the rate of change in the network. Networks such as Mangawhai with high growth should be revisited more frequently than networks where there is little change in population or assets.

Table 7-1: Typical Hydraulic Model Maintenance Programme

Task	Frequency
Review and undertake asset update	3 monthly - annually
Review and undertake update of population	6 monthly – annually
Validation check	6 monthly – 2 years
Full recalibration	As indicated by outcome of validation checks or every 5-10 years

8 References

Alta Consulting. (2022). Mangawhai Wastewater Treatment Plant Disposal Options – Estimate Review. Auckland: Alta Consulting.

Formative. 2022. Mangawhai Wastewater Network Dwelling projections methodology technical report

WSP. 2022. Mangawhai CCWWTP Growth Strategy: Basis of Design for Wastewater Treatment and Disposal. WSP Reference: 1-14129.38

WSP. 2022. Mangawhai Wastewater Model Build, Calibration and System Performance Assessment. WSP Reference: 1-14129.09

WSP. 2021. Mangawhai Community Wastewater System: Master Plan Strategy. WSP Reference:

WSP. 2022. PS-K Diversion to CWWTP option. WSP Reference: 1-14129.35

Kaipara District Council 2011. Engineering Standards. Retrieved from: https://www.kaipara.govt.nz/services/engineering-standards

Appendix A
Rising Main Performance and Upgrade Sizing Calculations

Upgrade ID	Rising Main	Existing Pump Rate (L/s)	Upgraded Pump Rate (L/s)	Existing Rising Mains					Upgraded Rising Mains		
				Details	Internal Diam. (m)	Existing Peak Velocity (m/s)	Upgraded Pumps Peak Velocity (m/s)	Upgrade Required?	Details	Internal Diam. (m)	Peak Velocity After Upgrade (m/s)
MP-4	PS-VC	7.3	16	110mm PE (Assumed: PE100, SDR 16)	0.0894	1.16	2.55	Yes	DN140 PE (Assumed: PE100, PN 16)	0.114	1.57
MP-5	PS-VA Section 1	40	60	150mm PVC (Assumed: PN16)	0.1668	1.83	2.75	Yes	200mm PVC (Assumed: PN16)	0.2184	1.60
	PS-VA Section 2	40	60	200mm PVC (Assumed: PN16)	0.2184	1.07	1.6	No	N/A	N/A	N/A
	PS-VA Section 3	40	60	250mm PVC (Assumed: PN16)	0.2699	0.7	1.05	No	N/A	N/A	N/A
MP-6-1	PS-VA Section 3	40	114.8	250mm PVC (Assumed: PN16)	0.2699	0.7	2.01	Yes	300mm PVC (Assumed: PN16)	0.3252	1.38
MP-6-2	PS-VD (New)	N/A	55	N/A	N/A	N/A	N/A	Yes	DN250 PE (Assumed: PE100, SDR 16)	0.2034	1.69

Upgrade ID	Rising Main	Existing Pump Rate (L/s)	Upgraded Pump Rate (L/s)	Existing Rising Mains					Upgraded Rising Mains		
				Details	Internal Diam. (m)	Existing Peak Velocity (m/s)	Upgraded Pumps Peak Velocity (m/s)	Upgrade Required?	Details	Internal Diam. (m)	Peak Velocity After Upgrade (m/s)
MP-6-3	PS-OF (Phase 1)	65	140	300mm PVC (Assumed: PN16)	0.3252	0.78	1.69	No	N/A	N/A	N/A
	PS-OF (Phase 2)	65	170	300mm PVC (Assumed: PN16)	0.3252	0.78	2.05	Yes	400mm PVC (Assumed: PN16)	0.3252	2.05
MP-7	PS-K	32	45	225 PE (Assumed: PE100, SDR 16)	0.1829	1.22	1.71	No	N/A	N/A	N/A

Appendix B
Upgrade Costing Details

Mangawhai Wastewater Network Ugrades 2021 - 2051
Schedule of Prices

PS Name	Upgrade Description - Design and Construction	Unit	Rate	QTY	Base Estimate	Expected Estimate	95th Percentile Est	Detail Design Estimate	Construction	Project ID	Assumptions
PS-VC	Upgrade wet well (dia.1.8m and invert 5m)	LS	$ 195,000.00	1	$ 195,000.00	$ 273,000.00	$ 390,000.00	$ 58,500.00	$ 136,500.00	MP-4	30% estimate for condition assessment to determine extent of upgrade required
	Construct new emergency storage tank	No.	$ 494,000.00	1	$ 494,000.00	$ 691,600.00	$ 988,000.00	$ 148,200.00	$ 345,800.00	MP-4	30% estimate for detail design Assumed emergency stroage volume = 15m m3 (12 hours ADWF)
	Duty/standby pumps with 16L/s capacity	No.	$ 91,000.00	2	$ 182,000.00	$ 254,800.00	$ 364,000.00	$ 27,300.00	$ 154,700.00	MP-4	2x new pumps 30% estimate for detail design
	Confirm electrics if upgrade is required	LS	$ 50,000.00	1	$ 50,000.00	$ 70,000.00	$ 100,000.00	$ -	$ 50,000.00	MP-4	Estimate for condition assessment only
	Rising main upgrade DN140 PE PE100 PN16	m	$ 1,560.00	125	$ 195,000.00	$ 273,000.00	$ 390,000.00	$ 468.00	$ 194,532.00	MP-4	30% estimate for detail design
PS-VA	Duty/standby pumps with 60L/s capacity	No.	$ 260,000.00	2	$ 520,000.00	$ 728,000.00	$ 1,040,000.00	$ 78,000.00	$ 442,000.00	MP-5	2x new pumps 30% estimate for detail design
	Confirm electrics if upgrade is required	LS	$ 50,000.00	1	$ 50,000.00	$ 70,000.00	$ 100,000.00		$ 50,000.00	MP-5	Estimate for condition assessment only
	Confirm wet well if upgrade is required	LS	$ 50,000.00	1	$ 50,000.00	$ 70,000.00	$ 100,000.00		$ 50,000.00	MP-5	Estimate for condition assessment only
	Rising main upgrade DN200 PE PE100 PN16	m	$ 1,690.00	990	$ 1,673,100.00	$ 2,342,340.00	$ 3,346,200.00	$ 501,930.00	$ 1,171,170.00	MP-5	30% estimate for detail design
	Rising main upgrade DN300 PE PE100 PN16	m	$ 1,950.00	1100	$ 2,145,000.00	$ 3,003,000.00	$ 4,290,000.00	$ 643,500.00	$ 1,501,500.00	MP-6-1_2 Stage 2	30% estimate for detail design
PS-VD	New pumping station with capacity of 25L/s	No.	$ 455,000.00	2	$ 910,000.00	$ 1,274,000.00	$ 1,820,000.00	$ 273,000.00	$ 637,000.00	MP-6-1_2 Stage 1	2x new pumps 30% estimate for detail design
	New pumping station with capacity of 55L/s	No.	$ 130,000.00	2	$ 260,000.00	$ 364,000.00	$ 520,000.00	$ 78,000.00	$ 182,000.00	MP-6-1_2 Stage 2	2x new pumps
	New emergency storage	LS	$ 1,560,000.00	1	$ 1,560,000.00	$ 2,184,000.00	$ 3,120,000.00	$ 468,000.00	$ 1,092,000.00	MP-6-1_2 Stage 1	30% estimate for detail design Assumed emergency stroage volume = 475m3 (12 hours ADWF)
	New downstream rising main DN250 PE, PE100 PN16	m	$ 1,755.00	500	$ 877,500.00	$ 1,228,500.00	$ 1,755,000.00	$ 263,250.00	$ 614,250.00	MP-6-1_2 Stage 1	30% estimate for detail design
	Upgrade downstream section of rising main from PS-VA, DN300 PE, PE100 PN16	m	$ 1,950.00	500	$ 975,000.00	$ 1,365,000.00	$ 1,950,000.00	$ 292,500.00	$ 682,500.00	MP-6-1_1	30% estimate for detail design
	Upgrade pumps station at PS-OF to include 140L/s capacity	No.	$ 260,000.00	2	$ 520,000.00	$ 728,000.00	$ 1,040,000.00	$ 156,000.00	$ 364,000.00	MP-6-1_3 Stage 1	2x new pumps 30% estimate for detail design
	Upgrade pumps station at PS-OF to include 170L/s capacity	No.	$ 780,000.00	2	$ 1,560,000.00	$ 2,184,000.00	$ 3,120,000.00	$ 468,000.00	$ 1,092,000.00	MP-6-1_3 Stage 2	2x new pumps 30% estimate for detail design
	Upgrade upstream rising main to PS-OF DN300 PE, PE100 PN16	m	$ 1,950.00	800	$ 1,560,000.00	$ 2,184,000.00	$ 3,120,000.00	$ 468,000.00	$ 1,092,000.00	MP-6-1_3 Stage 2	30% estimate for detail design
	Tee connection DN300 - DN250 with reducer DN300 - DN200, PE100 PN16 fittings with DN250 and DN200 Non-return valves	No.	$ 39,000.00	1	$ 39,000.00	$ 54,600.00	$ 78,000.00	$ 11,700.00	$ 27,300.00	MP-6-1_2 Stage 1	30% estimate for detail design
PS-G(F)	Upgrade WW main to DN225 PE, PE100 PN16 at 3.1m depth with 2 x new manholes	m	$ 1,755.00	170	$ 298,350.00	$ 417,690.00	$ 596,700.00	$ 89,505.00	$ 208,845.00	MP-1	30% estimate for detail design
PS-K_1 (K)	Upgrade WW main to DN225 PE, PE100 PN16 at 2.6m depth with 8 x new manholes	m	$ 1,755.00	360	$ 631,800.00	$ 884,520.00	$ 1,263,600.00	$ 189,540.00	$ 442,260.00	MP-3	30% estimate for detail design
Seabreeze (C)	Upgrade WW main to DN225 PE, PE100 PN16 at 1.1m depth with 4 x new manholes	m	$ 1,755.00	310	$ 544,050.00	$ 761,670.00	$ 1,088,100.00	$ 163,215.00	$ 380,835.00	MP-2	30% estimate for detail design
PS-K	Upgrade PS-K 45L/s	No.	$ 12,600.00	2	$ 25,200.00	$ 35,280.00	$ 50,400.00	$ 3,780.00	$ 21,420.00	MP-7	2x new pumps 15% estimate for detail design
PS-K Diversion					$ 460,750.00	$ 645,050.00	$ 921,500.00			MP-8	As per WSP memo dated 9 August 2022 (rounded in estimate)
Grand Total					**$ 15,315,000.00**	**$ 21,441,000.00**	**$ 30,630,000.00**	**$ 4,378,608.00**	**$ 10,911,192.00**		

Appendix C
Mangawhai Wastewater Network Dwelling projections methodology technical report (Formative)

Mangawhai Wastewater Network

Dwelling projections methodology technical report

Prepared for Kaipara District Council

Final

13 January 2022

Formative

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Contents

Figures

1 Introduction

1.1 Background

Kaipara District Council ("KDC") has engaged WSP to prepare a wastewater model for Mangawhai to inform management and design decisions for the town's wastewater network. That model will break down the Mangawhai area into catchments, with each catchment draining to a specific wastewater pump station and then into a specific section of rising main.

A core input to the model will be the current and future number of dwellings located in each catchment, including a timing of when growth is expected to occur. This will allow KDC to appropriately design and size components of the network to ensure both present and future needs are met. KDC has commissioned Formative Limited to provide dwelling projections for the defined Mangawhai wastewater catchments.

1.2 Objective

The objective of the project has been to produce a set of dwelling projections for use in KDC's wastewater model for Mangawhai. The objective of this report is to describe the methodology used to produce the dwelling projections.

1.3 Caveat

This report relates to dwelling projections, and not to wastewater connections. Although there is some relationship between dwelling numbers and wastewater connections in many areas, this is not a 1:1 relationship across all of Mangawhai. There are a number of dwellings in Mangawhai now that are not connected, even inside the defined wastewater catchment areas. Unconnected dwellings in Mangawhai fall into three categories:

- Those outside the wastewater catchment who do not now, and are not anticipated for the foreseeable future, have access to the wastewater network.
- Dwellings inside the wastewater catchment but for which no connection is yet available. These tend to be dwellings towards the rural fringe of Mangawhai that are anticipated to have wastewater infrastructure extended to them in the future, but are not currently serviced.
- Dwellings inside the wastewater catchment that could be connected have not yet connected to the wastewater network.

To reiterate, the data in this report does not relate to wastewater connections.

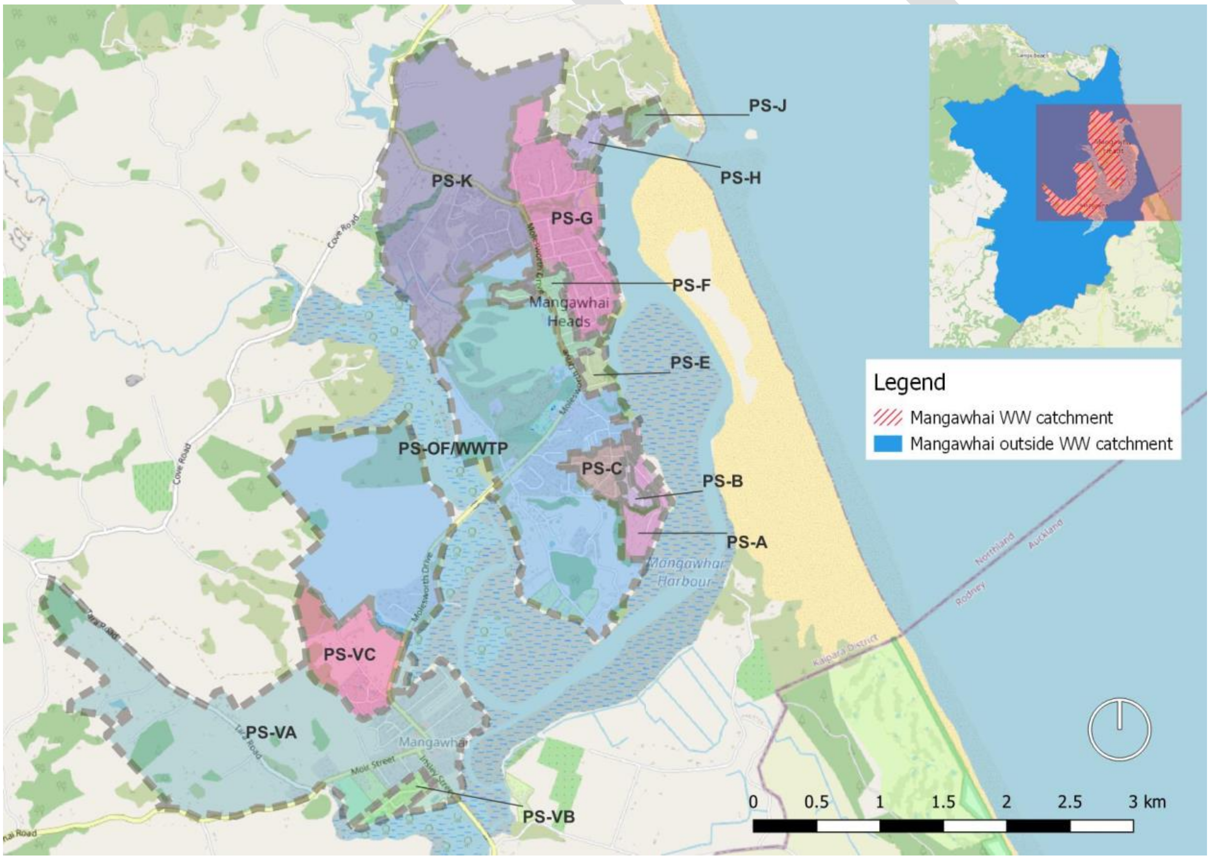
DRAFT

2 Scope

2.1 Geography

‘Mangawhai’ is defined for the purposes of this exercise as the area covered by the three Statistical Area 2[1] units (“SA2”) that together make up Mangawhai. Those three SA2s are: Mangawhai, Mangawhai Heads, and Mangawhai Rural. The core focus of the dwelling projections are those dwellings located in a geographic subset of those three SA2s. That subset is the area identified in the WSP catchments as being serviced as part of the Mangawhai wastewater network, which area is split into 14 pump station catchments (“PSC”) (the main body of Figure 2.1).

Figure 2.1: Mangawhai wastewater catchments spatial extent



Also included in the projections produced is a residual 15th catchment, which covers the area that is inside the three Mangawhai SA2s but that is not serviced as part of the Mangawhai wastewater network (the blue shaded area in Figure 2.1’s inset map). Note that Figure 2.1 shows only 14 catchments, and for utility purposes the single large PS-OF/WWTP defined by WSP has been split in

[1] A spatial area defined as part of New Zealand’s Statistical Standard for Geographic Areas 2018 (SSGA2018). SA2s replaced the area unit geography, and generally have a population of 1,000–3,000 residents, although less than that in rural areas.

these projections to two parts, divided by the estuary. Those two parts are called PS-OF/WWTP West (which includes Mangawhai Central) and PS-OF/WWTP East (the Mangawhai Heads part of the catchment).

Most Statistics NZ data is published at a Statistical Area 1[2] ("SA1") level, and SA1 data was used in this assessment. SA1 boundaries do not correlate with the wastewater catchment boundaries for Census data on dwelling numbers by type and location within Mangawhai, and GIS assessment of the relationship between dwelling location and PSC was undertaken to estimate counts to PSC, as described in section 3.2.

2.2 Demographic units

KDC's adopted demographic projections are those derived by Infometrics, and are projections of population and household numbers. The dwelling projections described in this report are consistent with those Infometrics projections, but differ in two main ways:

- Occupied dwelling counts tend to exceed household counts in a given geographic area, as they do in Mangawhai (by 3-4%). There are usually more occupied dwellings than households because included among them are usually some dwellings vacant awaiting new owners or tenants to move in, and properties vacant for renovation, as well as properties vacant long term.
- The total dwelling projections provided by Formative include both permanent residences and dwellings not permanently occupied, including those used as holiday homes. By contrast, Infometrics' household projections only consider permanently occupied dwellings. In the 2018 Census there were 1,080 "unoccupied dwellings – empty dwelling" in Mangawhai. Further description of the dwelling types used is provided below.

For the purposes of these projections we distinguish between "Permanently occupied dwellings" ("PODs") and "Not permanently occupied dwellings" ("NPODs").

2.2.1 PODs

Permanent dwellings are those classified as being in the Census categories "Occupied dwelling" and "Unoccupied dwelling – residents away". A dwelling is defined as an:

[2] A spatial area defined as part of New Zealand's Statistical Standard for Geographic Areas 2018 (SSGA2018). SA1s are a similar geographic scale to meshblocks although are defined so as to allow the release of more low-level data than is available at the meshblock level. SA1s generally have a population of 100–200 residents.

- "Occupied dwelling" if it was occupied at midnight on census night, or at any time during the next 12 hours,[3] and so may include some holiday homes that were occupied on Census night. That share is likely to be relatively small, given the mid-week timing of Census (Tuesday 6 March) outside school and public holidays after the end of summer. For the purposes of these projections it has been assumed that occupied dwellings are permanently occupied, and not holiday homes.
- "Unoccupied dwelling – residents away" where occupants of a dwelling are known to be temporarily away and are not expected to return on, or before, census night.[4]

2.2.2 NPODs

Dwellings that are not PODs are considered to be NPODs for this assessment. NPODs are those defined by Statistics NZ as "Unoccupied dwelling – empty dwelling", which may also include some permanently unoccupied dwellings that are never occupied, either permanently or for holidays:

> *An unoccupied dwelling is classified as 'empty' if it clearly had no current occupants and new occupants are not expected to arrive or move in on, or before, census night. Unoccupied dwellings that are being repaired or renovated are defined as empty dwellings. Unoccupied dwellings including private and non-private dwellings, baches, and holiday homes are defined as empty dwellings. A dwelling is classified as having 'residents away' where occupants of a dwelling are known to be temporarily away and are not expected to return on, or before, census night.*[5]

This assessment excludes dwellings under construction, which are considered to not yet be dwellings, and so will form part of future supply once they are completed.

[3] http://datainfoplus.stats.govt.nz/Item/nz.govt.stats/2f72bbd8-4374-4730-9137-5cc865167e98
[4] http://datainfoplus.stats.govt.nz/Item/example.org/67c2dc89-809d-40b0-ac43-f78eb3295699
[5] http://datainfoplus.stats.govt.nz/item/nz.govt.stats/8ecb3abd-fa5c-4150-bff4-c2df010b3447/3/

3 Data sources

This section summarises the data sources that were used in developing the projections. The data sources identified below were used in GIS and spreadsheet form, and interpreted in conjunction with multiple other layers to provide an indication of the potential location and amount of current and future developable residential capacity in Mangawhai.

3.1 Population and household projections

Population and household projections were sourced from KDC's adopted demographic projections. These were derived by Infometrics, and were provided in a spreadsheet format by KDC[6] and accompanied by a technical report.[7] The projections received are SA2 level population and household projections from 2013 to 2051. As described earlier, there are three SA2s in Mangawhai (Mangawhai, Mangawhai Heads, and Mangawhai Rural). The household projections were used to derive dwelling projections.

3.2 Census dwellings and household counts

Census, the main source of data that quantifies dwelling counts, publishes data only to an SA1 level.[8] Because SA1 boundaries do not correlate with Mangawhai's wastewater catchment boundaries, to establish baseline dwelling counts by PSC we have assessed the proportion of residential dwellings (PODs and NPODs) in each SA1 that are located in each PSC.

For this assessment the distribution of Census dwellings to PSC was made using the distribution of all buildings of greater than 70m^2.[9] The location of buildings is available to a point level, and so is one indication of the spatial distribution of dwellings within an area. This assessment assumed that each non-commercial building[10] represents exactly one dwelling,[11] and those dwellings were mapped in GIS and intersected with both PSCs and SA1s. This yields a matrix of building count by PSC[12] and SA1,[13] and therefore the share of buildings in each SA1 that are in each pump station's catchment. That share was then applied to Census SA1 totals for both PODs and NPODs. This assumes that PODs and NPODs

[6] Received as "Kaipara pivot v2.xlsx", on 19 October 2021
[7] "Population Projections 2018-2051 Kaipara District Council", October 2020, Infometrics
[8] https://www.stats.govt.nz/information-releases/statistical-area-1-dataset-for-2018-census-updated-march-2020
[9] 70m^2 was chosen so as to avoid including small ancillary residential buildings such as sheds and standalone garages as dwellings
[10] Classification of buildings to residential or non-residential was undertaken using Google Streetview and aerial photo imagery
[11] And so does not account for any joined dwellings such as duplexes and apartments
[12] n=14
[13] n=26

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within each SA1 are distributed identically across the PSCs. A subset[14] of the dwelling count matrix is shown in Figure 3.1 for illustrative purposes.

The output of this process is an estimation of Census dwellings to PSCs.

Figure 3.1: Dwelling count by SA1 and PSC (subset, for illustrative purposes)

SA1	PS-A	PS-B	PS-C	PS-E	PS-F	PS-G	PS-H	PS-J	Other PSCs	Not in a PSC	Total
Count of buildings >70sqm											
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7001105	-	-	-	-	-	66	62	39	.....	26	193
7001106	-	-	-	-	-	220	-	-	.....	-	220
7001107	-	-	-	-	63	129	-	-	.....	-	192
7001108	-	-	-	77	38	20	-	-	.....	-	204
7001109	-	-	32	-	-	-	-	-	.....	-	151
7001110	94	40	56	-	-	-	-	-	.....	-	243
7001111	5	-	17	-	-	-	-	-	.....	-	121
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Share of buildings >70sqm											
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7001105	0%	0%	0%	0%	0%	34%	32%	20%	.....	13%	100%
7001106	0%	0%	0%	0%	0%	100%	0%	0%	.....	0%	100%
7001107	0%	0%	0%	0%	33%	67%	0%	0%	.....	0%	100%
7001108	0%	0%	0%	38%	19%	10%	0%	0%	.....	0%	100%
7001109	0%	0%	21%	0%	0%	0%	0%	0%	.....	0%	100%
7001110	39%	16%	23%	0%	0%	0%	0%	0%	.....	0%	100%
7001111	4%	0%	14%	0%	0%	0%	0%	0%	.....	0%	100%
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

3.3 Wastewater connections

Current wastewater connections were provided as a GIS shapefile by KDC.[15] The shapefile includes fields that count the number of commercial and residential connections on each property, and whether there is the option for each property to have a new (commercial or residential) connection. The shapefile also contains a valuation number, which is a unique identifier which allows a link to be drawn to a list of KDC properties.

[14] The matrix does not show all SA1s, or all PSCs.
[15] Mangawhai_Properties_Wastewater_Connections.shp GIS file sourced from Kaipara District Councils property rating database; Magiq.

3.4 Properties

We were provided with a list of all properties in Mangawhai.[16] That list was used as a cross-check on the count of properties in each PSC, and to provide a measure of the area of each property, to assist in the assessment of additional potential development yield.

3.5 Airbnb listings

Airbnb listings in Mangawhai were used to verify the number of NPODs to PSC level. The process to achieve this was to map Airbnb data[17] to point location using coordinate data contained in the dataset. The Airbnb data mapped was entire homes (excluding private rooms in a dwelling), which is equivalent to a subset of NPODs that are available on the Airbnb platform. That data was used to check that Airbnb dwellings were, in all catchments, less than the estimates Census count of NPODs derived using the process described in section 3.2. In total within the PSCs 'entire home' Airbnbs account for 20% of all NPODs.

3.6 Spatial plan capacity estimates

The Mangawhai Spatial Plan[18] was used to inform capacity estimates and anticipated growth areas, interpreted in conjunction with the draft District plan zones. Figures 3.4.6 and 3.4.7 in the Spatial Plan were used to provide an indication of the possible magnitude and location of future growth, although Spatial Plan information was interpreted in the context that the Spatial Plan relates to a 30 year horizon, and not all capacity it anticipates will necessarily eventuate, and that which may not yield developable land for many years.

3.7 Draft District Plan zones

The draft Kaipara District Plan zones[19] were used as an aid to understanding the potential location and quantum of dwelling capacity that might be provided for in Mangawhai. Those zones are not yet publicly available, and are subject to change as the draft District Plan proceeds.

3.8 Wastewater catchments

Catchments were supplied by KDC, having been defined by WSP. A technical explanation of the catchments was provided in a WSP memo "Mangawhai Wastewater Network Future Catchment

[16] "Kaipara_District_Properties" layer in a supplied geodatabase
[17] http://insideairbnb.com/get-the-data.html
[18] https://www.kaipara.govt.nz/uploads/spatial%20planning/Mangawhai/CUR%20Mangawhai%20Spatial%20Plan%20Report%20DRAFT%202020%2006%2015%20SM.pdf
[19] Version current as of receipt 27 October 2021

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Delineation" (22 November 2021),[20]with an accompanying GIS shapefile.[21] The catchments defined are shown graphically in Figure 2.1 and in greater detail in Appendix 1.

3.9 Building footprints

Building footprints were used to estimate the distribution of Census dwellings within each SA1, to apportion dwellings to PSCs. The building footprints used were sourced from the LINZ WFS service.[22] That spatial distribution process is described in section 3.2.

3.10 Aerial photography

Aerial photography was used to assist in interpretation of building types, the location of new buildings (which in some cases due to currency may differ from footprint data) and vacant lots. Aerial photography used included Google Satellite and LINZ NZ Aerial Imagery.

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[20] Which we understand may have been subject to some minor and inconsequential text changes, and was potentially to be reissued in final form

[21] Wastewater connection data was sourced from KDC's property rating database; Magiq

[22] Dataset ID 101290, called "NZ Building Outlines", from https://data.linz.govt.nz/layer/101290/webservices/, last updated 14 June 2021, although exact date of capture of Mangawhai data is unavailable.

4 Approach

This section describes the process employed to calculate the dwelling demand projections for this project.

4.1 Dwellings baseline (2021)

The beginning point of the projections is to establish the number of dwellings in Mangawhai, by PSC, for the base year (2021). The number of dwellings in 2021 was set as the largest of:

- the number of residential wastewater connections
- the number of residential buildings larger than 70m^2
- total dwellings (PODs and NPODs) counted in the Census

No single one of those variables will accurately describe the number of dwellings in Mangawhai, because within the PSCs:

- there are properties that have dwellings but no wastewater connection
- there have been changes in dwelling numbers since each of the datasets were produced
- some properties have more than one dwelling
- some properties may have a dwelling that is smaller than 70m^2, while others will have non-dwellings that are larger than 70m^2.

The conclusion of that assessment is estimates of the number of dwellings in each PSC in 2021, with 2021 taken as the base year of the assessment. That estimate is that there are 2,701 dwellings in the PSCs, and a further 1,079 dwellings that are not in PSCs, but are in the study area (the three Mangawhai SA2s), for a total of 3,780 dwellings in all of Mangawhai (Figure 4.1). The process for estimating the share of all dwellings in each PSC that are PODs and NPODs is provided in section 3.2.

The 2,701 dwellings in the PSCs:

- compares to a Census 2018 count of 2,560 dwellings, 2,507 residential buildings of 70m^2+, and 2,510 residential wastewater connections
- includes 1,853 PODs, and 981 NPODs. Outside the PSCs there are a further 945 PODs, and 134 NPODs.

Note that for the PS-OF/WWTP catchments, the 2021 dwelling estimate was derived for the singular catchment, and then split to the two sub-catchments.

Figure 4.1: Estimated 2021 PSC dwelling counts

PSC	Residential WW connections	Count of residential buildings >70sqm	Census dwellings	Max. of these 3 (applied as 2021 dwelling estimate)
PS-A	79	99	94	99
PS-B	38	40	38	40
PS-C	104	105	101	105
PS-E	66	77	74	77
PS-F	86	145	154	154
PS-G	511	541	549	549
PS-H	65	62	64	65
PS-J	48	39	40	48
PS-K	491	361	408	491
PS-OF/WWTP West	25	58	42	49
PS-OF/WWTP East	406	375	380	384
PS-VA	421	465	462	465
PS-VB	85	66	64	85
PS-VC	85	74	90	90
Out of catchment	-	1,079	1,049	1,079
Total all	2,510	3,586	3,609	3,780
Total of PSCs				2,701

** orange cells: calculated as total for PS-OF/WWTP total, and then split*

4.2 Dwelling projections

Those baseline dwelling estimates are the first (2021) year in the dwelling projections. Future years were calculated by growing 2021 dwelling counts for all of Mangawhai, and then distributing that growth spatially. The projections of total dwelling numbers are calculated by summing the projections of PODs and NPODs as described in this subsection.

4.2.1 Permanent occupied dwelling projections

The dwelling projections are constrained by the household projections provided by Infometrics. To project total dwelling numbers in Mangawhai (PSCs and outside the wastewater catchment) our assessment calculates the growth in households that is projected each five year intercensal period, then factors that up to equate to an equivalent number of dwellings growth in that period, using the most recent (2018) ratio of dwellings to households in each SA2.[23] That current ratio is assumed to

[23] 1.03 dwellings per household I Mangawhai, 1.04 in Mangawhai Heads, and 1.01 in Mangawhai Rural.

hold constant into the future, resulting in the aggregate all of Mangawhai dwelling (PODs) projections shown in Appendix 2.

4.2.2 Non-permanent occupied dwelling projections

The Infometrics household projections are synonymous with (although slightly different to) PODs, but do not make any provision for NPODs, because NPODs do not accommodate households. Projections of NPODs (i.e. predominantly holiday homes) are therefore calculated separately, as explained below.

Within each PSC the share of all dwellings that are PODs and NPODs is estimated, for the base year, using Census data, as explained in section 3.2. The base year (2021) occupation structure is shown in Figure 4.2.

Figure 4.2: Mangawhai share of dwellings by occupation type (2021)

PSC	PODs	NPODs	Total dwellings
PS-A	56%	44%	100%
PS-B	55%	45%	100%
PS-C	66%	34%	100%
PS-E	54%	46%	100%
PS-F	62%	38%	100%
PS-G	52%	48%	100%
PS-H	46%	54%	100%
PS-J	46%	54%	100%
PS-K	74%	26%	100%
PS-OF/WWTP West	82%	18%	100%
PS-OF/WWTP East	71%	29%	100%
PS-VA	86%	14%	100%
PS-VB	89%	11%	100%
PS-VC	87%	13%	100%
Out of catchment	88%	12%	100%
Total all	74%	26%	100%
Total of PSCs	69%	31%	100%

We have assessed trends in dwelling occupation structure over time, in relation to settlement size, focussed on coastal settlements north of Auckland that are attractive to holiday home owners. That research enables us to conclude that as that type of settlement grows in size, the share of NPODs decreases, and the share of PODs increases. That change has been evident over the last intercensal period (2013-2018) and across most comparable settlements. That intuitively makes sense, given that

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a larger settlement will accommodate a larger base of retail and service businesses, making it more attractive (and viable) to live permanently in a location.

Based on that assessment the assumption is made that the proportion of all dwellings in the Mangawhai PSCs that are PODs will increase from the current 69% by 1% every 5 years, reaching 72% in 2028, 74% in 2038, and 76% in 2048 (on average, across all of the PSCs). Some PSCs will experience a greater increase in the share of PODs than others. The three PSCs in southern Mangawhai (PS-VA, PS-VB, and PS-VC) all have high shares of PODs now, at 86-89%), and therefore relatively little room for that share to increase further. The research undertaken also indicates that in comparable coastal settlements at least 10-15% of all dwellings are likely to be NPODs. In other parts of Mangawhai where POD shares are lower, there is greater potential for the share of NPODs to increase. The assumed shares of PODs are shown in Figure 4.3.

Figure 4.3: Share of dwellings that are PODs

PSC	2021	2023	2028	2033	2038	2043	2048
PS-A	56%	57%	57%	58%	58%	59%	59%
PS-B	55%	55%	56%	57%	57%	58%	58%
PS-C	66%	67%	68%	68%	69%	70%	70%
PS-E	54%	54%	55%	55%	56%	56%	57%
PS-F	62%	63%	63%	64%	64%	65%	66%
PS-G	52%	52%	53%	53%	54%	54%	55%
PS-H	46%	47%	47%	48%	48%	49%	49%
PS-J	46%	47%	47%	48%	48%	49%	49%
PS-K	74%	75%	76%	77%	77%	78%	79%
PS-OF/WWTP West	82%	83%	83%	84%	85%	86%	87%
PS-OF/WWTP East	71%	72%	73%	73%	74%	75%	75%
PS-VA	86%	88%	88%	88%	88%	88%	88%
PS-VB	89%	91%	91%	91%	91%	91%	91%
PS-VC	87%	89%	89%	89%	89%	89%	89%
Out of catchment	88%	89%	89%	89%	89%	89%	89%
Total all	74%	75%	76%	77%	78%	79%	79%
Total of PSCs	70%	71%	72%	73%	74%	75%	76%

The number of NPODs is calculated as the number of PODs divided by the proportion of dwellings that are PODs (in each year-PSC pair). Those resulting NPOD projections were subjected to several cross-checks to ensure outputs were reasonable. Those checks indicated that:

- Aggregate growth across all Mangawhai NPODs is projected to be 30-35 dwellings per year in the 2020s, decreasing to 20-30 in the 2030s. That is consistent with trends over the period 2006-2018, with a declining number of new NPODs observed over that period.

- Growth in NPODs in the range of coastal settlements north of Auckland (from Tutukaka in the north to Snells Beach in the south) has been in the order of 100 NPODs per year, implying an initial (and potentially ongoing) market share of NPOD growth in Mangawhai of around 30%. That also is consistent with recent trends.

4.3 Spatial allocation of growth

Having calculated the total POD and NPOD growth in Mangawhai, the final stage of the assessment was to spatially allocate that growth within Mangawhai. That allocation includes areas outside the PSCs. That spatial allocation involved several steps, as described below.

4.3.1 Dwelling capacity estimates

To accommodate growth a PSC must have capacity to do so, and PSCs with little capacity are unlikely to accommodate much growth. Because a number of the PSCs are geographically small, and largely fully developed with few or no vacant residential lots, they are unlikely to experience many net additional dwellings. There may be some replacement of older dwellings with large new ones, particularly in higher value parts of the town along the coastal fringe (e.g. PS-A, PS-E, and PS-G), however that replacement is unlikely to yield a net increase in dwelling numbers. There is some infill potential in those smaller catchments, however they lack the more significant potential of PSCs where there are large greenfields areas.

The potential to accommodate additional dwellings was assessed:

- By reviewing the additional capacity estimates produced as input to the Mangawhai Spatial Plan. That data was provided in spreadsheet form,[24] and then mapped by us, to allow summation to PSC.
- From our independent visual inspection of vacant capacity from Google Streetview and aerial photography, which was assisted by policy-based contributions from Paul Waanders (District Planner).[25]

From that assessment it was concluded that there is very limited potential (less than 30 dwellings) for net additional dwellings (PODs or NPODs) in the following seven PSCs: PS-A, PS-B, PS-C, PS-E, PS-H, PS-J, and PS-VB. Two PSCs (PS-F and PS-G) had greater potential (50-60 dwellings), although are largely

[24] Mitch Filtered - 20170414 Rating Data w zoning w capacities.xlsx
[25] Including in relation to Mangawhai Central, and the status of Plan Change 78, the status and interpretation of the Mangawhai Spatial Plan, and current progress on draft District Plan policy, including minimum lot sizes by zone and location.

fully developed already. The other four PSCs have the most significant potential for additional dwellings. Those five PSCs are:

- PS-K: the largely rural area in the north-west of Mangawhai Heads on the road north to Langs Beach (taking in Gumdiggers Lane and Jack Boyd Drive). This PSC includes Area A in Figure 4.4, one of two 'growth pockets' identified in the Spatial Plan, and anticipated by that Plan to provide for a potential of 302 lots in conjunction with Area D, and one of only two new areas with the emphasis on infill.
- PS-OF/WWTP: the largest PSC by area, extending from north of the golf course all the way south to the estuary and Estuary Drive, and taking in Mangawhai Central on the western side of the estuary, and a large part of the undeveloped area in Mangawhai Heads.
- PS-VA: the south-western-most part of Mangawhai that is located north of the Kaiwaka-Mangawhai Road. This is a geographically large PSC, and includes Area D (Figure 4.4) which is anticipated by the Spatial Plan to provide for a potential of 302 lots in conjunction with Area A. Much of the future growth area within this PSC is identified in the Spatial Plan as Rural Residential Zone 1 (minimum 0.4-0.8ha).
- PS-VC: this is the PSC in between Mangawhai Central and the Mangawhai shops, on the western side of Molesworth Drive. The PSC is sparsely populated at present, but located within the area that is anticipated to accommodate both infill dwellings and new dwellings on lots that are zoned but vacant.

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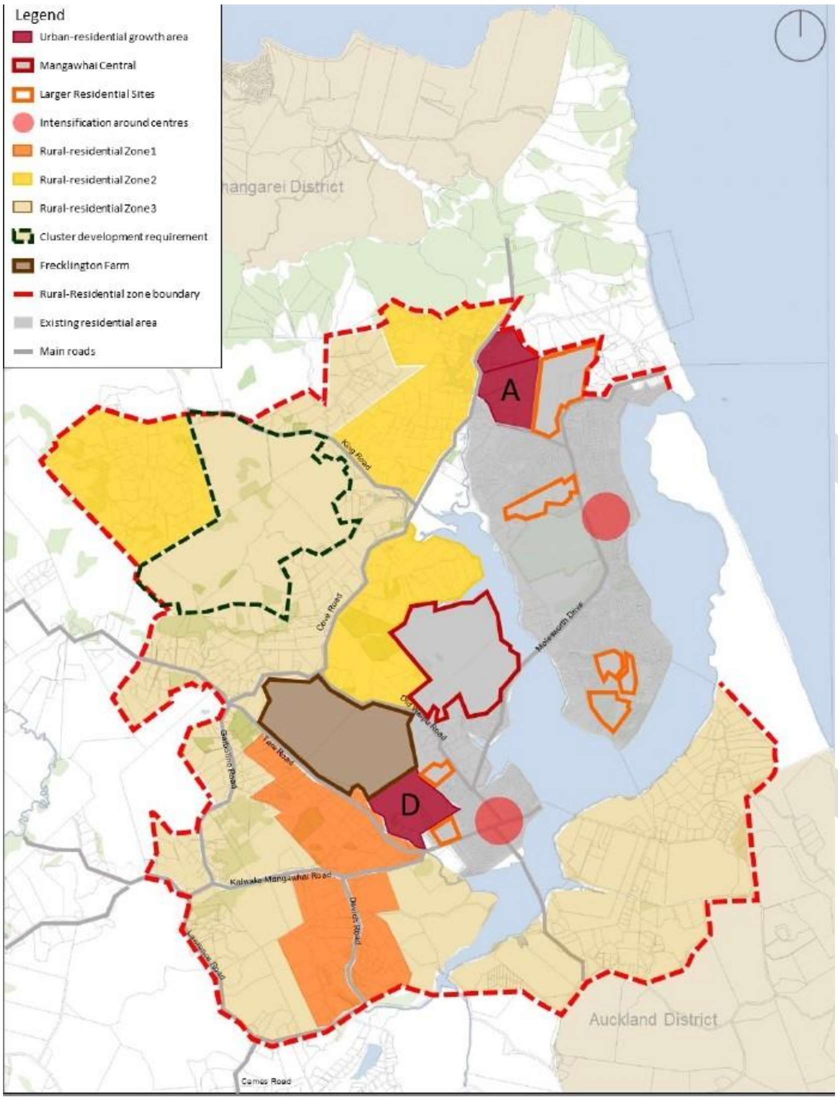
Figure 4.4: Mangawhai Spatial Plan, Figure 3.4.7 (Preferred growth option)



In addition to the areas inside the PSCs, the area outside the PSCs is also anticipated by the Spatial Plan to accommodate some future growth, on large lot Rural Residential zoned parcels. The dwelling capacity available in each zone was checked against Spatial Plan estimates of total additional capacity by location type (e.g. 'Zoned but not built', Infill, Minor Dwellings, rural-residential, etc.)[26] to ensure that the capacity assumed for this assessment was less than the Spatial Plan's capacity. A key finding of this assessment was that to provide for the level of growth projected by Infometrics, which equates to about 3,050 additional dwellings (PODs and NPODs) in the period 2021-2051, only 66% of the Spatial Plan's capacity (4,643 dwellings)[27] would need to be taken up. That confirms that the allocation assumed is reasonable, and achievable, in the context of the Spatial Plan's anticipation.

[26] From Figure 3.4.6 in the Spatial Plan
[27] Figure 3.4.6 in the Spatial Plan

The dwelling capacities assumed are summarised in Figure 4.5, where the dominance of four PSCs is evident. The capacity identified there is less than the Spatial Plan capacity, as it identifies only enough capacity to accommodate anticipated 30 year growth, and so does not identify as much 'Zoned but not built' and Infill capacity, for example.

Figure 4.5: Mangawhai PSC net additional dwelling capacity estimates (as at 2021)

PSC	Additional dwelling capacity estimate
PS-A	15
PS-B	10
PS-C	27
PS-E	14
PS-F	58
PS-G	54
PS-H	12
PS-J	9
PS-K	413
PS-OF/WWTP West	1,015
PS-OF/WWTP East	495
PS-VA	472
PS-VB	6
PS-VC	276
Out of catchment	308
Total all	3,184
Total of PSCs	2,876

4.3.2 Timing

Once the anticipated level of dwelling growth has been allocated spatially to the PSCs (and balance area outside the PSCs), the final stage in the process was to allocate growth over time. For this process it was assumed that the PSCs with little net additional dwelling capacity would have that capacity taken up evenly over the period to 2028, reflecting an imminent pressure on land availability, and the attractiveness to establish dwellings on existing lots in established areas. In practice this development may be phased over a longer time, however the small amount of growth assumed will mean that a longer actual phasing of that growth will be of little negative consequence for wastewater planning, and faster, rather than slower, assumed development will be conservative in that the assumption will not understate when any infrastructure upgrades would be required.

Assumptions relating to the staging of growth in PSCs with greater capacity are more important. Once the smaller PSCs have been allocated their share of growth, the balance of growth anticipated by the Infometrics-based projections must be spread across the remaining PSCs. That allocation was done broadly pro-rata to capacity of each of the six PSCs, and based on the assumption that each PSC would

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experience consistent growth over time, until dwelling capacity is exhausted. The assumed temporal distribution of dwelling growth is shown in Figure 4.6. That development phasing was assumed to apply to both PODs and NPODs.

Figure 4.6: Assumed temporal distribution of Mangawhai dwelling growth

PSC	2021-23	2023-28	2028-33	2033-38	2038-43	2043-48	Post 2048
PS-A	50%	50%	0%	0%	0%	0%	0%
PS-B	50%	50%	0%	0%	0%	0%	0%
PS-C	50%	50%	0%	0%	0%	0%	0%
PS-E	50%	50%	0%	0%	0%	0%	0%
PS-F	20%	40%	40%	0%	0%	0%	0%
PS-G	30%	30%	40%	0%	0%	0%	0%
PS-H	50%	50%	0%	0%	0%	0%	0%
PS-J	50%	50%	0%	0%	0%	0%	0%
PS-K	15%	20%	20%	20%	20%	5%	0%
PS-OF/WWTP West	4%	21%	24%	20%	12%	10%	6%
PS-OF/WWTP East	5%	19%	18%	14%	10%	10%	6%
PS-VA	10%	10%	17%	17%	17%	17%	12%
PS-VB	10%	30%	40%	20%	0%	0%	0%
PS-VC	13%	22%	22%	22%	21%	0%	0%
Out of catchment	14%	20%	20%	15%	16%	15%	0%

The output of that process is projections of dwelling numbers from 2021 to 2051, by PSC, for PODs and NPODs, as presented in the next section.

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5 Mangawhai dwelling projections

The dwelling projections derived from the above process are shown in Figure 5.1, and in full detail in Appendix 3. Those projections are that dwelling numbers in Mangawhai will double (+95%) in the period 2021-2051, with growth being concentrated inside the PSCs, and greater for NPODs than PODs. Those detailed projections are also provided in an accompanying spreadsheet.

Figure 5.1: Mangawhai dwelling projections

	PODs			NPODs			Total dwellings		
	In PSCs	Out of PSCs	Total Mangawhai	In PSCs	Out of PSCs	Total Mangawhai	In PSCs	Out of PSCs	Total Mangawhai
2021	1,853	945	2,798	848	134	981	2,701	1,079	3,780
2023	2,137	989	3,125	920	121	1,041	3,057	1,109	4,166
2028	2,718	1,050	3,768	1,073	128	1,202	3,792	1,178	4,970
2033	3,322	1,112	4,434	1,201	136	1,337	4,523	1,248	5,771
2038	3,819	1,158	4,977	1,272	141	1,414	5,092	1,299	6,391
2043	4,206	1,207	5,414	1,315	147	1,463	5,522	1,355	6,876
2048	4,456	1,253	5,709	1,326	153	1,479	5,782	1,407	7,188
2051	4,605	1,281	5,887	1,332	156	1,489	5,938	1,438	7,376

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6 Recommendations

The following recommendations are made to provide Council officers with guidance on the potential research that could be undertaken in the future.

First, the resident population and household projections are a key input into this assessment. The future is inherently uncertain, which means that the population and household projections may not match the actual growth that occurs. We consider that Council officers should assess the performance of the projections on an annual basis, and if growth exceeds the projections that the assessment in this report could be updated. Also, it is likely that KDC will commission new population and household projections in the coming two to three years which could also trigger the need for an update to this assessment. However, if growth tracks at a level similar to the population and household projections then there would not be a need to update the assessment.

Second, this report has assessed the number of dwellings in each catchment and does not assess whether they are served by infrastructure now or in the future. Given the current infrastructure some of these dwellings cannot be connected into the wastewater system. If there was more time available, it would be possible to develop an estimate of the number of dwellings in each catchment that *could* be served at each period. This would require an understanding of the potential role out of new infrastructure and a property level assessment. This potential research could be investigated when this study is updated in the future, which would provide a better understanding of demands on the infrastructure system, rather than assuming all dwellings can be served at all points in time.

Third, from our discussions with Council officers it is apparent that there are number of points in the system where there could be capacity constraints. Specifically, the addition of pipes to connect new dwellings to the wastewater system is only one part of the equation, with other capacity constraints at the pump station level, the treatment plant and the dispersal field. This research has assessed key drivers of demand (residents and holiday homes), but does not assess the supply side aspects. Our understanding is that the capacity in some parts of the system is close to capacity and that new capacity is being constructed in the coming years. Given the tight nature of supply, as compared to demands, it may be prudent to update undertake annual reviews of connection numbers and to consider this report on an annual basis until the new capacity is completed.

Finally, the baseline number of dwellings was estimated using a range of datasets. The final number of dwellings that has been used in this study is conservatively high, as it will include some dwellings that are connected to wastewater and others that are not. Therefore, it is considered that the change in dwellings between each point in time will provide the best understanding of the number of potential new connections. Specifically, the baseline number of dwellings should not be taken as the current number of dwellings that are connected to the system.

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Appendix 1 Wastewater catchment maps

Figure A1.1: Catchments PS-A, PS-B and PS-C

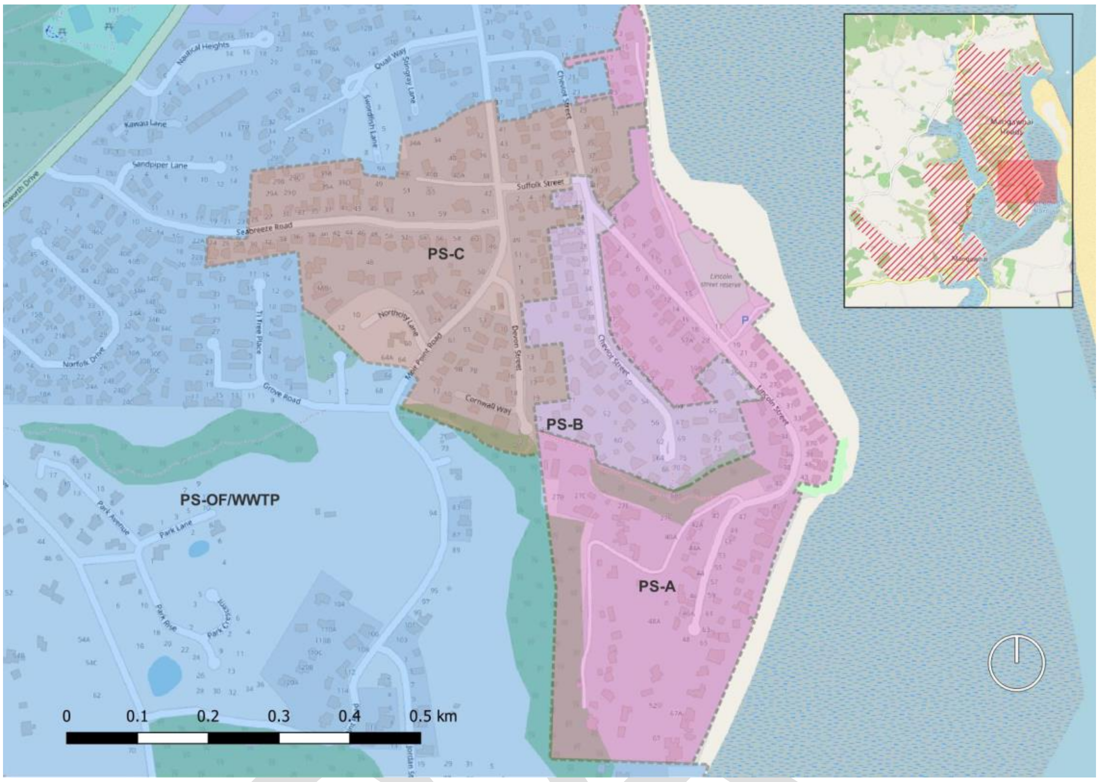

Figure A1.2: Catchments PS-E and PS-F

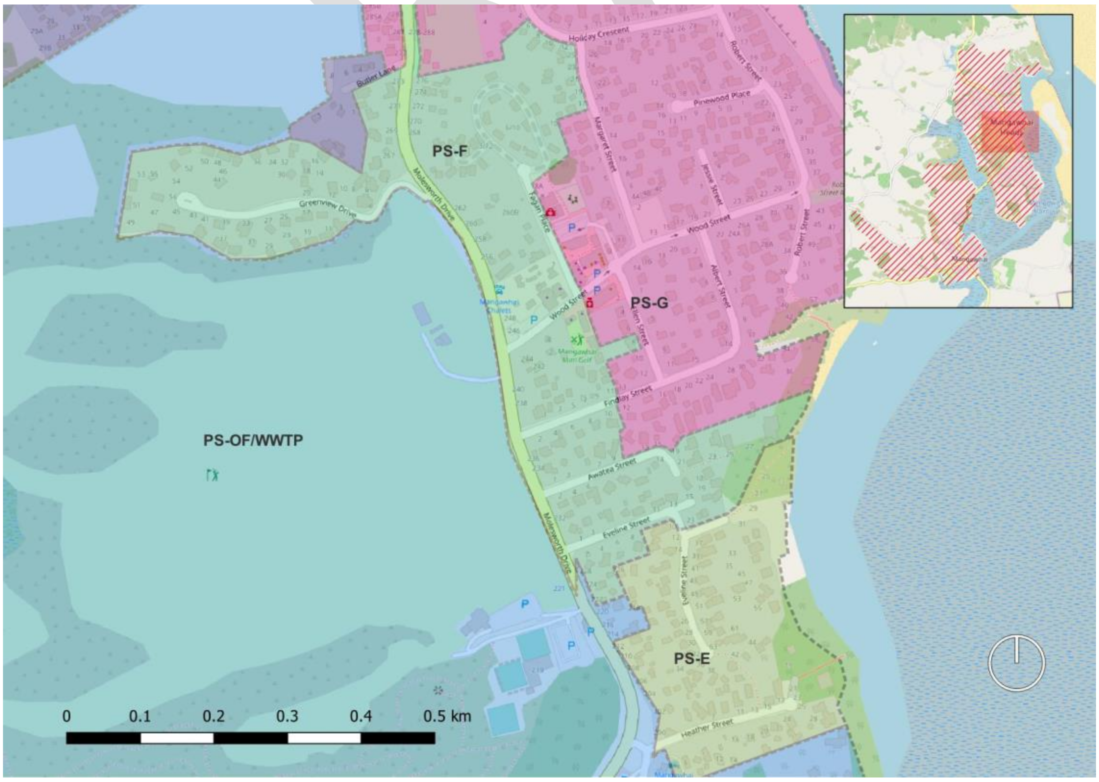

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Figure A1.3: Catchments PS-G and PS-K

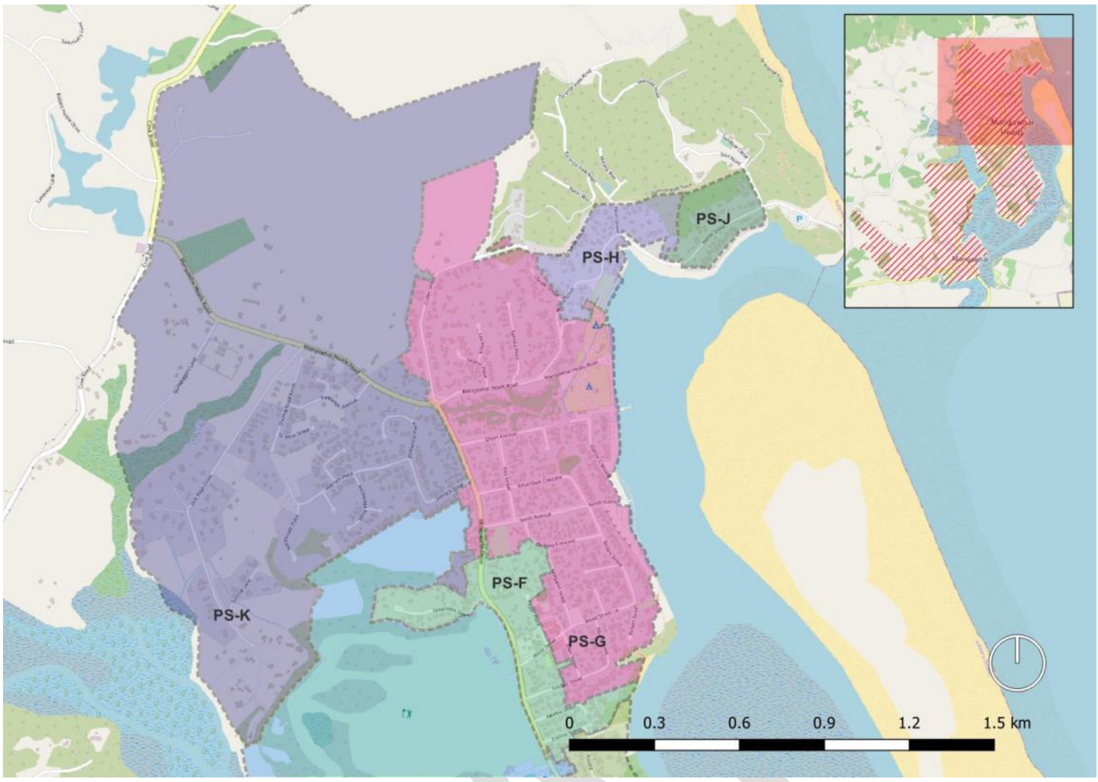

Figure A1.4: Catchments PS-H and PS-J

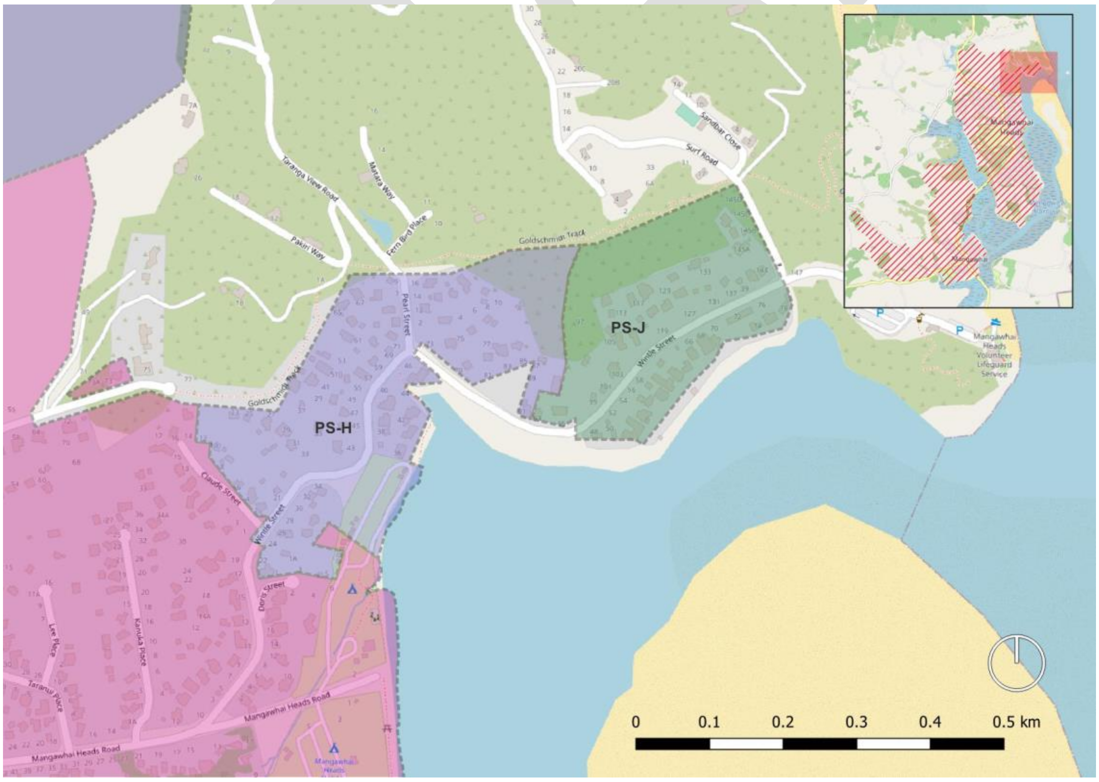

Figure A1.5: Catchment PS-OF/WWTP

Note: the single large PS-OF/WWTP defined by WSP has been split in these projections to two parts, divided by the estuary. Those two parts are called PS-OF/WWTP West (which includes Mangawhai Central) and PS-OF/WWTP East (the Mangawhai Heads part of the catchment).

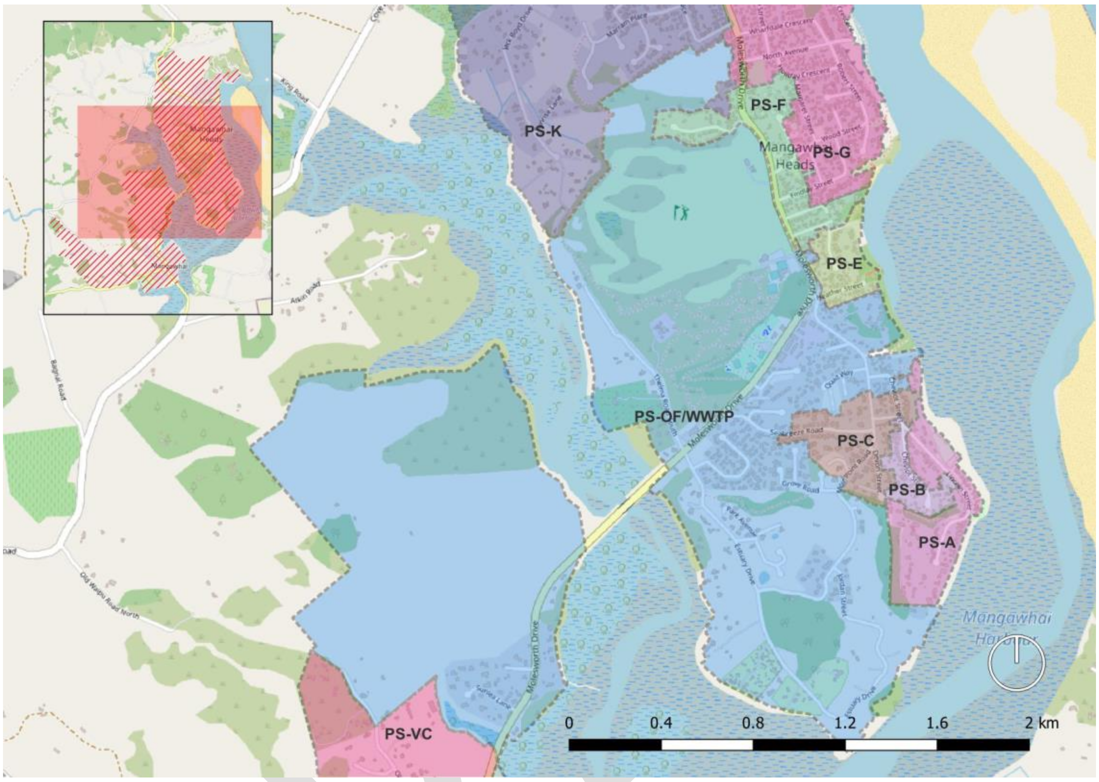

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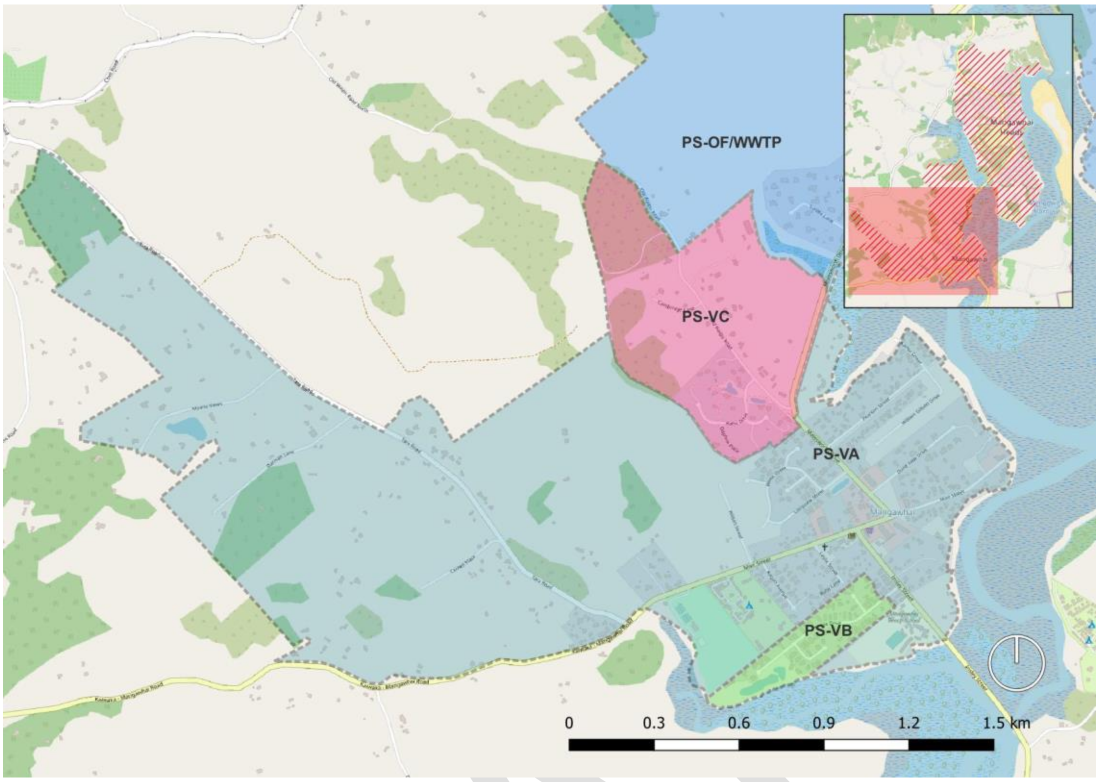
Figure A1.6: Catchments PS-VA, PS-VB and PS-VC



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Appendix 2 Infometrics household projections

The Infometrics household projections for the three Mangawhai SA2s are shown in the following table, together with the derived aggregate dwelling projections for all of Mangawhai (PODs only, excludes NPODs) that are used as the basis for the PSC dwelling projections.

Year	Infometrics household projections				Dwelling projections
	Mangawhai	Mangawhai Heads	Mangawhai Rural	Mangawhai total	
2021	552	1,091	1,077	2,719	2,796
2022	599	1,149	1,128	2,876	2,961
2023	648	1,208	1,181	3,037	3,126
2024	684	1,257	1,224	3,166	3,254
2025	720	1,305	1,267	3,291	3,382
2026	756	1,351	1,308	3,415	3,510
2027	791	1,398	1,349	3,537	3,639
2028	827	1,444	1,390	3,661	3,765
2029	859	1,491	1,438	3,787	3,899
2030	890	1,538	1,488	3,916	4,032
2031	923	1,586	1,538	4,046	4,165
2032	955	1,633	1,588	4,177	4,299
2033	988	1,681	1,638	4,307	4,432
2034	1,014	1,721	1,681	4,417	4,541
2035	1,041	1,760	1,723	4,524	4,648
2036	1,067	1,798	1,765	4,630	4,757
2037	1,092	1,835	1,806	4,733	4,866
2038	1,118	1,872	1,846	4,835	4,975
2039	1,141	1,903	1,878	4,922	5,063
2040	1,165	1,934	1,910	5,008	5,149
2041	1,188	1,964	1,941	5,093	5,238
2042	1,211	1,993	1,972	5,176	5,324
2043	1,233	2,023	2,003	5,259	5,411
2044	1,245	2,033	2,040	5,318	5,470
2045	1,256	2,043	2,078	5,377	5,530
2046	1,267	2,053	2,115	5,434	5,589
2047	1,277	2,063	2,152	5,492	5,647
2048	1,288	2,072	2,189	5,549	5,706
2049	1,295	2,078	2,223	5,597	5,766
2050	1,303	2,085	2,257	5,644	5,826
2051	1,310	2,091	2,291	5,692	5,885

Appendix 3 Detailed dwelling projections

Figure A3.1: Mangawhai permanent occupied dwelling projections

Year	PS-A	PS-B	PS-C	PS-E	PS-F	PS-G	PS-H	PS-J	PS-K	PS-OF/WWTP		PS-VA	PS-VB	PS-VC	Non-PSC	Total	Total PSCs
										West	East						
2021	55	22	69	41	95	284	30	22	364	40	273	402	76	78	945	2,798	1,853
2022	59	24	76	45	101	292	33	25	395	62	284	426	76	96	967	2,962	1,995
2023	63	27	83	48	107	300	36	27	426	85	296	449	77	114	989	3,125	2,137
2024	64	28	86	50	111	303	37	28	443	127	314	459	77	126	1,001	3,254	2,253
2025	66	29	88	51	116	307	39	29	459	170	333	468	77	138	1,013	3,383	2,369
2026	67	30	91	52	121	310	40	29	476	213	351	478	78	150	1,025	3,511	2,486
2027	69	31	94	54	125	313	41	30	492	255	370	487	78	163	1,038	3,640	2,602
2028	70	32	96	55	130	316	42	31	509	298	389	496	78	175	1,050	3,768	2,718
2029	70	32	96	55	135	321	42	31	525	347	407	512	79	187	1,062	3,902	2,839
2030	70	32	96	55	139	325	42	31	542	395	424	528	79	199	1,075	4,035	2,960
2031	70	32	96	55	144	329	42	31	558	444	442	545	80	211	1,087	4,168	3,081
2032	70	32	96	55	149	334	42	31	575	493	460	561	80	223	1,099	4,301	3,202
2033	70	32	96	55	153	338	42	31	591	541	478	577	81	236	1,112	4,434	3,322
2034	70	32	96	55	153	338	42	31	608	582	492	593	81	248	1,121	4,543	3,422
2035	70	32	96	55	153	338	42	31	624	623	506	609	81	260	1,130	4,651	3,521
2036	70	32	96	55	153	338	42	31	641	663	520	625	81	272	1,139	4,760	3,621
2037	70	32	96	55	153	338	42	31	657	704	534	641	82	284	1,149	4,869	3,720
2038	70	32	96	55	153	338	42	31	674	744	547	657	82	296	1,158	4,977	3,819
2039	70	32	96	55	153	338	42	31	691	768	557	673	82	308	1,168	5,065	3,897
2040	70	32	96	55	153	338	42	31	707	791	567	689	82	319	1,178	5,152	3,974
2041	70	32	96	55	153	338	42	31	724	814	577	705	82	331	1,188	5,239	4,052
2042	70	32	96	55	153	338	42	31	740	838	587	721	82	343	1,197	5,326	4,129
2043	70	32	96	55	153	338	42	31	757	861	597	737	82	354	1,207	5,414	4,206
2044	70	32	96	55	153	338	42	31	761	881	606	753	82	354	1,216	5,473	4,256
2045	70	32	96	55	153	338	42	31	765	902	616	769	82	354	1,226	5,532	4,306
2046	70	32	96	55	153	338	42	31	769	922	625	785	82	354	1,235	5,591	4,356
2047	70	32	96	55	153	338	42	31	773	942	635	801	82	354	1,244	5,650	4,406
2048	70	32	96	55	153	338	42	31	777	963	644	817	82	354	1,253	5,709	4,456
2049	70	32	96	55	153	338	42	31	781	983	653	833	82	354	1,263	5,768	4,506
2050	70	32	96	55	153	338	42	31	786	1,003	663	849	82	354	1,272	5,827	4,556
2051	70	32	96	55	153	338	42	31	790	1,024	672	866	82	354	1,281	5,887	4,605
2021-2031	15	10	27	14	49	45	12	9	194	404	169	143	4	133	142	1,369	1,228
2021-2051	15	10	27	14	58	54	12	9	425	984	399	464	6	276	336	3,088	2,752

Figure A3.2: Mangawhai non-permanent occupied dwelling projections

Year	PS-A	PS-B	PS-C	PS-E	PS-F	PS-G	PS-H	PS-J	PS-K	PS-OF/WWTP		PS-VA	PS-VB	PS-VC	Non-PSC	Total	Total PSCs
										West	East						
2021	44	18	36	36	59	265	35	26	127	9	111	63	9	12	134	981	848
2022	46	20	38	38	61	269	38	28	135	13	113	62	8	13	127	1,011	884
2023	48	22	41	41	64	274	41	30	142	18	115	62	8	15	121	1,041	920
2024	49	22	42	42	66	275	42	31	146	26	121	63	8	16	122	1,073	951
2025	50	23	43	43	68	277	43	32	150	34	127	64	8	18	124	1,105	981
2026	51	24	44	44	71	279	44	33	154	43	133	66	8	20	125	1,137	1,012
2027	52	24	45	45	73	280	46	34	158	51	139	67	8	21	127	1,169	1,043
2028	53	25	46	46	75	282	47	35	162	59	145	68	8	23	128	1,202	1,073
2029	52	25	46	45	78	285	47	35	166	67	151	70	8	24	130	1,229	1,099
2030	52	25	46	45	80	287	46	34	170	76	156	73	8	26	131	1,256	1,124
2031	52	25	45	45	82	290	46	34	174	84	162	75	8	27	133	1,283	1,150
2032	52	25	45	45	84	293	46	34	178	93	167	77	8	29	134	1,310	1,175
2033	52	24	45	45	87	295	46	34	182	101	173	79	8	31	136	1,337	1,201
2034	51	24	45	44	86	294	46	34	185	107	177	81	8	32	137	1,352	1,215
2035	51	24	44	44	86	293	46	34	189	113	180	84	8	34	138	1,367	1,229
2036	51	24	44	44	85	292	45	34	192	119	184	86	8	35	139	1,383	1,244
2037	51	24	44	44	85	291	45	34	195	125	188	88	8	37	140	1,398	1,258
2038	50	24	43	44	84	290	45	33	199	131	191	90	8	38	141	1,414	1,272
2039	50	24	43	44	84	288	45	33	202	133	193	92	8	40	143	1,424	1,281
2040	50	24	43	43	83	287	45	33	205	136	195	95	8	41	144	1,433	1,289
2041	50	24	43	43	83	286	45	33	208	138	197	97	8	43	145	1,443	1,298
2042	50	24	42	43	83	285	44	33	211	140	199	99	8	44	146	1,453	1,307
2043	49	23	42	43	82	284	44	33	215	143	201	101	8	46	147	1,463	1,315
2044	49	23	42	43	82	283	44	33	214	144	203	103	8	46	149	1,466	1,317
2045	49	23	42	43	81	282	44	33	213	145	205	106	8	46	150	1,469	1,320
2046	49	23	42	42	81	281	44	33	213	147	206	108	8	46	151	1,473	1,322
2047	49	23	41	42	81	280	44	32	212	148	208	110	8	46	152	1,476	1,324
2048	48	23	41	42	80	278	44	32	212	150	210	112	8	46	153	1,479	1,326
2049	48	23	41	42	80	277	43	32	211	151	211	114	8	46	154	1,482	1,328
2050	48	23	41	42	79	276	43	32	210	152	213	117	8	46	155	1,486	1,330
2051	48	23	40	41	79	275	43	32	210	154	214	119	8	46	156	1,489	1,332
2021-2031	8	7	10	9	23	25	11	9	47	75	51	12	-1	16	-1	301	302
2021-2051	4	5	5	6	20	10	8	6	83	145	104	56	-1	34	23	507	485

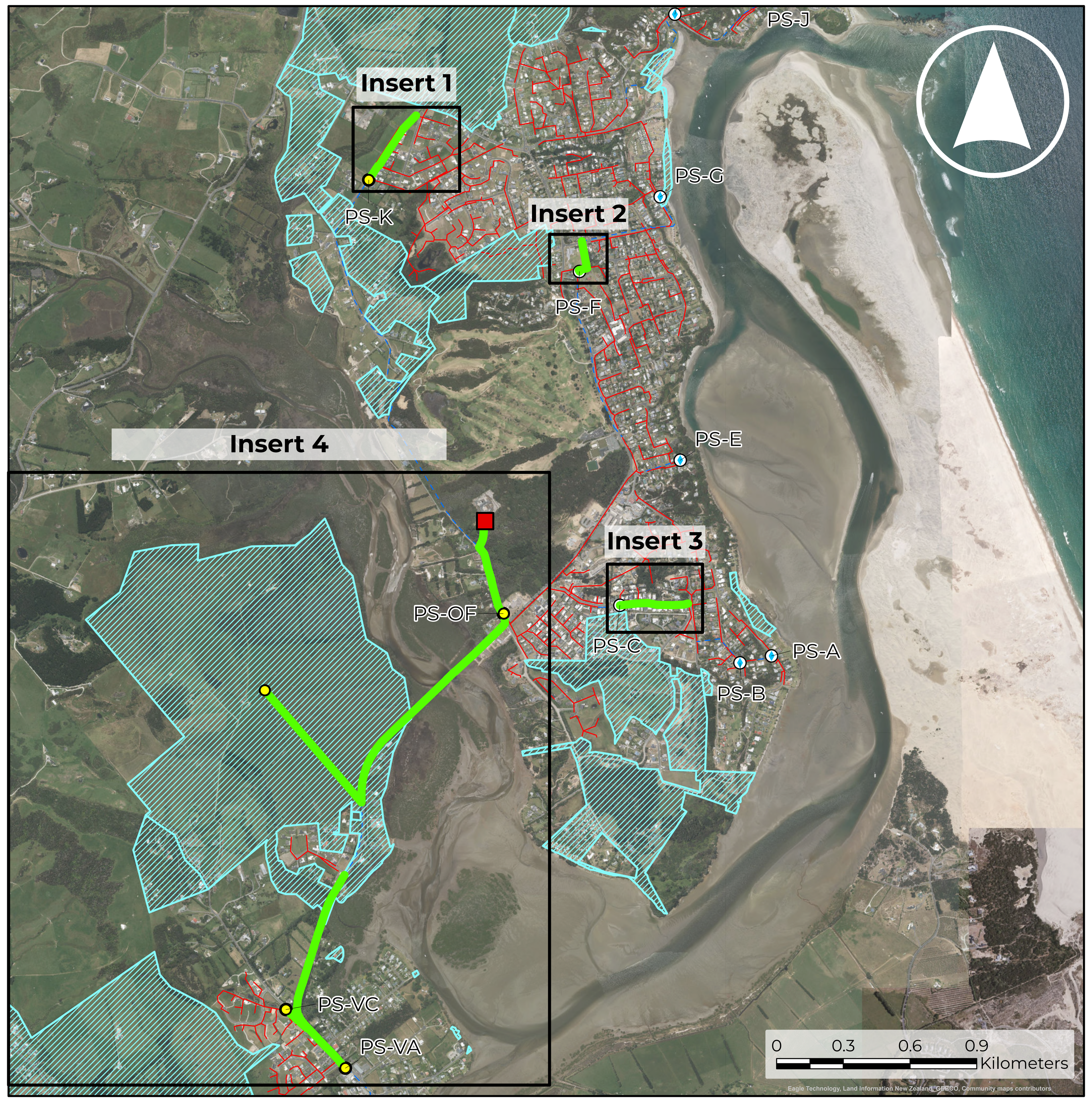
Figure A3.3: Mangawhai total dwelling projections

Year	PS-A	PS-B	PS-C	PS-E	PS-F	PS-G	PS-H	PS-J	PS-K	PS-OF/WWTP		PS-VA	PS-VB	PS-VC	Non-PSC	Total	Total PSCs
										West	East						
2021	99	40	105	77	154	549	65	48	491	49	384	465	85	90	1,079	3,780	3,780
2022	105	44	114	83	162	561	71	53	530	76	397	488	85	109	1,094	3,973	3,973
2023	111	49	124	89	171	574	77	57	568	103	411	511	84	129	1,109	4,166	4,166
2024	114	50	128	91	177	579	79	59	589	153	435	522	85	143	1,123	4,327	4,327
2025	116	52	131	94	184	584	82	61	610	204	460	532	85	156	1,137	4,488	4,488
2026	118	54	135	96	191	588	84	62	630	255	485	543	85	170	1,151	4,649	4,649
2027	121	55	139	98	198	593	87	64	651	306	509	554	86	184	1,165	4,809	4,809
2028	123	57	143	101	205	598	89	66	671	357	534	565	86	197	1,178	4,970	4,970
2029	123	57	142	101	212	605	89	66	692	414	557	583	87	211	1,192	5,130	5,130
2030	123	57	142	100	219	612	89	66	712	471	581	601	87	225	1,206	5,290	5,290
2031	122	57	142	100	226	619	88	66	732	528	604	619	88	239	1,220	5,450	5,450
2032	122	57	142	100	233	626	88	65	753	585	628	638	88	252	1,234	5,610	5,610
2033	122	56	141	100	240	633	88	65	773	643	651	656	89	266	1,248	5,771	5,771
2034	122	56	141	100	239	632	88	65	793	689	669	674	89	280	1,258	5,895	5,895
2035	121	56	141	100	239	631	88	65	813	736	686	692	89	293	1,268	6,019	6,019
2036	121	56	140	99	238	630	88	65	833	782	704	711	90	307	1,279	6,143	6,143
2037	121	56	140	99	238	629	87	65	853	829	721	729	90	321	1,289	6,267	6,267
2038	121	56	140	99	238	627	87	65	873	876	739	747	90	335	1,299	6,391	6,391
2039	121	56	140	99	237	626	87	65	893	901	751	765	90	348	1,310	6,488	6,488
2040	120	56	139	99	237	625	87	64	912	927	762	784	90	361	1,322	6,585	6,585
2041	120	56	139	98	236	624	87	64	932	952	774	802	90	374	1,333	6,682	6,682
2042	120	56	139	98	236	623	87	64	952	978	786	820	90	387	1,344	6,779	6,779
2043	120	55	139	98	235	622	86	64	971	1,004	798	838	90	400	1,355	6,876	6,876
2044	120	55	138	98	235	621	86	64	975	1,025	809	857	90	400	1,365	6,939	6,939
2045	119	55	138	98	235	620	86	64	978	1,047	820	875	90	400	1,375	7,001	7,001
2046	119	55	138	98	234	618	86	64	982	1,069	831	893	90	400	1,386	7,064	7,064
2047	119	55	138	97	234	617	86	64	985	1,090	842	911	90	400	1,396	7,126	7,126
2048	119	55	138	97	233	616	86	64	989	1,112	854	930	90	400	1,407	7,188	7,188
2049	118	55	137	97	233	615	86	63	992	1,134	865	948	90	400	1,417	7,251	7,251
2050	118	55	137	97	233	614	85	63	996	1,156	876	966	90	400	1,427	7,313	7,313
2051	118	55	137	97	232	613	85	63	1,000	1,177	887	984	90	400	1,438	7,376	7,376
2021-2031	23	17	37	23	72	70	23	18	241	479	220	154	3	149	141	1,670	1,670
2021-2051	19	15	32	20	78	64	20	15	508	1,128	503	519	5	310	359	3,596	3,596

Appendix D
Mangawhai Community Wastewater Network Upgrades Poster

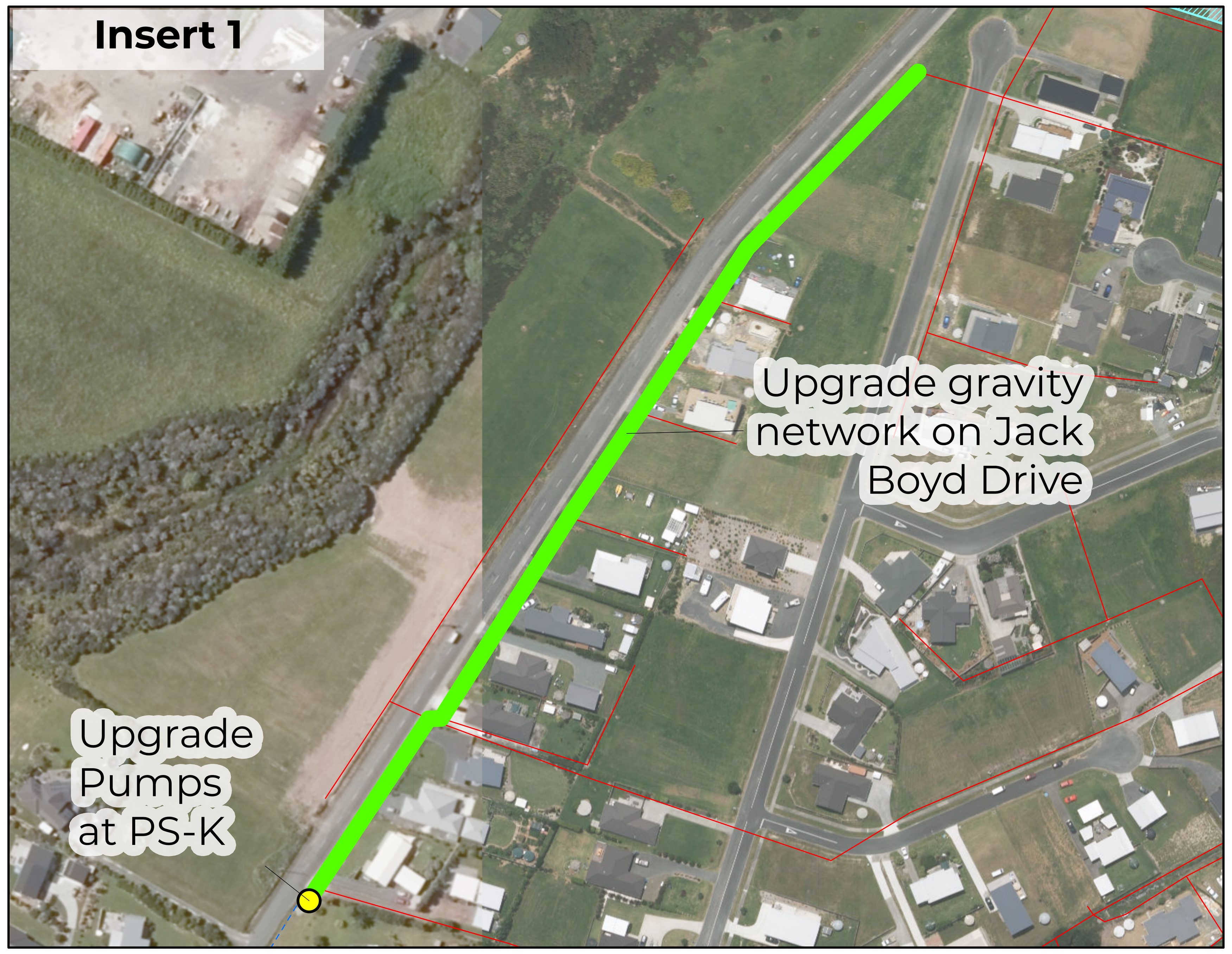
Mangawhai Community Wastewater Network Upgrades

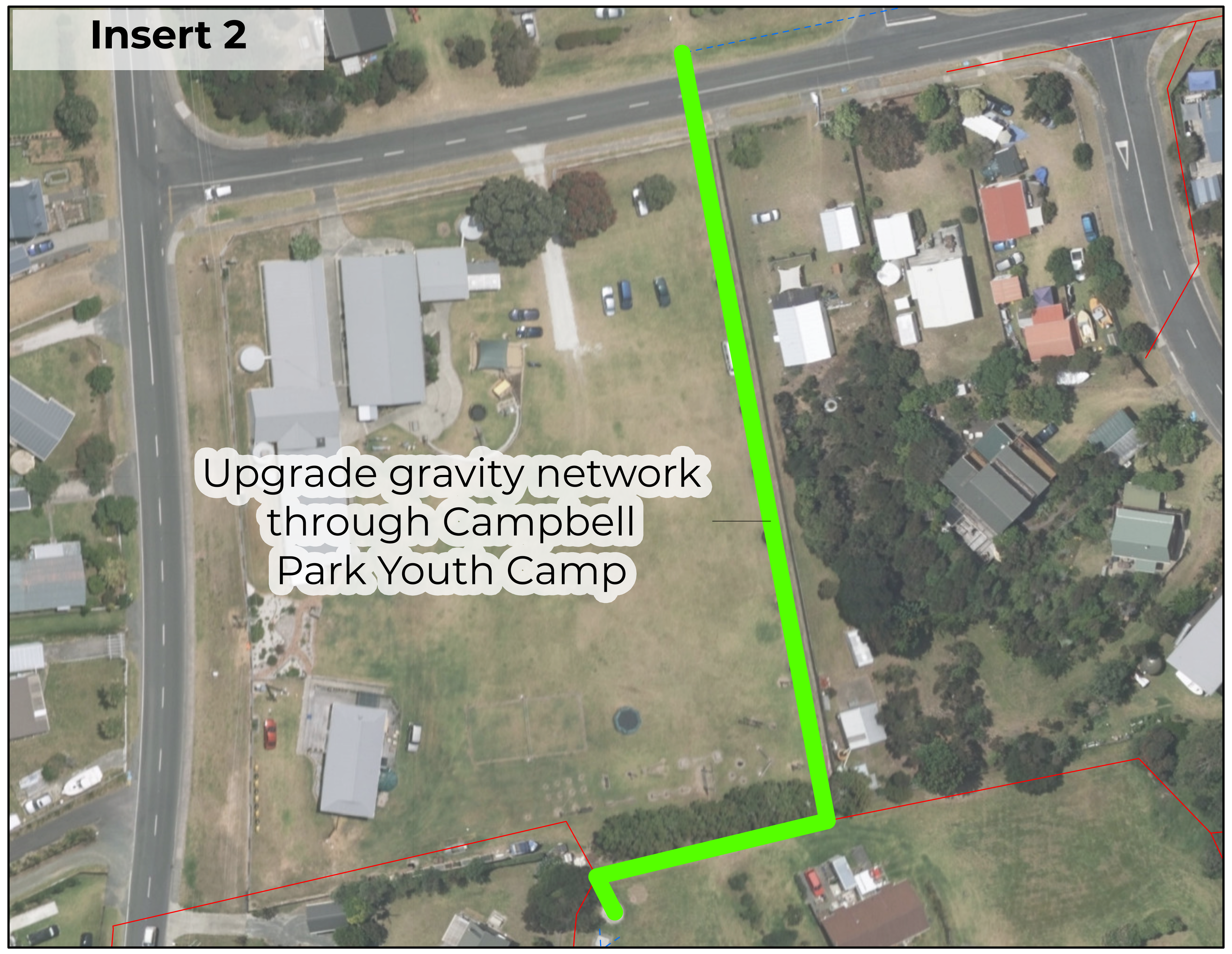
Kaipara te Oranganui
KAIPARA DISTRICT
Two Oceans Two Harbours

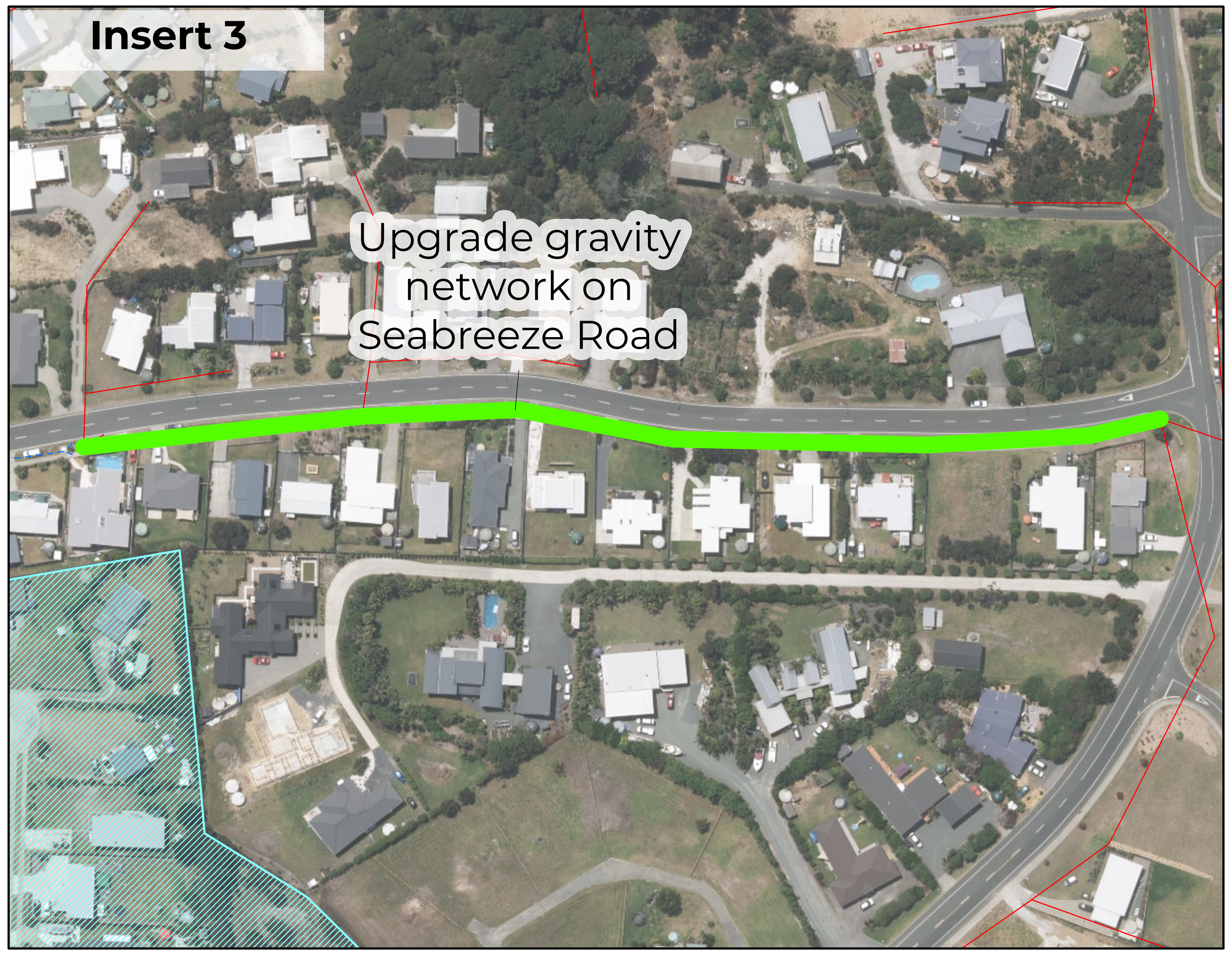


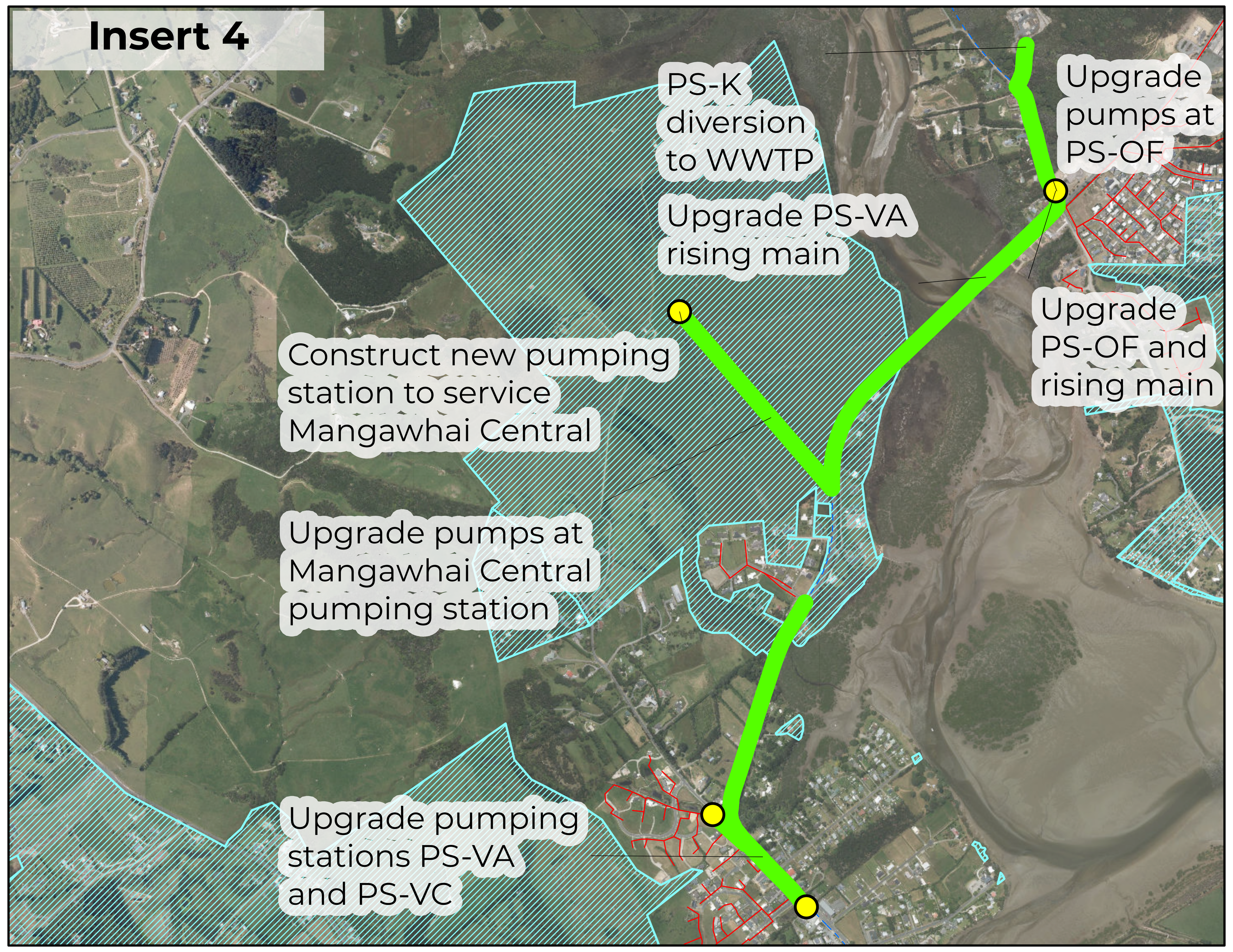
Legend

Existing Network
- Gravity Sewer
- Rising Main
- Pumping Stations
- Mangawhai Community Wastewater Treatment Plant
- New Development Areas









Upgrades Timing

Today

- PS-K diversion to WWTP
- Construct New Pumping Station to Service Mangawhai Central
- Upgrade gravity network through Campbell Park Youth Camp, Seabreeze Road & Jack Boyd Drive

2023

- Upgrade pumps at PS-OF

2028

- Upgrade pumping stations PS-VA, PS-VC and rising mains
- Upgrade pumps at PS-K

2033

- Upgrade pumps at Mangawhai Central pumping station
- Upgrade PS-VA rising main

2038

- Upgrade PS-OF pumps and rising main

2043

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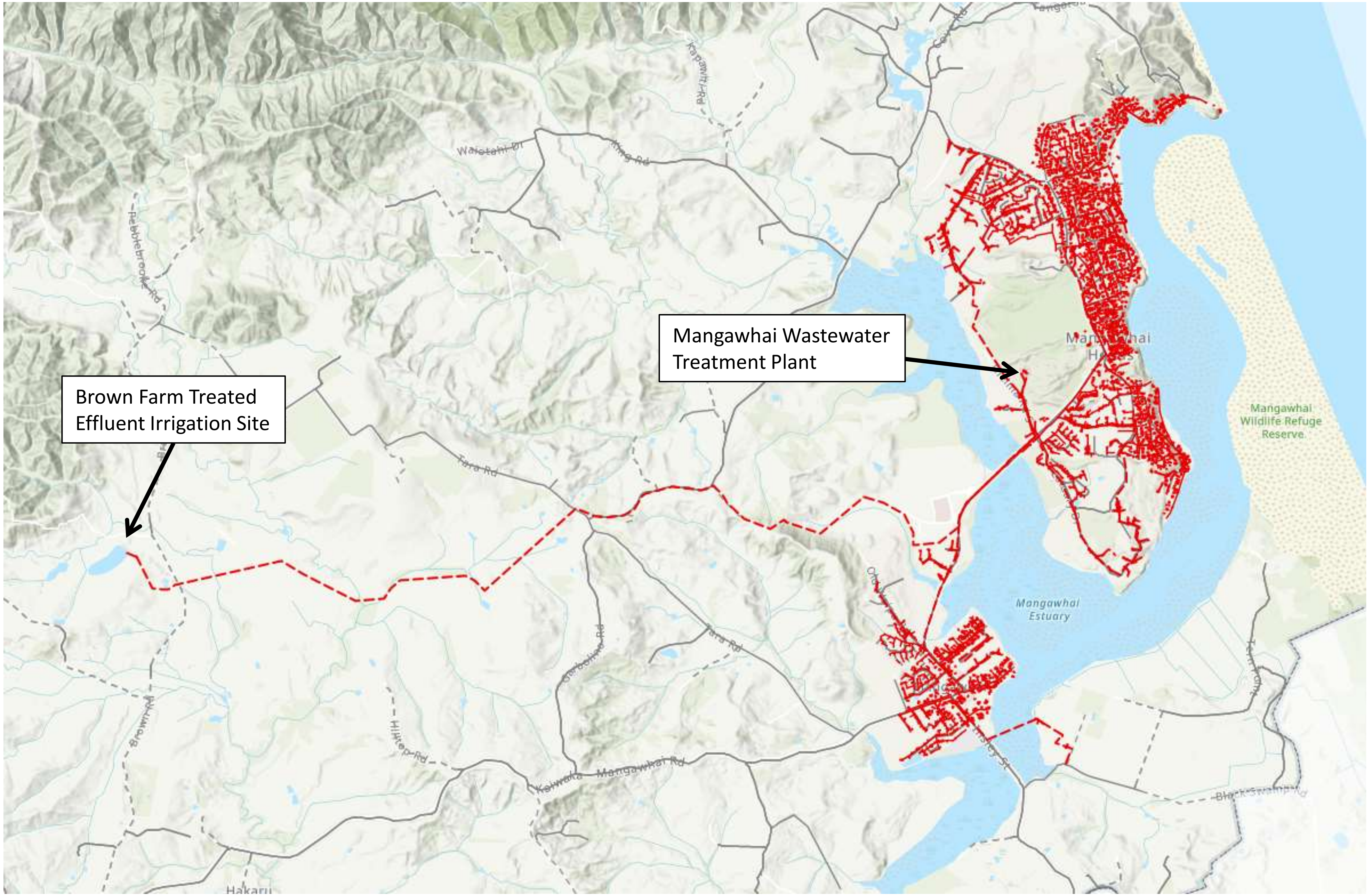
ATTACHMENT E

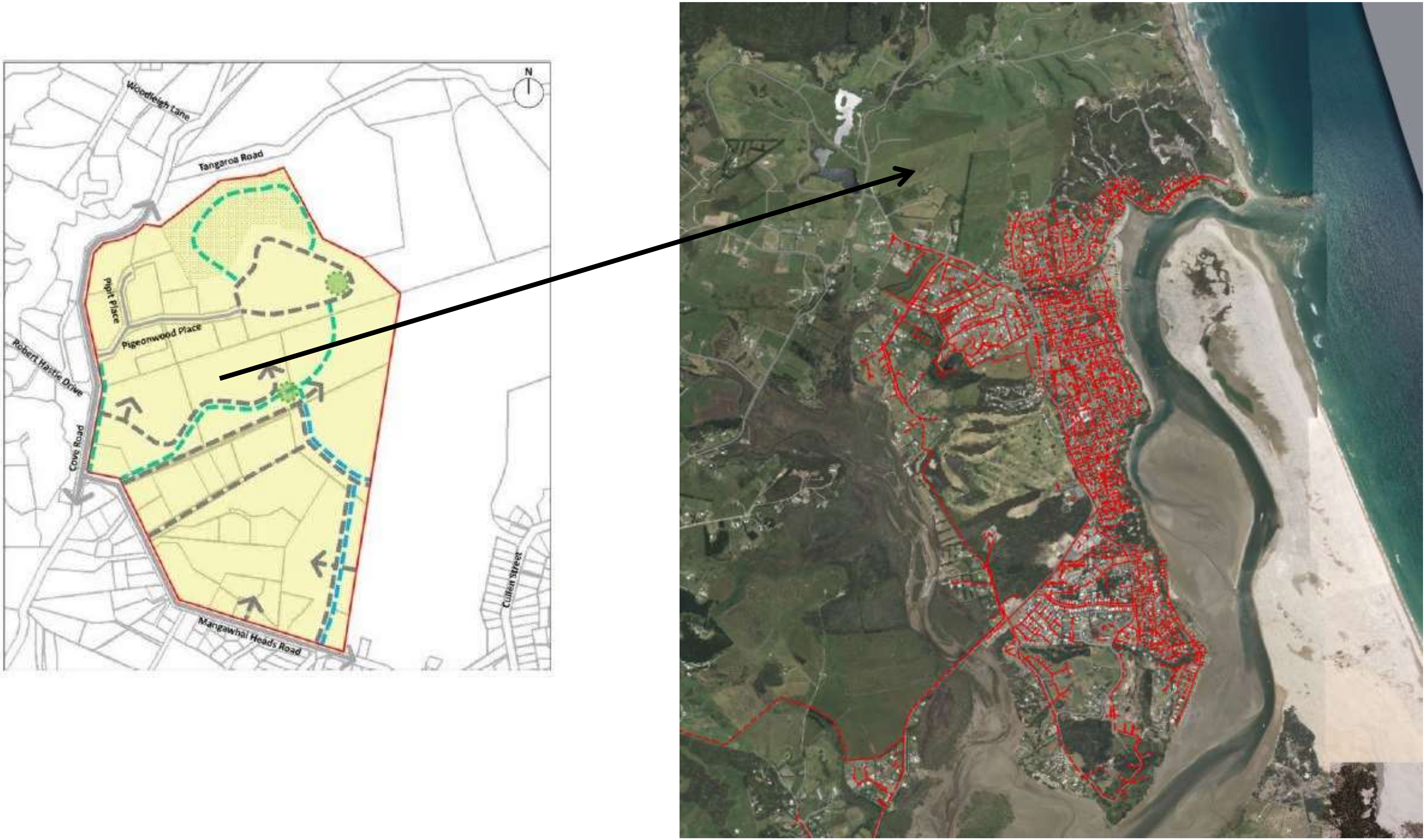
Attachment E – Current service area of the MCWWS



ATTACHMENT F

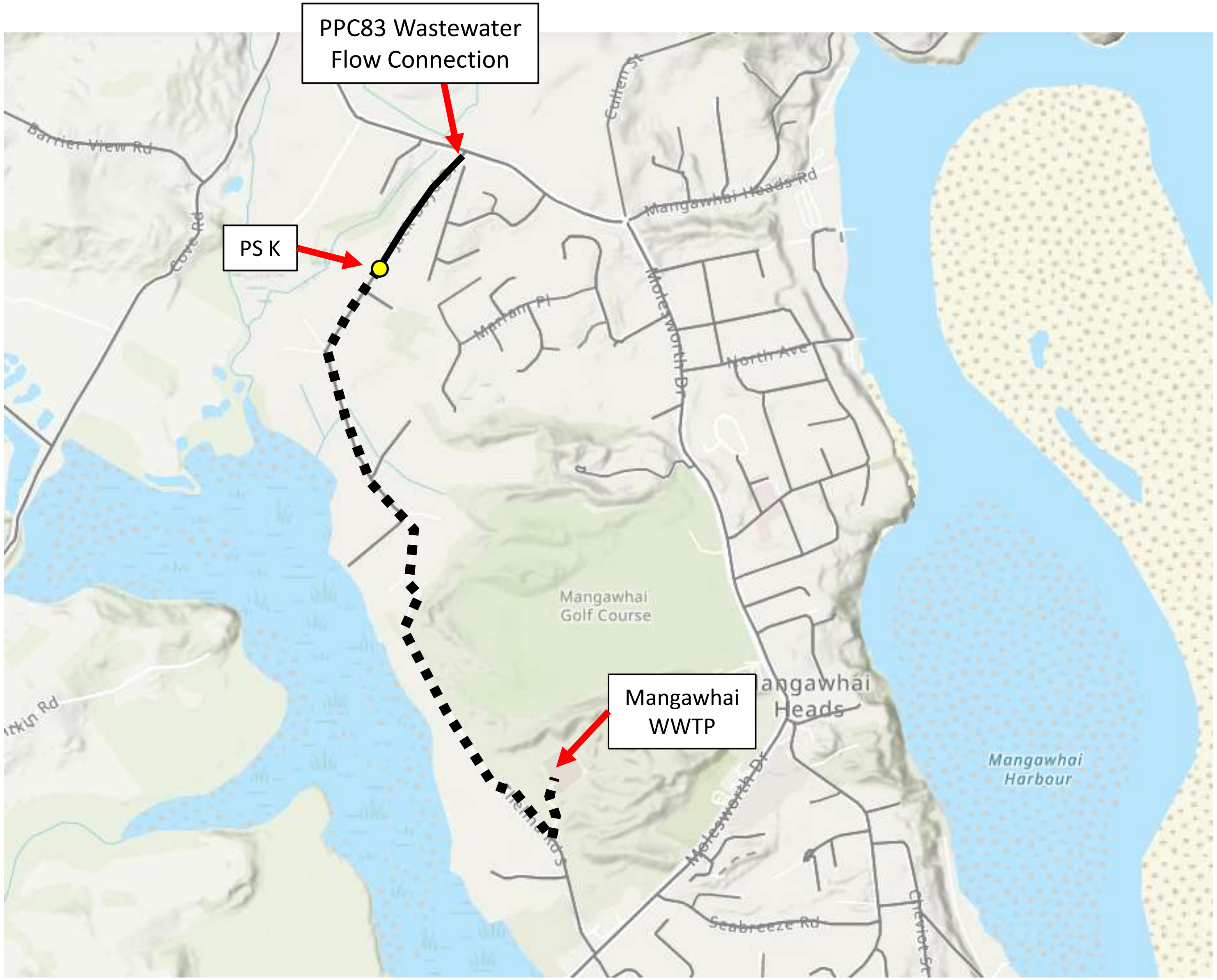
Attachment F - Mangawhai Wastewater Treatment Plant

ATTACHMENT G


Woodleigh Lane
Tangaroa Road
Pipiri Place
Pigeonwood Place
Robert Hastie Drive
Cove Road
Mangawhai Heads Road
Cullen Street
N

ATTACHMENT H

Schematic of PPC83 Wastewater Flow Conveyance Pathway to WWTP



ATTACHMENT I

Attachment I

Qualifications and Experience of Clinton Cantrell

My name is Clinton Cantrell. I am the Director of Sustainable Community Outcomes Consulting Ltd (SCO Consulting), based in Auckland, New Zealand. SCO Consulting specializes in Three Waters engineering consulting including water, wastewater and stormwater infrastructure systems and the environments they operate within.

I hold a Bachelor of Civil Engineering degree from the University of Florida, and completed post graduate studies in Environmental Engineering at Wayne State University (Michigan). I have over 30 years of international and national experience in engineering, focusing on planning and upgrades to three waters systems including wastewater network and treatment systems.

I am presently Director and majority owner of SCO Consulting based in Auckland, New Zealand. I provide technical oversight and direction for all SCO projects and the clients we service, which includes Kaipara District Council. Prior to establishing SCO Consulting in 2019, I was the Water Sector Director for Tonkin and Taylor – overseeing the growth and development of the water engineering business, and providing leadership and oversight for strategic projects. Prior to joining Tonkin and Taylor, I held global technical leadership roles for large engineering consultancies including MWH (Stantec) and AECOM. I have worked on small to large scale wastewater projects and programmes across the globe, and have led some of the largest and most complex wastewater projects in New Zealand including Watercare's Central Interceptor and Mangere Wastewater Treatment Master Plan.

In my current role as a technical advisor and expert for Kaipara District Council, I provide overall technical leadership for project involving the assessment and upgrades to the Mangawhai Wastewater Treatment Plant (WWTP) and the effluent disposal systems including Browns Farm and the option of irrigating the Mangawhai Golf Course with treated effluent.

I led an independent engineering peer review of the Mangawhai WWTP upgrades master plan completed in 2022 by WSP, and have more recently worked with a KDC appointed consortium of consulting experts to confirm a revised/staged upgrade plan for the Mangawhai WWTP which includes options for effluent disposal/irrigation at the Mangawhai Golf Course.